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Research article

The affecting factors of circular economy information and its impact on corporate economic sustainability-Evidence from China

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ABSTRACT

The Chinese government has implemented the circular economy-related legislation for guiding firms' responsible production in 2009. In the 12th-five (2011–2015) and 13th-five (2016–2020) Economic and Sustainable Plans, circular economy is also deemed the core part of green development in China. However, a significant research gap remains that which types of firms actively disclosed circular economy information (i.e., reducing, reusing and recycling) following the national policy to establish legitimacy and create a green advantage in China. Based on this perspective, this research focuses on the period of 2011–2017. The sample consists of 3,768 firms and is analyzed using regression analysis. The coding technique of content analysis is applied to measure disclosure of circular economy information. Content analysis is an analytic technique that converts text descriptions into quantitative data in a systematic and objective manner. The empirical evidence of this study shows that firms in environmentally-sensitive industries and larger firms tended to disclose significantly more circular economy information to meet the information needs of stakeholders. It also shows that state-owned enterprises played the role of a leader in implementing circular economy during 2013–2017. Besides, firms which disclosed more circular economy information were associated with significantly higher sustainable growth rate and return on equity. The findings of this paper suggest that corporate managers redesign production processes towards zero waste and resource effectiveness. The contribution of this paper is that it clarifies the affecting factors and financial impacts of circular economy information for Chinese firms. The findings can fill the literature gap related to the new highlights of environmental disclosure-related circular economy actions in developing countries.

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1. Introduction

With a large market, cheap labor and more slack environmental policies, China has been a popular destination for foreign direct investments since the economic reform in 1987. The establishment of factories by multinational enterprises has helped boost the economic development but also resulted in serious environmental pollution. Therefore, for enterprises as the major source of pollution, the Chinese government has formulated various regulations to avoid the recurrence of the "pollution first and management later" business model.

According to Lo and Sheu (2007), in recent years, enterprises are increasingly demanded to incorporate the concept of "environmental sustainability" into their business activities, take substantive actions and provide disclosures regarding the company's sustainability in the environmental aspect. As stakeholders have growing expectations and requirements, enterprises should have the awareness that in order to maintain environmental legitimacy and reputation of the organization, they need a more effective communication model for responding to stakeholder demands and conveying the organization's stance on environmental issues (Schlegelmilch and Pollach, 2005).

Which types of firms are more willing to disclose environmental information to reduce the information asymmetry for stakeholders, establish legitimacy and obtain sustainable resources? The affecting factors of environmental disclosure have been explored and linked to some firm characteristics, e.g., firm size, ownership, environmentally-sensitive industries (ESIs) and financial profitability. However, there is no consistent conclusion about the impact of firm characteristics on environmental disclosure. While some studies reveal that larger firms disclose more environmental information (Meng et al., 2015; Lee et al., 2017; Wang et al., 2018), some argue that firm size is not significantly related to disclosure level (Hassan, 2018; Melloni et al., 2017). A number of scholars suggest that firms whose ownership ultimately falls in the hand

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Nomenclature

Symbols	Definition
Certificate	Disclosure of circular economy information in the certificate dimension
DCEI	Disclosure of circular economy information (overall)
$\widehat{DCEI}$	The predicted value of disclosure of circular economy information
ESIs	Environmentally-sensitive industries
GROW	Asset growth rate
LEV	Financial leverage
OPR	Operating profit ratio
OWNT	Ownership types
POEs	Privately-owned enterprises
PROFIT	Profitability
RD	Research and development intensity
Recycling	Disclosure of circular economy information in the recycling dimension
Reducing	Disclosure of circular economy information in the reducing dimension
Reusing	Disclosure of circular economy information in the reusing dimension
ROE	Return on equity
RR	Retention ratio
SGR	Sustainable growth rate (formula 1)
SGR2	Sustainable growth rate (formula 2)
SI	Sensitive industry
SIZE	Firm size
SOEs	State-owned enterprises
Z	A vector of control variables in Equation (2) and Equation (3)
$\alpha_0, \beta_0, \gamma_0$	The constants in Equation (1)-(3)
$\alpha_1 - \alpha_4$	The coefficients in Equation (1)
β_1, β_2	The coefficients in Equation (2)
γ_1, γ_2	The coefficients in Equation (3)
$\varepsilon 1, \varepsilon 2, \varepsilon 3$	The error terms in Equation (1)-(3)
2SLS	The two-stage least squares

Subscripts

i	Refers to a specific firm
t	Refers to a specific year

of the government have a tendency to disclose more environmental information (Meng et al., 2015; Wang et al., 2018). However, Lu and Abeysekera (2014) suggest that although state-owned enterprises (SOEs) are motivated to disclose more information because of government supervision, the influence of the government on their disclosure is not significant. Besides, while some scholars have found a higher tendency to disclose more among firms in ESIs (Patten, 2002; Lu and Abeysekera, 2014), other scholars contend that disclosure is not affected by ESIs (Lee et al., 2017; Wang et al., 2018) or even negatively related to ESIs (Meng et al., 2015). From the financial perspective, firms with good profitability tend to disclose more environmental information (Lu and Abeysekera, 2014; Wang et al., 2018). However, the evidence in some studies suggests that financial profitability does not have a significant impact on disclosure level (Meng et al., 2015; Lee et al., 2017) or is in fact negatively related to disclosure level (Hassan, 2018). From the above studies, it can be found that when the research period, region, and environmental regulations are not the same, the content of corporate environmental disclosures will be different, which is the possible cause of inconsistent research results. So far, little academic attention has been paid to the new highlights of environmental disclosure-related circular economy actions in developing countries.

Circular economy is based on 3R principles, namely reducing, reusing and recycling (Su et al., 2013). To put it simply, circular economy is an innovative business strategy that seeks to achieve business goals by increasing the use of recycled resources and decreasing the environmental load. Corporate disclosure of information on their engagement in and performances of circular economy allows investors to have a better understanding of the company's current operations and thus identify risks and make investment decisions more effectively. It is also helpful for regulatory authorities in supervising enterprises and can guide enterprises to develop an optimal strategy.

Ghisellini et al. (2016) suggest that the traditional linear economic model is based on the "take-make-consume-dispose" mindset, which focuses solely on the product's life cycle and does not consider what subsequent actions are needed after the product's life cycle ends (Jawahir and Bradley, 2016). Therefore, some scholars have called for a transition from the traditional linear economy to circular economy. Circular economy is a closed-loop economic model that is intended to solve the worsening problems of growing waste and resource shortage by repetitive use of existing materials and proper treatment of waste for reuse (Kok et al., 2013). Wang et al. (2014) point out that many countries in the world have decided to implement responsible production based on "low pollution, low emissions and waste recycling" in order to protect environmental resources and ensure economic development. It is a reasonable decision of these countries because circular economy has been recognized as a "new business model" that guides businesses towards sustainable development (Sposato et al., 2017).

For example, Apple Inc. collects old and unused phones from consumers and removes key components for reuse. This program has helped the company reduce production costs and strengthen its competitiveness (Sarkis and Zhu, 2008; Zhu et al., 2018). This innovative business model developed based on circular economy principles not only contributes to environmental sustainability but also enables firms to generate more profits and improve shareholder value. The concept of circular economy was widely supported in China when it was first introduced into China in the 1990s. To alleviate the sharp contradiction between economic growth and environmental resource consumption, the Chinese government has implemented ≪The Circular Economy Promotion Law of the People's Republic of China≫to guide firms' responsible production in 2009. Besides, in the 12th-five (2011–2015) and 13th-five (2016–2020) Economic and Sustainable Plans, circular economy is also deemed the core part of green development in China. Transitioning to a circular economy model requires a systematic shift in business approaches (Frishammar and Parida, 2019). However, little research has attempted to explore firms with which characteristics are more likely to engage in disclosure of circular economy information (DCEI) and whether the disclosed circular economy information can be a signal of green competitiveness that can lead to higher sustainable growth rate (SGR) and return on equity (ROE) (i.e. important indicators of corporate economic sustainability) for firms in China. The objective of this study is to answer the two research questions.

2. Literature review

2.1. Circular economy information

Circular economy has been defined in a variety of ways. According to Franklin-Johnson et al. (2016), a circular economy, at its core, aims to achieve circular flows of materials and utilization of raw materials and energy in multiple stages. The core concept of circular economy is to minimize resource consumption and environ-

mental costs while maximizing the benefits (García-Barragán et al., 2019).

