A study of corporate social responsibility and innovation: Evidence from US firms

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Submitted to Swansea University in fulfilment of the requirements for the Degree of Doctor of Philosophy

2022
Swansea University

Summary:

This thesis studies the relation between corporate social responsibility and innovation. We discuss the effect based on different corporate social responsibility types which are institutional corporate social responsibility and technical corporate responsibility. Innovation is measured on both quantity level which is measured by the number of patents and quality level which is measured by the number of citations. This thesis also discusses the effects on corporate social responsibility and innovation from CEO education background perspectives. We employ ordinary least square and quantile estimation model in baseline regression. In addition, we employ propensity score matching approach and instrumental variable approach to address endogeneity concerns. Moreover, this thesis also involves how to apply propensity score matching approach and instrumental variable approach in quantile regression. We get the results as following: (1) corporate social responsibility generally has positive effect on innovation on both quality and quantity levels; (2) institutional corporate social responsibility conductive innovation on two levels; (3) technical corporate social responsibility inhibit innovation on both levels; (4) the effect of different corporate social responsibility types on innovation only affect firms with higher innovation outputs counts and better innovation outputs quality; (4) CEO with MBA degree promote corporate social responsibility and institutional corporate social responsibility for firms with higher corporate social responsibility scores; (5) CEO with later bachelor's degree awarded year tend to choose technical corporate social responsibility for the firms with lower technical corporate social responsibility scores; (6) the earlier CEO has MBA awarded year the better for firm have a good innovation quality; (7) and the earlier CEO has bachelor awarded year the better innovation performance for the firms with good innovation condition on both quality and quantity level.

Declarations and Statements

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed.....  .....

Date.....28/12/2022.....

This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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I hereby give my consent for my work, if relevant and accepted, to be available for photocopying and for inter-library loans **after expiry of a bar on access approved by the University.**

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The University's ethical procedures have been followed and, where appropriate, that ethical approval has been granted.

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Acknowledgements

Upon finishing my PhD dissertation, I would like to express my sincere appreciation to all those who have offered me invaluable help in this process.

First and foremost, I would like to appreciate my supervisors Dr Yuzhi Cai and Dr Xicheng Liu. I am deeply indebted to my respectable supervisor Dr Yuzhi Cai for her constant support and patience throughout my research and writing process. She not only affects me through her scholarly advice and expert guidance which lead me to be a real researcher, but also her charisma and professional personal characteristics which make me expect myself to be an excellent person just like her. Yuzhi's prudent and conscientious attitude towards academic research has impressed me. Her passion always inspires me during my PhD candidate period and will continuously inspire me in my future career development. I am a lucky person to be supervised by such a wonderful supervisor. Without her consistent and illuminating instruction, this dissertation could not have reached its present form.

I am thankful to all my friends for their thoughtfulness and encouragement. I am thankful to Yaping who is a generous girl and more fun than anyone and accompany me for the whole PhD stage. She has always been there for me unconditionally to wipe my tears and bring me joy. I am so lucky to have her in my life which brings me a lot of sweet memories and makes my PhD life sweeter and more colourful.

Also, I should give my hearty thanks to all the other faculty members of the Department of Accounting and Finance for their support. It is a happy journey to spend my master's and PhD time studying and working here with those lovely people.

In the end, I would also like to thank my parents for their support from the very beginning of my study. No matter how difficult I meet, they always are my back to encourage me so I can be brave and go ahead. They are the most brilliant parents in this world. Mom, I love you; Dad, I love you.

Swansea, UK, December 2022

Tianyi

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Introduction

1. Introduction of first essay

The first essay, "Can CSR conducive innovation?", contributes to the literature on the influence of CSR on innovation by empirically identifying that how and what types of CSR can promote firm innovative activity. To this end, the essay focusses specifically on the relationship between CSR/ICSR/TCSR on innovation outcomes during 1991 to 2007.

The estimation is based on the United Stated between 1991 and 2007. The CSR/ICSR/TCSR scores is extracted from MSCI ESG STATS (MSIC) database, the innovation information is acquired from NBER (National Bureau of Economic Research) and then matched and merged with the corporate level information from Compustat dataset. From the perspective of CSR based on different stakeholder's impact may have different impact on innovation output, this essay constructs ICSR scores targeting secondary stakeholders, TCSR scores targeting primary stakeholders, the number of patents measuring innovation output quantity and the number if citation measuring innovation output quality. More specifically, the calculation of ICSR involved community and diversity dimensions and the calculation of TCSR involved corporate governance, employee relations and product quality dimensions. The various CSR score are calculated based on the total strengths of each dimension minus total concerns of each dimension. Our variable construction has the advantage of greatly capture the innovation output on both quantity and quality level and go further of the impact of CSR.

The result provides evidence that CSR is positively and significantly associated with the number of patent and the number of citations. This shows that generally CSR providing an insurance like environment for innovation activity. What is more, ICSR is positively and significantly associated with innovation while TCSR is negatively and significant associated with innovation. The positive relationship is consistent with the theoretical prediction that secondary stakeholders have a long-term sight when focusing on CSR activities. The negative relationship is observed because primary stakeholders more care about short profit and have urgent to achieve their working target to prove themselves. Those ICSR activity take a real insurance like effect on innovation since innovation is a long-term and high risky activity and long-terms corporate social responsibility activity provide innovation a safer environment. Firms get allegiance from their employees, get support from their governments and get trust form their customers to offsetting the negative impact of the failure of innovation. ICSR likely provides greater tolerance and a friendly environment for innovation activities from a sustainable perspective.

The essay offers several extension tests to the baseline model. We used sub-sample to observe whether the results change with the time changing. This finds that our results do not change with the time changing and indicating that micro economic environment does not affect our results. The second extension test is additional considering the effect of firm size to the relationship between CSRs and innovation. The result shows that firm size does not affect our proposition. To solve unobserved heterogeneity issues in endogeneity problem, we employed another extension test--- PSM (propensity score matching). The results suggest that there is no endogeneity problem in the estimated models and firms involved in CSR and ICSR activities

have higher innovation outputs, but TCSR are not. To alleviate concern related to the potential endogeneity problem, this essay employs instrumental variable (IV) analysis. The results suggest that the baseline result is robust to the estimation.

Besides, firm size and cash flow interaction term are constructed to test the moderation effect of firm size and financial constraints. The results show (1) CSR/ICSR/TCSR still have significant effect on innovation on both quantity and quality level (2) firm level and financial constraints significantly have positive on innovation (3) after add interaction term into the regression, firm size and cash constraints shows a significant positive effect on innovation although not significant for interaction term which enhance the test efficiency in some extent. Chapter one contributes on both theoretical level and practice level. This chapter provide more evidence on agency theory, resource-based view, natural resource-based view and resource dependent theory. For innovative firm who is looking for a sustainability strategy could consider invest on ICSR activity since this type of investment bring firms benefits in a long-term. Government and public institutions could engage in firm CSR activity which will help firms in their community have a healthy development.

2. Introduction of second essay

The second essay, "Does CSR have same effect on different innovation level firms: a quantile regression analysis, contributes to the effect of CSR related activities to different innovation quantile levels of the firm. The dataset is same as essay one but focus on different research question. The analysis employed quantile regression to detect the effect on each quantile level. We divided the while distribution of the number of patent and the number of citation to five quantiles: 5%, 25%, 50%, 75%, and 95%. Patent and citation count lower than 50% quantile level is seen as low innovation output firm, while high innovation output firms are defined with greater patent and citation counts than 50%. Firms with patent and citation counts at 50% quantile level is seen as medium innovation level. These five levels represent for three typical conditions of the entire distribution. Therefore, we can observe the effect of CSR on innovation.

We examined the influence of different CSR types on innovation type by type and the analysis provides the evidence that the effect of CSR/ICSR/TCSR on innovation is not all the same for different innovation quantile levels. Comparing to the result of ordinary least square (OLS) estimation, CSR/ICSR/TCSR only affect innovation for both quantity and quality on 50% and higher quantile levels. In specifically, CSR promote innovation quantity on 75%, but nonsignificant effect on innovation quality. ICSR promote innovation quantity on 50% and 95% quantile levels and promote innovation quality on medium and higher quantile levels (50%, 75%, and 95%). While, TCSR have a significant negative effect on innovation quantity on 50% and a significant negative effect on innovation quality on medium and higher quantile levels (50%, 75%, and 95%). Since ICSR and TCSR classify based on CSR, we have tested the effect if ICSR and TCSR in the same regression to see whether the individual effect is weakened by each other. We have got the result that the effect of ICSR and TCSR on the number of patent and the number of citations is consistent with separately regression and there is no multicollinear problem in the regression. Thus, our baseline results above are reliable. On the basis of this result, one can conclude that the effect of CSRs on innovation only affect the firms with higher innovation

outputs or better innovation performance. In other words, for high innovation firms, it is more important to emphasis the effect of CSRs on firm's innovation performance. Besides, choosing a proper CSR type is also vital for promote innovation quality and quantity.

The analysis offers several extensions to the baseline results. First, the analysis shows that the firm size does not affect the baseline result which means the effect of CSRs on innovation only depends on the innovation output level rather than firm size. Second, our tests shows that firm's cash flow neither affect baseline result. This finding can be understood that the research and development cost does not affect the effect of CSRs on higher innovation output and better innovation output firms. To solve the endogeneity problems result from observed factors at firm level, we employed PSM test. The result show that CSR have significant positive effect on firms with higher innovation quantity (75%). ICSR have significant positive effect on firm with higher innovation quantity (95%) and for firms with medium and higher innovation quality (50%, 75%, 95%). While for PSM test of TCSR on innovation, the test does not show a significant result. Chapter 2 contributes to the literature by presenting new evidence on the moderating role of CSR on innovation activities by specifying CSR into ICSR and TCSR to test their effect on different innovation activity quantile levels. This chapter also complement the evidence on conflict resolution view, resource-based view, shareholder primacy theory and agency theory. Besides, our work promotes the critical thinking in CSR study that not all type of corporate social responsibility activity conducive corporate's sustainable development. Public should also initiate to participate in firms' CSR events.

3. Introduction of third essay

The third essay, "Impact of CEO educational traits on firm CSR and innovation", contributes to the "upper echelons" theory literature by analysing the effect of CEO education background on different CSR and innovation levels. We undertake this study to advance both theory and management practice. In terms of theory, we attempt to contribute to two areas. First, we attempt to add to the nascent literature that is developing theory-based arguments about MBA degree and degree awarded year at firm's innovation and CSR activity. Second, we attempt to explore the influence of CEO education background on different innovation levels and CSR score levels. The estimation is based on BordEx which contains information about CEO education and other CEO personalities. CSRs information extracted from MSCI ESG STATS (MSIC) database, innovation information is acquired from NBER, and financial information of the firms is acquired from Compustat dataset. We firstly reorganized CEO related information and then matched and merged with the other two databases. The firms in this essay are USA listed firms and covers 1991 to 2007. The CEO education background focusing on MBA degree, MBA degree awarded year and bachelor's degree awarded year.

The essay uses a methodology different from that of prior empirical studies on CEO education topic: the quantile model estimation. We classified CSR into ICSR and TCSR based on different stakeholders then discussed the effect of how CEO MBA degree and CEO bachelor's degree awarded year on CSR/ICSR/TCSR on different scoring levels. We discussed the influence of CEO MBA degree awarded year and bachelor's degree awarded year on innovation from two perspectives which are innovation quantity and innovation quality. This essay detects the effects

on five quantiles which are 5%, 25%, 50%, 75% and 95%. The results indicate for findings: the first is that CEO with MBA degree promote CSR and ICSR for the firms with higher CSR and ICSR scores (95% quantile level) while no significant effect on TCSR. The second finding is that the earlier CEO bachelor's degree awarded, the higher TCSR scores for firms with low TCSR scores. From this finding, it can be concluded that the earlier CEO graduate from their undergraduate, the more they focus on short term profit when they involve in CSR strategy for firms with low TCSR scores. The third finding is about the effect of CEO graduation year to innovation that the later CEO graduate from MBA degree, the lower innovation quality a firm will have. This effect only significant for firms with high citation counts (95%). The fourth finding is that the later CEO graduate from bachelor's degree, the lower innovation quality and quantity the firm will have if firm have high patent count (95%) and high citation count (95%).

To mitigate exogenous and reverse causation concerns, the method of IV is used to estimate the impact of CEO peer MB degree percentage on CEO MBA degree holding willing and GDP growth rate of the degree awarded year on the degree awarded year. Since traditional IV is not suitable for our quantile regression, we adopted the method of IV in quantile regression which is also another contribution on the research method for corporate finance. The results of IV approach are: (1) CEO with MBA degree have positive effect on CSR and ICSR scores for firm with high CSR and ICSR scores (95% quantile level), since CSR and sustainability development is one of the important modules in MBA curriculum; (2) CEO bachelor's degree awarded year have positive impact on TCSR scores for firms with low TCSR scores (5% quantile level), since those CEO's choice does not target real CSR and feel less dependent on the firm's stakeholders; (3) CEO with later MBA degree awarded year and later bachelor's degree awarded year have negative effect on innovation in high innovative firms, since those CEOs tend to increase corporate failures in innovative industries.

We also employed PSM test in this essay to address potential matching bias. In essay three, we discuss whether PSM give a good estimation and whether it does not in some circumstance.

In addition, we construct a channel for MBA degree awarded year to promote the effect of MBA degree on ICSR. The result indicates that the later CEO get MBA degree, the better for them to have a positive effect on ICSR for firms with higher ICSR scores (95% quantile level).

Moreover, this essay also controls CEO level variables which are CEO age and gender to all regressions based on the significant result of baseline regression. The extra robustness test results are following CEO with MBA degree inspire general CSR scores and male CEO will score 0.735 lower on CSR than the female CEO group; and CEO with MBA degree inspire ICSR scores after the effect of gender is taken into account. After considered age and gender, the regression efficiency is also enhanced. For the effect of bachelor's degree's awarded year on CSR, the effect of MBA degree awarded year on innovation, and the effect of bachelor's degree's awarded year on innovation, there is not significant relation after considered gender and age. For MBA degree awarded year on innovation, there is not significant relationship. Chapter 3 contributes on two sides. On the one hand, this study provides more evidence on stakeholder theory, upper echelon theory, and human capital theory. On the other hand, this study rich the literature on both research method and research topic about firm long-term sustainability, CEO's education-related issues, CSR-related issues, and innovation-related issue.

4. Organization of the dissertation

The dissertation is organized in to two parts. The first part, this Introduction, is intended to be self-contained. It provides a background to the research area address in the dissertation, the aim of the study, an outline of the theoretical concepts and constructs of CSR, innovation and CEO education used in the study, a discussion of the data used in the research, and a summary of our study.

The second part comprises three separate but related studies, each serving a specific object, as previously explained. The essays in order are entitled:

(i) Can CSR conducive innovation?

(ii) How does corporate social responsibility affect corporate innovation activities at different levels?

(iii) Impact of CEO educational traits on firm CSR and innovation

Essay One: Can CSR conducive innovation?

Abstract

The paper uses the data from NBER for innovation and KLD for CSR in 1991 to 2007 to study the relationship between innovation and different types of CSR activities. The OLS regression is used to detect the relationship between CSR/ICSR/TCSR and innovation on both quantity and quality level. We conduct the robustness studies by using the propensity scoring matching method to mitigate the influence of different characteristics on firm level. We also control the effect of firm size and check the effect of the macroeconomic environment to the findings. Instrumental variable approach is used to address the potential endogeneity problem. We find that CSR have positive effect on firm's innovation activities. More specifically, institution CSR (ICSR) activities have positive effect on the number of patent and the number of citations since it focuses on firm's long development. While technical CSR (TCSR) activities have negative effect on the number of patent and the number of citations since it focuses on the short-term benefits.

Key words: corporate social responsibility, TCSR, ICSR, innovation

1. Introduction

Boston Consulting Group's 13th annual report define the world's most innovative companies in 2019. The top three are Alphabet/Google, Amazon, and Apple. As the top innovation company, Google is also known for its philanthropic activities and friendly employee working environment. Amazon has been committed to sustainability for many years and co-founded the Climate Pledge in 2019 to commit to be net zero carbon across by 2040. Apple achieved of using 100% renewable energy for its operation. Apple also announced to become the partner of Malala funds to investing in girl's education and empowerment as least for 12 years since 2018. Is the corporate responsibility activities and innovative success merely a coincidence? This study examines whether a firm's commitment to achieving corporate social responsibility (CSR) spurs innovation.

Innovation plays an important role in firm's growth (Audretsch et al, 2014; Coad and Rao, 2008;) and competitive power. Since persistence in innovation play an important role for boosting firm performance for both small and large firms (Demirel and Mazzucato,2012). Generate new innovative ideas will help organisations to achieve a competitive advantage (Urbancova, 2013). In addition, Chang (2013) give evidence that green product innovation can increase manufacturing company's competitive advantages.

Meanwhile, CSR is defined as "actions that appear to further some social good, beyond the interest of the firm and that which is required by law" by McWilliams and Siegel (2001). Alternatively, CSR is defined as "achieving commercial success in ways that honour ethical values and respect people, communities and the natural environment" by the Business for Social Responsibility (BSR, 2006). Thereby, firm's CSR activities also have influence on firm's economic growth (Rexhepi et al., 2013; McAdam and Leonard, 2003) and performance on stakeholder value

(Deng et al., 2013), cash holdings (Cheung, 2016) and firm value (Buchanan et al., 2018). However, there is very little focus on study about whether and how CSR spurs innovations. Detecting this question is significant for firm's CSR activity policy and innovation strategies.

Firms may face high financing input but high failure outcome possibilities when pursuing innovation activities (Fang et al., 2014). Through involving in CSR activities, firms do benefits for their employees, communities, customers or the environment. Thereby, firms get allegiance from their employees, get support from their governments and get trust from their customers to offsetting the negative impact of the failure of innovation. Thus, CSR activities likely provides greater tolerance and a friendly environment for innovation activities from a sustainable perspective.

