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Chinese companies' transparency under sustainable development goals: the role of asset impairment and biological assets in audit

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ABSTRACT

The paper aims to analyse the role of asset impairment and biological assets in the company's audit and to estimate the impact of asset impairment losses and biological asset scale on audit fees. The object of the investigation was A-share listed companies from 2012 to 2021 in China. The study analysed 370 listed companies to obtain 28741 observations, of which 367 listed companies had 1854 observations with biological assets. The study applied the fixed effect model, three-step mediation test, Sobel mediation test and PSM matching test. The results show that asset impairment loss and biological asset size are significantly positively correlated with audit fees, and the scale of biological assets will strengthen the positive correlation between asset impairment loss and audit fees. It is further found that asset impairment and biological assets positively affect audit fees through two parallel intermediary paths of "audit working hours" and "violations". Finally, based on the above findings, this paper also attempts to make optimisation recommendations for the four relevant stakeholders involved in the audit. This paper contributes to improving accounting standards for biological assets and enriching the research on audit pricing based on the empirical justifications of their role in the company's audit.

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1. Introduction

With the continuous development of the socialist market economy, the Ministry of Finance of China (2019) has repeatedly revised the relevant standards for asset impairment. It allows improving the reliability and prudence requirements of accounting information quality (The Ministry of Finance & PRC, 2019). In 2001, asset impairment provisions were implemented in China under the Accounting

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Standard for Business Enterprises. Riccardi (2016) outlines that it allows providing transfer back for the impairment provisions. The revised Accounting Standard for Business Enterprises No. 8 Asset Impairment (CAS8) in 2006 added restrictions on reversing long-term asset impairment provisions. Accounting Standard for Business Enterprises No. 22—Recognition and Measurement of Financial Instruments (CAS22) were issued in 2017. It states that expected credit losses resulting from the impairment of financial assets should be accounted for through the "credit impairment loss" account and no longer go through the "asset impairment loss" account. By 2022, China's asset impairment accounting will have undergone twenty years of development. Scholars (Jacobs et al., 2022; Kohler et al., 2021) confirm that it is caused by the treatment of asset impairment, which depends largely on the professional judgment of accounting personnel, with a certain degree of arbitrariness and ambiguity. Thus, asset impairment provision is also regarded by listed companies as an important tool for surplus management.

Zhu et al. (2020) justify that agriculture is the core force in achieving sustainable development goals in China. In addition, the audit of agriculture companies is more complex than for companies from another sector due to the existence of biological assets. Liu et al. (2022) confirm that agricultural companies have a high risk of financial fraud due to the particularity of their biological assets. It should be noted that biological assets have the characteristics of biotransformation and natural appreciation, diversity of types, cyclical growth, and dual asset characteristics of current and noncurrent assets (Asian Legal Information Institute, 2022). In addition, the uncertainty of future economic interests determines that the recognition and measurement of biological assets are more complex than those of general assets. Consequently, surplus management is developed.

The studies (Chygryn & Krasniak, 2015; Gandía & Huguet, 2021; Huq et al., 2022) prove that the companies that provided external audits have informative financial statements compared to nonaudited companies. In addition, it allows stakeholders to make effective investment decisions for audited companies. As the main force of external supervision, auditing should pay attention (Bilan, 2013; Kwilinski et al., 2020; Kasych & Vochozka, 2017) to the role of asset impairment and biological assets in surplus management (Bilan, 2013; da Costa Marques, 2021; Kwilinski et al., 2020; Saputra et al., 2022; Zadorozhnyi & Yasyshena, 2019) and to urging the financial statements of audited units to reflect their true financial situation and operating results truthfully (Allee & Yohn, 2009; Cassar, 2011; Sroka, 2013).

In the auditing process, the subjectivity of asset impairment and the complexity of biological assets require auditors to expand the scope of audits and spend more time and resources on them (Ryabenkov & Vasyliyeva, 2013). It allows sufficient and appropriate audit results to be obtained. However, it provokes an increase in the audit workload and relevant costs.

The findings show that scientists (Alagpuria, 2021; Cao, 2021; Chen, 2018; Li, 2016; Lawson & Wang, 2016; Zhu et al., 2020) have mostly focused on specific accounting treatment operations and discussed the impact of asset impairment on surplus management, internal control and corporate value. However, relatively few studies (Ajekwe, 2021; Daly & Skaife, 2016; Garcia & Morales, 2021) use empirical

analysis to further examine the relationship between asset impairment, biological assets and audit fees. In this case, the paper aims to fill scientific gaps by (1) contributing to the literature by analysing the core factors that influence audit fees and prices and (2) developing an approach for assessing the link between asset impairment, biological assets and audit fees. In addition, the paper contributes to improving accounting standards for biological assets. Thus, the paper aims to empirically justify (1) the impact of asset impairment losses on audit fees; (2) the impact of biological asset scale on audit fees; (3) the moderating role of biological asset scale in the relation between asset impairment losses and audit fees; and (4) the impact of asset impairment and biological assets on audit fees from two channels of hours for audit (audit cost) and violations (audit risk). The object of investigation is A-share listed companies in China from 2012 to 2021. The study applies the following methods to achieve the paper's aims: fixed effect model, three-step mediation test, Sobel mediation test and PSM matching test.

The paper has the following structure: literature reviewer—analysis of the theoretical framework of linking among audit fees, asset impairment, biological assets, impairment losses and audit charges; justification of research hypothesis; methods—describing the methodology to check the highlighted hypothesis in the literature reviewer; results—explanation the empirical results of the investigation; discussion—comparison analysis of the obtained results with the previous investigations; conclusion—summarising of the core findings; theoretical & practical implications—recommendation for audit stakeholders (investors, companies' management, government departments, etc.) to improve the audit process; the last section—outlining the limitations and future research.

2. Literature review

2.1. Study on the influencing factors of audit charges

Audit fees are the prices reached by audit services' supply and demand sides. In addition, it is also a direct measure of the resources invested in the firm's audit. Simunic (1980) is the first to propose the audit fee model. Simunic (1980) argues that audit fees should be based on costs and risks in a competitive market. Hay et al. (2006) summarised the influencing factors of audit fees into three categories: customer attribute variables, accounting firm attribute variables, and audit contract attribute variables. On this basis, Chen, (2018) extends the classification criteria to four categories: audit subject attribute variables, audit object attribute variables, external environment variables, and audit contract attribute variables. Based on Chen, (2018), the study uses four variables to analyse the relevant literature on the influencing factors of audit fees.

Pratoomsuwan (2017) divides accounting firms into "N big" and "non-N big." Considering findings, Pratoomsuwan (2017) underlines that the audit fees of "N big" are significantly higher than those of "non-N big". Li (2016) takes China's A-share listed companies as a research sample and concludes that the "Top Ten" and "Big Four" accounting firms achieve higher audit income than other accounting firms due to their brand reputation. Wang and Xin (2010) examine the differences in audit fees and quality between the head office and the branch of the accounting firm. They

conclude that the audit fee and quality of the office are lower than that of the head office. Yang and Zhang (2016) analyse the impact of the organisational form of accounting firms on audit fees from the perspective of audit demand insurance theory and signal theory. Yang and Zhang (2016) prove that partnership accounting firms can charge relatively high audit fees.