Circular economy is based on 3R principles, namely reducing, reusing and recycling (Su et al., 2013). Reducing refers to decreasing consumption of resources and generation of pollutants (Su et al., 2013). It suggests that enterprises should reduce emissions of waste and consumption of resources through adoption of more advanced technologies or facilities (Anderson, 2007). Reusing means utilizing resources as many times as possible or in diverse ways (Brunori et al., 2005). Recycling is a process of turning end-of-life products into renewable energy or resources, allowing them to enter a new product life cycle (Hicks et al., 2005). Circular economy expands the existing corporate environmental management systems to help businesses create higher economic value from their material life cycles (Stahel, 2016). This suggests that businesses need to comply with the social and environmental principles of circular economy in their design of products and services. Therefore, circular economy applies to both internal and inter-organizational sustainable management (Korhonen et al., 2018).

Wang et al. (2014) state that many countries in the world are developing a circular economy based on "low pollution, low emissions and waste into resources". Xue et al. (2010) suggest that China should adopt "circular economy" as its national development strategy. Enterprises play the most important role in executing the requirements of a circular economy policy. How effectively the requirements are executed by enterprises determines the degree of circular economy implementation in the region or country.

2.2. Theories related to disclosure of circular economy information (DCEI)

2.2.1. Green competitiveness theory

Porter and van der Linde (1995) point out that enforcement of legislation on environmental protection motivates firms to seek technical innovations and increase their competitiveness. To comply with legal requirements and achieve a win-win result in both economic and environmental aspects, firms must engage in environmental behaviors that are substantive and beyond superficial greenwashing.

According to Kuo et al. (2015), green innovation is one of the approaches to sustainable development of a low-carbon circular economy. By improving the production process and reusing resources, firms can not only meet the requirements of environmental protection but also reduce production costs to create more profits and a competitive advantage (Rennings, 2000).

The circular economy model promotes reduction of the production costs, which can be interpreted as a relative increase in value of each link in the production system (Bastein et al., 2013). Eiadat et al. (2008) argue that enterprises introduce environmental innovations for the purpose of maintaining their competitive advantages. Unlike SOEs, privately-owned enterprises (POEs) are not supported by the government. Maintaining competitive is therefore more important for them. When developing a green economy has become a national policy, firms may face suspension of business and lose their competiveness if they fail to comply with the standards set forth by the policy. Moreover, some researchers find that consumers prefer partly circulated products over fully or not at all circulated products, and circular products can likely successfully enter the existing market at the retail price of a new product (Hunka et al., 2021). The results show a promising path for firms considering a transition to circular business models.

2.2.2. Voluntary disclosure theory (signaling theory)

Voluntary disclosure theory is also termed signaling theory (Luo and Tang, 2014). According to voluntary disclosure theory, when a company has made certain achievements in circular economy, "concealing the good deed" is certainly not what the company has hoped for. The company will actively disclose its green information in the hope of shaping a positive corporate image. Dye (1985) shows that enterprises can take advantage of signaling theory to convey messages to the public and increase corporate transparency. By conveying positive and favorable information to stakeholders, they can distinguish themselves from companies of lower performance to avoid adverse selection by investors.

Clarkson et al. (2013) proposes that adopting an active environmental strategy and sending this kind of signal to investors can increase the firm's stock price. In recent years, more and more commercial banks have become more careful when offering loans to high-pollution firms, because environmental pollution entails a higher financial risk. Firms with higher borrowing power tend to have a higher value. This can be the evidence for the assumption about corporate engagement in environmental protection and firm value. It is mentioned in Yu (2015) that when investors find from the received signals that the company of interest has relatively lower potential environmental debt and risk, they will perceive a higher value and reputation of the company. Green signals also suggest regulatory compliance, allowing stakeholders to understand if the firm is at risk of being suspended.

2.2.3. Stakeholder theory

Freeman's (1984) stakeholder theory asserts that a firm's operating performance cannot be judged simply by shareholder value but by the value enjoyed by anyone affected by the company. Stakeholders of different attributes have different influences on a company. They influence a company's management decisions by controlling the resources that are essential for its continuous operation (Ullmann, 1985). The recommendations were developed for enhancing the corporate environmental performance of businesses through incentives and unique rewards, improving communication among stakeholders (Kazancoglu et al., 2021). However, Roberts (1992) offers evidence showing that government can use legislation, tax subsidies or preferential treatments to influence corporate strategies. Unlike other stakeholders, government can exert a greater and coercive influence on enterprises through legislation. Therefore, government is viewed as the most important stakeholder of enterprises (Steurer, 2010; Roberts, 1992). Scholars have obtained evidence from China that corporate environmental disclosure is positively and significantly related to government (Liu and Anbumozhi, 2009). Because China is a socialist country, the government has absolute power over corporate operations. When violating any state legislation, enterprises are subject to punishments that can range from fines, suspension of business to revocation of license, in the worst case. Li and Zhang (2010) have also pointed out that the majority of publicly listed firms in China are SOEs which are dominated by the government. It can be inferred from the above discussion that the government is the most important stakeholder of publicly listed enterprises in China. The lack of legislation for efficient circular economy is revealed as one of important barriers (Kazancoglu et al., 2021). According to prior literatures, governments could play a major stimulating role in promoting the transition of firms towards circular economy (Manninen et al., 2018).

2.2.4. Management theory

Environmental disclosure is conducted for two common purposes: One is, as the final stage of performance improvement, to report the environmental performance of the company to the public. This is the so-called "inside-out" approach of management (Schaltegger and Wagner, 2006). The other is to use disclosure as a means to motivate the organization to pursue higher environmental performance. This is the "outside-in" approach of manage-

ment (Burritt and Schaltegger, 2010). According to the outside-in approach, having dialogues with stakeholders and responding to their expectations can help firms evaluate their green behavior and management and guide them towards sustainable development. The firms that embark on proactive environmental practices perform better than their counterparts that do not integrate environmental solutions into their overall business strategy (Adomako et al., 2019).

It has been found that firms with poorer environmental performance are likely to provide more disclosure of environmental information with an intention to redress the poor performance and gain legitimacy (Cho and Patten, 2007). However, once disclosure is used as a means to legitimize poor environmental performances, there may be no strong incentive for firms to be active in making improvements. In this situation, firms can take a management orientation to contrast the changes they have made. For example, they can highlight the incremental gains they have achieved in the aspect of environmental performance.

The "outside-in" approach offers a different view, which has different implications from the legitimacy perspective. It suggests that firms will respond to public pressure and demand for information. Environmental disclosure and reporting of sustainable development affect corporate decisions and create a momentum for performance improvement (Burritt and Schaltegger, 2010). Environmental disclosure provides stakeholders a signal about a company's dedication to improving the society and the environment (Branco and Rodrigues, 2006). It also creates value and benefits (including a better corporate image) (Hooghiemstra, 2000), allowing firms to stand out from competitors (Hasseldine et al., 2005) and boost their value (Clarkson et al., 2015).

2.3. Disclosure factors of circular economy information

2.3.1. Ownership type of the firm

China is a political system based on socialism. The Chinese government has been recognized as the most important stakeholder of enterprises in China. The empirical evidence in Roberts (1992) also confirms that government can use legislation to influence enterprises. The evidence in Li and Zhang (2010) shows that most enterprises in China are dominated by the government. Zhu and Zhang (2015) mention that the Chinese government encourages enterprises to implement various environmental protection measures and demand SOEs to play a leading role in fulfilling corporate social responsibilities (CSR) as expected by the society. However, some scholars have obtained different findings. For example, Lu and Abeysekera (2014) investigate the relationship between state ownership and environmental disclosure in a sample of firms in China during 2008. Their finding suggests that the abovementioned relationship is not significant. A plausible explanation is that supplementary measures were not available at the time when the environmental disclosure policy was implemented in China. Even though firms were willing to comply with the national policy, no specific and detailed guidelines were available for them to follow.

≪The Circular Economy Promotion Law of the People's Republic of China≫ went into effect in 2009. SOEs will undoubtedly endeavor to comply with the requirements of this law and disclose circular economy information to stakeholders. It can be inferred that there is a positive relationship between state ownership and DCEI. Therefore, this study proposes H1 as follows:

H1: SOEs disclose more circular economy information than POEs.

2.3.2. Industry sensitivity

Branco and Rodrigues (2008) show that the content of social or environmental disclosure varies from industry to industry. Patten (2002) draws on a sample of top 500 toxic release inventory (TRI) firms in the US to find that ESIs are positively and significantly related to disclosure of release of toxic substances. Campbell (2004) uses a sample of firms in the UK and divides it into ESIs and non-ESIs to investigate how ESIs are related to environmental disclosure. Campbell's findings reveal that firms in ESIs tend to disclose more environmental information. ESIs have more environmental impacts and are subject to greater scrutiny by stakeholders. As mentioned earlier, Chinese government is the most influential stakeholder. Enterprises need to disclose circular economy information to demonstrate their compliance with the policy requirements set forth by the government. Therefore, this study proposes H2 as follows:

H2: Enterprises in ESIs disclose more circular economy information.