There are various types of CSR based on different stakeholders' impact. Freeman et al. (2008) creates a parsimonious classification as following: technical CSR (TCSR) and institutional CSR (ICSR). TCSR targets primary stakeholders' impact. Primary stakeholders may legitimate claims on the firm and its managers and have both urgency power (utilitarian, coercive, or normative) to enforce those claims. While ICSR targets the firm's secondary stakeholders' impact. Secondary stakeholders have legitimate claims on the firm but lack both urgency and power to enforce those claims (Mitchell et al., 1997), (Mattingly and Berman, 2006). In other words, TCSR creates a business environment that acquire benefits in short term, while ICSR creates a business environment that helps for long-term and more stable development.

The above two types of CSR activities bring different innovation activity environments for corporate. Since real CSR activities, like ICSR that is secondary stakeholders' target, could make an 'insurance-like' environment for innovation. The characteristics of innovation are high risk, long-term and high investment. Therefore, institutional CSR tends to have positive effect on innovation. If the firm engaged in the TCSR activities that utilitarian or short sight which satisfies primary stakeholders' whish, the firm may not have a good risk and financial environment to do innovation. Therefore, the technical CSR activities may have negative influence on innovation. Thus, this paper confirms the hypothesis that CSR and ICSR have positive influence on firm's innovation activities while TCSR have negative effects.

This study uses total CSR, ICSR and TCSR scores to measure different types of CSR activities. Patent and citation counts are used to measure firm's innovation productivity. Our study finds that CSR activities have positive influence on firm's innovation activities in general. ICSR is positively associated with innovation while TCSR is negatively associated with innovation after specifying CSR. The findings are robust to subsamples which changes with the years. Moreover, the study applies propensity score matching and instrumental variable approach to address potential endogeneity concerns. To provide more evidence, further model that includes firm size into control variables is tested and the results are consistent with the view from former model.

We also construct firm size and cash flow interaction term to test the moderation effect of firm size and financial constraints. The results show (1) CSR/ICSR/TCSR still have significant effect on innovation on both quantity and quality level (2) firm level and financial constraints significantly have positive on innovation (3) after add interaction term into the regression, firm size and cash constraints shows a significant positive effect on innovation although not significant for

interaction term which enhance the test efficiency in some extent. Our work is also meaningful as an instruction for corporate decision strategy. For innovative firm who is looking for a sustainability strategy could consider invest on ICSR activity since this type of investment bring firms benefits in a long-term. Government and public institutions could engage in firm CSR activity which will help firms in their community have a healthy development.

The rest of the paper is organized as follow. Section 2 is the literature review about CSR and innovation research. Section 3 shows the data processing. Section 4 discuss the empirical results. Section 5 is the robustness checks. And section 6 is the conclusion.

2. Literature review

2.1. Two different views about CSR in corporate finance

In the corporate finance tradition, Berle and Means (1932) argue that ''…theory about governance in public corporations where the ownership and control is separated, and the owner (shareholders) rely on the board of directors to represent their interests. The theory states that over time the boards become so dominated by the management that their supervisory role becomes ineffective and the executives get to have the final say.'' This operating situation derives two differences attitudes to corporate social responsibility (CSR) which are the agency theory and the good governance theory.

Friedman's (1970) well-known argument is that ''the only social responsibility of corporations is to make money" (Aupperle et al., 1985; Shleifer and Vishny, 1997; McWilliams and Siegel, 2001; Mackey et al., 2007). This view argues that CSR as a tool for managers who through implement CSR to satisfy their own benefit rather than achieving commercial success on communities or natural environment. Moreover, CSR activities result from manager's individualism is for increasing benefits from themselves (Barnea and Rubin, 2010). Thus, CSR is seen as the manifestation of agency problem. Under agency theory, corporate costs on CSR as a kind of investment that is reducing the value. Cheng et al. (2013) explore that the marginal dollar spent on CSR is a result of agency problems and validate their conjecture by showing that measures of corporate rewards, such as use of corporate jets, are correlated with corporate CSR. Avishek and David (2017) believe that CSR not only distorts investment sensitivity to growth prospects but also have negatively influence on the sensitivity of external finance to Q. This kind of distortion reflects in the firm performance. In addition, CSR aggravates investment sensitivity to cash flow. Since investors respond strongly negatively to negative events and weakly negatively to positive events (Kruger, 2015). Strongly negative events have strong influence on firm value and agency perspective implies that positive news about CSR is bad news for shareholders. What is more, CSR results in the decreasing of future stock price and reducing the firm ROA to expense the firm value (Di and Kostovesky, 2014). A direct market reaction to CSR with a lag resulting from delays in investors' learning about CSR policy changes result in the decrease of future stock price and the firm ROA. Moreover, managers may rise wages to increase their employees' loyalty, even when this is not optimal

for shareholders based on the shareholder expense view (Pagano and Volpin, 2005). In addition, higher high-CSR issuer not only inspires SEOs' opportunistic motives, but also significant decrease operating performance in post-issuance comparing to low-CSR issuers (Walker et al., 2016; Marie et al., 2018).

In contract, in the good governance theory, Freeman's (1984) stakeholder theory believes that firms can use CSR to mitigate conflicts between managers and non-investing stakeholders, to improve firm reputation, and to enhance firm profitability (Freeman, 1984; Makni et al., 2009; Jo and Harjoto, 2011, 2012). Like greater free cash flow and higher advertising outlays demonstrate higher levels of corporate social responsibility (Richard et al., 2014). Besides, CSR can also attenuate the negative relation between managerial entrenchment and value (Allen et al., 2014). In acquire and mergers activity, mergers by high CSR acquirers take less time to complete and are less likely to fail than mergers by low CSR acquires. Moreover, high CSR acquirers undertake mergers that benefit firm stakeholders, their mergers are likely to lead to greater stakeholder satisfaction than mergers by low CSR acquirers and, thus, their shareholders benefit more from the mergers (Xin et al., 2013).

Ethical theories posit that managers must accept social responsibility as ethical obligation, take into consideration legitimate interests of all stakeholders and ''do the right thing'' (Carroll, 1979; Donaldson et al., 1995; Phillips et al., 2003). Adrian (2016) suggests that due to the CSR firms tend to have a better relationship with the stakeholders which provides an insurance-like protection that can mitigate harm from negative (especially firm-specific) events. Therefore, CSR firms tend to have low systematic risk and less sensitive to aggregate shocks due to greater loyalty from CSR investors and/or customers.

In addition, political theories insist that managers or firms need to take into account the community and seek ways of formalizing willingness to improve the community (Matten and Crane, 2005). Furthermore, in the perspective of integrative theories, managers need to integrate social demands into their business model as its success is dependent on society (Agle et al., 1999; Swanson, 1995; Wood, 1991). Usually, family firms are more responsibility to shareholders than non-family firms on investments which could improve the community. Because family owner typically regards their ownership as an asset to be passed on to future generations. Family owners tend to be actively involved in the management of the firm and viewing the firm as an extension of themselves as well as deriving a sense of identify from the firm (Amal et al., 2018).

2.2. Research on the relationship between Corporate Management Strategies and Innovation

From the perspective of corporate managerial, more independent boards use more equity-based compensation, especially stock options, to promote managerial risk-taking (Yuan and Wen, 2017). Board independence also positive effect corporate innovation (Lu and Wang, 2017). Besides, managerial incentives also play an important role on a firm's innovation activities. Since CEO incentive schemes increases both corporate innovation effort and innovation performance (Lin et al., 2009). For IPO firms, if they backed by more

failure-tolerance VC investors are significantly more innovative and VC failure tolerance (Tian and wang, 2011).

From the perspective of firm's basic financial items, research and development (R&D) investment as the main resource of innovation have significant effect with innovation outputs. Demirel (2012) observes that the positive impact of R&D on firm's growth is highly conditional upon a combination of firm-specific characteristics such as firm size, patenting and persistence in patenting. While Brav and Wei (2018) find that target firms increase innovation output with stringer effects among firms with more diversified innovation portfolio despite a tightening in R&D expenditures. On the other hand, innovation also have tight impact on firm's equity. Cash flow and external equity have significant effects of high-tech firms through dynamic R&D models (Brown at al., 2009). Similarly, He and Wintoki (2016) believes that intensified domestic and international competition among R&D firms magnifies the marginal impact of financial constraints upon the decisions to hold cash. While firms' default probabilities are negatively related to the quantity, impact, originality, and generality of their patent portfolios. Meanwhile, bonds issued by more innovative firms have lower issuance premiums and lower realized excess returns (Hsu et al., 2015). Moreover, innovation strategy associates with future stock price that exploration-oriented firms are more prone to stock price crash risk while exploitation-oriented firms are less prone to stock price crash risk (Jia, 2018).

From other perspectives to study innovation, innovation is affected by firm's location, firm's network, firm's policy strategy and investor's behaviour (Adhikari and Agrawal, 2015; Chuluun et al., 2017; Bradley et al., 2017; Chemmanur and Tian, 2012; Jiang and Yuan, 2017). Firms headquartered in areas with a taste for gambling tend to be more innovative (Adhikari and Agrawal, 2015). Because gambling preferences of both local investors and managers appear to influence firms' innovative endeavours and facilitate transforming their industry growth opportunities into firm value. In addition, a reduction in R&D expenditures, reduced productivity of inventors, and departures of innovative inventors appear to be plausible underlying mechanisms through which unionization impedes firm innovation (Bradley et al., 2017). Besides, antitakeover provisions (ATPs) contribute positively to firm value for firms involved in intensive innovation, while ATPs negatively impact firm value for firms that are not conducting a significant extent of innovation (Chemmanur and Tian, 2012). Furthermore, institutional investors' site visits significantly enhance corporate innovation. Especially for firms with a lower-quality information environment and poor corporate governance.

2.3. Hypothesis development

Plenty of prior papers study the relationship between innovation and firm running conditions while there are still gaps on detecting the effect of CSR on innovation. For example, there is very little focus on study about whether and how CSR spurs innovations in the literature. Directing this question is significant for firm's CSR activity policy and innovation strategies.

Our study follows the CSR construction of Mattingly and Berman (2006) that differentiates CSR activities as institutional CSR (ICSR) and technical CSR (TCSR).

Chang (2014) indicates that primary stakeholders, including employees, consumers, shareholders, etc. Primary stakeholders have direct economic exchange with a firm and the firm cannot survive as a going concern without continuing participation of primary stakeholders. TCSR activities targeting primary stakeholders are likely to result in exchange capital, which would be consumed in the exchange as primary stakeholders recognize their power and the nature of such exchange. With the power, they could demand superior financial and social performance and their demand is likely to receive immediate attention.

On the other hand, ICSR focuses on the CSR activities which engaged by secondary stakeholders. Secondary stakeholders refer to those influence or affect, or are influenced or affected by the firm, but who do not have direct economic exchange with the firm. The firm is not dependent for its survival on secondary stakeholders (Clarkson 1995). Secondary stakeholders have little power and urgency in pressing their legitimate claims on the firm and its managers. Therefore, ICSR strengths, which are CSR activities that target secondary stakeholders, are unlikely to be viewed as purely self-interested actions by managers designed to enhance exchange capability.

Godfrey (2009) point out that ICSR are more likely to be viewed as voluntary acts of social beneficence and reflect the firm's moral characteristics. As secondary stakeholders recognize the ''altruistic'' and pure nature of ICSR, they grant moral capital, which belongs to reputational capital for doing social good, to the firm for its engagement in CSR activities. Positive moral capital will provide ''insurance-like'' benefits when the firm is subject to negative events and face sanctions from stakeholders (Godfrey, 2005). According to previously studies on innovation, see for example Brown et al (2009), Kamoto (2016), Yuan and Wen (2017), He and Wintoki (2016), it is a high-risk activity which may influence firms' stock price, cask holding, growth opportunities and many other ricks that firms may facing. While CSR firms tend to have a better relationship with the stakeholders which provides an insurance-like protection that can mitigate harm from negative (especially firm-specific) events (Adrian, 2016). What is more, CSR is able to mitigate conflicts between managers and non-investing stakeholders, to improve firm reputation, and to enhance firm profitability (Freeman, 1984; Makni et al., 2009; Jo and Harjoto, 2011, 2012). Therefore, in general, CSR activities could promote innovation activities.

And especially, ICSR which is the positive moral capital will provide ''insurance-like'' benefit when firms in exposure to innovation failure risks. While TCSR as the activities that result from satisfy manager short-sighted and take advantages needs, it has negative affect on firm's innovation. Therefore, we have following hypotheses:

Hypothesis 1: CSR has positive effect on innovation.

Hypothesis 2: ICSR has a positive effect on innovation.

Hypothesis 3: TCSR has a negative effect on innovation.

Previously studies test on the relationship between CSR and innovation, see for example MacGregor and Fontrodona (2008), Mishra (2017), Rexhepi and Bexheti (2013), Bocquet and Mothe (2011). But lack of the detecting the effect on innovation by specifying CSR types. This

paper contributes to two strands of literature. First, this paper contributes to the recent and growing literature on the relationship between innovation and various CSR activities. Secondly, it adds to the debate of whether ICSR activities is beneficial to firms.

3. Data processing:

3.1. CSR measurement dimensions

There are varieties CSR measurement dimension in previously literatures. In order to make it clear, the detail is summarized in this section.

3.1.1. Calculating CSR scores with different dimensions

About the measurement dimensions, most of the paper focus on CSR study on the relationship between CSR and innovation include community, product diversity, employee relationship and environmental stewardship when they calculate the net CSR score. However, there still some distinguishes, Chang (2014) just considers the basic five dimensions above in the net CSR score; Mishra (2017) also includes human rights dimension in the calculation of net CSR score. While Godfrey (2009) adopt a different dimension with Mishra (2017) which supplement corporate governance dimension in the net CSR score. Table 1 in appendix gives explanation in detail.

The reasons that exclude corporate governance from the net CSR scores as following. Because prior research (Biddle et al., 2009) finds that governance influences investment efficiency, this category is excluded from the calculate of the CSR score but control for this MSCI category in the multivariate models (Cook, 2019). In addition to corporate governance, the literature suggests that financial constraints may be correlated with CSR, innovation, and firm value. In the baseline regression, Mishra (2017) addresses this issue by controlling for two proxies that may provide indications of the firm's governance quality (insider ownership and an indicator variable for Delaware Incorporation) and two proxies of financial constraints Corporate social responsibility and CEO confidence Kaplan and Zingales' 1997 index (KZ index) and Hadlock and Piece's 2010 index (SA index). However, they repeat their analysis using a CSR index that includes corporate governance qualitative area scores (originally excluded) in their robustness test.

3.1.2. Calculating CSR scores based on quintiles of CSR scores

There is another way to deal with the CSR scores that is quintile the CSR scores. To aid with the interpretation of the results (and to ensure the results are not driven by extreme values), Cook (2019) construct a measure that consists of five quintiles (CSR Score (Quintile)). This variable is coded as follows: 1 if CSR Score is less than -1, 2 if

CSR Score is -1, 3 if CSR Score is 0, 4 if CSR Score is +1, and 5 if CSR Score is greater than +1.

3.1.3. Calculating CSR scores according two different classifications---- ICSR and TCSR

Another measurement about CSR is used that classify the CSR activities into ICSR and TCSR. This measurement is used by other paper according to the former studies. The influence of ICSR and TCSR on the economics activities are robustness (Chang, 2014; Godfrey, 2009). However, there is no study focus on the relationship between ICSR/ICSR and innovation. This is also the particular part of our research.

Our paper coded ICSR participation 1 if the firm scored greater than zero on any of the positive items under the community or diversity dimensions, zero otherwise. Then coded TCSR participants 1 if one firm scored greater than zero on any of the positive items under the governance, employee relations, or product quality, zero otherwise. (Mattingly and Berman, 2006; Godfrey, 2009).

The classification of the performance of TCSR/ICSR is shown following. The discrete variables are used to measure CSR engagement provided with the ability to further analysis the data based on a ''treatment groups'' approach. Using ICSR/TCSR engagement variables as a basis, Godfrey (2009) classified firms into one of four ''treatment'' categories:

(1). Participation in either type of CSR activity (neither)

(2). Participation in ICSR activity

(3). Participation in TCSR activity

(4). Participation in both types of CSR activity (both).

About the dimensions to calculate ICSR and TCSR, Godfrey (Godfrey, 2009) include community relationship and product diversity when calculate the scores of ICSR, and Chang (2014) deal with their data in the same way. However, for the calculation of TCSR, Godfrey (2009) uses employee relationship, product quality and corporate governance. While Kiyong's paper only cover employee relationship and product quality in the basic TCSR measurements and cover the same dimensions as Godfrey in the alternative measurements of the TCSR.

While Mattingly and Berman (2006) proposed that use the net CSR measurement to reduce the size effect may involve a potential problem that default CSR strengths and concerns have the similar constructs and could be combined. To alleviate this problem, Chang and Kim (Chang, 2014) constructed another set of ICSR/TCSR variables. The differences between the alternative sets and the original sets are the measurement dimension. In the alternative sets, they add environment issue dimension into the ICSR strength and add corporate governance dimension into the TCSR strength. The concerns of alternative ICSR/TCSR keep the same dimensions with

the original measurement sets. In additional, the size-adjusted variable based on the alternative ICSR/TCSR variables also be constructed to diminish the firm size effect to the CSR score and make the scores and results more objectively.

3.2. CSR measurement of this paper:

CSR data from the MSCI ESG STATS database (formerly known as KLD), which tracks CSR activities for a wide set of publicly traded firms and provide rating for firms' social performance in the following categories: community, diversity, employee relationships, human rights, environment, product, and corporate governance. For each category, MSIC include several positive indicators (strengths) and negative indicators (concerns). When a firm meets one of MSCI's positive indicators it receives a value of one in the strengths dimension; when it meets a negative condition, it receives a value of one in the concerns dimension. Firms without strengths or concerns in a given category receive a value of zero. Following prior research, see for example Chang (2014), Richard et al. (2014), Xin et al. (2013), Adrian (2016), our paper use net CSR scores which is defined as total strengths minus total concerns (CSR Score): Net CRS scores= Total strengths – Total concerns.

The rating criteria are robustness across firms and that rating before it is made public. The data collection process for each company follows no rigid annual schedule, but the calendar year-end data for any year represents all ratings collected during the year (Godfrey, 2009).