Firth (1985) analyses the New Zealand audit market and concludes that company size is the most important factor influencing audit fees. In addition, Firth (1985) empirically justifies that the proportion of accounts receivable and the complexity of the business also affect audit fees. Bell et al. (2001) argue that if the customer's operational risk is high, the audit risk will increase and compensate for the expected loss of the audit. Thus, the auditor could charge a risk premium. It leads to an increase in the audit fee. Yang (2015) highlights that equity concentration and political correlation are significantly inversely correlated with audit fees. At the same time, board diligence and independent director size positively correlate with audit fees. However, Hu and Zhuang (2020) confirm that the impact of the major shareholder shareholding ratio on audit fees is U-shaped rather than a single negative correlation. The results of the analysis allow us to conclude that surplus management (Cao, 2021; Lawson & Wang, 2016), internal control (Feng, 2020; Hoitash et al., 2008) and managerial characteristics (Gao, 2022; He & Liu, 2015) are covered in audit fee research.

Chen et al. (2016) investigate the impact of audit fee price control on audit fees. Based on the results, Chen et al. (2016) conclude that for "nonbig four" firms, price control has a significant positive correlation with audit fees. Zhang (2019) investigates the relationship between accounting soundness and audit fees in the framework of environmental uncertainty. Thus, if the environmental uncertainty of listed companies increases, the inhibitory effect of accounting soundness on reducing audit fees will be more significant. In addition, if economic policy uncertainty increases, business risks and agency costs will grow, increasing audit fees (Chu et al., 2018).

Cheng and Chen (2016) conclude that audit fees result from a game between the audited unit and the accounting firm. In addition, scholars (Luo, 2013; Liu, 2005) confirm that the allocation of the right to appoint the transaction, the bargaining power of both parties to the audit (Luo, 2013), and the audit tenure (Liu, 2005) could have an impact on the audit price.

2.2. Study on asset impairment and audit charges

IAS 36 Impairment of Assets (Asian Legal Information Institute, 2022) provides that if enterprises measure their assets at fair value and the recovered value is lower than the carrying amount, a provision for asset impairment is accrued. Accounting Standard No. 8 Impairment of Assets (CAS8) states that if the recoverable amount of an asset (including assets and asset groups) is less than its carrying amount, asset impairment will occur. Thus, the recoverable amount should be measured as the net value of the asset's disposal expenses and the present value of the expected future cash flows.

The impact of asset impairment on audit fees is generally achieved through surplus management. Zucca and Campbell (1992) find that some companies that made provisions for the impairment of assets are motivated to use asset impairment provisions

for surplus management, such as "smooth profits" and "big baths". Duan and Chen (2017) prove that listed companies with large asset impairments usually have strong incentives for surplus management, and their audit risks are high. Wang et al. (2020) analyse the relationship between asset impairment losses and audit fees. Wang et al. (2020) propose to consider the rule of law as the regulatory variable. Wang et al. (2020) prove that the positive effect of asset impairment losses on audit fees in areas with a high level of the rule of law is more significant.

2.3. Study on biological assets and audit fees

IAS41 defined biological assets as living animals or plants. It is measured at fair value except where fair value is not reliably available. China's Accounting Standard for Business Enterprises No. 5—Biological Assets (CAS5) is more consistent with IAS41 (Jacobs et al., 2022; Kohler et al., 2021; Riccardi, 2016; The Ministry of Finance & PRC, 2019). It defines biological assets as living animals and plants, but the initial measurement of biological assets should be recorded at cost. Thus, if there is conclusive evidence that the fair value of biological assets is sustainable and stable, it should be measured at fair value. At the same time, CAS5 divides biological assets into three categories: expendable biological assets, productive biological assets and public welfare biological assets. In addition, the expendable and productive biological assets could be subject to impairment provisions, but the latter's impairment provisions could not be reversed. Furthermore, public welfare biological assets are not subject to impairment provisions.

Mustafa and Youssef (2010) argue that biological assets are susceptible to natural environmental influences. It provokes the audit challenges that distinguish them from other assets when conducting audits on biological assets. Based on empirical analysis, Wang et al. (2018) conclude that features of "living assets" provoke an increasing audit workload. In addition, biological assets could also indirectly affect audit fees by accruing or reversing the surplus management path of impairment. Zhang and Zhao (2020) suggest that the audit fees of listed companies with biological assets are significantly higher than those of listed companies without biological assets. This could be explained by the large space for managing biological asset surpluses. In addition, the audit fees of listed companies with biological assets and provisions for impairment of biological assets are higher.

Considering the abovementioned analysis, further investigations should be focused on the analysis of the relationship between asset impairment, biological assets and audit fees.

2.4. Asset impairment losses and audit charges

The experts of ACCA (2022) define the risk of material misstatement as "the risk that the financial statements are materially misstated prior to audit". In addition, studies (Alagpuria, 2021; Dyball & Seethamraju, 2021; Gajdzik & Sroka, 2012; Kwilinski et al., 2020; Lendel et al., 2016; Srivastava & Shafer, 1992) justify that material misstatement is objectively independent of the audit of financial statements. Thus, with acceptable audit risk, the certified public accountant could only rely on expanding the

scope of the audit and adding audit procedures to reduce the inspection risk. The increase in audit workload could inevitably lead to an increase in audit costs and ultimately increase audit fees (Mostenska et al., 2015; Tambovceva et al., 2017).

On the one hand, asset impairment could more truly reflect the value of assets and digest the company's bad debts and nonperforming asset bubbles, which is the embodiment of the prudent and reliable quality of accounting information (Dzwigol et al., 2020; Yang, 2010). At the same time, the characteristics of liquid asset impairment provisions could be reversed, and asset impairment assessments rely on the professional judgment of accounting personnel. In addition, asset impairment information disclosure is still incomplete, which leaves a large space for the surplus management of enterprises, increasing the risk of material misstatement.

Audit fees depend on the workforce and material resources invested by the accounting firm in the audit (Bistrova et al., 2013; Mishchuk et al., 2016). In addition, it depends on the estimation of the risk compensation. Therefore, the impact of asset impairment on audit fees could be analysed specifically from two aspects:

1. Asset impairment leads to higher audit costs. The recoverable amount in asset impairment involves a vast range of measures: considerable extent, subjectivity, complexity and uncertainty. In this case, auditors need to adopt more audit procedures to verify the reliability of the amount of asset impairment losses. It reduces the risk of inspection, leading to an increase in audit fees (Wang, 2014).
2. Asset impairment leads to greater audit risks. The amount of asset impairment provision or transfer back could directly affect the net profit of the enterprise. If the amount of asset impairment loss is large, the audit risk will increase due to uncertainty. At this time, the accounting firm needs to increase the audit fee to compensate for the risks. Considering this, the study checks the following hypothesis:

H1: The greater the amount of asset impairment loss set aside or transferred back by the listed company, the higher the audit fee of the listed company.

2.5. Biological assets and audit charges

Inherent and control risks have higher inherent risks due to their natural appreciation, functional diversity, cyclicality and seasonality, integrity and regionality (Li et al., 2017). The particularity of biological assets allows agricultural listed companies to manipulate profits. In this case, agricultural listed companies have a higher level of surplus management than nonagricultural listed companies (Li et al., 2017).

The impact of biological assets on audit fees is also manifested in audit costs and audit risks:

1. Biological assets lead to higher audit costs. The inventory verification of biological assets is a complex procedure requiring relevant experience in the biological field. It is difficult to assess the quality of biological assets and often requires additional substantive procedures and external experts to coordinate audits. Consequently, it provokes an increase in audit fees (Zhao, 2021).