2.3.3. Firm size

Patten (1991) states that larger firms disclose relatively more environmental information than small ones. Cormier and Gordon (2001) point out that larger firms attract more attention from stakeholders and have greater environmental impacts, so they are under higher pressures and will be more motivated to disclose more to gain stakeholder support (Karim et al., 2006). This view is shared by another study which suggests that for CSR and a better corporate image, larger firms are willing to disclose more information to meet public expectations (Elijido-Ten, 2004). Therefore, this study proposes H3 as follows:

H3: Larger firms disclose more circular economy information.

2.3.4. Financial profitability

Cormier and Magnan (1999) argue that firms with good profitability are able to solve the environmental problem they have encountered in a shorter time. Mao and Wang (2018) probe into firms in China and empirically confirm that the cost of green production is so high that only firms with a certain financial ability can afford it.

Companies involved in green production, one on hand, will improve their production chain technology to reduce product costs and gain higher profits; on the other, they will disclose a broad range of information about circular economy to stakeholders, in an attempt to draw a clear line between them and enterprises with poor financial performances and non-green enterprises. The disclosure provides a signal that the companies have a good profitability and are green enterprises that care about the environment. It is helpful for these companies to differentiate themselves from competitors and boost their competitive advantages. Therefore, this study proposes H4 as follows:

H4: Firms with a better financial profitability disclose more circular economy information.

2.4. The impact of DCEI on SGR and ROE

Some studies have examined whether environmental disclosure contributes to firm value by using Tobin's Q to measure firm value (Li et al., 2018). Yu and Tsai (2018) suggest that it is more accurate to measure a firm by shareholder value than by firm value. This is because corporate managers must have an efficient business model and exercise efficient decision making to earn profits and increase shareholder value. Yu and Tsai (2018) also propose that shareholder value is an important proxy variable for the efficiency of managers' decision making and business model. Circular economy information is a green signal showing whether the company is developing towards a zero-waste recycling system. It is also a new business model for firms to achieve sustainable development. For

Table 1
Sample composition.

Year	Initial number of firms	Final number of firms
2011	447	410
2012	581	532
2013	520	462
2014	592	523
2015	576	514
2016	705	634
2017	737	693
Total	4158	3768

corporate managers, there are also benefits of environmental disclosure (Hu et al., 2018), including reduced information asymmetry, having access to more favorable financing terms (Choi, 1973; Verrecchia, 1983) and lower cost of debt financing (Benlemlih and Girerd-Potin, 2017). Fan et al. (2020) found a positive relationship between environmental disclosure quality and firm valuation among Chinese firms in the high-polluting industries. These benefits can ultimately turn into a green competitive advantage, allowing the company to create more net profits and a higher ROE. Therefore, this paper proposes H5–1 as follows:

H5–1: Firms which disclose more circular economy information have a higher ROE.

Yu and Tsai (2018) propose to measure shareholder value by sustainable growth rate (SGR). SGR is the highest growth rate that a firm can maintain without increasing the financial leverage or seeking external financing. The Chinese government has implemented circular economy-related laws and provides tax incentives to encourage companies to adopt circular economy research. However, when violating any circular economy law, companies may be forced to suspend operations in severe cases. Therefore, when a company actively releases information about their circular economy 3R activities, it conveys the signal of sustainable development to the shareholders. Therefore, this paper also proposes H5–2 as follows:

H5–2: Firms which disclose more circular economy information have a higher SGR.

3. Methods

3.1. Sample selection

The data sources include CSMAR database and corporate annual reports, CSR reports or sustainability reports released by sample firms on their websites. The sample period spans 7 years from 2011 to 2017. The financial and insurance industry has certain special industry characteristics (Chih et al., 2008), and the manufacturing industry has much greater environmental impact than the financial and insurance industry. Including both industries in the sample may lead to biased results. Therefore, firms in the financial and insurance industry along with foreign firms were excluded from our sample. This study collected data for 7 consecutive years. The initial sample consisted of 4158 firms. After missing values were excluded, the final valid sample consisted of 3768 firms, as shown in Table 1.

3.2. Content analysis

Content analysis is a tool for determining the presence of certain words, themes, or concepts within some given qualitative data (i.e. text). Content analysis is also recognized as a method that can convert text descriptions into quantitative data in a systematic and objective manner (Berelson, 1952; Krippendorff, 1980). Generally, variables measured in content analysis can be divided into quantitative and qualitative items. Quantitative items are data measured in quantity units, and qualitative items refer to text descriptions (e.g. Aerts and Cormier, 2009). Prior literature on environmental disclosure suggests that content analysis is a dominant method for measuring a firm's degree of environmental disclosure (Kuo and Chen, 2013). DCEI is a new highlight of environmental disclosure focusing on 3R actions in China. In this study, the coding technique of content analysis was applied to measure and capture DCEI of sample firms. Content analysis is commonly adopted in related studies (Kuo et al., 2012; Al-Tuwaijri et al., 2004; Aerts and Cormier, 2009).

First, this study established a disclosure-scoring measure using content analysis method for DCEI based on the 3R principles to evaluate sample companies (see Table 2). Second, this paper divided the reducing dimension into two sub-dimensions, including energy saving and waste reduction. In Chinese firms' CSR or sustainability reports, energy saving and waste reduction are separately specified. However, according to accounting principles, the raw materials saved remain in the inventory account and will be reused in future production. Hence, reduction of raw materials is classified into reusing in this study.

The scoring method is as follows: There is a score for each dimension. If the company's CSR report provides specific numbers, statistics or text descriptions regarding its effort or performance in the given dimension, the company receives 1–3 points in this dimension depending on the implementation level; if the CSR report provides nothing in the given dimension, 0 point is given. Besides, based on the 3R principles, this paper also evaluated whether each company has acquired an international certificate to increase the credibility of its disclosures. 1 is given if the company has an international certificate; 0 is given if otherwise.

3.3. Empirical model

The prior literature does not clarify which characteristics of firms are the affecting factors on disclosure of circular economy information (DCEI), but it provides some related variables, e.g., ownership types (OWNT), sensitive industry (SI), firm size (SIZE), and profitability (PROFIT). Therefore, in accordance with the previous studies, this section describes our regression model used to examine the affecting factors of DCEI, and the nature of relationship between DCEI and return on equity (ROE) and sustainable growth rate (SGR), respectively. We choose and describe the dependent, independent and control variables that may have an impact on our regression model in this study. To test our hypotheses H1, H2, H3, and H4, this study establishes Equation (1) as follows:

$$DCEI_{it} = \alpha_0 + \alpha_1 OWNT_{it} + \alpha_2 SI_{it} + \alpha_3 SIZE_{it} + \alpha_4 PROFIT_{it} + \varepsilon 1_{it} \quad (1)$$

where i and t denote firm i in year t, respectively; $DCEI_{it}$ refers to the score of DCEI for firm i in year t; The criteria used to score the DCEI are provided in Table 2. OWNT is a dummy variable of ownership type, which is 1 if the firm belongs to state-owned and is 0 if private-owned; SI refers to environmental impacts of industry, which is 1 if the firm belongs to ESIs and is 0 if otherwise; ESIs include mining, production/supply of power, gas and water, architecture, communication technology, transportation and the major manufacturing businesses. SIZE refers to firm size. We measured it by the natural logarithm of total assets and defined firms with a value greater than the average as large firms and firms with a value smaller than the average as small firms. This variable is 1 if the firm is large and is 0 if otherwise. PROFIT denotes profitability. This variable is 1 if the firm has a positive net profit and is 0 if otherwise. Finally, $\varepsilon 1$ is an error term, and α_0 is the constant. For our hypotheses H1, H2, H3, and H4 to be confirmed, the coefficients of all independent variables must be positive and statistically significant in Equation (1).

Table 2
Items for measuring disclosure of circular economy information.