The Socrates data contain 41 separate binary item measures of firm engagement along six social dimensions (community involvement, corporate governance, employee relations, environmental stewardship, diversity, and product quality), with a firm scoring 1 for the observed presence of the measure, 0 for its absence. Socrates captures data on activities seen as both positive and negative. Each item for six dimensions is shown in appendix 1 in detail.

Since the theoretical interest surrounds the qualitative choice of engagement in CSR activities. Godfrey and Merrill coded overall CSR participants variable 1, if a firm scoring greater than zero for any one of the positive items, 0 otherwise. CSR negative level by summing the total negative individual item scores across the six major dimensions (Godfrey, 2009).

The development of KLD database. According to the investigated of Godfrey (2009), the KLD added two new item measures that affected institutional CSR participation (TCSR) variables: community support of education in year 1993, and the provision of benefits to gay/lesbian partners in year 1995. Godfrey (2009) included these measures in the counts in the relevant years. To test whether the inclusion of these new items skewed the data, Godfrey's paper examined the mean values of each variable increased; however, for each year-over-year period, the mean does not differ significantly. The growth in CSR participation does not seem to be an artifact of including more measures, but rather an increase in underlying participation rates by firms.

Our study uses the CSR dataset from KLD database which provide the rating and scores of companies in different industries. It provides information for 4,885 different firms in 16 years from 1991 to 2006. Our paper then supplements this information to include the period 1991-2006 for 793 firms and the score about strengths and concerns of each company. Calculating the total net CSR scores of each company in the interested years. Like the former researcher, see for example McCarthy et al. (2017), our paper uses the following expression of each company in one year:

Net CRS scores

= Total strengths – Total concerns

= (COMstrength + DIVstrength + ENVstrength + EMPstrength + PROstrength+ HUMstrength+ CORstrength) – (COMconcern + DIVconcern + ENVconcern + EMPconcern + PROconcern+ HUMconcern+ COR concern)

COM refers to community involvement, DIV refers to diversity, ENV refers to environmental stewardship, EMP refers to employee relations, PRO refers to product quality, HUM refers to human rights and COR refers to corporate governance. The controversial business issue part does not be considered in our research, like alcohol, gambling, tobacco, firearms, military, and nuclear power (Cook, 2019). The details information of each dimension is shown in Appendix 1.

There are some observations in CSR database missing. About missing variables in former research, see for example Kogan et al. (2017), Cook (2019), they assume the firm had no patents when the paper cannot match an observation in the MSCIA sample with an observation in the patent database. However, out paper processing the missing variables in a different method. In order to diminish the effect of missing observations on the research, two new variables are generated. The first one is a dummy variable called CSR_exist which equals to 1 if the company have CSR rating, otherwise equals to zero. The second one is CSR_interactive= CSR_exist* scores of CSR. The two variables are created on net scores of CSR, the net value of ICSR and the net value of TCSR. This method which is used to remedy the missing variable problem also be used when deal with the R&D information. This method also be applied when deal with the missing variables problem on CSR scores. If the data is not absence, the interactive value will keep the original value. However, if one data is missing, the interactive data will equal to zero which will not be ignored by the software and do not influence the final results. In addition, implement this method to deal with the missing variable could keep the completeness of the dataset and keep the useful information that maybe used in different models.

3.3. Innovation measuring:

Our study adopt patent counts and citation counts as the measurement of innovation. We follow the instruction from NBER to organize the innovation data files. The instruction offers patent citation data file Lessons, insights and methodological (Hall et al., 2001).

Following the paper of Hall (2005) to solve the citation truncation problem that citations to a given patent typically keep coming over long periods of time, the correction method is only observing the number of citations until the last date of the available data.

Application year (appyear in the dataset): following the instruction book of NBER datasets (Hall, 2001). The innovation variables are constructed based on the patent application year. The application year is more important than the grant year since it is closer to the time of the actual innovation. (Chemmanur, 2014).

The number of patents held by the firm at the end of the year (Cook, 2019). The number of citations each patent has as of the end of the year. (Cook, 2019) Capturing the importance of patents by counting the number of citations received by each patent in the subsequent year. Because the simple count of patents may not distinguish breakthrough innovations from incremental technological discoveries (Chemmanur, 2014).

The distributions of patents and patent citations are highly skewed, so we use the natural logarithm of each of those variables (Cook, 2019). The value of natural logarithm is used based on the patent or citation counts plus one to avoid losing firm-year observations with zero patents or zero citations per patent (Chemmanur, 2014). The aggregate of patent/citation number is used when measure innovation. Firms can hold and/or generate multiple patents in a given year; therefore, the aggregate of the number of patent held and/or generated in any given year. Similarly, a patent may receive multiple citations, so aggregate number of patent citation for a given firm in a given year (Cook et al., (2019).

Our paper uses the number of patent and the number of citations to measure innovation rather than R&D value. Because the R&D can only measure the input of investment. The patent number and citation number can measure how the R&D investment is success. The number of patents can be the proxy of the ''output'' of investment activities and the number of citation intensity can be the proxy of ''high-quality'' outputs. (Hall et al., 2001)

Chemmanur (2014) indicates that the patent-based measures are better as records on other papers. Because they capture the actual innovation output and capture how effectively a firm has used its innovation inputs (both observable and unobservable).

Prior researchers used R&D expenditures as an input-based proxy for innovation, this paper deviate from this proxy because they include R&D expenditures in two models of investment efficiency. Also, because firm must go through a rigorous vetting process, it is believed that patents provide unambiguous and out-put-based evidence that the firm was successful in the innovation process. Similarly, if other firms cite an original patent, this citation provides corroboration of the value of the patent; thus, it is considered that firms with more patent citations to be on the frontline of innovation (Cook, 2019).

3.4. Control variables:

Control variables in our paper are Tobin's Q, firm leverage, R&D intensity, current ratio, CAPX, ROA and book value of total asset. The seven control variables above may have

influence on firm's equity that may affect the expenses on innovation and CSR. Using gvkey as identifier to download fundamental data about the interested firm in 1991-2007 from Compustat. Gvkey as the unique identifier to match the information at firm level with the combined dataset of innovation and KLD.

Tobin's Q is the ratio of market value of total asset to the book value of total asset. The marginal impact of design innovation on Tobin's Q decreased with increasing levels of technology innovation (Rubera and Droge, 2012). Tobin's q has impact on firm's sensitivity to innovation activities (Coad and Rao, 2006).

The firm leverage is total debt divided by the book value of asset. Leverage ratio accesses the ability of a firm to meet its financial obligations and measures how firm's financing construction. If firms select additional innovation projects, they must have some unexploited investment opportunities that were not profitable using more costly external finance (Hottenrott and Peters, 2012). Research and development input have directly influence on the capital for innovation activities (Hall and Lerner, 2010).

R&D intensity is research and development expenses over the book value of total asset. The R&D information has missing observations, which may result from the confidential purpose. To remedy this problem, the two variables are created---R&D_exist and R&D_interactive. If the company have the fully information of R&D, R&D_exist will equal to 1, otherwise it equals to zero. The R&D_interactive equals to R&D_exist multiply the value of R&D.

Current ratio is the ratio of current asset to current liability. Current ratio as one of the impotent liquidity indicators for firms, the increase in liquidity causes a reduction in future innovation (Fang et al., 2014). Firm's capital expenditure are funds used to acquire technology, equipment and invest in new projects and investment which directly have influence on the innovation projects.

CAPX is often used to undertake new projects or investment by a company. Making capital expenditures on fixed assets can include repairing a roof, purchasing a piece of equipment, or building a new factory. In order to control for firms making current capital investments, CAPX is controlled which equals to capital expenditure divided by the book value of total asset (Dong, 2017).

ROA an indicator of firm's profitability which equals to earnings before interest, tax, depreciation, and amortization divided by the book value of total asset (Chang, 2014). ROA is controlled into the regression to avoid greater profitability invest large amount on CSR and innovation activities impact.

By considering that larger firms may have greater capability to invest much capital on innovation and CSR activities. However, those capital may merely a little part for their total capability. Smaller firms may not spend large amount of capital on innovation and CSR activities, but they may spend a considerable part of their capital on these two activities. As the findings of Audretsch (1991), Stock (2002), Rogers (2004) and Shefer (2005), firm size have strong influences on firms' innovation activities. To alleviate the impact of firm

size to innovation and CSR abilities, firm size as a control variable is added in robustness check model.

The mean value of current ratio, R&D intensity, CAPX, leverage and Tobin's Q larger than their median which means the variables are right skew. In additional, to reduce the effective of outliers and to keep the consistency, the natural logarithm of those variables is be used. What is more, to mitigate the effective of outliers, all accounting variables are Winsorized at the top and bottom one percent (Chen, 2016).

3.5. Merge data files

Firstly, dropped missing variables that lack of gvkey, remain 16,466 observations. Duplicates drop gvkey, remain 3,729 different firms. Listing all company name of innovation database and listing all the company name of KLD database. Using computer programme to match two name sets. Using the company name as the unique identifier to combine innovation data and CSR data. After matching two name sets, delate the company that could not match with another database. There are 9815 observations for CSR data from 1991 to 2006 for 1,765 firms. There are 517,194 observations for innovation data from 1967 to 2005 for 1813 firm.

Secondly, Using the combined dataset above to match with fundamental data through gvkey. The final file is regression doing. After refined the useless variables, there are 10,902 observations for 793 firms from year 1991 to year 2007.

The last step is processing the regression doing file by deal with the missing variables. The number of patent and the number of citations forward one year. Thus, the observations of fundamental and CSR are the lagged-one year information relative to the observations of innovation.

3.6. Summary of variables used in the study

The table below provides the definition and the calculation of each variable in detail.

Variables	Final value	notes
CSR measurements		
CSR	CSR_exist* CSR scores	CSR_exist=1 if the firms have CSR scores otherwise CSR_exist=0 CSR scores= CSR strengths-CSR concerns
ICSR	ICSR_exist* ICSR scores	ICSR_exist=1 if the firm ICSR scored greater than zero on any of the positive items under the community or diversity dimensions, zero otherwise

		ICSR scores= ICSR strengths- ICSR concerns
TCSR	TCSR_exist* TCSR scores	TCSR_exist=1 if one firm TCSR scored greater than zero on any of the positive items under the governance, employee relations, or product quality, zero otherwise TCSR scores= TCSR strengths- TCSR concerns
Innovation measurements		
patent	The number of patents forward one year	
citation	The number of citations forward one year	
Control variables		
Tobin's Q	= market value of total asset/ book value of total asset	
Leverage	=total debt/ book value of asset	
interR&D intensity	= R&D_exist * R&D value	R&D_exist=1 if the firm have R&D value otherwise R&D_exist=0 R&D value= research and development expenses/ book value of total asset
Current ratio	= current asset/ current liability	
CAPX	= capital expenditure/ book value of total asset	
ROA	= earnings before interest, tax, depreciation, and amortization/ book value of total asset	
LnBV	ln(Book value of total asset)	

3.7. Summary statistics

3.7.1. Descriptive statistics

The summary statistics of the measurement of innovation, CSR and control variables are given in Table 1. Table 1 shows that firms generate around 0.6 patent and around 0.6 non-self-citation on an average level per year. The mean value of Tobin's Q equals to 2.4 which implies the firm's stock not undervalued; leverage of 21% which means 21 percent of firm's assets are financed by creditors and 79 percent are financed by owners' equity in average; R&D intensity ratio of 6% shows that the expenditures by those firms on its research and development account for 6 percent of their sales; the average current ratio is 2.72% which refers to firms in this study have enough financial resources to remain solvent in the short-term in average; the mean value of CAPX which is often used to undertake new projects or investments by the firm equals to 0.057; the mean value of ROA for the firms in this paper is 12% which means 12 percent of their investment converting into net income; and the mean value of natural logarithm of book value of total asset is 7.32.

The average CSR scores is -0.01 which is very close to 0 and it represents an offset that the positive contributions and negative effects by the firms. The maximum CSR value is 14 which indicates a good CSR environment while the minimum value is -9 which indicates the firm with a quite poor contribution to the society.

The average ICSR score is 0.13 which is greater than 0 so it means most of the firms have positive value on community and product diversity dimensions. The maximum value for ICSR is 10 which means the best performance on community contributions and have a good product diversity condition while the minimum value is -3 which means the firm have negative scores on community and diversity dimensions.

The average scores of TCSR is -0.12 which is smaller than 0 and smaller than the average value of ICSR. It shows that the dimensions that primary stakeholder focus on bring negative value for the whole CSR activity scoring. The maximum value of TCSR is 4 which indicates the firm with more positive scores on each item belonging to corporate governance, employee relationships and product quality dimensions. While the minimum value is -7 which indicates the firms with negative scores on the former three dimensions. The sum value of ICSR and the sum value of TCSR are not simply equals to total CSR scores by adding up together but emphasis the meaning to study ICSR and TCSR solely.

3.7.2. Sample comparison of firms with different CSR activities

In this section, we compare subsamples of firms with different CSR activities condition and the results are shown in Table 2.

First, we divide firms into two groups: One group contains firms that participate in CSR activities (dcsr equals to 1), and another group contains firms that do not participate in any CSR activities (dcsr equals to 0). The results are shown on the first three columns of Table 2, firms participate in CSR activities have more innovation output on both quantity and quality level. The number of patents of the firms engaging in CSR activities is the four times than the firms do not engage in CSR activities.

Then, the firms are divided into two groups: One group contains firms that participate in ICSR activities (dicsr equals to 1), and another group contains firms that do not participate in ICSR activities (dicsr equals to 0). The results are shown on the column (4), (5) and (6) in Table 2. Firms participate in ICSR activities have more innovation output on both quantity and quality level on average.

Finally, the firms are divided into two groups: One group contains firms that participate in TCSR activities (dtcsr equals to 1), and another group contains firms that do not participate in TCSR activities (dtcsr equals to 0). The results are shown in the last three columns of Table 2. On average, firms participate in TCSR activities also have better innovation performance which perform as more outputs on quality and quantity levels.

We compare means across subsamples of firms involves in the three types of CSR activities and the firms that do not involve in three types of activities respectively. Generally, firms participate in any types of CSR activities benefit to the innovation activities. Consistent with the conjecture, firms involve in CSR and the firms involve in ICSR have more patents and citations through compare the means value between column (1) and (2) for CSR and (4) and (5) for ICSR. While in this test, firms involve in TCSR also have more patents and citations through compare column (7) and (8). This result is not consistent with previously conjecture. Thus, it deserves to do further tests. All the results above are statistically significant differences.

4. Empirical results

4.1. Impact of CSR on innovation

To examining whether CSR has a positve impact on innovation, we use the fixed effect model.

Fixed effects (FE) model is a model in which the model parameters are fixed or non-random qualities in statistics and the model is usually used to analyse panel data. When using this FE model, it is assumed that some factors within the individual may impact or bias the predictor or outcome variables and need to be controlled. And the fixed effect removes the effect on those time-invariant characteristics so the net effect of the predictors on the outcome variable could be assessed. There is another assumption when using fixed effect model that those time-invariant characteristics are unique to the individual and should not be correlated with

other individual characteristics. Only if each entity is different, the entity's error term and the constant which captures individual characteristics should not be correlated with the others.

For a certain firm, the study compares the firm in years that involves in variety CSR activities with the firm in year that does not involves in CSR activities and with the firms which does not involves in CSR activities in all years.

Firms with higher patent counts and citations counts can result from the whole economy environment which motivates firms have more innovation activities. In addition, firms with higher patent and citation counts can lead by the industry they exist. If the firm belongs to high innovation industry, they will have more patent and citation counts than average. Some of the variables are observable but some variables are not and quite difficult to measure. Some of the variable will change over time while others are not. If all the relevant but unobserved variables are also time-invariant in a panel data, estimation strategy called fixed effects can help to remove the bias that caused by omitted variables even if the those omitted variables are not included in our models. Thus, the time dependent and time independent variables should make distinguished. The year fixed effects control for factors changing each year that are common to all firms for a given year. Industry fixed effects control for factors changing each industry that are common to all firms in a certain industry.

This model allows us to check how CSR affect innovation activities on patent number and citation number. More specifically, our model is given below.

$$Y_{it} = a_1 CSR_{i,t-1} + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon_{i,t-1} \quad (1)$$

where Y_{it} represents the number of patent or the number of citations, $Control_{i,t-1}$ =c($Tobin's\ Q_{i,t-1}, Leverage_{i,t-1}, RD\ intensity_{i,t-1}, Current\ ratio_{i,t-1}, CAPX_{i,t-1}, ROA_{i,t-1}$) is a vector of control variables. a_1 is the coefficient of $CSR_{i,t-1}$. a_2 is the coefficients of the control variables. Industry fixed effects defined based on two-digit SIC codes, $Year_{t-1}$ captures year fixed effects and $Firm_i$ captures the fixed effect on firm level.

The estimated models are given in columns (1) of panel A and panel B of Table 3, where panel A is the estimation on innovation quantity level which is measured by the number of patents and panel B is the estimation on quantity level which is measured by the number of citations. The results show that CSR have positive effect on firm's innovation activities on quantity and quality levels.

CSR is positively correlated with the number of patents and the number of citations, which implies firm's CSR activities providing a good environment for innovation outputs. This finding consists with the hypothesis 1 that CSR have a positive effect on innovation. Because generally, CSR provide an insurance environment for risky activities, innovation, of the firm.

4.2. Impact of ICSR on innovation

To examining whether ICSR has an impact on innovation, we estimate the fixed effect model:

$$Y_{it} = a_1 ICSR_{i,t-1} + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon_{i,t-1} \quad (2)$$

The estimated models are given in columns (2) of panel A and panel B of Table 3, where panel A is the estimation on innovation quantity level which is measured by the number of patents and panel B is the estimation on quantity level which is measured by the number of citations. The results show that ICSR have positive effect on firm's innovation activities on both quantity and quality levels.

As the results showing, the finding give evidence for the second hypothesis that ICSR have positive influence on innovation. ICSR activities result from the impact of secondary stakeholders which do not have urgent profit pursuing. They target further development of the firms, so they prefer 'the real' social activities even those activities do not bring the increase of the profit in short term. Just because of those 'real' ICSR activities that create an insurance for high risky innovation activities.