2. Biological assets lead to greater audit risks. The analysis results show that biological assets are highly concealed and depend on the natural environment. In addition, biological assets do not have fair pricing during the existence period due to the dispersion of transaction objects and the high proportion of cash transactions. The risks are caused by the uncertainty of biological assets that need to be compensated by increasing audit fees. Therefore, this paper argues that biological assets affect audit fees and checks the following assumptions:

H2: Under certain circumstances of other conditions, listed companies with biological assets have higher audit costs than those without biological assets.

2.6. Asset impairment losses, biological asset size and audit fees

Biological assets can be divided into three categories: expendable biological assets, productive biological assets, and public welfare biological assets. In addition to public welfare, biological assets without impairment provision, expendable biological assets and productive biological assets could be charged for impairment. It could be when there are signs of impairment. The expendable biological assets could be turned back after the impairment influencing factors have disappeared, providing manipulation space for surplus management (The Ministry of Finance, PRC, 2019). Therefore, biological assets could also impact audit fees through the indirect effect of impairment of expended biological assets. This amplifies the degree of impact between asset impairment losses and audit fees (Wang et al., 2018). Based on the above analysis, this paper proposes the following hypothesis:

H3: Biological asset size strengthens the positive correlation between asset impairment losses and audit fees.

Studies (Bell et al., 2001; Bae et al., 2021; Choi et al., 2022; Zhang & Huang, 2013) theoretically explain that under modern risk-oriented audits, audit fees depend on audit cost inputs and audit risk premiums. In addition, the cost and risk of the audit are two parallel intermediary paths that may exist between asset impairment and biological assets affecting audit fees. Considering this, the study checks the following hypothesis:

H4: The hours for audit (audit cost) and violations (audit risk) have a mediating role between asset impairment, biological assets, and audit fees.

3. Materials and methods

3.1. Variable

The study is based on the annual data of all A-share listed companies from 2012 to 2021. The study applies the following under investigation:

1. The financial listed companies are excluded because their report structure is significantly different from other industries.
2. Exclude companies with financial distress and embedded risks.
3. Exclude samples with missing values in the calculation of each indicator.

4. Exclude samples with an asset-liability ratio greater than 1.

Thus, 4370 listed companies were selected to obtain 28741 observations. A total of 367 listed companies have a total of 1854 observations with biological assets. In addition, the main continuous variables are narrowly indented (1% and 99% quantiles) to reduce the impact of abnormal outliers. Expendable biological asset data are manually collected from the annual reports of enterprises (annual reports from the official websites of the Shanghai Stock Exchange and Shenzhen Stock Exchange), and other data and related indicators are obtained from CSMAR databases. The study uses Stata 15.1 and Excel 2010 to check the hypotheses of the investigation.

3.1.1. Explained variable

Audit expense (Fee)—the total audit cost of listed companies selected from the CSMAR database company research series. It is measured by its large amount by the natural logarithm of the total audit cost.

3.1.2. Explanatory variable

Referring to a previous study (Zhang & Zhao, 2020), the explanatory variables in this study include impairment loss (*Devalue*)—the natural logarithm of the absolute value of asset impairment loss and credit impairment loss of listed companies, with a positive expected symbol; biological asset scale (Ba_0)—net consumable biological assets and productive biological assets plus 1 natural log, with a positive expected symbol; and the proportion of biological assets (Ba_1), referring to the proportion of net consumable biological assets and productive biological assets in total assets, with a positive expected symbol.

3.1.3. Group variable

Ba_2—dummy variable that measured whether the enterprise held biological assets. If the listed company has biological assets (Ba_2) equal to 1. Otherwise, it is 0. Ba_3 is a dummy variable that measures the importance level of the enterprise's biological assets. If the proportion of the listed company's biological assets (Ba_1) is greater than 0.1%, the value is 1. Otherwise, it is 0.

3.1.4. Control variables

Based on the research design (Wang et al., 2020), the study applies the asset-liability ratio (*Lev*), current ratio (*Liq*), growth capacity (*Growth*), accounts receivable ratio (*Rec*), net interest rate on assets (*Roa*), company size (*Size*), audit opinion (*Op*), loss (*Loss*), nature of property rights (*Soe*), and type of firm (Big_4) as control variables to eliminate the impact of other factors on audit fees.

3.1.5. Adjustment variables

The scale of biological assets (Ba_0) and the proportion of biological assets (Ba_1) are used as adjustment variables when testing H3.

The descriptive statistics of the selected variables are shown in Table 1.

Table 1. Variables describe the statistical analysis.

Variable	N	Mean	St. Dev.	Minimum	Maximum
Fee	28741	13.832	0.678	12.611	16.213
Devalue	28741	16.524	1.987	11.014	21.352
Ba_0	28741	1.078	4.152	0	19.513
Ba_1	28741	0.117	0.754	0	6.447
Ba_2	28741	0.065	0.246	0	1
Ba_3	28741	0.043	0.202	0	1
Lev	28741	0.416	0.205	0.054	0.885
Liq	28741	2.559	2.580	0.328	16.556
Growth	28741	0.170	0.412	−0.578	2.612
Rec	28741	0.123	0.104	0	0.472
Roa	28741	0.037	0.063	−0.273	0.193
Size	28741	22.181	1.291	19.867	26.181
Op	28741	0.031	0.172	0	1
Loss	28741	0.103	0.304	0	1
Soe	28741	0.337	0.473	0	1
Big_4	28741	0.058	0.234	0	1

Note: St. Dev. – standard deviation; N – number of observations.
Source: developed by the authors using the relevant software.

3.2. Model building

Based on previous studies (Lendel et al., 2016; Li et al., 2017; Mishchuk et al., 2016; Mostenska et al., 2015; Wang, 2014; Yang, 2010; Zhao, 2021), the models for checking H1 (Equation 1), H2 (Equation 2) and H3 (Equation 3) are as follows:

$$\begin{aligned} Fee_{i,t} = {} & \alpha_0 + \alpha_1 Devalue_{i,t} + \alpha_2 Lev_{i,t} + \alpha_3 Liq_{i,t} + \alpha_4 Growth_{i,t} + \alpha_5 Rec_{i,t} + \alpha_6 Roa_{i,t} \\ & + \alpha_7 Size_{i,t} + \alpha_8 Op_{i,t} + \alpha_9 Loss_{i,t} + \alpha_{10} Soe_{i,t} + \alpha_{11} Big4_{i,t} + \sum IND \\ & + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{1}$$

where $\alpha_0 \ldots \alpha_{11}$ – the searching parameters of the model; t – the observation period of the variable for i-company; IND, YEAR – processed as virtual variables industry and year; $\varepsilon_{i,t}$ – the error term

$$\begin{aligned} Fee_{i,t} = {} & b_0 + b_1 Ba_{i,t} + b_2 Lev_{i,t} + b_3 liq_{i,t} + b_4 Growth_{i,t} + b_5 Rec_{i,t} + b_6 Roa_{i,t} + b_7 Size_{i,t} \\ & + b_8 Op_{i,t} + b_9 Loss_{i,t} + b_{10} Soe_{i,t} + b_{11} Big_{4i,t} + \sum IND + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{2}$$

where $b_0 \ldots b_{11}$ – the searching parameters of the model; IND, YEAR – processed as virtual variables industry and year; $\varepsilon_{i,t}$ – the error term

$$\begin{aligned} Fee_{i,t} = {} & \delta_0 + \delta_1 Ba^{\#}_{i,t} + \delta_2 Dev^{\#}{}_{i,t} + \delta_3 Ba^{\#}_{i,t} \times Dev^{\#}_{i,t} + \delta_4 Lev_{i,t} + \delta_5 Liq_{i,t} + \delta_6 Growth_{i,t} \\ & + \delta_7 Rec_{i,t} + \delta_8 Roa_{i,t} + \delta_9 Size_{i,t} + \delta_{10} Op_{i,t} + \delta_{11} Loss_{i,t} + \delta_{12} Soe_{i,t} + \delta_{13} Big_{4i,t} \\ & + \sum IND + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{3}$$

where $\delta_0 \ldots \delta_{13}$ – the searching parameters of the model; $Ba^{\#}_{i,t}$, $Dev^{\#}{}_{i,t}$, $Ba^{\#}_{i,t} \times Dev^{\#}_{i,t}$ – to verify H3 and to eliminate the collinearity problem between the explanatory variables Ba_0, Ba_1 and *Devalue*, the interaction terms Ba_0Dev and Ba_1Dev, Ba_0, Ba_1, and *Devalue* are "aligned" to obtain variables; IND, YEAR – processed as virtual variables industry and year; $\varepsilon_{i,t}$ – the error term