Disclosure of circular economy information		Scoring criteria	Score
Reducing	Energy saving	0 point: There is no mention of any measure regarding energy reduction. 1 point: There is only a descriptive outline of energy reduction measure(s). For example, the company has been active in promoting the government's energy saving policy. 2 points: There are goals, and quantified data on energy saving are available. For example, the company has saved approximately XX Kilowatt-hours of power or approximately XX tonnes of standard coals of power. 3 points: Goal achievement is evaluated through a comparison of energy reduction performance in the current period with performances in prior periods.	0–3 points
	Waste reduction	0 point: There is no mention of any measure regarding waste reduction. 1 point: There is only a descriptive outline of waste reduction measure(s). For example, the company has minimized emission of waste and use of packaging. 2 points: There are goals, and quantified data on waste reduction are available. For example, the company has processed XX tonnes of solid waste. 3 points: Goal achievement is evaluated through a comparison of waste reduction performance in the current period with performances in prior periods.	0–3 points
Reusing		0 point: There is no mention of any measure regarding reusing. 1 point: There is only a descriptive outline of reusing measure(s). For example, the company recycles waste and has comprehensive utilization of the recovered waste. 2 points: There are goals, and quantified data on reusing are available. For example, the company has utilized a total of XXX tonnes of waste. 3 points: Goal achievement is evaluated through a comparison of reusing performance in the current period with performances in prior periods.	0–3 points
Recycling		0 point: There is no mention of any measure regarding recycling. 1 point: There is only a descriptive outline of recycling measure(s). For example, the company burns waste to generate energy, uses waste heat to generate power or recovers resources from waste. 2 points: There are goals, and quantified data on recycling are available. For example, the company has generated XX tonnes of standard coals of power from waste heat. 3 points: Goal achievement is evaluated through a comparison of recycling performance in the current period with performances in prior periods.	0–3 points
Certificate (possession of any international certificate)		International certificates, such as ISO5001 energy management system certification, can help increase the credibility of a company's disclosure.	1 point
Total			13 points

To test our hypotheses H5–1, this study establishes Equation (2) as follows:

$$ROE_{it} = \beta_0 + \beta_1 \widehat{DCEI}_{it} + \beta_2 Z + \varepsilon 2_{it} \quad (2)$$

ROE is the ratio of net income to shareholders' equity. DCEI is a dependent variable in Equation (1) but an independent variable in Equation (2), thus DCEI is an endogenous variable. An endogenous variable is a variable in a statistical model that's changed or determined by its relationship with other variables within the model. So, this study uses the two-stage least squares (2SLS) with panel data model to solve the problem of endogeneity. The mathematical calculation process of the 2SLS regression model using panel data has attracted the attention of scholars (Semykina and Wooldridge, 2010). Empirically, because panel data combines cross-sections and time series, STATA software can calculate and provide coefficient estimates for each variable in the model.

The first stage of the 2SLS model, the dependent variable of Equation (1) (i.e. $DCEI_{it}$) is regressed over independent variable, and the predicted value of $DCEI_{it}$ is saved as $\widehat{DCEI}_{it}$. The second stage of the 2SLS model, Equation (2) is estimated using the predicted value of $DCEI_{it}$ (i.e. $\widehat{DCEI}_{it}$) instead of the original variable ($DCEI_{it}$) to explore the nature of relationship between $\widehat{DCEI}$ and ROE.

Moreover, Z is a vector of variables which contains a set of control variables that might affect ROE, such as financial leverage (LEV) (Han et al., 2016), asset growth rate (GROW) (Alareeni and Hamdan, 2020), operating profit ratio (OPR) (Chari and Mohanty, 2007), and research and development intensity (RD) (Andersen and Dejoy, 2011). LEV is measured as total debts divided by total assets of the firm; GROW is measured by dividing the difference between the ending value and the beginning value of total assets by the beginning value of total assets; OPR is measured as operating profit divided by net revenue of the firm; RD is measured as expenditures by a firm on its research and development divided by the firm's net revenue. Finally, $\varepsilon 2$ is an error term, and β_0 is the constant. For our hypotheses H5–1 to be confirmed, the coefficient $\beta_1$must be positive and statistically significant in Equation (2).

Again, this paper also measured a firm's financial performance and economic sustainability by SGR (Murphy, 2020). SGR is defined as the highest growth rate that a company can maintain without increasing its financial leverage or seeking external financing. SGR is the product of ROE and retention ratio (RR) (Murphy, 2020). RR is obtained by subtracting the firm's dividend payout ratio from 1. If the dividend payout is 20%, the SGR expected will be only 80% of the ROE rate. In short, SGR is the growth rate after removing the effect of dividend payout rate from ROE. According to the above explanation, Z is a vector of variables which contains a set of control variables that might also affect SGR. Therefore, to test our hypotheses H5–2, this research replaces the dependent variable ROE in Equation (2) with SGR and proposes Equation (3) as follows:

$$SGR_{it} = \gamma_0 + \gamma_1 \widehat{DCEI}_{it} + \gamma_2 Z + \varepsilon 3_{it} \quad (3)$$

Equation (3) is estimated using the predicted value of $DCEI_{it}$ (i.e. $\widehat{DCEI}_{it}$) instead of the original variable ($DCEI_{it}$) to explore the nature of relationship between $\widehat{DCEI}$ and SGR. For our hypotheses H5–2 to be confirmed, the coefficient $\gamma_1$must be positive and statistically significant in Equation (3).

4. Results

4.1. Descriptive statistics

The descriptive statistics of our sample over a period of 7 years from 2011 to 2017, including mean, standard deviation, minimum value and maximum value, are provided in Table 3. The total score

Table 3
Descriptive statistics.

	Mean	Standard deviation	Minimum value	Maximum value
DCEI	2.60	1.88	1.0	12
Reducing	1.91	1.14	0	6
Reusing	0.37	0.64	0	3
Recycling	0.15	0.42	0	3
Certificate	0.17	0.38	0	1
OWNT	0.55	0.50	0	1
SI	0.80	0.40	0	1
SIZE	0.44	0.50	0	1
PROFIT	0.98	0.14	0	1
SGR	0.09	0.09	−0.9	1
ROE	0.09	0.09	−0.9	1
LEV	0.49	0.20	0	1
GROW	2.27	3.16	0	35
OPR	0.27	0.17	−0.3	1
RD	0.12	0.01	0.06	0.25
Number of firms	3768			

Note: The symbols refer to the nomenclature section.

Table 4
Correlation matrix of variables in the empirical model.

	DCEI	OWNT	SI	SIZE	PROFIT	LEV	GROW	OPR	RD	ROE	SGR
DCEI	1										
OWNT	0.106***	1									
SI	0.108***	0.0538***	1								
SIZE	0.279***	0.251***	−0.101***	1							
PROFIT	0.00611	−0.0245	−0.00339	0.0683***	1						
LEV	0.115***	0.208***	−0.195***	0.162***	−0.0307*	1					
GROW	−0.142***	−0.236***	0.133***	−0.185***	0.0517***	−0.249***	1				
OPR	−0.111***	−0.184***	−0.0671***	−0.141***	0.0831***	−0.298***	0.129***	1			
RD	−0.0507***	−0.0375**	0.0782***	−0.0998***	−0.0190	−0.125***	0.174***	0.153***	1		
ROE	−0.0230	−0.0597***	−0.0493***	0.0839***	0.202***	−0.0980***	0.145***	0.263***	−0.0399**	1	
SGR	0.0243**	−0.0632***	−0.0437***	0.0782***	0.200***	−0.107***	0.154***	0.167***	−0.0386**	0.0567**	1

Note: * $p<0.1$, ** $p<0.05$, *** $p<0.01$; The symbols refer to the nomenclature section.

of DCEI is 13 points, and the sample firms have an average of 2.60 points. In the reducing, reusing and recycling dimensions, the mean scores are 1.91, 0.37 and 0.15 respectively. Certification is a dummy variable, which is 1 if the firm has acquired any international certificate and is 0 if otherwise. The mean score of this variable is 0.17. It can be observed from these statistics that the overall disclosure score is low, and the score is mainly contributed by achievements in the energy saving and waste reduction subdimensions.

OWNT is a dummy variable, where 1 denotes SOE and 0 denotes POE. The mean of this variable is 0.55. SI is a dummy variable, which is 1 if the firm belongs to ESIs and is 0 if otherwise. The mean of this variable is 0.80. SIZE is a dummy variable measured by the natural logarithm of ending total assets. It is 1 if the firm has a value higher than the average and is 0 if otherwise. The mean of this variable is 0.44. PROFIT is a dummy variable, where 1 denotes that the firm has a positive net profit and 0 denotes that the firm gains no profit in current year. The mean is 0.98. When the values of a variable do not follow normal distribution, a square root, logarithm or Box-Cox can be taken to make them normally distributed (Osula and Adebisi, 2001). In this study, DCEI has a skewness value of 1.471>0; GROW has a skewness value of 4.490>0. Both values are positive (skewed to the right), suggesting that these variables with a lower value constitute the majority. Therefore, this study converted data of these variables into natural logarithms for subsequent regression analysis.