4.3. Impact of TCSR on innovation

To examining whether ICSR has an impact on innovation, we estimate the fixed effect model:

$$Y_{it} = a_1 TCSR_{i,t-1} + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon_{i,t-1} \quad (3)$$

This model allows us to check how TCSR affect innovation activities on patent number and citation number where the estimated models are given in columns (3) of Table 3 where panel A is the estimation on innovation quantity level which is measured by the number of patents and panel B is the estimation on quantity level which is measured by the number of citations. The results show that TCSR have negative effect on firm's innovation activities on both quantity and quality.

The findings give evidence for the third hypothesis that TCSR have negative influence on innovation. TCSR activities result from the impact of primary stakeholders which pursing more increase on the profits and manage to achieving more successful in a short period to prove their abilities. Those stakeholders target on short term profit and prefer TCSR activities which is helping on their personal achievement. Thus, TCSR cannot provide a safety environment for firms when they participate in high risky innovation activities.

4.4. Impact of ICSR and TCSR on innovation

Even ICSR and TCSR targeting different stakeholders claims, we estimate them in one regression to exclude the influence on each other.

$$Y_{it} = a_1 ICSR_{i,t-1} + bTCSR_{i,t-1} + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon_{i,t-1} \quad (4)$$

This model allows us to check how CSR activities influence innovation if the firm involves in two different CSR activity types at the same time, where the estimated models are given in column (4)

of Table 3. The result shows that ICSR have positive effect on both levels while TCSR have negative effect on two levels. This result is same as the estimation that test them solely in different regressions. The estimation emphasising the effect of ICSR and TCSR on innovation activities.

4.5. Further discussions

CSR and ICSR have positive correlation but TCSR have negative correlation for both proxies of innovation. Thus, CSR activities have positively influence on innovation generally. However, the results changed after distinct the classification of CSR activities. For CSR activities that target to secondary stakeholders (ICSR) have a positive relationship with the proxies of innovation. While for the CSR activities that target to primary stakeholders (TCSR) have a negative relationship with the two proxies of innovation. In other words, CSR activities promote innovation activities in generally, but the relationship will change after classify CSR activities.

The results may be due to two types of the stakeholders focus of different aim in the operating of the business. For the secondary stakeholders (ICSR), they could influence firm's primary stakeholders and do not have urgency and power to enforce their claim. Therefore, they would choose 'real' corporate social activities which could offer a 'insurance-like' benefit to the firm. Firm's innovation activities is a high risk activity, the 'insurance-like' benefit give innovation a better environment to improve. In contract, for the primary stakeholders (TCSR), they may be utilitarian to have both urgency and power about their claim. They are likely to choose those CSR activities that could make sure managers have more flexible choice or bring more economic benefit to the firm in a short term. However, the benefits of innovation activity are a relative long-term investment. The aim of primary stakeholders' crash to the nature of innovation activities, thus TCSR have a negative influence on firm's innovation (Godfrey, 2009).

5. Robust check

In this section, we conduct several robustness checks to ensure that the results we obtained above are robust.

5.1. Controlling firm size

The first robustness check is to test whether the results from section 4 remain in all type of firm size.

In general, larger firm have higher ability to do CSR activities. Sometimes larger corporate scales may have larger asset scales input on CSR activities and higher input on their innovations. There might be a situation that the larger firms have a better performance on CSR activities than smaller firms. However, the larger firm's input on CSR only take account very small part of their total assets and this percentage is much lower than the percentage of smaller firms. In this circumstance, it is not reasonable to get the conclusion about the relationship between CSR and

innovation. Is the good performance on innovation affected by firm's CSR activities? Or just because larger firms have more power on innovation activities? The answers are revealed in this section.

In order to check whether firm size can affect our results obtained in section 4, this study included the firm size into the models and re-estimated these models again. In general, market capital, total sales and total assets are used in measuring the size of the firms in corporate finance studies. According to Dang (2018), market capital reflects the ownership of equity only and total sales are more related to product market and not forward looking, thus total assets is used in this paper as the proxy of firm size.

The results of column (1), (2), and (3) in Table 4 following the equations:

$$Y_{it} = a_1 x_{i,t-1} + a_2\, Control_{i,t-1} + c\, BV_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon_{i,t-1} \quad (5)$$

The results of column (4) in Table 4 following the equations:

$$Y_{it} = a_1 ICSR_{i,t-1} + bTCSR_{i,t-1} + a_2\, Control_{i,t-1} + c\, BV_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon_{i,t-1} \quad (6)$$

Where Y_{it} represents the number of patents all panel A and represents the number of citations in all panel B. $x_{i,t-1}$ represents CSR, ICSR and TCSR for column (1), (2) and (3) respectively.

$Control_{i,t-1}$ =c($Tobin's\ Q_{i,t-1}, Leverage_{i,t-1}, RD\ intensity_{i,t-1}, Current\ ratio_{i,t-1}, lnCAPX_{i,t-1}, ROA_{i,t-1}$) is a vector of control variables. a_1 is the parameter $of\ ICSR_{i,t-1}$ in and b is the parameter of $TCSR_{i,t-1}, a_2$ is a vector of parameters of the control variables and c is the parameter of $BV_{i,t-1}$ which is the logarithm of book value of total asset. Industry fixed effects defined based on two-digit SIC codes and Year capture year fixed effects.

Table 4 provides the relationship between CSR/ICSR/TCSR and innovation, as measured by patents (Panel A) and citations (Panel B). The first 6 control variables are the same as model 1 to model 4. The last control variable which is the logarithm of book value of total assets is added to examining whether firm size have influence on the relationship between CSR and innovation activities.

Across all regressions, the coefficient on CSR and ICSR are positive and statistically significant at the 5% level. While the coefficient on TCSR is negative and statistically significant at the 5% level as well. Those results provide strong and consistent evidence that firms to do CSR activities with a long perspective have better performance on innovation activities than the firms engaging in CSR activities with short sight or utilitarian reason. What is more, the results confirm that the conclusions from the fixed effect section are not affected by firm size.

5.2. Effect of the changes in economy and technology

In this section, we check whether the changes in economy and technology affect our findings. If they do not, then we can confirm that the relationship between CSR and innovation activities is not affected by the whole economic environment.

With the development of the economy and the technique skills, the productivities of innovation of the firms in each area may change. Thus, it is important to check whether this factor have influence on the relationship of CSR and innovation. The United States, along with 19 other countries, signed the Convention founding the Organization for Economic Co-Operation and Development on 14 December 1960. And thereby came into force of sustainable economic growth and employment in the following year. Besides, the OECD Forum for the Future pursue taking place beforehand around the theme of ''People, Nature and Technology: Sustainable Societies in the 21st Century'' which considers four key areas of human activity--- technology, economy, society and government. Scientific and technical progress is the single most important factor in generating sustained economic growth. It is estimated to account for as much as half of the nation's long-term growth over the past 50 years. Technology underpins the fastest growing industries and high-wage jobs, provides the tools needed to compete in the business world, and drives growth in every major industrialized nation.

Americans believe that the U.S. must remain ever vigilant and militarily strong, the need to maintain economic strength has taken on primary importance today. It is now recognized that economic strength facilitates not only a strong but promotes other societal needs, such as social and political stability, good health, and the preservation of freedom. The U.S. has a large and diverse complex of federal R&D laboratories and facilities. Those institutions act on proposals describes the recommended action and its expected benefits. It identifies the key stakeholders and their likely views and provides examples of best practice from 7 government or the private sector. It is obviously that American national technology development scheme, their economic strategy and management of stakeholders' relationship is changing during 1990 to the next twenty-five years. Therefore, it is necessary to focusing on the effects under year changing.

To check the potential effect of the development of the economy and technique skills on the results this study obtained and to check the robustness of the previously results, we estimated the models on different time periods separately, 1992-2007, 1993-2007, 1994-2007, 1995-2006, 1996-2007, 1997-2007. To keep the sufficient of the sample size and the accurate of the robustness test, the year changing test only carried out on these six periods.

The estimate results are in Tables 5 to 10 where Columns (1), (3) and (5) follow the model 1,2,3 respectively. Column (7) follows the model 4. Columns (2), (4), (6) follow the model 5 which presents the result of CSR/ICST and TCSR respectively and column (8) follows the model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations.

The results are consistent that CSR and ICSR activities can promote the development of firm's innovation, while TCSR have negative effect on firm's innovation activities. What is more, the

findings will not change with the changing of year. Thus, the findings of this study will not be affected by the development of the economy and the technique skills. The findings of this study are robust.

5.3. Endogeneity

Endogeneity is a critical issue because it compromises key conditions for claiming causality (Bascle, 2008; Hamilton & Nickerson, 2003). Referring to previous papers in corporate finance area, the literature focuses on the following endogeneity: selection bias, omitted variable, causality issue and measurement error (Wooldridge, 2015). These four types of endogeneity can all occur at the same time or be interrelated with each other (Wooldridge, 2010), which means that researchers should evaluate the complete endogeneity potential of their studies. In general, by summarize most reviewed articles, Zhang et al, (2022) concluded that 12 common methods are frequently by scholars to correct endogeneity issues. 12 common methods include the instrumental variable IV method, the two-stage Heckman technique, the Difference GMM and System GMM methods, PSM and other matching methods, DID and other quasi natural experiments, fixed effects, lagged explanatory variables, more control variables, and proxy variables (Zhang et al., 2022).

In detail, to address selection bias problem, Two-stage Heckman technique is usually used (Heckman, 1979, 1990; Nizamuddin, 2018; Semykina et al., 2010). Fixed effect, difference GMM and system GMM is preferred to choose by researchers to address omitted variable problem (Coad and Rao, 2008; Godfrey, 2009; Cheng et al., 2013). It is suggested that scholars need to seriously consider the possibility of measurement errors and take action to ameliorate their effect (Zhang et al., 2022). Among of the four mainly endogeneity issues, causality issue plays an important role. It includes simultaneous causality and causality reverse issues. Simultaneous causality refers to the situation where there is a reciprocal causal relationship between independent and dependent variables (Wooldridge, 2015). Endogeneity due to simultaneity or reversed causality are often tackled by controlling for the time lag between independent variables and the dependent variable in the model (Croce & Martí, 2014).

As enunciated above, various type of techniques is used. Among of them, PSM is mostly suitable for correcting endogeneity stemming from either omitted variable or selection bias (Nekhili et al., 2018), as other endogeneity issues (including simultaneous causality and measurement error) cannot be neutralized by randomized matching. PSM may help deal with endogeneity stemming from omitted variables because omitted variables might influence the distribution of groups in the sample, whereas PSM uses propensity scores to simulate randomly matched groups (Nekhili et al., 2018). The utilize of PSM approach often requires a large sample size and often suffers from the risk of nonrandomized sample matching (Hamilton & Nickerson, 2003). In our paper, we have 793 firms covering 15 years which meet large sample requirement of PSM test.

The most common IV method is two-stage least square (2SLS) which is also the method applied in my paper. If the selected instrumental variable cannot meet the conditions, the IV method cannot successfully mitigate the endogeneity issues (Semadeni et al., 2014). In other words, the quality of the instruments is crucial for the effectiveness of the IV method. To identify whether

the instruments are valid, overidentifying restriction tests, such as the Sargan test (Sargan, 1958), Hansen's J-statistic (L. P. Hansen, 1982), and the Basmann statistic (Basmann, 1960) are used.

To avoid weak instrumental selected problems, the conditional likelihood ratio test could be used if only one variable is believed to be endogenous; while the AR tests is recommended if models include more than one endogenous variable (Moreira, 2003; Anderson & Rubin, 1949). If the tests indicate a weak instrument, a better instrument should be found or apply alternative regression techniques (Baltagi, 2007). Moreover, to ensure the validity of methods used in controlling for endogeneity, the Hausman or Durbin–Wu–Hausman (DWH) test is often recommended as a proxy for the presence of underlying endogeneity issues.

The results so far suggest a relation between firm's CSR level and innovation. For total CSR and ICSR, the higher scores indicate a higher innovation production on both quantity and quality aspects, while for TCSR it shows a negative relation. However, this finding could be biased due to endogeneity matching between the CSR level and innovation. For instance, firms with more innovation could place greater emphasis on other elements of the firms rather than the CSR level. Thus, we will address the endogeneity concerns by using the propensity score matching method and instrumental variable approach. More details about robustness checks are shown following.

5.3.1. The propensity scores matching method

Propensity score matching is a statistical matching technique that usually used in empirical finance research to solve unobserved heterogeneity issues in endogeneity problem. Unobserved heterogeneity issues can be explained as the third-party factor that both correlated with independent variable and dependent variable. Rosenbaum and Rubin (1983) proposed propensity score matching as a method to remove the bias in the estimation of treatment effects from observational data. One of the primary problems faced when using observational data is the bias of the estimations for the treatment. Because the omitted variable bias or selection bias of the firms who experience a certain treatment often vary from the objective firms in systematic ways. And those biases in systematic ways could not be addressed or accounted for. Propensity score matching can be thought as a step that goes beyond that of just regression with controls to try to address selection issues more coherently.

There are four steps outlined by Pan and Bai (Pan and Bai, 2015) that are used in the process of propensity score matching. The first step is estimating propensity scores where the propensity score can be thought of as simply a likelihood or probability that an individual unit experiences the treatment. So, in the other words if the study were trying to establish the effects of CSR/ICSR/TCSR, the study would first estimate the likelihood or propensity that firms involve CSR/ICSR/TCSR activities. To estimating propensity scores, it can be done difference ways but typically it's done either using a logistic regression or appropriate regression model.

This study using Stata to do the regressions which set logit model by default, so the logit regression which was appropriate for binary outcomes to predict whether the firms attend CSR/ICSR/TCSR activities is be used in this study. In the first step, it is not actually predicting the outcome of interest yet. The regression just predicting whether an individual received treatment. Thus, this is a regression predicting the independent variable (CSR/ICSR/TCSR). In order the test how CSR/ICSR/TCSR effect on innovation, the first should be generate a propensity or a likelihood that the firm with different characteristics is partaking in CSR/ICSR/TCSR activities. Those characteristics are the variables that will be matched on and will be the covariance and control variables in the regressions. A propensity score which also could be seen as likelihood or probabilities will be created in this step.

π(X) = Prob (A =1 |X) (7)

In the above expression, π is the propensity scores, A is the changing conditions and X is the attributes.

The second step is matching. Using the propensity scores to match up individuals that have a similar propensity or similar likelihood or similar probability of doing all types of CSR activities so matching those and have a more comparison group. The goal of the matching technique is to achieve balance between the treatment and comparison group on observable traits. In this study, CSR, ICSR and TCSR have positive scores defined as treatment group while with the negative scores defined as control group. Once matching the evaluate the quality of matching, again the purpose of the matching is to get a treatment and comparison group that looks similar on observable characteristics. If we are failure to get two groups that looks similar, or we don't have balance of covariates then we might think that our match has not done a very good job. There are several different ways to go about matching like Nearest neighbour matching, Calliper matching, Radius matching, Other matching techniques (Mahalanobis), Greedy and optimal matching or with and without replacement. Some of the more common ones are nearest neighbour matching that match two units that have most similar propensity scores. The theory of nearest neighbour matching as the equation following:

$$\text{ATT} = \frac{1}{N^T} \sum_{i \in T} [Y_i^T - \sum_{j \in C(i)} W_{ij} Y_j^C] \qquad (8)$$

ATT is the average treatment effect on the treated, N^T is the number of treated units, C(i) set of controls matched to treated unit i, N_i^C number of controls matched to treated unit i, $W_{ij} = \frac{1}{N_i^C}$ if j $\in$ C(i) and 0 otherwise. π(X) is included in the outcome regression model and π(X) and Y is assumed a linear relationship.

Once the matching finished, the quality of matching should be evaluated. There are several different ways to evaluate outcomes in the third step. Comparing means by using t-test, calculating standardized bias for each covariate, through percent bias reduction or graphing comparisons like histograms or boxplots. Comparing means using t-test is used in this paper to check whether the matching achieve balance between the treatment group and the comparison group.

The last step is evaluating the outcomes which could be done by comparing means of matched samples or run a regression on the matched sample controlling for unbalanced covariates. The latter method is adopted by this study. There are still limitations of propensity score matching like omitting variable bias may still be an issue and assuming independence conditional on the covariates. In some situation, this is little different than the assumption of OLS model. After all, if two firms have all the same measures on the number of covariates but some of them involves in CSR types while the other does not. There is a good reason to think that perhaps something different about their situation that the study does not consider.

5.3.2. The results of propensity score matching test.

To mitigate endogeneity concerns, we adopt propensity score matching method, whereby firm years with positive CSR/ICSR/TCSR scores are matched with those negative CSR/ICSR/TCSR scores. Those matched firms present similarity characteristics on other level except CSR/ICSR/TCSR scores. For panel A to panel C in Table 11 to Table 13 discuss CSR, ICSR and TCSR respectively, where the treatment variable equals to 1 if CSR/ICSR/TCSR are positive otherwise equals to 0.

While for panel D in Table 11 to Table 13 which is discussing about the co-effect of ICSR and TCSR, the treatment variable is defined as 1 if both ICSR and TCSR are positive and defined as 0 if both ICSR and TCSR are less than or equals 0. During the test, we also considered other defining methods such as defining treatment variable equals to 1 when both ICSR and TCSR are larger than 0. And defining treatment variable equals to zero if one of them smaller or equals than zero. But the sample size is two small which could not illustrate the co-effect influence well. Thus, after a trade-off between testing accurate and the diversity of the sub-sample, we choose the definition way which used in the paper.

The first step is to estimate a logit regression of whether a firm has a positive CSR/ICSR/TCSR. The propensity score is then the probability estimated from the logit regression. The same set of control variables is used like the model of section 5.1. Then the study applies the nearest-neighbour method to ensure that firms with positive CSR/ICSR/TCSR scores (treatment group) are sufficiently similar to their matched firms with a negative CSR/ICSR/TCSR scores firms (control group). Specifically, each firm with positively score is matched to a firm with negatively score with the closest propensity score. If a firm in the control group is matched to more than one firm in the treatment group, only the pair with the smallest difference in propensity scores between the two firms is retained.