According to the theoretical analysis of H3, the regression coefficient of the interaction term sum should be significantly positive.

The study applies models (4–7) to check Hypothesis 4. Considering the studies (Han et al., 2022; Sun & Hu, 2022), working hours are used to measure audit costs as a path for asset impairment and biological assets. In terms of empirical testing methods, the three-step mediation test procedure of Wen and Ye (2014) is used to construct models (4) and (5), and the Sobel mediation test is applied to consolidate and prove the mechanism of action.

$$\begin{aligned} Fee_{i,t} = {} & \gamma_0 + \gamma_1 Devalue_{i,t}(\gamma_1 Ba_{0,i,t}) + \gamma_2 Eff_{i,t} + \gamma_3 Lev_{i,t} + \gamma_4 Liq_{i,t} + \gamma_5 Growth_{i,t} \\ & + \gamma_6 Rec_{i,t} + \gamma_7 Roa_{i,t} + \gamma_8 Size_{i,t} + \gamma_9 Op_{i,t} + \gamma_{10} Loss_{i,t} + \gamma_{11} Soe_{i,t} + \gamma_{12} Big_{4,i,t} \\ & + \sum IND + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{4}$$

where $\gamma_0 \ldots \gamma_{12}$ – the searching parameters of the model; $\varepsilon_{i,t}$ – the error term; $Eff_{i,t}$ – the audit working hours in i-company in t-time:

$$\begin{aligned} Eff_{i,t} = {} & \sigma_0 + \sigma_1 Devalue_{i,t}(\sigma_1 Ba_{0,i,t}) + \sigma_2 Lev_{i,t} + \sigma_3 Liq_{i,t} + \sigma_4 Growth_{i,t} + \sigma_5 Rec_{i,t} \\ & + \sigma_6 Roa_{i,t} + \sigma_7 Size_{i,t} + \sigma_8 Op_{i,t} + \sigma_9 Loss_{i,t} + \sigma_{10} Soe_{i,t} + \sigma_{11} Big_{4,\ i,t} \\ & + \sum IND + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{5}$$

where $\sigma_0 \ldots \sigma_{11}$ is the searching parameters of the model and $\varepsilon_{i,t}$ is the error term.

The asset impairment provision and reversal and the unique characteristics of biological assets could be characterised as a subjectivity process. Li et al. (2022) consider audit risk to be asset impairment and biological assets that affect audit charges. In this case, the audit risk of the enterprise is measured by the violation behaviour:

$$\begin{aligned} Fee_{i,t} = {} & \varphi_0 + \varphi_1 Devalue_{i,t}(\varphi_1 Ba_{0,i,t}) + \varphi_2 Vio_{i,t} + \varphi_3 Lev_{i,t} + \varphi_4 Liq_{i,t} + \varphi_5 Growth_{i,t} \\ & + \varphi_6 Rec_{i,t} + \varphi_7 Roa_{i,t} + \varphi_8 Size_{i,t} + \varphi_9 Op_{i,t} + \varphi_{10} Loss_{i,t} + \varphi_{11} Soe_{i,t} \\ & + \varphi_{12} Big_{4,i,t} + \sum IND + \sum YEAR + \varepsilon_{i,t} \end{aligned} \tag{6}$$

where $\varphi_0 \ldots \varphi_{12}$ – the searching parameters of the model; $\varepsilon_{i,t}$ – the error term; $Vio_{i,t}$ – the violation behaviour in i-company at t-time. When the enterprise has violation behaviour in the current year, *Vio* is 1. Otherwise, it is 0:

$$Vio_{i,t} = \omega_0 + \omega_1 Devalue_{i,t}(\omega_1 Ba_{0,i,t}) + \omega_2 Lev_{i,t} + \omega_3 Liq_{i,t} + \omega_4 Growth_{i,t} + \omega_5 Rec_{i,t} + \omega_6 Roa_{i,t} + \omega_7 Size_{i,t} + \omega_8 Op_{i,t} + \omega_9 Loss_{i,t} + \omega_{10} Soe_{i,t} + \omega_{11} Big_{4,i,t} + \sum IND + \sum YEAR + \varepsilon_{i,t} \quad (7)$$

The robustness test for modified models (1)–(3) provides a way to check the validity of the regression analysis findings. All modified model variables (1)–(3) involve the one-period lag treatment for the main variables. The consideration of lag values is justified by the assumption that the audit fee of the current period will be affected by the asset impairment loss and the scale of biological assets in the previous period. The study applies the propensity score matching (PSM) test to check the assumption that audit fees depend on the company's observable characteristics (asset liability and current ratios).

4. Findings

The findings of univariate tests for companies Ba_2 and Ba_3 are shown in Table 2.

The average difference between the two samples of analysed companies (Ba_2 and Ba_3) is 0.211. The listed companies with an importance level of biological assets greater than 0.1% have audit costs significantly higher (at the 1% level) than companies with a low importance level of biological assets. The results of the univariate test (Table 2) allow preliminary confirmation of H2.

The results of the Pearson correlation coefficient test (Table 3) show a positive statistically significant correlation between *Devalue*, Ba_0, Ba_1 and *Fee*. At the same time, it is in line with the assumptions of H1 and H2.

In addition, the results of the collinearity test (Table 4) show that the maximum value of variance inflation factors (VIF) is 2.73, which is less than the value of threshold multicollinearity (10). Thus, the findings confirm no multicollinearity, which allows applying the fixed effect model for regression analysis.

The results for checking H1 and H2 (applies to models 1 and 2) are shown in Table 5. The impact of *Devalue* on *Fee* is positive and statistically significant for all panel data of analysed companies: 1) all companies—column 1; 2) companies with biological assets ($Ba_2 = 1$)—column 4; 3) companies with biological assets more than 0.1% of total assets (Ba_3=1)—column 7). The regression coefficients for all cases are significant at the 1% level. It confirms H1—the larger the amount of asset impairment loss accrued or reversed by the listed company, the higher the audit fee of the listed company.

Table 2. The findings of univariate tests.

		X = 1		X = 0			
Variable	Group variable	N	Mean	N	Mean	Mean difference	t
Fee	$X = Ba_2$	1854	14.030	26887	13.819	0.211***	13.049
	$X = Ba_3$	1226	13.970	27515	13.826	0.144***	7.260

Note: *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

Table 3. Correlation analysis of the variables.