4.2. Correlation analysis

Before regression analysis, collinearity of variables in the regression model should be tested. This study used a Pearson's correlation matrix to observe the correlations among the variables in the empirical model. Correlation coefficient greater than 0.7 indicates collinearity between the two variables. According to Table 4, there is no collinearity between any two variables.

4.3. Regression analysis

As shown in Table 5 and Table 6, in the full sample (7 years), OWNT is positive (coefficient=0.0354, $t = 1.64$) but does not reach the level of significance. Hence, H1 is not supported. This finding echoes the result of Lu and Abeysekera (2014). In the subsample of the early 12th-five period, the relationship between OWNT and DCEI is not significant (coefficient=0.0441, $t = 1.07$). However, the results in the late 12th-five period (coefficient=0.0994, $t = 3.28$) and the early 13th-five period (coefficient=0.0775, $t = 2.04$) suggest that SOEs disclose more circular economy information. This implies that the regulations governing DCEI were not fully established in the early 12th-five period. With the lapse of time, many measures had been introduced to support the implementation of the regulations. As a result, in the later periods, SOEs would comply with legal requirements and disclose more circular economy information to become a leader in implementing this policy.

Among the firm characteristics, SI is positively and significantly related to DCEI (coefficient=0.227, $t = 8.66$). This finding is consistent with the findings of previous studies (Liu and Anbumozhi, 2009; Lu and Abeysekera, 2014). Hence, H2 is supported. This hypothesis also holds in the three subsamples. This suggests that firms in ESIs would disclose more circular economy information to express that their environmental performances are good enough to protect them from the risk of business suspension and to further maintain their competitive advantages.

Table 5
The affecting factors on disclosure of circular economy information and its impact to the firm's return on equity.

	2011–2017(Full sample)		2011–2012(Early 12th-five period)		2013–2015(Late 12th-five period)		2016–2017(Early 13th-five period)	
	DCEI	ROE	DCEI	ROE	DCEI	ROE	DCEI	ROE
OWNT	0.0354		0.0441		0.0994***		0.0705**	
	(1.64)		(1.07)		(3.28)		(2.04)	
SI	0.227***		0.151***		0.165***		0.357***	
	(8.66)		(3.06)		(4.47)		(8.59)	
SIZE	0.386***		0.305***		0.341***		0.337***	
	(17.78)		(7.26)		(11.21)		(9.61)	
PROFIT	−0.0573		0.0328		−0.178		0.0401	
	(−0.80)		(0.26)		(−1.64)		(0.35)	
$\widehat{DCEI}$		0.0509***		0.104***		0.0485***		0.0451***
		(6.49)		(4.43)		(3.23)		(4.12)
LEV		0.0740***		0.0533		0.0628**		0.0643***
		(5.10)		(1.60)		(2.53)		(3.06)
GROW		0.0169***		0.00705		0.0194***		0.0127***
		(5.35)		(0.99)		(3.57)		(2.86)
OPR		0.227***		0.282***		0.259***		0.176***
		(22.32)		(11.80)		(14.65)		(11.72)
RD		−0.602***		−0.340		−0.711***		−0.482***
		(−5.71)		(−1.28)		(−4.21)		(−3.10)
_cons	0.411***	−0.0509***	0.257*	−0.0594**	0.369***	−0.0482***	0.548***	−0.0461***
	(5.48)	(−4.66)	(1.93)	(−2.42)	(3.25)	(−2.82)	(4.71)	(−2.58)
Number of firms	3768	3768	942	942	1499	1499	1327	1327
Wald chi2 (6)		612.78		150.32		291.17		166.21
Prob > chi2		0.0000		0.0000		0.0000		0.0000
Durbin	48.0344 (p = 0.0000)		32.2913 (p = 0.0000)		10.1315 (p = 0.0015)		14.5901 (p = 0.0001)	
Wu-Hausman F	48.5642 (p = 0.0000)		33.1891 (p = 0.0000)		10.1528 (p = 0.0015)		14.6745 (p = 0.0001)	

Note: The value within parentheses is t; * p<0.1, ** p<0.05, *** p<0.01; The symbols refer to the nomenclature section.

Table 6
The affecting factors on disclosure of circular economy information and its impact to the firm's sustainable growth rate.

	2011–2017(Full sample)		2011–2012(Early 12th-five period)		2013–2015(Late 12th-five period)		2016–2017(Early 13th-five period)	
	DCEI	SGR	DCEI	SGR	DCEI	SGR	DCEI	SGR
OWNT	0.0354		0.0441		0.0994***		0.0705**	
	(1.64)		(1.07)		(3.28)		(2.04)	
SI	0.227***		0.151***		0.165***		0.357***	
	(8.66)		(3.06)		(4.47)		(8.59)	
SIZE	0.386***		0.305***		0.341***		0.337***	
	(17.78)		(7.26)		(11.21)		(9.61)	
PROFIT	−0.0573		0.0328		−0.178		0.0401	
	(−0.80)		(0.26)		(−1.64)		(0.35)	
$\widehat{DCEI}$		0.0509***		0.101***		0.0494***		0.0458***
		(6.51)		(4.37)		(3.30)		(4.18)
LEV		0.0706***		0.0508		0.0585**		0.0613***
		(4.89)		(1.55)		(2.37)		(2.92)
GROW		0.0172***		0.00739		0.0194***		0.0132***
		(5.45)		(1.04)		(3.58)		(2.98)
OPR		0.226***		0.279***		0.259***		0.176***
		(22.33)		(11.82)		(14.71)		(11.70)
RD		−0.601***		−0.349		−0.712***		−0.473***
		(−5.72)		(−1.33)		(−4.23)		(−3.04)
_cons	0.411***	−0.0509***	0.257*	−0.0578**	0.369***	−0.0483***	0.548***	−0.0473***
	(5.48)	(−4.66)	(1.93)	(−2.38)	(3.25)	(−2.83)	(4.71)	(−2.64)
Number of firms	3768	3768	942	942	1499	1499	1327	1327
Wald chi2 (6)		622.51		152.25		297.34		168.52
Prob > chi2		0.0000		0.0000		0.0000		0.0000
Durbin	48.3846 (p = 0.0000)		30.8256 (p = 0.0000)		10.6761 (p = 0.0011)		15.2329 (p = 0.0001)	
Wu-Hausman F	48.923 (p = 0.0000)		31.6317 (p = 0.0000)		10.7025 (p = 0.0011)		15.3285 (p = 0.0001)	

Note: The value within parentheses is t; * p<0.1, ** p<0.05, *** p<0.01; The symbols refer to the nomenclature section.

As found in the literature (Lu and Abeysekera, 2014; Lee et al., 2017; Meng et al., 2014), larger firms are also significantly related to higher DCEI (coefficient=0.386, t = 17.78). Hence, H3 is supported. This hypothesis also holds across the three subsamples. This implies that in order to fulfill CSR and create a better image, large firms will disclose more circular economy information. While meeting public expectations, the disclosure can also convey to major stakeholders that the company has adopted a new business model for creating profits and caring for the environment. The message will attract more green investors and consolidate the firm's competitive advantage. Firms with better financial profitability are found to be negatively related to DCEI but not to the level of significance (coefficient=−0.0573, t=−0.80). Therefore, H4 is not supported. The results in the three subsamples also reject this hypothesis.

As shown in Table 5, $\widehat{DCEI}$ is positively and significantly related to ROE. (coefficient=0.0509, t = 6.49). It can also be found in Table 6 that $\widehat{DCEI}$ is positively and significantly related to SGR (coefficient=0.0509, t = 6.51). These two findings indicate that firms which disclosed more circular economy information were as-

Table 7
The affecting factors on disclosure of circular economy information and its impact to the firm's sustainable growth rate (robustness test).