Our paper conducts two diagnostic tests to verify that the observations in the treatment and control group are sufficiently indistinguishable in terms of observable characteristics. The first test involves are re-estimating the logit model using the matched sample. The results are shown in Table 11. It shows that the estimates are not significant which indicating no distinguishable trends between the treatment and control groups. In addition, most of the coefficients in post matched column are smaller in magnitude than those in pre matched

column in panel A to D in Table 11, implying that the results are not merely an artefact of a decline in the number of degrees of freedom in the restricted sample.

The second test is to examine the difference in the means for each observable characteristic between the treatment and matched control groups. The results are reported in Table 12. Overall, the diagnostic test results appear to suggest that propensity score matching removes observable differences other than the difference in CSR/ICSR/TCSR scores between the treatment and control groups. Thus, it increases the likelihood that any difference innovation between the two groups is due to the presence of CSR/ICSR/TCSR scores.

Finally, Table 13 presents the propensity score matching estimates. The results suggest that there is no endogeneity problem in the estimated models and firms involved in CSR and ICSR activities have higher innovation outputs but TCSR are not.

5.3.3. Instrument variable (IV) approach

Instrument variable (IV) approach is widely used in CSR and innovation related studies. On one hand, IV approach is employed on detecting the effect of CSR on credit ratings, executive compensation, shareholder value and firm value (Jiraporn et al, 2014; Cai et al, 2011; Ongsakul et al, 2020; Sheikh, 2018). On the other hand, IV approach is employed on detecting the influence on innovation. For example, the effect of employee-friendly workplace, the effect of institution ownership, institutional quality and the impact of patent system on innovation (Chen et al, 2016; Aghion et al, 2013; Tebaldi and Elmslie, 2013; Lerner, 2002). In our study, dependent and independent variables are both continuous variables so two stage least square (2SLS) IV approach is employed to deal with potential endogeneity problem. The approach is completed in following steps.

The first step is specifying a model for CSR/ICSR/TCSR and run it using OLS in STATA to acquire the predicted participation:

$$X_{i,t-1} = a_1 Z_{i,t-3} + a_2 Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon 1_{i,t-1} \quad (9)$$

Where $X_{i,t-1}$ represents the CSR, ICSR and TCSR scores in three independent regressions, $Control_{i,t-1}$ =c($Tobin's\ Q_{i,t-1}, Leverage_{i,t-1}, RD\ intensity_{i,t-1}, Current\ ratio_{i,t-1}, CAPX_{i,t-1}, ROA_{i,t-1}, BV_{i,t-1}$) is a vector of control variables. a_1 is the coefficient of instrumental variables. $Z_{i,t-3}$ is the instrumental variable which are CSR, ICSR and TCSR scores with two years lag in three independent regressions. Industry fixed effects defined based on two-digit SIC codes, $Year_{t-1}$ captures year fixed effects and $Firm_i$ captures the fixed effect on firm level.

Then, the following participation is generated:

$$\hat{X}_{i,t-1} = \hat{a}_1 Z_{i,t-3} + \hat{a}_2 Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j \quad (10)$$

Where $\hat{X}_{i,t-1}$ does not influenced by the error term $\varepsilon_{i,t-1}$ which means it is not affected by the unobservable (the source of endogeneity).

The second step is run equation (13) using OLS which is using predicted participation in OLS model to substitute original CSR/ICSR/TCSR scores.

$$Y_{it} = a_1(\hat{X}_{i,t-1} + \varepsilon 1_{i,t-1}) + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon 2_{i,t-1} \quad (11)$$

$$Y_{it} = a_1\hat{X}_{i,t-1} + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + (a_1\varepsilon 1_{i,t-1} + \varepsilon 2_{i,t-1}) \quad (12)$$

$$Y_{it} = a_1\hat{X}_{i,t-1} + a_2\, Control_{i,t-1} + Firm_i + Year_{t-1} + Industry_j + \varepsilon^*{}_{i,t-1} \quad (13)$$

Where Y_{it} is innovation measured by the number of patent and the number of citation in two independent regressions. $Z_{i,t-3}$ affect $X_{i,t-1}$ and it does not affect Y_{it} directly which only through affect $X_{i,t-1}$. The standard errors are corrected by using ivregress command in STATA.

5.3.4. The result of Instrument variable (IV) approach

Our estimations may be biased due to the endogeneity problems which could occur when certain factors not captured by the model. The factors are correlated with both a firm's CSR performance (unobserved heterogeneity) and its innovation output, or when the firms with either higher innovation productivity or with better innovation outcomes quality firms are more likely to do CSRs activity (reverse causality). To verify that the endogeneity does not drive the result, we employ instrumental variable estimator as two stage least square (2sls) regression to address these potential concerns. The instrumental variable approach to extract the exogenous component of CSRs and use it to explain innovation outputs. Since CSR is a long-term sustainable strategy, use the CSR/ICSR/TCSR scores with two years lag as the instrumental variable of each CSR type which capture the exogenous variation in a firm's tendency to engage in CSRs activities (Gazzola and Gazzola, 2014). Besides, CSR policy is serves for conduce more related CSR activities and CSR scores as the proxy of CSR activity, we assumed that the previous CSR/ICSR/TCSR scores have positive effect on later year's CSR/ICSR/TCSR scores. The instrumental variable is expected to be uncorrelated with firm innovation, except through the impact on CSRs scores.

Columns (1) of table 14 present the result of the first-stage regression where the dependent variable is the CSR scores. Consistent with our predictions for the instruments, the coefficient estimate is positive and significant at 1% level. In addition, we conduct another two tests to verify their validity. The first one is to test the joint significant of the instrumental and find that the value of the F-test are large and highly significant. As Staiger and Stock (1997) suggest that it could be consider the weak IV is not exist when the F-test larger than 10. Therefore, the CSR scores with two years lag is not a weak IV. Second, we employed Durbin-Wu- Hausman test to examine the prerequisite of IV approach which is the existing of endogenous explanatory variable. The results of second stage (both column (2) and (3))

indicate that the null hypothesis cannot be reject which means we cannot reject no significant difference between IV regression and baseline regression. In other words, it cannot be proved that the potential biased problem results from endogenous. Thus, the test does not satisfy the prerequisite of IV approach and the test is not an effective test.

We also employed IV approach on the effect of ICSR on innovation. Column (1) of table 15 presents the result of the first-stage regression where the dependent variable is ICSR scores. The instrumental variable of ICSR is ICSR scores with two years lag. Consistent with our prediction for the instruments, the coefficient is positive and significant at 1% level. The F-statistics is large enough and highly significant which indicate a non-weak instrumental variable. In addition, the F-statistics of Durbin-Wu- Hausman test is highly significant (p-value = 0.000) for both column (2) and (3). Thus, the null hypothesis can be rejected that satisfied the prerequisite of IV approach. The coefficient of the number of patent increases to 0.882 and statistically significant. The coefficient of the number of citations increases to 0.525 and significant at 1% level. Both the coefficient of the number of patent and the number of citations is more closely to a level that economic reasonable. After accounting for the potential endogeneity of innovation, ICSR continues to be positive and significant determinant of innovation on both quantity and quality.

Table 16 presents the IV approach on the effect of TCSR on innovation. Column (1) of table 16 shows the result of the first-stage regression where the dependent variable is TCSR scores. The instrumental variable of TCSR is the TCSR scores with two years lag. Consistent with our prediction that the sustainable characteristic of CSR, the coefficient of instrumental variable is positive and significant at 1% level. The F-statistics is large and highly significant indicating an effective instrumental variable. The F-statistics of Durbin-Wu- Hausman test is significant at 1% level (for both column (2) and (3)) indicating that a biased estimation results from endogenous problem exist in OLS regression. The coefficient of TCSR on second stage are negative on both quantity and quality measures which consistent with our baseline regression. The coefficient of TCSR in columns (2) is -1.024 which means the number of patents will decrease 1 with TCSR scores increase 1. The coefficient of TCSR on column (3) is -0.859 which means the number of citations will less nearly 1 with the TCSR score increase 1. The above coefficients are closer to real economic performance comparing to baseline regression.

In summary, we employ instrumental variable approach to address potential estimation bias due to endogeneity problem. The instrumental variable is CSR/ICSR/TCSR scores with two years lag. For IV approach on the effect of CSR on innovation, the result show that IV is not a proper approach. However, the employing of IV approach on test the effect of ICSR and TCSR show a more effective estimation. We infer that the working mechanism of instrumental variable approach makes the estimation more precise and CSR as a combined type contains many factors that we cannot control. Therefore, the results of regression with IV and without IV do not have significant difference. While after classifying the CSR into more specific types, the factors can be captured targeted, so we get a more effective estimation. The main results are robust to endogeneity tests with instrumental variables that ICSR contributes to

innovation while TCSR have impede innovation outputs on both quality and quantity aspects. We argue that the effect of ICSR and TCSR on innovation is causal.

5.3.5. Moderation effect of firm size and financial constraints

To test whether firm size and financial constraints moderate the effect of CSR/ICSR/TCSR on innovation, we apply moderation effect test. Our aim is to explore if larger/smaller firms expand/constraint the effect and if higher/lower cash flow expand/constrains the effect. I construct 6 interaction terms which are net CSR scores* book value of total asset, net ICSR scores* book value of total asset, net TCSR scores* book value of total asset, net CSR* gross cash flow, net ICSR scores* gross cash flow and net TCSR scores* gross cash flow. I did sets of moderation effect test which including 3 regressions in each set. The first regression is the effect of CSR/ICSR/TCSR on patent counts and citation counts; the second regression is the effect of CSR/ICSR/TCSR and the moderation variable on innovation; the third regression is the effect of CSR/ICST/TCSR, moderation variable and interaction term on innovation at the same time.

Table 17 and Table 18 present the moderation effect of firm size and financial constraints respectively. The results show (1) CSR/ICSR/TCSR still have significant effect on innovation on both quantity and quality level (2) firm level and financial constraints significantly have positive on innovation (3) after add interaction term into the regression, firm size and cash constraints shows a significant positive effect on innovation although not significant for interaction term which enhance the test efficiency in some extent. In summary, adding interaction term improved my regression efficiency in some extent, but neither firm size nor financial constraints have significant moderation effect on our current sample.

6. Conclusions:

This paper focus on non-financial firms over period 1991-2007 and investigates whether and how CSR affect firm's innovation activities. We find that both CSR and ICSR have positive influence on firm' innovation activities in terms of quality and quality, and TCSR has a negative influence on firms' innovation activities in terms of quality and quantity.

Therefore, we conclude that firms engage in CSR activities have positive effect on innovation on the number of patents and the number of citations. Our study not only detecting the relationship between CSR activities and firms' innovation activities, but also specifies CSR activities into ICSR which is institution corporate social responsibility activities and TCSR which is technical corporate responsibility activities. ICSR have positive effect on innovation on both quality and quantity levels because secondary stakeholders may consider more about the long-term development the firms, however, TCSR have negative influence on firm's innovation on both quality and quantity levels because primary stakeholder may focus more on short-term benefit which is utilitarian and short sighting.

The first robustness check is to test whether the conclusion will be affected by firm size. After controlling firm size, we observe that the conclusion is consistent. The second robustness test is to check whether the relation between innovation and CSR acitivities is affected by the development of the economy and the technology over time and the result is consistent that implying the changing of the ecomonic environment doea not affect the influence relationship of CSR/ICSR/TCSR on innovation. The third robustness check is to check for possible endogeneity by using propensity score matching method. After matching firms with similarly characteristics without CSR scores to check whether the relationship between innovation and CSR activities is affected by the financial level factors. And the result of the propensity score matching test is that the conclusion is consistency. The fourth robustness test is IV approach and the results of the effect of ICSR and TCSR are consistent with baseline regression. The fifth robustness test is creating firm size and cash flow interaction term to test the moderation effect of firm size and financial constraints.

The contribution of this paper is shedding light on that not all types of CSR activities have positive effect on firm's innovations. What is more, this paper not only expand the research on CSR and innovation area, but also filling the gap that the effect of different CSR type activities on firm's business. For innovative firm who is looking for a sustainability strategy could consider invest on ICSR activity since this type of investment bring firms benefits in a long-term. Government and public institutions could engage in firm CSR activity which will help firms in their community have a healthy development.

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Appendix 1: CSR dimensions

Figure 1: CSR dimensions

Name	label
Environment strengths	
1	Beneficial products and services
2	Pollution prevention
3	Recycling
4	Clean energy
5	Property, plant, equipment (through 1995)
6	Environment other strength
7	Management systems strengths
8	Number of strengths
Environment concerns	
1	Hazardous waste
2	Regulatory problems
3	Ozone depleting chemicals
4	Substantial emissions
5	Agriculture chemicals
6	Environment other concerns
7	Linate change (from 1999)
8	Number of concerns
Community strengths	
1	Charitable giving (from 1991 through 2011)
2	innovative giving
3	Support for housing
4	Support for education (from 1994)

5	Non-US charitable giving
6	Volunteer programs (from 2005)
7	Other strengths (from 1991 through 2011)
Community concerns	
1	Investment controversies
2	Negative economic impact
3	Tax disputes
4	Community other concerns
Human rights strengths	
1	Positive record in South Africa (1994-1995)
2	Indigenous people's relations strength (from 2000)
3	Labour rights strength (from 2000)
4	Human rights other
Human rights concerns	
1	South Africa (1991-1994)
2	Northern Ireland (1991-1994)
3	Burma concern (from 1995)
4	Mexico (1995-2002)
5	Labour rights concern (from 1998)
6	Indigenous peoples relations concern (from 2000)
7	Human rights other concerns
Employee strengths	
1	Union relations
2	No-layoff policy (through 1994)
3	Cash profit sharing
4	Employee involvement

5	Retirement benefits strength
6	Employee strengths- other strength (from 1991 through 2011, from 2013)
7	Health and safety strength
Employee concerns	
1	Union relations
2	Health and safety concern
3	Retirement benefits concerns
4	Workforce reductions
5	Employee relations other concerns
Diversity strengths	
1	CEO
2	Promotion (from 1991 through 2011)
3	Board of directors
4	Work-life benefits (from 1991 through 2011)
5	Women and minority contracting
6	Employment of the disabled
7	Gay and lesbian policies (from 1993 through 2011)
8	Diversity other strength
Diversity concerns	
1	Controversies
2	Non-representation (from 1993 through 2011)
3	Diversity other concerns
Product strengths	
1	Quality
2	R&D innovation

3	Benefits to economically disadvantaged
4	Product other strengths
Product concerns	
1	Product safety
2	Marketing- contracting concern
3	Antitrust
4	Product other concerns
Corporate governance strengths	
1	Limited compensation
2	Ownership strengths
3	Corporate governance other strength
4	Transparency strength 1996-2012)
5	Political accountability strength (from 2005)
Corporate governance concerns	
1	High compensation
2	Ownership concern
3	Accounting concerns (from 2005)
4	Transparency concerns (2005-2012)
5	Political accountability concern (from 2005)
6	Corporate governance other concerns
Alcohol concerns	
1	Alcohol involvement
2	Alcohol other concerns
Gambling concerns	
1	Gambling involvement

2	Gambling other concern (through 2002)
Military concerns	
1	Military involvement
2	Minor weapons contracting (1991-2002)
3	Major weapons- related supplier (1991-2002)
4	Military other concerns (through 2002)
Nuclear concerns	
1	Nuclear involvement
2	Nuclear design (through 2002)
3	Nuclear fuel cycle (through 2002)
4	Nuclear other concern (through 2002)
Tobacco concerns	
1	Tobacco involvement
2	Tobacco other concerns (through 2002)
Firearms concerns	
1	Firearms involvement (from 1999)

Appendix 2: Tables

Table 1: Descriptive Statistics--- characteristics of each variable.

Table 1 describe the summary statistics of innovation measures, CSR measures and control variables. fpatent is the logarithm value of 1 plus firm's number of patent and forward one year compared to independent and control variables. fcitaiton is the logarithm value 1 plus firm's number of citation and forward one year compared to independent and control variables. tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value the logarithm value of firm's book value of total asset.

Variable	Obs.	mean	Std. dev	Min	Median	Max
Innovation measures						
Fpatent	10,108	0.59	1.35	0.00	0.00	7.33
Fcitation	10,108	0.57	1.32	0.00	0.00	11.88
CSR measures						
Intercsr	10,902	-0.01	1.14	-9.00	0.00	14.00
Intericsr	10,902	0.13	0.81	-3.00	0.00	10.00
Intertcsr	10,902	-0.12	0.69	-7.00	0.00	4.00
Main controls						
tobinq_w	10,113	2.42	1.90	0.84	1.76	12.40
leverage_w	10,762	0.21	0.18	0.00	0.19	0.91
interRDintensity_w	10,902	0.06	0.09	0.00	0.03	0.52
currentratio_w	10,259	2.72	2.51	0.53	1.95	16.98
CAPX_w	10,543	0.057	0.04	0.00	0.05	0.24
ROA_w	10,614	0.12	0.15	-0.61	0.14	0.41
LnBV_w	10,821	7.32	1.98	2.41	7.36	12.20

Table 2: Difference in the means for each observable characteristic.

Table 2 is to study whether the existence of CSR/ICSR/TCSR matter for innovation. fpatent is the logarithm value of 1 plus firm's number of patent and forward one year compared to independent and control variables. fcitaiton is the logarithm value 1 plus firm's number of citation and forward one year compared to independent and control variables. tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX and ROA_w is the winsorized value of firm's ROA. * p<0.1, ** p<0.05, *** p<0.01.

	Mean			Mean			Mean		
variables	dcsr=0: A (N=8,552) (1)	dcsr=1: B(N=2,350) (2)	Test of difference(B-A) (3)	dicsr=0: A (N=10,458) (4)	dicsr=1: B (N=444) (5)	Test of difference (B-A) (6)	dtcsr=0: A (N=10,469) (7)	dtcsr=1: B (N=433) (8)	Test of difference (B-A) (9)
fpatent	0.09	2.26	2.17***	0.52	2.20	1.69***	0.52	2.29	1.77***
fcitation	0.13	2.05	1.92***	0.50	2.05	1.55***	0.50	2.08	1.58***
tobinq_w	2.38	2.52	0.14***	2.41	2.59	0.19**	2.42	2.37	-0.05
leverage_w	0.21	0.22	0.15***	0.21	0.22	0.01	0.21	0.21	0.00
interRDintensity_w	0.07	0.05	-0.01***	0.06	0.05	-0.01**	0.06	0.05	-0.01**
currentratio_w	2.81	2.40	-0.41***	2.73	2.50	-0.23*	2.74	2.37	-0.37***
CAPX_w	0.06	0.05	-0.003**	0.057	0.052	0.004**	0.057	0.057	0.003
ROA_w	0.11	0.15	0.04***	0.12	0.15	0.03***	0.12	0.14	0.02***

Table 3: The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation.