Variable	Fee	Devalue	Ba_0	Ba_1	*Lev*	*Liq*	*Growth*	*Rec*	*Roa*	*Size*	*Op*	*Loss*	*Soe*	Big_4
Fee	1													
Devalue	0.515***	1												
Ba_0	0.082***	0.044***	1											
Ba_1	0.019***	−0.014**	0.665***	1										
Lev	0.403***	0.392***	0.057***	0.021***	1									
Liq	−0.314***	−0.305***	–0.045***	−0.021***	−0.653***	1								
Growth	0.018***	−0.024***	−0.003	−0.001	0.019***	−0.030***	1							
Rec	−0.123***	0.159***	−0.092***	−0.093***	0.018***	−0.026***	0.048***	1						
Roa	−0.077***	−0.328***	−0.011*	−0.036***	−0.366***	0.236***	0.226***	−0.022***	1					
Size	0.766***	0.546***	0.086***	−0.005	0.523***	−0.362***	0.040***	−0.204***	−0.016***	1				
Op	0.031***	0.116***	0.016***	0.020***	0.126***	−0.061***	−0.071***	−0.005	−0.293***	−0.039***	1			
Loss	0.029***	0.264***	0.011*	0.032***	0.186***	−0.106***	−0.185***	−0.015***	−0.676***	−0.050***	0.268***	1		
Soe	0.251***	0.147***	0.008	−0.011*	0.292***	−0.213***	−0.083**	−0.193***	−0.096***	0.383***	−0.046***	0.024***	1	
Big_4	0.437***	0.145***	−0.010*	−0.007	0.103***	−0.075***	−0.012**	−0.083***	0.037***	0.337***	−0.024***	−0.031***	0.139***	1

Note: *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

Table 4. Results of the collinearity test for the variables.

Variable	Devalue	Ba_0	Ba_1	*Lev*	*Liq*	*Growth*	*Rec*
VIF	1.99	1.83	1.82	2.48	1.76	1.08	1.27
	Rec	*Roa*	*Size*	*Op*	*Loss*	*Soe*	Big_4
VIF	1.27	2.32	2.73	1.12	1.93	1.24	1.14

Source: developed by the authors using the relevant software.

Table 5. The results of fixed effect regression analysis for Model (1) and Model (2).

	Fee								
	Full sample			$Ba_2 = 1$			$Ba_3 = 1$		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Devalue	0.032***			0.037***			0.038***		
	(18.10)			(5.46)			(4.60)		
Ba_0		0.003***			0.010**			0.024**	
		(5.19)			(2.22)			(2.24)	
Ba_1			0.016***			0.021***			0.024***
			(4.33)			(4.35)			(4.27)
Lev	−0.022	−0.039**	−0.041**	0.165**	0.143*	0.122	0.167*	0.137	0.126
	(−1.13)	(−1.98)	(−2.07)	(2.18)	(1.87)	(1.60)	(1.81)	(1.47)	(1.36)
Liq	−0.011***	−0.012***	−0.012***	−0.012**	−0.013**	−0.014**	−0.003	−0.007	−0.007
	(−9.41)	(−10.77)	(−10.80)	(−2.01)	(−2.29)	(−2.41)	(−0.43)	(−0.90)	(−0.91)
Growth	0.005	0.007	0.007	−0.017	−0.021	−0.024	−0.003	−0.013	−0.016
	(0.77)	(1.05)	(1.00)	(−0.73)	(−0.92)	(−1.05)	(−0.11)	(−0.46)	(−0.57)
Rec	0.030	0.167***	0.171***	0.160	0.328***	0.409***	0.646***	0.907***	0.986***
	(1.14)	(6.58)	(6.75)	(1.24)	(2.59)	(3.19)	(3.84)	(5.42)	(5.90)
Roa	−0.292***	−0.513***	−0.510***	−0.313	−0.427*	−0.357	−0.200	−0.323	−0.284
	(−5.05)	(−9.06)	(−9.01)	(−1.39)	(−1.89)	(−1.58)	(−0.75)	(−1.21)	(−1.08)
Size	0.339***	0.370***	0.371***	0.384***	0.417***	0.427***	0.362***	0.385***	0.406***
	(100.33)	(130.06)	(130.74)	(31.85)	(40.61)	(41.52)	(24.17)	(27.53)	(31.21)
Op	0.123***	0.137***	0.138***	0.120**	0.136***	0.139***	0.157***	0.169***	0.170***
	(8.26)	(9.15)	(9.19)	(2.38)	(2.69)	(2.76)	(2.63)	(2.81)	(2.86)
Loss	0.023**	0.053***	0.053***	−0.041	0.008	0.012	−0.048	0.002	0.003
	(2.13)	(4.88)	(4.90)	(−1.02)	(0.21)	(0.32)	(−0.99)	(0.05)	(0.06)
Soe	−0.056***	−0.058***	−0.059***	−0.009	−0.001	0.003	−0.055**	−0.046*	−0.042
	(−9.72)	(−10.00)	(−10.05)	(−0.45)	(−0.05)	(0.13)	(−2.07)	(−1.70)	(−1.58)
Big_4	0.605***	0.602***	0.600***	0.379***	0.357***	0.350***	0.395***	0.383***	0.382***
	(47.72)	(47.13)	(47.05)	(7.76)	(7.14)	(7.10)	(7.25)	(6.92)	(6.98)
Constant	5.706***	5.500***	5.461***	4.583***	4.248***	4.104***	4.986***	4.619***	4.492***
	(93.15)	(90.36)	(87.64)	(21.11)	(19.22)	(18.48)	(17.90)	(16.02)	(15.77)
IND/YEAR	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	28,741	28,741	28,741	1,854	1,854	1,854	1,226	1,226	1,226
R^2	0.667	0.663	0.663	0.690	0.686	0.688	0.660	0.656	0.660
Adj.R^2	0.666	0.662	0.662	0.683	0.679	0.682	0.650	0.645	0.649

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation, the number in parentheses is a t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

According to the results of columns (2), (5), and (8) of Table 5, the coefficients of Ba_0 and Ba_1 are positive, at least at the 5% and 1% significance levels. It confirms H2—companies with biological assets have higher audit fees than those without biological assets.

The empirical results of checking H3 are shown in Table 6. The regression coefficients of *Devalue* for companies with Ba_3=1, Ba_2=1 and Ba_2=0 are statistically significant at the 1% level. The values of the coefficient are 0.038, 0.037 and 0.032, respectively. It allows confirming that asset impairment losses play a significant role in the companies' group with biological assets.

Table 6. The results of fixed effect regression analysis for the model (3).