	2011–2017 (Full sample)		2011–2012 (Early 12th-five period)		2013–2015 (Late 12th-five period)		2016–2017 (Early 13th-five period)	
	DCEI	SGR2	DCEI	SGR2	DCEI	SGR2	DCEI	SGR2
OWNT	0.0354		0.0441		0.0994***		0.0705**	
	(1.64)		(1.07)		(3.28)		(2.04)	
SI	0.227***		0.151***		0.165***		0.357***	
	(8.66)		(3.06)		(4.47)		(8.59)	
SIZE	0.386***		0.305***		0.341***		0.337***	
	(17.78)		(7.26)		(11.21)		(9.61)	
PROFIT	−0.0573		0.0328		−0.178		0.0401	
	(−0.80)		(0.26)		(−1.64)		(0.35)	
$\widehat{DCEI}$		0.0536***		0.135***		0.0317**		0.0486***
		(4.97)		(4.26)		(2.49)		(3.32)
LEV		0.0763***		0.0614		0.0681*		0.0518*
		(3.83)		(1.37)		(1.94)		(1.84)
GROW		0.0139***		0.00512		0.0142*		0.00898
		(3.21)		(0.53)		(1.85)		(1.51)
OPR		0.296***		0.387***		0.322***		0.231***
		(21.23)		(11.99)		(12.90)		(11.50)
RD		−0.791***		−0.483		−0.882***		−0.665***
		(−5.47)		(−1.35)		(−3.69)		(−3.19)
_cons	0.411***	−0.0533***	0.257*	−0.0861***	0.369***	−0.0385	0.548***	−0.0424*
	(5.48)	(−3.55)	(1.93)	(−2.60)	(3.25)	(−1.59)	(4.71)	(−1.77)
Number of firms	3768	3768	942	942	1499	1499	1327	1327
Wald chi2 (6)		521.59		152.93		210.91		151.83
Prob > chi2		0.0000		0.0000		0.0000		0.0000
Durbin	29.2077 ($p = 0.0000$)		27.8146 ($p = 0.0000$)		11.42047 ($p = 0.0008$)		9.19087 ($p = 0.0024$)	
Wu-Hausman F	29.3812 ($p = 0.0000$)		28.4479 ($p = 0.0000$)		12.41306 ($p = 0.0005$)		9.20615 ($p = 0.0025$)	

Note: The value within parentheses is t; * $p<0.1$, ** $p<0.05$, *** $p<0.01$; The symbols refer to the nomenclature section.

sociated with significantly higher ROE and SGR. (i.e. indicators of corporate economic sustainability). H5–1 and H5–2 are supported not only in the full sample but also in all the subsamples. It can be inferred that corporate disclosure of their efforts in "recovery of resources from waste" provides the environmental information required by the national policy. Moreover, it also allows stakeholders to avoid adverse selection when making green investments or offering green financing. There are also benefits of the disclosure for enterprises, including reduced government supervision, having access to more favorable financing terms and lower capital cost. These benefits can ultimately help firms create a green competitive advantage and gain more profits.

4.4. Robustness test

A different measure of SGR has been proposed. Ross et al. (2019) propose to measure SGR by (ROE × RR)/(1-ROE × RR). This study further used this measure (denoted by SGR2 in the Table 7) to test the robustness of our findings. As shown in Table 7, $\widehat{DCEI}$ is still positively and significantly related to SGR2 (coefficient=0.0536, $t = 4.97$). This finding is consistent with the conclusion obtained above.

5. Discussion

5.1. Discussion of results

The objective of this study is two-fold. One is to investigate the effects of four firm characteristics, namely ownership type, environmental impacts of industry, firm size, and financial profitability on DCEI. The other is to examine if disclosing circular economy information can lead to higher SGR and ROE (i.e. indicators of corporate economic sustainability). The empirical results show that state ownership is not significantly related to DCEI in China. However, there is a remarkable finding in the subsamples, that is, with the lapse of time, SOEs would increase DCEI as a response to the government's policy. This suggests SOEs gradually became a leader in implementing the circular economy policy during 2013–2017 (from late 12th-five period to the early 13th-five period). Firms in ESIs and larger firms are positively and significantly related to DCEI. According to voluntary disclosure theory and green competitiveness theory, when a company actively releases information on their circular economy 3R activities, it conveys the signal of sustainable development to the shareholders. These benefits can ultimately result in higher green competitiveness, which allows the enterprises to create higher financial return. The robustness test also offers additional support for this finding.

Our empirical results indicate that the sample firms have a low average score of DCEI, and about 80% of which is contributed by the score in the reducing dimension. A plausible explanation is that the requirements in the reducing dimension are easier to accomplish, and the level of technology involved and the cost of adoption are also lower. This study suggests that while maintaining effort in the reducing dimension, enterprises should be more active in developing their actions in the reusing and recycling dimensions. There is still large room for improvement in these two dimensions.

From the viewpoint of sustainable production, Maitre-Ekern (2021) argues that the transition to a sustainable circular economy requires moving away from linear production processes and the throwaway mentality. Specifically, the responsibility of producers should cover the products' entire life cycle, not just their end-of-life. From the perspective of sustainable consumption, Elzinga et al. (2020) stress the importance of understanding the demand-side of circular economy. A number of studies have suggested that certain customers are willing to pay more for products with labels that signal social and environmental benefits (e.g. Tully and Winer 2014; Chen et al., 2018). According to Boyer et al. (2021), customers generally prefer a more circular product when compared to products with otherwise identical attributes. Besides, customers are consistently willing to pay more for products with low or moderate levels of circular content. Applying circular economy label at low or moderate levels of recycled content could be a profitable strategy for manufacturers

of products such as mobile phones and robot vacuum cleaners. Moreover, Fan et al. (2020) also found a positive relationship between environmental disclosure quality and firm valuation among Chinese firms in the high-polluting industries. Our findings support recent studies which suggest that firms which take 3R actions and disclose substantive information tend to have significantly higher firm valuation.

5.2. Implications for research

Zhu et al. (2010) indicate that large firms tend to be more active in implementing environmental practices in order to exceed their competitors. This research examines whether Chinese firms, including firms in ESIs, have adopted more substantive 3R actions related to resources efficiency to mitigate global warming.

The empirical results are also consistent with the environmental management literature, showing that the real value of environmental actions to ESIs lies in those actions that can effectively eliminate environmental burdens and recover the value of waste resources, rather than just the actions of impression management.

5.3. Implications for practice

Environmental stances are difficult to fake, especially for a firm in ESIs. Previous research has shown that managers may respond to stakeholder expectations with symbolic responses rather than substantive actions. Our results confirm that corporate engagement in recovery of resources from waste does not harm the interests of shareholders and will instead boost financial value. Corporate managers may consider adoption of this win-win strategy for achieving environmental and economic goals at the same time.

5.4. Implications for national policy

The policy goal of developing a circular economy in China is to alleviate the sharp contradiction between economic growth and environmental resource consumption. In 2009, China implemented and established a special fund for circular economy to encourage research and development of techniques and products that meet the principles of circular economy. China also offered tax incentives to industrial activities that promote the development of circular economy. Empirical evidence shows that this national policy has a guiding effect on enterprises.

5.5. Implications for society and public's attitudes

In China, organizations can achieve environmental legitimacy by meeting the expectations of their society; however, expectations for environmental performance seem to be changing. The requirements and expectations of the government and the general public for firms may be different now than they were ten years ago. The attitude of the Chinese government and the public towards corporate environmental behavior may be the driving force for Chinese companies to move towards green and environmental protection. The results of this study indicate that using CSR reports to disclose substantive 3R environmental actions may help companies in ESIs to establish their legitimacy image and increase their financial performance.

5.6. Limitation and future research

There are two limitations to this study. One limitation is that employing an empirical model which is based on normalization of values and quantification of qualitative information entails some risks. Normalized values frequently do not reflect the difference of real values within a single quantity, and may lead to inaccurate information in strategic decisions.

Fujii and Tatsuo (2012) pointed out that the environmental management mechanism varies by region and country. This is because every region or country has its own environmental plan established based on its unique corporate governance model and economic system. The other limitation of this research is that this study only focuses on Chinese companies. These results cannot be generalized to other developed or developing countries. Further research is needed to investigate the circular economy 3R actions of firms in developing countries, as well as in developed countries. The obtained results can clarify the relationship between disclosure of circular economy information and the important indicators of corporate economic sustainability and establish more general inferences.

6. Conclusions

The Chinese government has implemented the circular economy-related legislation for guiding firms' responsible production in 2009. The government uses legislation, tax subsidies or preferential treatments to influence corporate strategies, so the government is the most influential stakeholder in China. Enterprises need to disclose circular economy information to demonstrate their compliance with the policy requirements set forth by the government. The empirical evidence shows that firms in ESIs and larger firms disclose significantly more circular economy information to meet the information needs of key stakeholders. The study also shows that SOEs significantly played the role of a leader in implementing circular economy during 2013–2017. From the policy effect of circular economy, government played a major stimulating role in promoting the transition of firms towards circular economy in China.

Besides, firms which disclose more circular economy information are associated with significantly higher SGR and ROE. Our results confirm that corporate engagement in recovery of resources from waste does not harm the interests of shareholders and will instead boost financial value. Corporate managers may consider adoption of this win-win strategy for achieving environmental and economic goals at the same time. Our results also show a promising path for firms considering a transition to circular business models, because the customers gradually prefer a more circular product when compared to products with otherwise identical attributes. Moreover, the attitude of the Chinese government and the public towards corporate environmental behavior may be the driving force for Chinese companies to move towards green and environmental protection.