Table 3 study the relationship between CSR/ICSR/TCSR and innovation. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX and ROA_w is the winsorized value of firm's ROA. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. * p<0.1, ** p<0.05, *** p<0.01.

Panel A. CSR/ICSR/TCSR and patent counts									

	Dependent Variable=fpatent			
	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
intercsr	0.046***			
	(0.010)			
intericsr		0.221***		0.212***
		(0.013)		(0.013)
intertcsr			-0.132***	-0.108***
			(0.016)	(0.016)
tobinq_w	0.044***	0.042***	0.042***	0.041***
	(0.007)	(0.008)	(0.007)	(0.007)
leverage_w	0.288***	0.277***	0.299***	0.282***
	(0.093)	(0.092)	(0.093)	(0.091)
interRDintensity_w	-0.261	-0.218	-0.227	-0.189
	(0.276)	(0.272)	(0.275)	(0.271)
currentratio_w	0.008	0.008	0.009	0.008
	(0.007)	(0.007)	(0.007)	(0.007)
CAPX_w	3.057***	3.003***	3.099***	3.024***
	(0.337)	(0.332)	(0.336)	(0.331)
ROA_w	0.034	0.029	0.053	0.041
	(0.136)	(0.133)	(0.135)	(0.133)
_cons	0.248***	0.223***	0.225***	0.207***
	(0.049)	(0.048)	(0.049)	(0.048)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	8846	8846	8846	8846

adj. R-sq	0.160	0.181	0.162	0.185

Panel B. CSR/ICSR/TCSR and citation counts

	Dependent Variable=fcitation			
	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
intercsr	0.035*			
	(0.021)			
intericsr		0.165***		0.157***
		(0.029)		(0.029)
intertcsr			-0.122***	-0.106***
			(0.034)	(0.033)
tobinq_w	0.042***	0.041***	0.041***	0.031***
	(0.013)	(0.013)	(0.013)	(0.012)
leverage_w	0.129	0.125	0.142	0.132
	(0.143)	(0.142)	(0.143)	(0.141)
interRDintensity_w	-1.060***	-1.018***	-1.030***	-0.989***
	(0.374)	(0.371)	(0.366)	(0.366)
currentratio_w	-0.013	-0.012	-0.011	-0.011
	(0.009)	(0.009)	(0.009)	(0.009)
CAPX_w	-0.248	-0.233	-0.217	-0.208
	(0.436)	(0.427)	(0.434)	(0.425)
ROA_w	-0.120	-0.128	-0.112	-0.122
	(0.203)	(0.195)	(0.197)	(0.191)
_cons	0.763***	0.735***	0.741***	0.718***
	(0.097)	(0.097)	(0.097)	(0.010)

Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	8846	8846	8846	8846
adj. R-sq	0.094	0.105	0.098	0.109

Robustness check

Table 4: The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation after controlling firm size.

Table 4 study the relationship between CSR/ICSR/TCSR and whether the firm size have the influence on the relationship of CSR and innovation. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (2) and (3) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (4) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel b is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A. CSR/ICSR/TCSR and patent counts

	Dependent Variable=fpatent			
	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
intercsr	0.046***			
	(0.010)			
intericsr		0.221***		0.212***
		(0.013)		(0.013)
intertcsr			-0.133***	-0.108***
			(0.016)	(0.016)
tobinq_w	0.0432***	0.041***	0.041***	0.0403***
	(0.008)	(0.008)	(0.008)	(0.0071)
leverage_w	0.292***	0.282***	0.305***	0.287***

	(0.093)	(0.092)	(0.093)	(0.092)
interRDintensity_w	-0.313	-0.278	-0.296	-0.260
	(0.287)	(0.283)	(0.286)	(0.282)
currentratio_w	0.008	0.007	0.009	0.007
	(0.007)	(0.007)	(0.00696)	(0.007)
CAPX_w	3.004***	2.943***	3.030***	2.955***
	(0.346)	(0.341)	(0.345)	(0.340)
ROA_w	0.0304	0.026	0.049	0.036
	(0.136)	(0.134)	(0.135)	(0.133)
LnBV_w	-0.010	-0.012	-0.013	-0.014
	(0.015)	(0.015)	(0.015)	(0.015)
_cons	0.330**	0.316**	0.332**	0.316**
	(0.133)	(0.131)	(0.132)	(0.130)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	8846	8846	8846	8846
adj. R-sq	0.189	0.209	0.191	0.212

Panel B. CSR/ICSR/TCSR and citation counts

	Dependent Variable=fcitation			
	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)
intercsr	0.034*			
	(0.020)			
intericsr		0.157***		0.150***
		(0.0295)		(0.029)
intertcsr			-0.114***	-0.099***

			(0.034)	(0.032)
tobinq_w	0.060***	0.058***	0.058***	0.057***
	(0.013)	(0.013)	(0.013)	(0.012)
leverage_w	0.055	0.0535	0.069	0.062
	(0.139)	(0.138)	(0.139)	(0.138)
interRDintensity_w	-0.025	-0.022	-0.018	-0.013
	(0.359)	(0.357)	(0.352)	(0.352)
currentratio_w	-0.012	-0.011	-0.011	-0.010
	(0.008)	(0.008)	(0.008)	(0.008)
CAPX_w	-0.240	-0.227	-0.211	-0.203
	(0.439)	(0.430)	(0.437)	(0.428)
ROA_w	-0.220	-0.223	-0.210	-0.216
	(0.195)	(0.189)	(0.191)	(0.185)
LnBV_w	0.288***	0.277***	0.282***	0.272***
	(0.038)	(0.038)	(0.038)	(0.037)
_cons	-1.143***	-1.101***	-1.127***	-1.085***
	(0.258)	(0.252)	(0.258)	(0.250)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	8846	8846	8846	8846
adj. R-sq	0.109	0.119	0.112	0.122

Table 5 to Table 10 check the impact of the changes in economy and the technology.

Table 5. The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation between year 1992-2007

Table 5 is the robustness test of the results in baseline regression. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (3) and (5) shows the results of model 1, 2 and 3. Column (7) shows the results of model 4. Column (2), (4), (6) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (8) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A. CSR/ICSR/TCSR and patent counts								
	Dependent Variable=fpatent							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.043*	0.042*						
	(0.023)	(0.022)						
intericsr			0.190***	0.183***			0.184***	0.177***
			(0.031)	(0.030)			(0.030)	(0.030)
intertcsr					-0.104***	-0.095***	-0.085**	-0.077**
					(0.036)	(0.035)	(0.034)	(0.033)

tobinq_w	0.023*	0.043***	0.021*	0.041***	0.021*	0.041***	0.020*	0.040***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
leverage_w	0.127	0.040	0.119	0.0352	0.141	0.0545	0.124	0.041
	(0.136)	(0.132)	(0.135)	(0.131)	(0.135)	(0.132)	(0.134)	(0.131)
interRD	-0.877**	0.324	-0.839**	0.320	-0.857**	0.326	-0.817**	0.327
intensity_w								
	(0.348)	(0.337)	(0.340)	(0.329)	(0.345)	(0.333)	(0.337)	(0.327)
currentratio_w	-0.022**	-0.021***	-0.021**	-0.021***	-0.020**	-0.020***	-0.020**	-0.020***
	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)
CAPX_w	-0.222	-0.239	-0.189	-0.206	-0.198	-0.216	-0.170	-0.189
	(0.425)	(0.423)	(0.416)	(0.415)	(0.424)	(0.423)	(0.415)	(0.414)
ROA_w	-0.083	-0.214	-0.099	-0.225	-0.079	-0.208	-0.097	-0.221
	(0.179)	(0.175)	(0.170)	(0.167)	(0.175)	(0.172)	(0.167)	(0.164)
LnBV_w		0.325***		0.314***		0.321***		0.311***
		(0.039)		(0.038)		(0.039)		(0.037)
_cons	0.795***	-1.377***	0.762***	-1.336***	0.775***	-1.367***	0.747***	-1.325***
	(0.084)	(0.253)	(0.083)	(0.245)	(0.085)	(0.251)	(0.083)	(0.244)

Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	8359	8359	8359	8359	8359	8359	8359	8359
adj. R-sq	0.165	0.191	0.186	0.210	0.167	0.193	0.189	0.213

Panel B: CSR/ICSR/TCSR and patent quality

	Dependent Variable= fcitation							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.034	0.03334						
	(0.021)	(0.020)						
intericsr			0.162***	0.156***			0.155***	0.149***
			(0.029)	(0.029)			(0.029)	(0.029)
intertcsr					-0.118***	-0.111***	-0.102***	-0.096***
					(0.036)	(0.036)	(0.034)	(0.034)
tobinq_w	0.040***	0.058***	0.039***	0.056***	0.039***	0.056***	0.038***	0.055***
	(0.013)	(0.013)	(0.0123	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)

leverage_w	0.137	0.065	0.130	0.060	0.151	0.079	0.137	0.0678
	(0.144)	(0.141)	(0.143)	(0.140)	(0.144)	(0.141)	(0.142)	(0.140)
interRD	-1.017**	-0.013	-0.984**	-0.015	-0.991**	-0.008	-0.958**	-0.008
intensity_w								
	(0.394)	(0.377)	(0.392)	(0.376)	(0.387)	(0.371)	(0.387)	(0.371)
currentratio_w	-0.010	-0.009	-0.009	-0.009	-0.008	-0.009	-0.008	-0.008
	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)
CAPX_w	-0.062	-0.076	-0.033	-0.047	-0.033	-0.049	-0.010	-0.026
	(0.453)	(0.454)	(0.444)	(0.446)	(0.450)	(0.452)	(0.441)	(0.443)
ROA_w	-0.050	-0.159	-0.063	-0.168	-0.045	-0.153	-0.060	-0.164
	(0.206)	(0.201)	(0.198)	(0.194)	(0.201)	(0.197)	(0.194)	(0.191)
LnBV_w		0.272***		0.263***		0.267***		0.258***
		(0.039)		(0.038)		(0.039)		(0.038)
_cons	0.705***	-1.112***	0.677***	-1.076***	0.683***	-1.098***	0.659***	-1.063***
	(0.085)	(0.259)	(0.084)	(0.251)	(0.0841)	(0.258)	(0.083)	(0.249)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	8359	8359	8359	8359	8359	8359	8359	8359
adj. R-sq	0.099	0.111	0.110	0.121	0.102	0.114	0.113	0.124

Table 6. The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation between year 1993-2007

Table 6 is the robustness test of the results in baseline regression. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (3) and (5) shows the results of model 1, 2 and 3. Column (7) shows the results of model 4. Column (2), (4), (6) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (8) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR/ICSR/TCSR and patent counts								
	Dependent Variables= fpatent							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.043*	0.042*						
	(0.023)	(0.022)						
intericsr			0.187***	0.181***			0.182***	0.176***
			(0.031)	(0.031)			(0.031)	(0.031)

intertcsr					-0.101***	-0.095**	-0.0849**	-0.080**
					(0.037)	(0.038)	(0.035)	(0.034)
tobinq_w	0.022*	0.043***	0.021*	0.041***	0.021*	0.042***	0.020*	0.040***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
leverage_w	0.137	0.053	0.126	0.0454	0.152	0.069	0.133	0.053
	(0.136)	(0.133)	(0.135)	(0.132)	(0.135)	(0.132)	(0.134)	(0.132)
interRDintensity_w	-0.828**	0.346	-0.795**	0.340	-0.811**	0.348	-0.776**	0.346
	(0.354)	(0.341)	(0.345)	(0.333)	(0.350)	(0.338)	(0.341)	(0.331)
currentratio_w	-0.022**	-0.022***	-0.022**	-0.023***	-0.021**	-0.021***	-0.021**	-0.021***
	(0.001)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)
CAPX_w	-0.377	-0.392	-0.344	-0.359	-0.369	-0.385	-0.335	-0.351
	(0.448)	(0.447)	(0.439)	(0.439)	(0.446)	(0.446)	(0.437)	(0.437)
ROA_w	-0.047	-0.178	-0.065	-0.191	-0.045	-0.175	-0.064	-0.189
	(0.180)	(0.176)	(0.170)	(0.168)	(0.176)	(0.173)	(0.167)	(0.165)
LnBV_w		0.314***		0.304***		0.311***		0.301***
		(0.040)		(0.039)		(0.040)		(0.039)
_cons	0.815***	-1.305***	0.783***	-1.269***	0.803***	-1.293***	0.772***	-1.257***

	(0.086)	(0.260)	(0.085)	(0.253)	(0.087)	(0.260)	(0.085)	(0.252)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7856	7856	7856	7856	7856	7856	7856	7856
adj. R-sq	0.171	0.194	0.191	0.212	0.174	0.196	0.194	0.215

Panel B: CSR/ICSR/TCSR and patent quality

	Dependent Variable= fcitation							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.033	0.032						
	(0.022)	(0.021)						
intericsr			0.162***	0.157***			0.155***	0.150***
			(0.030)	(0.031)			(0.030)	(0.030)
intertcsr					-0.119***	-0.113***	-0.105***	-0.10***
					(0.038)	(0.038)	(0.036)	(0.036)
tobinq_w	0.037***	0.055***	0.036***	0.054***	0.036***	0.054***	0.035***	0.053***

	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
leverage_w	0.170	0.098	0.160	0.0907	0.185	0.113	0.168	0.010
	(0.145)	(0.142)	(0.143)	(0.141)	(0.144)	(0.142)	(0.142)	(0.140)
interRDintensity_w	-0.994**	0.020	-0.965**	0.015	-0.971**	0.024	-0.941**	0.023
	(0.410)	(0.391)	(0.406)	(0.388)	(0.402)	(0.383)	(0.400)	(0.382)
currentratio_w	-0.011	-0.011	-0.011	-0.011	-0.010	-0.010	-0.008	-0.010
	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)
CAPX_w	-0.237	-0.250	-0.208	-0.222	-0.226	-0.240	-0.197	-0.211
	(0.468)	(0.468)	(0.460)	(0.461)	(0.465)	(0.465)	(0.457)	(0.458)
ROA_w	-0.074	-0.187	-0.089	-0.199	-0.072	-0.184	-0.088	-0.196
	(0.206)	(0.202)	(0.198)	(0.194)	(0.201)	(0.197)	(0.193)	(0.190)
LnBV_w		0.271***		0.263***		0.267***		0.259***
		(0.039)		(0.037)		(0.039)		(0.037)
_cons	0.704***	-1.127***	0.676***	-1.095***	0.689***	-1.111***	0.663***	-1.080***
	(0.090)	(0.260)	(0.09)	(0.252)	(0.090)	(0.258)	(0.089)	(0.249)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	7856	7856	7856	7856	7856	7856	7856	7856
adj. R-sq	0.103	0.115	0.114	0.125	0.107	0.118	0.117	0.128

Table 7. The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation between year 1994-2007

Table 7 is the robustness test of the results in baseline regression. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (3) and (5) shows the results of model 1, 2 and 3. Column (7) shows the results of model 4. Column (2), (4), (6) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (8) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR/ICSR/TCSR and patent counts								
	Dependent Variable= fpatent							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.040*	0.040*						
	(0.023)	(0.022)						
intericsr			0.179***	0.173***			0.173***	0.167***
			(0.032)	(0.032)			(0.032)	(0.031)

intertcsr					-0.100**	-0.093**	-0.090**	-0.077**
					(0.039)	(0.038)	(0.037)	(0.036)
tobinq_w	0.024**	0.045***	0.023**	0.043***	0.023*	0.044***	0.022**	0.042***
	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)	(0.011)	(0.011)	(0.011)
leverage_w	0.169	0.090	0.159	0.083	0.183	0.104	0.165	0.089
	(0.141)	(0.138)	(0.139)	(0.137)	(0.139)	(0.137)	(0.138)	(0.136)
interRDintensity_w	-0.645*	0.518	-0.616*	0.508	-0.623*	0.522	-0.595*	0.514
	(0.369)	(0.366)	(0.360)	(0.357)	(0.364)	(0.363)	(0.356)	(0.355)
currentratio_w	-0.021**	-0.022**	-0.020**	-0.021**	-0.020**	-0.020**	-0.020**	-0.021**
	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)
CAPX_w	-0.536	-0.605	-0.486	-0.554	-0.515	-0.584	-0.470	-0.538
	(0.467)	(0.466)	(0.460)	(0.459)	(0.466)	(0.464)	(0.457)	(0.456)
ROA_w	0.0164	-0.105	-0.001	-0.117	0.0165	-0.103	-0.001	-0.116
	(0.187)	(0.182)	(0.178)	(0.174)	(0.183)	(0.179)	(0.175)	(0.171)
LnBV_w		0.306***		0.296***		0.301***		0.292***
		(0.042)		(0.041)		(0.042)		(0.041)
_cons	0.834***	-1.253***	0.799***	-1.218***	0.817***	-1.239***	0.785***	-1.207***

	(0.091)	(0.278)	(0.091)	(0.271)	(0.092)	(0.278)	(0.091)	(0.270)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7339	7339	7339	7339	7339	7339	7339	7339
adj. R-sq	0.179	0.198	0.196	0.215	0.181	0.200	0.200	0.217