	Fee					
				Full sample		
Variable	$Ba_3 = 1$ (1)	$Ba_2 = 1$ (2)	$Ba_2 = 0$ (3)	(4)	(5)	(6)
Devalue	0.038***	0.037***	0.032***	0.032***		
	(4.60)	(5.46)	(17.94)	(18.10)		
$Ba_0^{\#}$					0.003***	
					(3.99)	
$Ba_1^{\#}$						0.018***
						(4.92)
$Dev^{\#}$					0.032***	0.032***
					(17.98)	(18.12)
$Ba_0^{\#} \times Dev^{\#}$					0.001***	
					(4.58)	
$Ba_1^{\#} \times Dev^{\#}$						0.005***
						(2.78)
Lev	0.167*	0.165**	−0.036*	−0.022	−0.022	−0.024
	(1.81)	(2.18)	(−1.83)	(−1.13)	(−1.13)	(−1.24)
Liq	−0.003	−0.012**	−0.011***	−0.011***	−0.011***	−0.011***
	(−0.43)	(−2.01)	(−8.82)	(−9.41)	(−9.49)	(−9.40)
Growth	−0.003	−0.017	0.006	0.005	0.006	0.005
	(−0.11)	(−0.73)	(1.04)	(0.77)	(0.86)	(0.77)
Rec	0.646***	0.160	0.019	0.030	0.029	0.036
	(3.84)	(1.24)	(0.68)	(1.14)	(1.10)	(1.36)
Roa	−0.200	−0.313	−0.283***	−0.292***	−0.300***	−0.288***
	(−0.75)	(−1.39)	(−4.87)	(−5.05)	(−5.19)	(−4.98)
Size	0.362***	0.384***	0.335***	0.339***	0.338***	0.339***
	(24.17)	(31.85)	(105.90)	(100.33)	(100.06)	(100.54)
Op	0.157***	0.120**	0.124***	0.123***	0.122***	0.123***
	(2.63)	(2.38)	(8.37)	(8.26)	(8.15)	(8.21)
Loss	−0.048	−0.041	0.028***	0.023**	0.022**	0.023**
	(−0.99)	(−1.02)	(2.60)	(2.13)	(2.06)	(2.11)
Soe	−0.055**	−0.009	−0.058***	−0.056***	−0.055***	−0.055***
	(−2.07)	(−0.45)	(−9.86)	(−9.72)	(−9.46)	(−9.53)
Big_4	0.395***	0.379***	0.619***	0.605***	0.608***	0.605***
	(7.25)	(7.76)	(56.96)	(47.72)	(47.81)	(47.69)
Constant	4.986***	4.583***	5.854***	5.706***	6.242***	6.189***
	(17.90)	(21.11)	(89.05)	(93.15)	(84.78)	(83.06)
IND/YEAR	YES	YES	YES	YES	YES	YES
N	1,226	1,854	26,887	28,741	28,741	28,741
R^2	0.660	0.690	0.666	0.667	0.667	0.667
$Adj.R^2$	0.650	0.683	0.665	0.666	0.667	0.667

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation. The number in parentheses was the t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

The interaction terms in model (3) $Ba_0^{\#} \times Dev^{\#}$ and $Ba_1^{\#} \times Dev^{\#}$ show that the coefficients are 0.001 and 0.005, respectively (significant at the 1% level). It allows confirming H3—the biological asset size strengthens the positive relationship between asset impairment loss and audit fees.

The findings (Table 7) show that the coefficients of *Devalue* and Ba_0 in columns (1) and (2) are 0.032 and 0.003, respectively (significant at the 1% level). It proves that asset impairment and biological assets are positively related to audit fees. The coefficients of asset impairment and biological assets in columns (3) and (4) of Table 7 are 0.004 and 0.001, respectively. It shows that the larger the amount of asset impairment accrued and reversed, the longer the audit time, and the larger the scale of biological assets, the longer the audit person hours.

Table 7. Audit cost intermediary affects test results.

	Fee		*Eff*		*Fee*	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Devalue	0.032***		0.004***		0.032***	
	(18.10)		(4.71)		(17.85)	
Ba_0		0.003***		0.001***		0.003***
		(5.19)		(4.06)		(4.98)
Fee					0.095***	0.100***
					(9.17)	(9.52)
Lev	−0.022	−0.039**	−0.001	−0.004	−0.022	−0.039**
	(−1.13)	(−1.98)	(−0.13)	(−0.35)	(−1.14)	(−1.98)
Liq	−0.011***	−0.012***	0.001	0.001	−0.011***	−0.012***
	(−9.41)	(−10.77)	(1.27)	(0.99)	(−9.49)	(−10.83)
Growth	0.005	0.007	−0.023***	−0.022***	0.007	0.009
	(0.77)	(1.05)	(−5.80)	(−5.74)	(1.10)	(1.38)
Rec	0.030	0.167***	0.055***	0.074***	0.025	0.160***
	(1.14)	(6.58)	(3.87)	(5.31)	(0.95)	(6.31)
Roa	−0.292***	−0.513***	−0.286***	−0.315***	−0.265***	−0.482***
	(−5.05)	(−9.06)	(−9.63)	(−10.93)	(−4.59)	(−8.51)
Size	0.339***	0.370***	0.009***	0.013***	0.338***	0.369***
	(100.33)	(130.06)	(5.62)	(9.64)	(100.17)	(129.47)
Op	0.123***	0.137***	0.101***	0.103***	0.114***	0.127***
	(8.26)	(9.15)	(13.44)	(13.74)	(7.59)	(8.44)
Loss	0.023**	0.053***	0.016***	0.020***	0.022**	0.051***
	(2.13)	(4.88)	(2.88)	(3.64)	(1.99)	(4.69)
Soe	−0.056***	−0.058***	−0.038***	−0.038***	−0.053***	−0.055***
	(−9.72)	(−10.00)	(−12.50)	(−12.52)	(−9.11)	(−9.36)
Big_4	0.605***	0.602***	−0.067***	−0.067***	0.611***	0.608***
	(47.72)	(47.13)	(−15.16)	(−15.13)	(48.05)	(47.49)
Constant	5.706***	5.500***	4.288***	4.256***	5.296***	5.075***
	(93.15)	(90.36)	(139.93)	(141.19)	(69.43)	(67.06)
IND/YEAR	YES	YES	YES	YES	YES	YES
N	28,741	28,741	28,730	28,730	28,730	28,730
R^2	0.667	0.663	0.116	0.116	0.668	0.664
$Adj.R^2$	0.666	0.662	0.115	0.114	0.667	0.663
Sobel Z			4.703***	3.748***		

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation. The number in parentheses was the t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

The results in columns (5) and (6) of Table 7 show that *Devalue*, Ba_0 and *Eff* positively promote audit fees. Thus, it indicates that the relationship in two chains, "asset impairment—audit hours—audit fees" and "biological assets—audit hours—Part of the intermediary path of "audit fees". The loss of asset impairment and the scale of biological assets increased auditing hours. The accounting firm would charge more audit fees as cost compensation. The coefficient values of the Sobel test are 4.703 and 3.748 (significant at the 1% level), and the two results confirm each other.

The findings show that asset impairment and biological assets positively relate to audit fees. The coefficients of *Devalue* and Ba_0 (Table 8) in columns (1) and (2) are 0.032 and 0.003, respectively (significant at the 1% level).

The results in Table 8 indicate that the larger the amount of asset impairment accrued and reversed. The coefficients of asset impairment and biological assets in columns (3) and (4) are 0.008 and 0.001, respectively (significant at the 1% level). *Devalue*, Ba_0 and *Vio* in columns (5) and (6) positively promote audit fees. Thus, it

Table 8. Audit test results of risk intermediary effect.