However, the findings of this study benefit both internal users (such as managers and shareholders) and external users (such as policy makers). The corporate managers may reconsider and redesign production processes towards zero waste and resource effectiveness. Shareholders do not need to worry that the adoption of circular economy operations will damage the profits of the company. The policy makers can review the effect of this legislation on the promotion of circular economy by enterprises. The contribution of this paper is that it clarifies the affecting factors and financial impacts of circular economy information for Chinese firms. This study can fill the literature gap related to new highlights of environmental disclosure focusing on 3R actions in developing countries. Further research is needed to investigate the circular economy 3R actions of firms in developing countries, as well as in developed countries. Additionally, there is no comparative analysis of circular economy in developed and emerging economies. The aforementioned research gaps in circular economy can be used as the direction of future research.

Declaration of Competing Interest

No conflict of interest.

References

Adomako, S., Amankwah-Amoah, J., Danso, A., Konadu, R., Owusu-Agyei, S., 2019. Environmental sustainability orientation and performance of family and non-family firms. Bus. Strat. Env. 28 (6), 1250–1259.

Aerts, W., Cormier, D., 2009. Media legitimacy and corporate environmental communication. Account. Organ. Soc. 34 (1), 1–27.

Alareeni, B.A., Hamdan, A., 2020. ESG impact on performance of US S&P 500-listed firms. Corp. Gov. 20 (7), 1409–1428.

Al-Tuwaijri, S.A., Christensen, T.E., Hughes II, K.E., 2004. The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach. Account. Organ. Soc. 29 (5–6), 447–471.

Andersen, M.L., Dejoy, J.S., 2011. Corporate social and financial performance: the role of size, industry, risk, R&D and advertising expenses as control variables. Bus. Soc. Rev. 116 (2), 237–256.

Anderson, M.S., 2007. An introductory note on the environmental economics of the circular economy. Sustain. Sci. 2 (1), 133–140.

Bastein, A.G.T.M., Roelofs, E., Rietveld, E., Hoogendoorn, A, 2013. Opportunities For a Circular Economy in the Netherlands. TNO, Delft.

Benlemlih, M., Girerd-Potin, I., 2017. Corporate social responsibility and firm financial risk reduction: on the moderating role of the legal environment. J. Bus. Finance Account. 44 (7–8), 1137–1166.

Berelson, B., 1952. Content Analysis in Communication Research. Free Press, Wilmington (IL).

Boyer, R.H.W., Hunka, A.D., Linder, M., Whalen, K., Habibi, S, 2021. Product Labels for the Circular Economy: are Customers Willing to Pay for Circular? Sustain. Prod. Consum. 27, 61–71.

Branco, M.C., Rodrigues, L.L., 2006. Corporate social responsibility and resource-based perspectives. J. Bus. Ethics 69 (2), 111–132.

Branco, M.C., Rodrigues, L.L., 2008. Factors influencing social responsibility disclosure by Portuguese companies. J. Bus. Ethics 83 (4), 685–701.

Brunori, C., Cremisini, C., Massanisso, P., Pinto, V., Torricelli, L., 2005. Reuse of a treated red mud bauxite waste: studies on environmental compatibility. J. Hazard. Mater. 117 (1), 55–63.

Burritt, R.L., Schaltegger, S., 2010. Sustainability accounting and reporting: fad or trend? Account. Audit. Account. J. 23 (7), 829–846.

Campbell, D., 2004. A longitudinal and cross-sectional analysis of environmental disclosure in UK companies—A research note. Br. Account. Rev. 36 (1), 107–117.

Chari, L.S., Mohanty, R.P., 2007. Value drivers of return on equity: a study of Indian companies. Int. J. Account. Audit. Perform. Eval. 4 (6), 633–649.

Chen, X., Gao, Z., Swisher, M., House, L., Zhao, X., 2018. Eco-labeling in the fresh produce market: not all environmentally friendly labels are equally valued. Ecol. Econ. 154, 201–210.

Chih, H.L., Shen, C.H., Kang, F.C., 2008. Corporate social responsibility, investor protection, and earnings management: some international evidence. J. Bus. Ethics 79 (1–2), 179–198.

Cho, C.H., Patten, D.M., 2007. The role of environmental disclosures as tools of legitimacy: a research note. Account. Organ. Soc. 32 (7–8), 639–647.

Choi, F.D.S, 1973. Financial disclosure and entry to the European capital market. J. Account. Res. 11, 159–175.

Clarkson, P.M., Fang, X., Li, Y., Richardson, G., 2013. The relevance of environmental disclosures: are such disclosures incrementally informative? J. Account. Public Policy 32 (5), 410–431.

Clarkson, P.M., Li, Y., Pinnuck, M., Richardson, G.D., 2015. The valuation relevance of greenhouse gas emissions under the European Union carbon emissions trading scheme. Eur. Account. Rev. 24 (3), 551–580.

Cormier, D., Gordon, I.M., 2001. An examination of social and environmental reporting strategies. Account. Audit. Account. J. 14 (5), 587–617.

Cormier, D., Magnan, M., 1999. Corporate environmental disclosure strategies: determinants, costs and benefits. J. Account. Audit. Finance 14 (4), 429–451.

Dye, R.A., 1985. Disclosure of nonproprietary information. J. Account. Res. 123–145.

Eiadat, Y., Kelly, A., Roche, F., Eyadat, H., 2008. Green and competitive? An empirical test of the mediating role of environmental innovation strategy. J. World Bus. 43 (2), 131–145.

Elijido-Ten, E. (2004). Determinants of environmental disclosures in a developing country: an application of the stakeholder theory. In Fourth Asia Pacific interdisciplinary research in accounting conference, Singapore.

Elzinga, R., Reike, D., Negro, S.O., Boon, W.P.C, 2020. Consumer acceptance of circular business models. J. Clean. Prod. 254, 119988.

Fan, L., Yang, K., Liu, L., 2020. New media environment, environmental information disclosure and firm valuation: evidence from high-polluting enterprises in China. J. Clean. Prod. 277, 123253.

Franklin-Johnson, E., Figge, F., Canning, L., 2016. Resource duration as a managerial indicator for Circular Economy performance. J. Clean. Prod. 133, 589–598.

Freeman, R.E., 1984. Strategic management: A stakeholder Perspective. Pitman, Boston.

Frishammar, J., Parida, V., 2019. Circular business model transformation: a roadmap for incumbent firms. Calif. Manage. Rev. 61 (2), 5–29.

Fujii, H., Tatsuo, K., 2012. Environmental management mechanisms in U.S., Japanese manufacturing firms. Int. J. Bus. Adm. 3 (6), 13–24.

García-Barragán, J.F., Eyckmans, J., Rousseau, S., 2019. Defining and measuring the circular economy: a mathematical approach. Ecol. Econ. 157, 369–372.

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32.

Han, J.-J., Kim, H.J., Yu, J., 2016. Empirical study on relationship between corporate social responsibility and financial performance in Korea. Asian J. Sustain. Soc. Responsib. 1 (1), 61–76.

Hassan, O.A., 2018. The impact of voluntary environmental disclosure on firm value: does organizational visibility play a mediation role? Bus. Strategy Environ. 27 (8), 1569–1582.

Hasseldine, J., Salama, A.I., Toms, J.S., 2005. Quantity versus quality: the impact of environmental disclosures on the reputations of UK Plcs. Br. Account. Rev. 37 (2), 231–248.

Hicks, C., Dietmar, R., Eugster, M., 2005. The recycling and disposal of electrical and electronic waste in China—Legislative and market responses. Environ. Impact Assess. Rev. 25 (5), 459–471.

Hooghiemstra, R., 2000. Corporate communication and impression management–new perspectives why companies engage in corporate social reporting. J. Bus. Ethics 27 (1–2), 55–68.

Hu, H., Chang, C.P., Dong, M., Meng, W.N., Hao, Y., 2018. Does environmental information disclosure affect the performance of energy-intensive firms' borrowing ability? evidence from China. Energy Environ. 29 (5), 685–705.

Hunka, A.D., Linder, M., Habibi, S., 2021. Determinants of consumer demand for circular economy products. A case for reuse and remanufacturing for sustainable development. Bus. Strat. Env. 30 (1), 535–550.

Jawahir, I.S., Bradley, R., 2016. Technological elements of circular economy and the principles of 6R-based closed-loop material flow in sustainable manufacturing. Procedia CIRP 40, 103–108.