Panel B: CSR/ICSR/TCSR and patent quality

	Dependent Variable= fcitation							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.022	0.022						
	(0.023)	(0.022)						
intericsr			0.148***	0.143***			0.140***	0.135***
			(0.030)	(0.031)			(0.030)	(0.030)
intertcsr					-0.128***	-0.123***	-0.115***	-0.110***
tobinq_w					(0.040)	(0.039)	(0.038)	(0.038)
	0.040***	0.058***	0.040***	0.057***	0.039***	0.057***	0.039***	0.056***

leverage_w	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)
	0.234	0.166	0.224	0.158	0.247*	0.179	0.233	0.167
interRDintensity_w	(0.147)	(0.145)	(0.145)	(0.143)	(0.146)	(0.144)	(0.144)	(0.142)
	-0.910**	0.097	-0.885**	0.0892	-0.879**	0.104	-0.856**	0.098
currentratio_w	(0.435)	(0.422)	(0.432)	(0.418)	(0.426)	(0.415)	(0.424)	(0.413)
	-0.009	-0.010	-0.008	-0.009	-0.007	-0.008	-0.007	-0.008
CAPX_w	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)
	-0.207	-0.266	-0.165	-0.224	-0.179	-0.238	-0.142	-0.201
ROA_w	(0.482)	(0.481)	(0.475)	(0.474)	(0.480)	(0.479)	(0.472)	(0.471)
	-0.080	-0.185	-0.095	-0.196	-0.081	-0.183	-0.095	-0.194
LnBV_w	(0.219)	(0.213)	(0.212)	(0.206)	(0.214)	(0.208)	(0.207)	(0.202)
		0.264***		0.256***		0.259***		0.251***
		(0.040)		(0.039)		(0.040)		(0.039)
_cons	0.663***	-1.143***	0.634***	-1.114***	0.640***	-1.124***	0.615***	-1.097***
	(0.090)	(0.280)	(0.089)	(0.270)	(0.089)	(0.276)	(0.088)	(0.267)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	7339	7339	7339	7339	7339	7339	7339	7339
adj. R-sq	0.108	0.119	0.118	0.128	0.114	0.123	0.122	0.131

Table 8. The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation between year 1995-2007

Table 8 is the robustness test of the results in baseline regression. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (3) and (5) shows the results of model 1, 2 and 3. Column (7) shows the results of model 4. Column (2), (4), (6) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (8) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR/ICSR/TCSR and patent counts								
	Dependent Variable= fpatent							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.038	0.037						
	(0.024)	(0.023)						
intericsr			0.177***	0.170***			0.172***	0.166***
			(0.034)	(0.033)			(0.033)	(0.033)

intertcsr					-0.097**	-0.090**	-0.0836**	-0.078**
					(0.040)	(0.040)	(0.0374)	(0.0370)
tobinq_w	0.028**	0.050***	0.026**	0.048***	0.027**	0.049***	0.0256**	0.047***
	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
leverage_w	0.231	0.153	0.219	0.145	0.244*	0.167	0.225	0.151
	(0.144)	(0.143)	(0.143)	(0.141)	(0.143)	(0.142)	(0.141)	(0.140)
interRDintensity_w	-0.537	0.585	-0.514	0.566	-0.514	0.589	-0.493	0.571
	(0.388)	(0.391)	(0.379)	(0.381)	(0.383)	(0.390)	(0.374)	(0.379)
currentratio_w	-0.021**	-0.021**	-0.020**	-0.021**	-0.020**	-0.020**	-0.020**	-0.020**
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)
CAPX_w	-0.713	-0.781	-0.689	-0.755	-0.709	-0.776	-0.687	-0.752
	(0.493)	(0.486)	(0.486)	(0.479)	(0.491)	(0.485)	(0.483)	(0.477)
ROA_w	0.094	-0.035	0.069	-0.055	0.092	-0.035	0.066	-0.056
	(0.200)	(0.194)	(0.192)	(0.186)	(0.197)	(0.191)	(0.189)	(0.183)
LnBV_w		0.303***		0.292***		0.298***		0.288***
		(0.044)		(0.043)		(0.045)		(0.043)
_cons	0.805***	-1.307***	0.779***	-1.256***	0.791***	-1.289***	0.768***	-1.239***

	(0.095)	(0.303)	(0.094)	(0.295)	(0.095)	(0.305)	(0.094)	(0.295)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6812	6812	6812	6812	6812	6812	6812	6812
adj. R-sq	0.188	0.205	0.204	0.220	0.190	0.207	0.207	0.223

Panel B: CSR/ICSR/TCSR and patent quality

	Dependent Variable= fcitation							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.016	0.016						
	(0.023)	(0.023)						
intericsr			0.143***	0.138***			0.136***	0.131***
			(0.030)	(0.031)			(0.030)	(0.030)
intertcsr					-0.137***	-0.131***	-0.126***	-0.121***
					(0.042)	(0.040)	(0.039)	(0.039)
tobinq_w	0.043***	0.063***	0.042***	0.061***	0.042***	0.061***	0.041***	0.060***

	(0.014)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
leverage_w	0.289*	0.221	0.277*	0.212	0.301**	0.234	0.286*	0.221
	(0.150)	(0.150)	(0.149)	(0.149)	(0.149)	(0.149)	(0.148)	(0.148)
interRDintensity_w	-0.848*	0.137	-0.829*	0.122	-0.814*	0.144	-0.798*	0.130
	(0.457)	(0.448)	(0.454)	(0.443)	(0.447)	(0.441)	(0.446)	(0.437)
currentratio_w	-0.009	-0.009	-0.009	-0.009	-0.008	-0.008	-0.008	-0.008
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
CAPX_w	-0.425	-0.484	-0.406	-0.464	-0.421	-0.479	-0.403	-0.460
	(0.502)	(0.497)	(0.494)	(0.489)	(0.499)	(0.494)	(0.490)	(0.486)
ROA_w	-0.026	-0.140	-0.048	-0.157	-0.031	-0.141	-0.051	-0.158
	(0.233)	(0.227)	(0.226)	(0.220)	(0.228)	(0.222)	(0.221)	(0.216)
LnBV_w		0.266***		0.257***		0.259***		0.251***
		(0.042)		(0.042)		(0.042)		(0.041)
_cons	0.623***	-1.232***	0.602***	-1.190***	0.603***	-1.203***	0.585***	-1.164***
	(0.093)	(0.303)	(0.092)	(0.296)	(0.093)	(0.301)	(0.092)	(0.293)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	6812	6812	6812	6812	6812	6812	6812	6812
adj. R-sq	0.114	0.124	0.123	0.131	0.120	0.129	0.128	0.136

Table 9. The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation between year 1996-2007

Table 9 is the robustness test of the results in baseline regression. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (3) and (5) shows the results of model 1, 2 and 3. Column (7) shows the results of model 4. Column (2), (4), (6) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (8) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR/ICSR/TCSR and patent counts								
	Dependent Variable: fpatent							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.035	0.034						
	(0.024)	(0.023)						
intericsr			0.181***	0.175***			0.176***	0.171***
			(0.034)	(0.034)			(0.034)	(0.034)

intertcsr					-0.099**	-0.093**	-0.086**	-0.081**
					(0.041)	(0.040)	(0.037)	(0.037)
tobinq_w	0.031**	0.053***	0.029**	0.050***	0.030**	0.052***	0.028**	0.049***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)
leverage_w	0.263*	0.191	0.247*	0.178	0.275*	0.204	0.252*	0.184
	(0.147)	(0.146)	(0.144)	(0.143)	(0.146)	(0.145)	(0.143)	(0.142)
interRDintensity_w	-0.543	0.543	-0.522	0.524	-0.523	0.544	-0.503	0.526
	(0.397)	(0.405)	(0.386)	(0.392)	(0.390)	(0.403)	(0.381)	(0.389)
currentratio_w	-0.021**	-0.021**	-0.021**	-0.021**	-0.020**	-0.020**	-0.020**	-0.020**
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)
CAPX_w	-0.672	-0.681	-0.642	-0.652	-0.679	-0.688	-0.649	-0.658
	(0.515)	(0.502)	(0.507)	(0.495)	(0.512)	(0.500)	(0.504)	(0.492)
ROA_w	0.114	-0.023	0.078	-0.053	0.108	-0.026	0.072	-0.056
	(0.210)	(0.203)	(0.202)	(0.195)	(0.207)	(0.200)	(0.199)	(0.193)
LnBV_w		0.298***		0.288***		0.294***		0.283***
		(0.047)		(0.046)		(0.047)		(0.046)
_cons	0.887***	-1.225***	0.866***	-1.169***	0.878***	-1.200***	0.858***	-1.147***

	(0.097)	(0.326)	(0.095)	(0.317)	(0.097)	(0.330)	(0.095)	(0.318)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6267	6267	6267	6267	6267	6267	6267	6267
adj. R-sq	0.197	0.212	0.214	0.228	0.200	0.214	0.217	0.231

Panel B: CSR/ICSR/TCSR and patent quality

	Dependent Variable= fcitation							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.011	0.011						
	(0.023)	(0.023)						
intericsr			0.137***	0.132***			0.129***	0.125***
			(0.030)	(0.0305)			(0.030)	(0.030)
intertcsr					-0.134***	-0.129***	-0.125***	-0.120***
					(0.041)	(0.041)	(0.040)	(0.040)
tobinq_w	0.046***	0.0648***	0.045***	0.0627***	0.045***	0.063***	0.044***	0.061***

	(0.015)	(0.015)	(0.015)	(0.0147)	(0.015)	(0.015)	(0.014)	(0.014)
leverage_w	0.306**	0.245	0.291*	0.232	0.315**	0.255	0.298*	0.241
	(0.155)	(0.156)	(0.154)	(0.155)	(0.155)	(0.156)	(0.153)	(0.155)
interRDintensity_w	-0.788*	0.133	-0.771	0.119	-0.759	0.136	-0.744	0.123
	(0.474)	(0.467)	(0.472)	(0.463)	(0.464)	(0.460)	(0.463)	(0.456)
currentratio_w	-0.007	-0.007	-0.008	-0.00724	-0.006	-0.006	-0.007	-0.006
	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
CAPX_w	-0.403	-0.411	-0.381	-0.389	-0.413	-0.420	-0.390	-0.398
	(0.526)	(0.518)	(0.518)	(0.511)	(0.519)	(0.512)	(0.512)	(0.505)
ROA_w	0.037	-0.08	0.009	-0.102	0.028	-0.085	0.001	-0.107
	(0.241)	(0.235)	(0.234)	(0.229)	(0.236)	(0.230)	(0.229)	(0.224)
LnBV_w		0.253***		0.245***		0.246***		0.239***
		(0.045)		(0.044)		(0.045)		(0.044)
_cons	0.631***	-1.161***	0.615***	-1.117***	0.618***	-1.124***	0.603***	-1.085***
	(0.089)	(0.316)	(0.088)	(0.310)	(0.089)	(0.316)	(0.088)	(0.309)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	6267	6267	6267	6267	6267	6267	6267	6267
adj. R-sq	0.121	0.129	0.129	0.136	0.127	0.134	0.134	0.140

Table 10. The effect of CSR/ICSR/TCSR/ICSR and TCSR on innovation between year 1997-2007.

Table 10 is the robustness test of the results in baseline regression. intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA and LnBV_w is the winsorized value of firm's book value of total assets. Industry fixed effect and year fixed effect also be considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression, N is the number of the sample and adj. R-sq is the adjusted R square. Column (1), (3) and (5) shows the results of model 1, 2 and 3. Column (7) shows the results of model 4. Column (2), (4), (6) shows the results of model 5 which present the result of x is CSR, ICSR and TCSR respectively. Column (8) shows the results of model 6. The measurement of innovation in panel A is the number of patents and the measurement of innovation in panel B is the number of citations. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR/ICSR/TCSR and patent counts								
	Dependent Variable= fpatent							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	0.022	0.022						
	(0.025)	(0.024)						
intericsr			0.173***	0.168***			0.166***	0.162***
			(0.035)	(0.035)			(0.034)	(0.034)

intertcsr					-0.109***	-0.104***	-0.094**	-0.089**
					(0.040)	(0.040)	(0.037)	(0.037)
tobinq_w	0.036**	0.059***	0.033**	0.056***	0.035**	0.0574***	0.033**	0.055***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)
leverage_w	0.251*	0.195	0.239*	0.185	0.259*	0.204	0.244*	0.191
	(0.147)	(0.148)	(0.144)	(0.145)	(0.146)	(0.147)	(0.143)	(0.144)
interRDintensity_w	-0.510	0.562	-0.486	0.545	-0.489	0.562	-0.468	0.547
	(0.410)	(0.430)	(0.401)	(0.417)	(0.401)	(0.424)	(0.393)	(0.411)
currentratio_w	-0.018*	-0.020**	-0.018*	-0.020**	-0.017*	-0.019**	-0.017*	-0.019**
	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)
CAPX_w	-0.502	-0.538	-0.470	-0.506	-0.521	-0.556	-0.486	-0.521
	(0.546)	(0.531)	(0.537)	(0.523)	(0.540)	(0.525)	(0.533)	(0.518)
ROA_w	0.155	0.032	0.107	-0.010	0.146	0.0263	0.099	-0.016
	(0.216)	(0.209)	(0.209)	(0.202)	(0.211)	(0.204)	(0.205)	(0.199)
LnBV_w		0.297***		0.285***		0.291***		0.281***
		(0.050)		(0.049)		(0.051)		(0.049)
_cons	0.792***	-1.346***	0.771***	-1.286***	0.776***	-1.323***	0.759***	-1.268***

	(0.098)	(0.358)	(0.096)	(0.347)	(0.098)	(0.360)	(0.095)	(0.348)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5706	5706	5706	5706	5706	5706	5706	5706
adj. R-sq	0.206	0.219	0.223	0.234	0.211	0.223	0.226	0.238

Panel B: CSR/ICSR/TCSR and patent quality

	Dependent Variable= fcitation							
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercsr	-0.005	-0.005						
	(0.024)	(0.024)						
tobinq_w			0.118***	0.114***			0.107***	0.104***
			(0.033)	(0.033)			(0.032)	(0.033)
leverage_w					-0.144***	-0.140***	-0.134***	-0.131***
					(0.039)	(0.039)	(0.038)	(0.038)
interRDintensity_w	0.047***	0.065***	0.045***	0.062***	0.045***	0.063***	0.044***	0.061***

	(0.016)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)
currentratio_w	0.255	0.210	0.244	0.201	0.261	0.217	0.251	0.209
	(0.160)	(0.163)	(0.159)	(0.162)	(0.160)	(0.163)	(0.159)	(0.161)
CAPX_w	-0.794	0.053	-0.776	0.043	-0.763	0.056	-0.750	0.047
	(0.488)	(0.485)	(0.488)	(0.482)	(0.477)	(0.474)	(0.477)	(0.472)
ROA_w	-0.004	-0.006	-0.005	-0.006	-0.003	-0.005	-0.004	-0.005
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)
LnBV_w	-0.469	-0.498	-0.446	-0.475	-0.492	-0.519	-0.469	-0.497
	(0.547)	(0.539)	(0.541)	(0.533)	(0.539)	(0.531)	(0.533)	(0.526)
intericsr	-0.051	-0.148	-0.086	-0.179	-0.067	-0.161	-0.098	-0.188
	(0.247)	(0.243)	(0.241)	(0.238)	(0.239)	(0.236)	(0.235)	(0.232)
intertcsr		0.234***		0.227***		0.227***		0.221***
		(0.047)		(0.046)		(0.046)		(0.046)
_cons	0.616***	-1.074***	0.603***	-1.032***	0.596***	-1.040***	0.586***	-1.004***
	(0.096)	(0.339)	(0.094)	(0.334)	(0.095)	(0.334)	(0.094)	(0.330)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

N	5706	5706	5706	5706	5706	5706	5706	5706
adj. R-sq	0.130	0.135	0.135	0.140	0.136	0.142	0.141	0.146

PSM Test

Table 11. The logistic regression model for the propensity scores.

Table 11 reports the parameter estimates from the logit model used to estimate the propensity scores. Industry effects are constructed based on the Fama-French 12-industry classification. Statistical significance is based on the heteroscedasticity-robust firm-clustered standard errors reported in parentheses. The dependent variable is an indicator variable for the presence of CSR for panel A, ICSR for panel B, TCSR for panel C and both ICSR and TCSR for panel D. Panel D is the tests considering the combination effect of ICSR and TCSR on responsible variable. ***, **, and * indicate significant at the 1%, 5%, 10% levels, respectively.

Panel A: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have positive CSR scores and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	0.037	0.035
	(1.06)	(0.91)
leverage_w	-0.496	0.104
	(-1.07)	(0.23)
interRDintensity_w	0.448	-1.253
	(0.32)	(-0.94)
currentratio_w	0.050*	-0.022
	(1.71)	(-0.66)
CAPX_w	0.086	0.041
	(0.74)	(0.42)
ROA_w	2.415***	-0.668
	(3.28)	(-0.84)
LnBV_w	0.340***	0.076
	(2.78)	(0.71)

Industry effects	Yes	Yes
Year effects	Yes	Yes
N	8461	1519
Pseudo-R2	0.103	0.107

Panel B: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have positive ICSR scores and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	0.059*	-0.010
	(1.82)	(-0.30)
leverage_w	-0.435	-0.367
	(-0.98)	(-0.88)
interRDintensity_w	1.877	0.775
	(1.58)	(0.65)
currentratio_w	0.042	-0.014
	(1.46)	(-0.45)
CAPX_w	0.059	-0.027
	(0.52)	(-0.29)
ROA_w	2.380***	-0.326
	(3.36)	(-0.44)
LnBV_w	0.406***	0.167
	(3.35)	(1.61)
Industry effects	Yes	Yes
Year effects	Yes	Yes

N	8461	1635
Pseudo R2	0.115	0.090

Panel C: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have positive TCSR scores and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	-0.053	-0.008
	(-0.95)	(-0.12)
leverage_w	-1.292*	-0.561
	(-1.92)	(-0.87)
interRDintensity_w	0.950	3.150
	(0.38)	(1.44)
currentratio_w	0.057	0.012
	(1.18)	(0.21)
CAPX_w	0.072	0.049
	(0.45)	(0.36)
ROA_w	3.317***	-1.127
	(3.13)	(-0.87)
LnBV_w	0.343**	0.075
	(2.11)	(0.51)
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	8461	758
Pseudo R2	0.093	0.092

Panel D: Pre-match propensity score regression and post-match diagnostic regression		
	Dependent variable: Dummy equals 1 for firms have both positive ICSR scores and positive TCSR scores and 0 for firms have both ICSR and TCSR scores smaller and equal to 0	
Variables	**Pre-match**	**Post-match**
tobinq_w	-0.007	-0.117
	(-0.12)	(-1.48)
leverage_w	-0.842	0.118
	(-1.44)	(0.12)
interRDintensity_w	3.575**	3.943
	(2.20)	(1.34)
currentratio_w	0.048	0.023
	(0.91)	(0.28)
CAPX_w	0.059	0.196
	(0.43)	(0.85)
ROA_w	4.562***	0.472
	(4.11)	(0.26)
LnBV_w	0.453***	-0.068
	(3.10)	(-0.27)
Industry effects	Yes	Yes
Years effects	Yes	Yes
N	7610	386
Pseudo R2	0.126	0.122

Table 12. Difference in the means for each observable characteristic.