	Fee		*Vio*		*Fee*	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Devalue	0.032***		0.008***		0.032***	
	(18.10)		(6.32)		(17.89)	
Ba_0		0.003***		0.001**		0.003***
		(5.19)		(2.00)		(5.11)
Vio					0.045***	0.050***
					(5.85)	(6.43)
Lev	−0.022	−0.039**	0.098***	0.094***	−0.027	−0.044**
	(−1.13)	(−1.98)	(5.96)	(5.69)	(−1.36)	(−2.22)
Liq	−0.011***	−0.012***	−0.001*	−0.002**	−0.011***	−0.012***
	(−9.41)	(−10.77)	(−1.69)	(−2.14)	(−9.36)	(−10.70)
Growth	0.005	0.007	−0.003	−0.002	0.005	0.007
	(0.77)	(1.05)	(−0.54)	(−0.44)	(0.79)	(1.06)
Rec	0.030	0.167***	−0.073***	−0.037*	0.034	0.169***
	(1.14)	(6.58)	(−3.35)	(−1.79)	(1.27)	(6.67)
Roa	−0.292***	−0.513***	−0.494***	−0.552***	−0.270***	−0.486***
	(−5.05)	(−9.06)	(−9.55)	(−10.69)	(−4.65)	(−8.55)
Size	0.339***	0.370***	−0.010***	−0.002	0.339***	0.370***
	(100.33)	(130.06)	(−4.09)	(−0.98)	(100.60)	(130.26)
Op	0.123***	0.137***	0.199***	0.203***	0.114***	0.127***
	(8.26)	(9.15)	(11.74)	(11.92)	(7.64)	(8.46)
Loss	0.023**	0.053***	0.027***	0.035***	0.022**	0.051***
	(2.13)	(4.88)	(2.72)	(3.52)	(2.02)	(4.73)
Soe	−0.056***	−0.058***	−0.034***	−0.035***	−0.055***	−0.057***
	(−9.72)	(−10.00)	(−7.70)	(−7.80)	(−9.45)	(−9.70)
Big_4	0.605***	0.602***	−0.033***	−0.034***	0.607***	0.604***
	(47.72)	(47.13)	(−4.76)	(−4.87)	(47.82)	(47.26)
Constant	5.706***	5.500***	0.213***	0.159***	5.696***	5.492***
	(93.15)	(90.36)	(4.64)	(3.51)	(93.14)	(90.40)
IND/YEAR	YES	YES	YES	YES	YES	YES
N	28,741	28,741	28,741	28,741	28,741	28,741
R^2	0.667	0.663	0.060	0.059	0.667	0.663
$Adj.R^2$	0.666	0.662	0.0585	0.0574	0.667	0.663
Sobel Z			4.316***	2.383**		

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation. The number in parentheses was the t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

indicates the relationship in two chains, "Asset Impairment—Irregularities—Audit Fees" and "Biological Assets—Irregularities—Part of the intermediary path of “audit fees”.

The robustness test results are shown in Tables 9 and 10. The finding confirms the obtained empirical results.

In the next stage of the investigation, the propensity score matching (PSM) test is applied to check the assumption that audit fees depend on the company’s observable characteristics, such as asset liability and current ratios. The control group is selected and matched through 1:1 no-replacement matching, and finally, 3750 observation samples are obtained. Furthermore, the control variables pass the stationarity test. The findings show (Figure 1) differences between the samples before matching. After matching, other differences were eliminated.

The results of the sample tests after PSM matching are shown in Table 11.

The empirical results allow confirming the obtained result at the previous stages of analysis. In conclusion, all results for the research hypothesis are robust.

Table 9. Results of Model (1) and model (2) robustness tests.

	Fee		
Variable	Model (1)	Model (2)	Model (2)
$Devalue_{d-1}$	0.031***		
	(16.07)		
$Ba_{0,\ t-1}$		0.003***	
		(4.98)	
$Ba_{1,\ t-1}$			0.018***
			(4.47)
Lev_{t-1}	−0.013	−0.029	−0.031
	(−0.63)	(−1.36)	(−1.45)
Liq_{t-1}	−0.010***	−0.012***	−0.012***
	(−7.53)	(−8.55)	(−8.56)
$Growth_{t-1}$	−0.148**	−0.348***	−0.344***
	(−2.25)	(−5.38)	(−5.32)
Rec_{t-1}	0.040***	0.041***	0.041***
	(6.06)	(6.21)	(6.18)
Roa_{t-1}	0.059**	0.194***	0.199***
	(1.98)	(6.69)	(6.86)
$Size_{t-1}$	0.341***	0.370***	0.371***
	(99.49)	(128.64)	(129.69)
Op_{t-1}	0.121***	0.135***	0.135***
	(6.73)	(7.44)	(7.48)
$Loss_{t-1}$	0.015	0.045***	0.045***
	(1.25)	(3.70)	(3.71)
Soe_{t-1}	−0.092***	−0.093***	−0.093***
	(−14.67)	(−14.83)	(−14.86)
$Big4_{t-1}$	0.593***	0.591***	0.588***
	(49.73)	(49.27)	(49.09)
Constant	5.827***	5.636***	5.590***
	(90.92)	(88.71)	(86.11)
IND/YEAR	YES	YES	YES
N	24,037	24,037	24,037
R^2	0.648	0.645	0.644
$Adj.R^2$	0.647	0.644	0.644

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation. The number in parentheses was the t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

5. Discussion

The empirical results confirm the investigation's hypothesis that asset impairment losses and biological asset scale impact audit fees. Thus, in the case of models (1)–(2), increasing asset impairment losses by 1% leads to increasing audit fees on average by 3.7% for companies with biological assets and by 2.4% for companies without biological assets. Similar conclusions are proven by Choi et al. (2022) for Chinese companies listed on the South Korean stock market. In addition, Choi et al. (2022) outline that auditing for Chinese companies is more difficult than auditing provided by external auditors and requires more time and effort.

In addition, the empirical results show that biological asset size reinforces the relationship between asset impairment loss and audit fees. This is consistent with the findings of previous studies (Choi et al., 2022; Nguyen, 2021; Tran, 2021).

Considering the results, the work hours for audit and audit risk have a statistically significant impact on audit fees for all analysed countries' groups. These results are supported by (Alharbi & Al-Adeem, 2022; Caramanis & Lennox, 2008; Choi et al.,

Table 10. Model (3) Results of the robustness test.

	Fee	
Variable	Model (3)	Model (3)
$Ba_0{}^{\#}{}_{t-1}$	0.003***	
	(3.99)	
$Ba_1{}^{\#}{}_{t-1}$		0.022***
		(5.28)
$Dev^{\#}{}_{t-1}$	0.030***	0.031***
	(15.94)	(16.09)
$Ba0^{\#} \times Dev^{\#}{}_{t-1}$	0.002***	
	(5.24)	
$Ba1^{\#} \times Dev^{\#}{}_{t-1}$		0.006***
		(3.37)
Lev_{t-1}	−0.013	−0.015
	(−0.63)	(−0.72)
Liq_{t-1}	−0.010***	−0.010***
	(−7.61)	(−7.50)
$Growth_{t-1}$	−0.154**	−0.141**
	(−2.36)	(−2.15)
Rec_{t-1}	0.040***	0.040***
	(6.12)	(6.06)
Roa_{t-1}	0.058*	0.066**
	(1.92)	(2.19)
$Size_{t-1}$	0.339***	0.341***
	(98.96)	(99.56)
Op_{t-1}	0.120***	0.121***
	(6.65)	(6.69)
$Loss_{t-1}$	0.015	0.016
	(1.25)	(1.27)
Soe_{t-1}	−0.090***	−0.090***
	(−14.40)	(−14.46)
Big_{4t-1}	0.596***	0.593***
	(49.99)	(49.74)
Constant	6.341***	6.279***
	(83.25)	(81.50)
IND/YEAR	YES	YES
N	24,037	24,037
R^2	0.649	0.648
$Adj.R^2$	0.648	0.648

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation. The number in parentheses was the t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

2022; Vasyliyeva et al., 2014). However, compared to the obtained results, the scholars proved that audit quality had a statistically significant impact on audit fees.