Karim, K.E., Lacina, M.J., Rutledge, R.W., 2006. The Association Between Firm Characteristics and the Level of Environmental Disclosure in Financial Statement Footnotes. Emerald Group Publishing Limited, pp. 77–109 In Environmental accounting.

Kazancoglu, I., Sagnak, M., Kumar Mangla, S., Kazancoglu, Y., 2021. Circular economy and the policy: a framework for improving the corporate environmental management in supply chains. Bus Strat. Env. 30 (1), 590–608.

Kok, L., Wurpel, G., & Ten Wolde, A. (2013). Unleashing the Power of the Circular Economy. Report by IMSA Amsterdam for Circle Economy.

Korhonen, J., Nuur, C., Feldmann, A., Birkie, S.E., 2018. Circular economy as an essentially contested concept. J. Clean. Prod. 175, 544–552.

Krippendorff, K., 1980. Content analysis: An introduction to Its Methodology. Sage, Newbury Park, CA.

Kuo, L., Chen, Yi-Ju V, 2013. Is environmental disclosure an effective strategy on establishment of environmental legitimacy for organization? Manag. Decis. 51 (7), 1462–1487.

Kuo, L., Yeh, C.C., Yu, H.C., 2012. Disclosure of corporate social responsibility and environmental management: evidence from China. Corp. Soc. Respon. Environ. Manage. 19 (5), 273–287.

Kuo, L., Yu, H.C., Chang, B.G., 2015. The signals of green governance on mitigation of climate change-evidence from Chinese firms. Int. J. Clim. Chang. Strateg. Manag. 7 (2), 154–171.

Lee, E., Walker, M., Zeng, C.C., 2017. Do Chinese state subsidies affect voluntary corporate social responsibility disclosure? J. Account. Public Policy 36 (3), 179–200.

Li, W., Zhang, R., 2010. Corporate social responsibility, ownership structure, and political interference: evidence from China. J. Bus. Ethics 96 (4), 631–645.

Li, Y., Gong, M., Zhang, X.Y., Koh, L., 2018. The impact of environmental, social, and governance disclosure on firm value: the role of CEO power. Br. Account. Rev. 50 (1), 60–75.

Liu, X., Anbumozhi, V., 2009. Determinant factors of corporate environmental information disclosure: an empirical study of Chinese listed companies. J. Clean. Prod. 17 (6), 593–600.

Lo, S.F., Sheu, H.J., 2007. Is corporate sustainability a value-increasing strategy for business? Corp. Gov. Int. Rev. 15 (2), 345–358.

Lu, Y., Abeysekera, I., 2014. Stakeholders' power, corporate characteristics, and social and environmental disclosure: evidence from China. J. Clean. Prod. 64, 426–436.

Luo, L., Tang, Q., 2014. Does voluntary carbon disclosure reflect underlying carbon performance? J. Contemp. Account. Econ. 10 (3), 191–205.

Maitre-Ekern, E., 2021. *Re*-thinking producer responsibility for a sustainable circular economy from extended producer responsibility to pre-market producer responsibility. J. Clean. Prod. 286, 125454.

Manninen, K., Koskela, S., Antikainen, R., Bocken, N., Dahlbo, H., Aminoff, A., 2018. Do circular economy business models capture intended environmental value propositions? J. Clean. Prod. 171, 413–422.

Mao, Y., Wang, J., 2018. Is green manufacturing expensive? Empirical evidence from China. Int. J. Prod. Res. 1–13.

Melloni, G., Caglio, A., Perego, P., 2017. Saying more with less? disclosure conciseness, completeness and balance in integrated reports. J. Account. Public Policy 36 (3), 220–238.

Meng, X.H., Zeng, S.X., Leung, A.W., Tam, C.M., 2015. Relationship between top executives' characteristics and corporate environmental responsibility: evidence from China. Hum. Ecol. Risk Assess. Int. J. 21 (2), 466–491.

Meng, X.H., Zeng, S.X., Shi, J.J., Qi, G.Y., Zhang, Z.B., 2014. The relationship between corporate environmental performance and environmental disclosure: an empirical study in China. J. Environ. Manage. 145, 357–367.

Murphy, C.B. (2020). Sustainable Growth Rate – SGR Definition. Retrieved from https://www.investopedia.com/terms/s/sustainablegrowthrate.asp

Osula, D.O., Adebisi, O., 2001. Testing the stability of travel expenditures in Nigeria. Transp. Res. Part A Policy Pract. 35 (4), 269–287.
Patten, D.M., 1991. Exposure, legitimacy, and social disclosure. J. Account. Public Policy 10 (4), 297–308.
Patten, D.M., 2002. The relation between environmental performance and environmental disclosure: a research note. Account. Organ. Soc. 27 (8), 763–773.
Porter, M., van der Linde, C., 1995. Green and competitive: ending the stalemate. Harv. Bus. Rev. 73 (5), 120–134.
Rennings, K., 2000. Redefining innovation—Eco-innovation research and the contribution from ecological economics. Ecol. Econ. 32 (2), 319–332.
Roberts, R.W., 1992. Determinants of corporate social responsibility disclosure: an application of stakeholder theory. Account. Organ. Soc. 17 (6), 595–612.
Ross, S.A., Westerfield, R.W., Jordan, B.D., 2019. Fundamentals of Corporate Finance. McGraw-Hill.
Sarkis, J., Zhu, H., 2008. Information technology and systems in China's circular economy: implications for sustainability. J. Syst. Inf. Technol. 10 (3), 202–217.
Schaltegger, S., Wagner, M., 2006. Integrative management of sustainability performance, measurement and reporting. Int. J. Account. Audit. Perform. Eval. 3 (1), 1–19.
Schlegelmilch, B.B., Pollach, I., 2005. The perils and opportunities of communicating corporate ethics. J. Mark. Manage. 21, 267–290.
Semykina, A., Wooldridge, J.M., 2010. Estimating panel data models in the presence of endogeneity and selection. J. Econom. 157 (2), 375–380.
Sposato, P., Preka, R., Cappellaro, F., Cutaia, L., 2017. Sharing economy and circular. How technology and collaborative consumption innovations boost closing the loop strategies. Environ. Eng. Manag. J. 16 (8), 1797–1806.
Stahel, W.R., 2016. The circular economy. Nature 531 (7595), 435–438.
Steurer, R., 2010. The role of governments in corporate social responsibility: characterising public policies on CSR in Europe. Policy Sci 43 (1), 49–72.
Su, B., Heshmati, A., Geng, Y., Yu, X., 2013. A review of the circular economy in China: moving from rhetoric to implementation. J. Clean. Prod. 42, 215–227.
Tully, S.M., Winer, R.S., 2014. The role of the beneficiary in willingness to pay for socially responsible products: a meta-analysis. J. Retail. 90 (2), 255–274.
Ullmann, A.A., 1985. Data in search of a theory: a critical examination of the relationships among social performance, social disclosure, and economic performance of US firms. Acad. Manage. Rev. 10 (3), 540–557.
Verrecchia, R., 1983. Discretionary disclosure. J. Account. Econ. 5, 179–194.
Wang, P., Che, F., Fan, S., Gu, C., 2014. An institutional theory and corporate governance theory perspective. Chinese Manag. Stud. 8 (3), 487–501.
Wang, P., Wang, F., Hu, N., 2018. The effect of ultimate ownership on the disclosure of environmental information. Aust. Account. Rev. 28 (2), 186–198.
Xue, B., Chen, X.P., Geng, Y., Guo, X.J., Lu, C.P., Zhang, Z.L., Lu, C.Y., 2010. Survey of officials' awareness on circular economy development in China: based on municipal and county level. Resour. Conserv. Recycl. 54 (12), 1296–1302.
Yu, H.C., Tsai, B.Y., 2018. Environmental policy and sustainable development: an empirical study on carbon reduction among Chinese enterprises. Corp. Soc. Responsib. Environ. Manag. 25 (5), 1019–1026.
Yu, Y., 2015. An empirical analysis of the relationship between environmental performance and sustainable e-governance in China. Technol. Forecast. Soc. Change 96, 71–78.
Zhu, Q., Zhang, Q., 2015. Evaluating practices and drivers of corporate social responsibility: the Chinese context. J. Clean. Prod. 100, 315–324.
Zhu, Q., Geng, Y., Fujita, T., Hashimoto, S., 2010. Green supply chain management in leading manufacturers-case studies in Japanese large companies. Manag. Res. Rev. 33 (4), 380–392.
Zhu, Z., Chu, F., Dolgui, A., Chu, C., Zhou, W., Piramuthu, S., 2018. Recent advances and opportunities in sustainable food supply chain: a model-oriented review. Int. J. Prod. Res. 1–23.