6. Conclusion

Using the annual data of A-share listed companies from 2012 to 2021 as a sample, the paper empirically justifies the impact of asset impairment losses and the size of biological assets on audit fees. In addition, the study confirms the mediating role of biological assets in the relationship between asset impairment losses and audit fees. The empirical results show that the accrual and reversal of asset impairment losses mainly depended on the professional judgment of auditors. The findings prove that increased audit costs and risk provoke the growth of audit fees.

Biological assets and their complexity for accounting lead to difficulties for auditors in obtaining information. Therefore, accounting firms would charge the audited

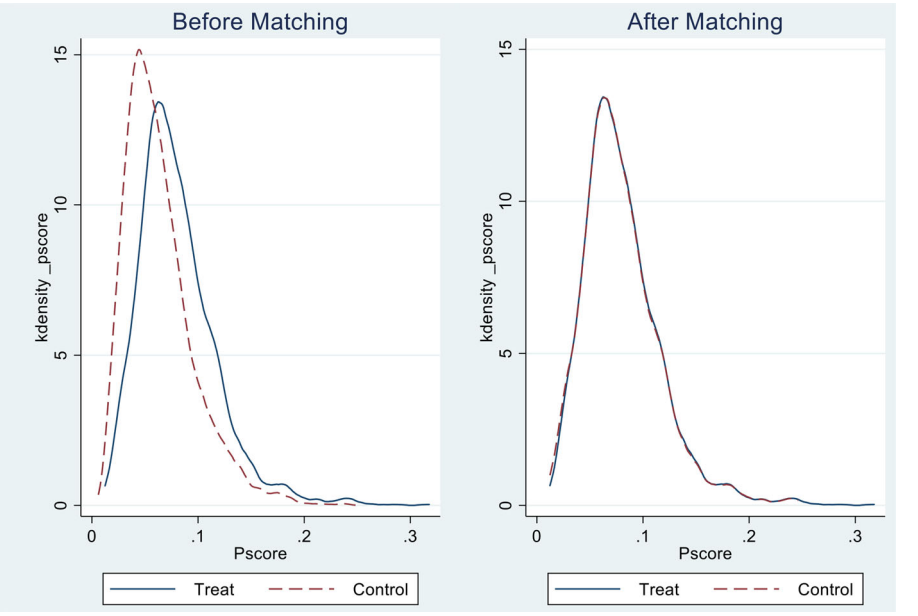

Figure 1. Nuclear density plot before and after PSM matching.
Source: developed by the authors using the relevant software.

units. The findings show that listed companies with biological assets have higher audit fees than those without biological assets. Biological assets could indirectly affect audit fees through impairment losses of consumable biological assets, thereby magnifying them. The influence between impairment losses and audit fees indicates that the size of the biological assets strengthens the positive correlation between asset impairment losses and audit fees. The study proves that audit hours and violations have a statistically significant impact on audit fees.

7. Theoretical & practical implications

The paper's findings contribute to the theoretical framework of analyses of core factors that impacted audit fees and prices. In addition, one of the scientific outputs of the investigations is the developed approach for assessing the link between asset impairment, biological assets and audit fees.

The paper's empirical results highlight the practical implications for a different group of stakeholders.

7.1. For investors

It is necessary to realise that the provision and reversal of asset impairment losses have become a means of corporate earnings management. In addition, biological assets are a high-incidence area for financial fraud. Investors could appropriately supplement relevant knowledge, proactively identify projects with asset impairment and abnormal biological assets, and avoid unnecessary investment losses.

Table 11. Results of the sample tests after PSM matching.

	Fee			
Variable	(1)	(2)	(3)	(4)
Ba_0	0.004***			
	(3.74)			
Ba_1		0.017***		
		(3.71)		
Ba_2			0.059***	
			(3.00)	
Ba_3				0.049***
				(2.75)
Lev	0.133**	0.118**	0.136**	0.132**
	(2.51)	(2.22)	(2.56)	(2.48)
Liq	−0.005	−0.005	−0.005	−0.005
	(−1.42)	(−1.60)	(−1.46)	(−1.46)
Growth	−0.011	−0.013	−0.011	−0.012
	(−0.69)	(−0.81)	(−0.68)	(−0.71)
Rec	0.052	0.029	0.041	0.018
	(0.83)	(0.48)	(0.65)	(0.30)
Roa	−0.431***	−0.413***	−0.441***	−0.431***
	(−2.77)	(−2.65)	(−2.84)	(−2.77)
Size	0.382***	0.391***	0.384***	0.389***
	(51.87)	(55.24)	(52.29)	(54.91)
Op	0.110***	0.113***	0.112***	0.113***
	(2.76)	(2.85)	(2.80)	(2.83)
Loss	0.074**	0.076***	0.073**	0.075**
	(2.51)	(2.59)	(2.46)	(2.53)
Soe	−0.061***	−0.061***	−0.063***	−0.062***
	(−4.09)	(−4.11)	(−4.23)	(−4.17)
Big_4	0.461***	0.445***	0.461***	0.448***
	(16.37)	(15.92)	(16.31)	(16.00)
Constant	5.093***	4.895***	5.075***	4.979***
	(33.29)	(31.63)	(33.17)	(32.74)
IND/YEAR	YES	YES	YES	YES
N	3,700	3,700	3,700	3,700
R^2	0.673	0.673	0.672	0.672
$Adj.R^2$	0.669	0.669	0.669	0.669

Note: Industry (IND) and year (YEAR) are processed as virtual variables, limited to space, not special presentation. The number in parentheses was the t-value; *, ** and *** were significant at the statistical levels of 10%, 5% and 1%, respectively.
Source: developed by the authors using the relevant software.

7.2. For management of the listed companies

Management should strictly abide by international accounting standards. In addition, the audit process requires strengthening corporate governance and internal control. It improves accounting personnel's business capabilities and effectively carries out accounting for biological assets and asset impairment, eliminating audit risks. The transparency of the company's financial system could enhance investors' confidence and trust in the company. Listed companies should also continuously optimise the company's financial management and reasonably reduce audit expenses.

7.3. For accounting firms

Auditing companies should implement innovative methods and instruments that allow declining time and receive reliable and valid audit reports. The findings show that auditing companies should continuously improve the expertise of auditors in providing audits for companies with biological assets.

7.4. For government

Relevant regulatory agencies should strengthen the supervision of asset impairment and biological asset-related projects. They should regulate the information disclosure of listed companies' asset impairment and biological assets and maintain a fair and orderly market environment. It could be realised by improving the accounting standards for asset impairment and biological assets and the applicability and coverage of the standards.

8. Limitations and future research

Despite the actual data of the study, the paper has a few limitations that could be highlighted as further directions for investigations. First, the object of investigation is limited to one country, which restricts the implications of findings and recommendations to other countries. In addition, the paper focused on analysing A-listed companies, which are not open to foreign stakeholders compared to B-listed companies. Thus, it is necessary to extend the object of analysis in future research. In addition, the asymmetry of information could provoke the decline of audit efficiency and consequently increase the cost in the long term. Thus, future analysis should consider accessibility to information. In addition, audits are closely related to agricultural companies' transparency, which influences sustainable development. In this case, analysing the relationship between companies' transparency (considering ESG reports) and audit fees is necessary. The study analyses only internal factors (the asset-liability ratio, growth capacity, net interest rate on assets (*Roa*), company size, type of firm, etc.) which influence audit fees from open. At the same time, audit fees could be changed by the external factors of the company's environment (corruption, law regulation, voice and accountability, location, inflation, etc.

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