Table 12 examines the difference in the means for each observable characteristic between the treatment and matched control groups. Panel A shows the univariate comparisons of firm characteristics between firms with negative CSR and positive CSR scores and the corresponding t-statistics. Pane B shows the univariate comparisons of firm characteristics between firms with negative ICSR and positive ICSR scores and the corresponding t-statistics. Panel C shows the univariate comparisons of firm characteristics between firms with negative TCSR and positive TCSR scores and the corresponding t-statistics. Panel D shows the univariate comparisons of firm characteristics between firms with both ICSR and TCSR scores negatively and both ICSR and TCSR scores positively and the corresponding t-statistics. Industry effects are constructed based on the Fama-French 12-industry classification.

Panel A. Difference in the means for each observable characteristic of the CSR regression

Variables	Firm-year obs. with negative CSR scores (N=1,526)	Firm-year obs. with positive CSR scores (N=1,526)	Difference	t-stat
tobinq_w	2.439	2.664	-0.225	-2.326
leverage_w	0.207	0.202	0.005	0.659
interRDintensity_w	0.049	0.053	0.004	-1.122
currentratio_w	2.429	2.398	0.031	0.268
CAPX_w	4.924	4.950	-0.026	-0.286
ROA_w	0.160	0.165	-0.005	-1.033
LnBV_w	7.946	7.986	-0.040	-0.491

Panel B. Difference in the means for each observable characteristic of the ICSR regression

Variables	Firm-year obs. with negative ICSR scores (N=1,693)	Firm-year obs. with positive ICSR scores (N=1,693)	Difference	t-stat
tobinq_w	2.663	2.745	-0.082	-0.800
leverage_w	0.203	0.203	0.000	0.023
interRDintensity_w	0.053	0.057	-0.004	-1.125
currentratio_w	2.463	2.398	0.065	0.575
CAPX_w	4.876	4.965	-0.089	-1.006

ROA_w	0.165	0.163	0.002	0.475
LnBV_w	7.899	8.016	-0.117	-1.485

Panel C. Difference in the means for each observable characteristic of the TCSR regression

Variables	Firm-year obs. with negative TCSR scores (N=797)	Firm-year obs. with positive TCSR scores (N=797)	Difference	t-stat
tobinq_w	2.448	2.453	-0.005	-0.048
leverage_w	0.205	0.196	0.009	0.802
interRDintensity_w	0.043	0.048	0.005	-1.208
currentratio_w	2.232	2.292	-0.060	-0.465
CAPX_w	4.964	5.001	-0.037	-0.304
ROA_w	0.170	0.167	0.002	0.361
LnBV_w	7.988	8.031	-0.043	-0.385

Panel D. Difference in the means for each observable characteristic of the ICSR&TCSR regression

Variables	Firm-year obs. with negative ICSR and TCSR scores (N=1,650)	Firm-year obs. with positive ICSR and TCSR scores (N=1,650)	Difference	t-stat
tobinq_w	2.677	2.625	0.052	0.266
leverage_w	0.206	0.201	0.005	0.326
interRDintensity_w	0.045	0.052	-0.007	-1.189
currentratio_w	2.113	2.189	-0.076	-0.436
CAPX_w	5.109	5.124	-0.015	-0.090
ROA_w	0. 171	0. 176	-0.005	-0.480

LnBV_w	8.158	8.150	0.008	0.055

Table 13. PSM estimate results.

Table 13 presents the propensity score estimate results. Panel A shows the average treatment effect estimates for CSR. Panel B shows the average treatment effect estimates for ICSR. Panel C shows the average treatment effect estimates for TCSR. Panel D shows the average treatment effect estimates for considering ICSR and TCSR at the same time. The variable fpatent and fcitation are the number of patents and the number of citations. Industry effects are constructed based on the Fama-French 12-industry classification. ***, **, and * indicate significant at the 1%, 5%, 10% levels, respectively.

Panel A. Propensity score matching estimate---CSR

Variables	Firm-year obs. with positive CSR scores (N=8,844)	Firm-year obs. with negative CSR scores (N=8,844)	Difference	t-stat
fpatent	2.380	0.610	1.770***	19.83
fcitation	2.097	0.560	1.537***	18.04

Panel B. Propensity score matching estimate---ICSR

Variables	Firm-year obs. with positive ICSR scores (N=8,846)	Firm-year obs. with negative ICSR scores (N=8,846)	Difference	t-stat
fpatent	2.380	0.730	1.650***	19.04
fcitation	2.109	0.670	1.439***	17.36

Panel C. Propensity score matching estimate---TCSR

Variables	Firm-year obs. with positive TCSR scores (N=8,846)	Firm-year obs. with negative TCSR scores (N=8,846)	Difference	t-stat

fpatent	2.409	0.779	1.30***	12.59
fcitation	2.018	0.643	1.375***	11.90

Panel D. Propensity score matching estimate---ICSR& TCSR

Variables	Firm-year obs. with ICSR&TCSR scores (N=7,997)	Firm-year obs. without ICSR&TCSR scores (N=7,997)	Difference	t-stat
fpatent	2.509	0.639	1.869***	10.73
fcitation	2.057	0.547	1.510***	9.30

Table 14. CSR and innovation: Instrumental variables.

This table presents estimates of the instrumental variables method using two-stage least square (2SLS) regression. Columns (1) present the first-stage regression results in which the dependent variable is the CSR scores. The instrumental variable is intercsrL2 which is CSR scores lags two years. Column (2) and (3) report the second-stage regression result. The dependent variables are fpatent which is the natural logarithm of one plus a firms' total patent counts and fcitation which is the natural logarithm of one plus a firm's total citation counts (non-self-citation) in a given year. All other controls are the same as those in the baseline models which also includes firm size on extra. Industry and year effect are included. Industry effects are constructed based on the Fama-French 12-industry classification. Statistical significant is based on the heteroskedasticity robust firm-clustered standard errors reported in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

	Dependent variable: intercsr	Dependent variable: fpatent	Dependent variable: fcitation
variables	first stage (1)	second stage (2)	second stage (3)
intercsrL2	0.287***		
	(0.023)		
intercsr		0.111	-0.038
		(0.075)	(0.062)
tobinq_w	0.002	0.068***	0.081***
	(0.007)	(0.008)	(0.010)

leverage_w	0.042	-0.379***	-0.183*
	(0.084)	(0.081)	(0.097)
currentratio_w	0.012**	-0.006	-0.006
	(0.005)	(0.005)	(0.006)
CAPX_w	0.666**	-0.079	-0.902***
	(0.334)	(0.394)	(0.342)
ROA_w	0.298**	0.596***	0.590***
	(0.119)	(0.118)	(0.129)
interRDintensity_w	-0.005	1.551***	0.653***
	(0.213)	(0.230)	(0.236)
LnBV_w	-0.000	0.401***	0.284***
	(0.012)	(0.013)	(0.012)
Constant		-2.517***	-1.448***
		(0.126)	(0.127)
Controls	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Observations	7,399	7,399	7,399
Number of gvkey	723	723	723
F-statistic	570.958***		
DWH F-statistics		0.519	2.283

Table 15. ICSR and innovation: Instrumental variables.

This table presents estimates of the instrumental variables method using two-stage least square (2SLS) regression. Columns (1) present the first-stage regression results in which the dependent variable is the ICSR scores. The instrumental variable is intercsrL2 which is ICSR scores lags two years. Column (2) and (3) report the second-stage regression result. The dependent variables are fpatent which is the natural logarithm of one plus a firms' total patent counts and fcitation which is the natural logarithm of one plus a firm's total citation counts (non-self-citation) in a given year. All other controls are the same as those in the baseline models which also includes firm size on extra. Industry and year effect are included. Industry

effects are constructed based on the Fama-French 12-industry classification. Statistical significant is based on the heteroskedasticity robust firm-clustered standard errors reported in parentheses. *** and ** indicate significance at the 1% and 5% levels, respectively.

	Dependent variable: intericsr	Dependent variable: fpatent	Dependent variable: fcitation
variables	first stage (1)	second stage (2)	second stage (3)
intericsrL2	0.358***		
	(0.028)		
intericsr		0.882***	0.525***
		(0.087)	(0.067)
tobinq_w	0.020**	0.0463***	0.067***
	(0.006)	(0.009)	(0.010)
leverage_w	-0.056	-0.333***	-0.161
	(0.060)	(0.088)	(0.099)
currentratio_w	-0.000	-0.00298	-0.005
	(0.004)	(0.005)	(0.006)
CAPX_w	0.224	-0.337	-1.148***
	(0.229)	(0.372)	(0.335)
ROA_w	0.284**	0.280**	0.361***
	(0.088)	(0.125)	(0.130)
interRDintensity_w	0.189	1.250***	0.469**
	(0.151)	(0.236)	(0.233)
LnBV_w	0.060***	0.332***	0.243***
	（0.060)	(0.015)	(0.013)
Constant	-0.257**	-2.236***	-1.302***
	(0.095)	(0.139)	(0.131)
Controls	Yes	Yes	Yes

Industry effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Observations	7,399	7,399	7,399
Number of gvkey	723	723	723
F-statistic	899.292***		
DWH F-statistics		64.680***	23.204***

Table 16. TCSR and innovation: Instrumental variables

This table presents estimates of the instrumental variables method using two-stage least square (2SLS) regression. Columns (1) present the first-stage regression results in which the dependent variable is the TCSR scores. The instrumental variable is intercsrL2 which is TCSR scores lags two years. Column (2) and (3) report the second-stage regression result. The dependent variables are fpatent which is the natural logarithm of one plus a firms' total patent counts and fcitation which is the natural logarithm of one plus a firm's total citation counts (non-self-citation) in a given year. All other controls are the same as those in the baseline models which also includes firm size on extra. Industry and year effect are included. Industry effects are constructed based on the Fama-French 12-industry classification. Statistical significant is based on the heteroskedasticity robust firm-clustered standard errors reported in parentheses. *** and ** indicate significance at the 1% and 5% levels, respectively.

	Dependent variable: intertcsr	Dependent variable: fpatent	Dependent variable: fcitation
variables	first stage (1)	second stage (2)	second stage (3)
intertcsrL2	0.280***		
	(0.024)		
intertcsr		-1.024***	-0.859***
		(0.145)	(0.121)
tobinq_w	-0.016	0.049***	0.064***
	(0.005)	(0.009)	(0.010)
leverage_w	0.040	-0.329***	-0.149
	(0.052)	(0.090)	(0.101)
currentratio_w	0.010***	0.00811	0.004

	(0.003)	(0.005)	(0.006)
CAPX_w	0.383	0.496	-0.537
	(0.197)	(0.426)	(0.359)
ROA_w	-0.007	0.635***	0.571***
	(0.070)	(0.127)	(0.134)
interRDintensity_w	0.057	1.602***	0.689***
	(0.125)	(0.249)	(0.246)
LnBV_w	-0.047***	0.339***	0.232***
	(0.007)	(0.018)	(0.015)
Constant	0.276***	-2.143***	-1.161***
	(0.074)	(0.154)	(0.143)
Controls	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Observations	7,399	7,399	7,399
Number of gvkey	723	723	723
F-statistic	546.449***		
DWH F-statistics		128.584***	68.347***

Table 17. Moderation effect of firm size

Panel A: CSR-innovation						
	Dependent variable = innovation					
	(1)	(2)	(2-1)	(2-2)	(3-1)	(3-2)
	patent_csr1	citation_csr1	patent_csr1	citation_csr1	patent_csr3	citation_csr3
intercsr	0.043*	0.035*	0.042**	0.034*	0.136	-0.037
	(0.022)	(0.021)	(0.021)	(0.0199)	(0.086)	(0.096)
lnBVOT_w			0.332***	0.288***	0.332***	0.287***
			(0.038)	(0.038)	(0.038)	(0.038)
intercsr_bvot					-0.012	0.009
					(0.012)	(0.012)
tobinq_w	0.024**	0.042***	0.044***	0.060***	0.044***	0.060***
	(0.011)	(0.013)	(0.011)	(0.013)	(0.011)	(0.013)
leverage_w	0.121	0.129	0.036	0.055	0.037	0.054
	(0.135)	(0.143)	(0.130)	(0.139)	(0.130)	(0.139)
interRDintensity_w	-0.881**	-1.060***	0.312	-0.025	0.314	-0.027

	(0.342)	(0.374)	(0.333)	(0.359)	(0.333)	(0.359)
currentratio_w	-0.022**	-0.013	-0.0209***	-0.0115	-0.0210***	-0.0115
	(0.00869)	(0.00883)	(0.008)	(0.008)	(0.008)	(0.008)
CAPX_w	-0.220	-0.248	-0.211	-0.240	-0.208	-0.243
	(0.400)	(0.436)	(0.397)	(0.439)	(0.396)	(0.439)
ROA_w	-0.101	-0.120	-0.216	-0.220	-0.224	-0.214
	(0.177)	(0.203)	(0.171)	(0.195)	(0.170)	(0.195)
_cons	0.781***	0.763***	-1.416***	-1.143***	-1.418***	-1.141***
	(0.082)	(0.097)	(0.251)	(0.258)	(0.252)	(0.258)
N	8846	8846	8846	8846	8846	8846
adj. R^2	0.160	0.094	0.189	0.109	0.189	0.109

Panel B: ICSR-innovation						
	Dependent variable= innovation					
	(1)	(2)	(2-1)	(2-2)	(3-1)	(3-2)
	patent_icsr1	citation_icsr1	patent_icsr1	citation_icsr1	patent_icsr3	citation_icsr3

intericsr	0.192***	0.165***	0.183***	0.157***	0.235*	0.016
	(0.030)	(0.029)	(0.029)	(0.030)	(0.138)	(0.158)
lnBVOT_w			0.320***	0.277***	0.320***	0.276***
			(0.037)	(0.038)	(0.037)	(0.038)
intericsr_bvot					-0.007	0.018
					(0.019)	(0.021)
tobinq_w	0.023**	0.041***	0.043***	0.058***	0.042***	0.058***
	(0.011)	(0.013)	(0.011)	(0.013)	(0.011)	(0.013)
leverage_w	0.117	0.125	0.035	0.054	0.0370	0.0487
	(0.133)	(0.142)	(0.129)	(0.138)	(0.129)	(0.138)
interRDintensity_w	-0.832**	-1.018***	0.315	-0.022	0.316	-0.024
	(0.334)	(0.371)	(0.325)	(0.357)	(0.326)	(0.356)
currentratio_w	-0.021**	-0.012	-0.020***	-0.011	-0.020***	-0.011
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
CAPX_w	-0.204	-0.233	-0.196	-0.227	-0.193	-0.235
	(0.392)	(0.427)	(0.389)	(0.430)	(0.389)	(0.431)
ROA_w	-0.110	-0.128	-0.220	-0.223	-0.224	-0.212

	(0.168)	(0.195)	(0.163)	(0.189)	(0.163)	(0.189)
_cons	0.748***	0.735***	-1.369***	-1.101***	-1.370***	-1.097***
	(0.081)	(0.097)	(0.243)	(0.252)	(0.244)	(0.251)
N	8846	8846	8846	8846	8846	8846
adj. R^2	0.181	0.105	0.209	0.119	0.209	0.119

Panel C: TCSR-innovation						
	Dependent variable= innovation					
	(1)	(2)	(2-1)	(2-2)	(3-1)	(3-2)
	patent_icsr1	citation_icsr1	patent_icsr1	citation_icsr1	patent_icsr3	citation_icsr3
intericsr	0.192***	0.165***	0.183***	0.157***	0.235*	0.0158
	(0.030)	(0.029)	(0.029)	(0.030)	(0.138)	(0.158)
lnBVOT_w			0.320***	0.277***	0.320***	0.276***
			(0.037)	(0.038)	(0.037)	(0.038)
intericsr_bvot					-0.007	0.018
					(0.019)	(0.021)

tobinq_w	0.023**	0.041***	0.043***	0.058***	0.042***	0.058***
	(0.011)	(0.011)	(0.011)	(0.013)	(0.011)	(0.013)
leverage_w	0.117	0.125	0.035	0.054	0.037	0.049
	(0.133)	(0.142)	(0.129)	(0.138)	(0.129)	(0.138)
interRDintensity_w	-0.832**	-1.018***	0.315	-0.022	0.316	-0.024
	(0.334)	(0.371)	(0.325)	(0.357)	(0.326)	(0.356)
currentratio_w	-0.021**	-0.012	-0.020***	-0.011	-0.020***	-0.011
	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
CAPX_w	-0.204	-0.233	-0.196	-0.227	-0.193	-0.235
	(0.392)	(0.427)	(0.389)	(0.430)	(0.389)	(0.431)
ROA_w	-0.110	-0.128	-0.220	-0.223	-0.224	-0.212
	(0.168)	(0.195)	(0.163)	(0.189)	(0.163)	(0.189)
_cons	0.748***	0.735***	-1.369***	-1.101***	-1.370***	-1.097***
	(0.081)	(0.097)	(0.243)	(0.252)	(0.244)	(0.251)
N	8846	8846	8846	8846	8846	8846
adj. R^2	0.181	0.105	0.209	0.119	0.209	0.119

Table 18: Moderation effect of financial constraints

Panel A: CSR-innovation						
	Dependent variable= innovation					
	(1)	(2)	(2-1)	(2-2)	(3-1)	(3-2)
	patent_csr1	citation_csr1	patent_csr1	citation_csr1	patent_csr3	citation_csr3
intercsr	0.043*	0.035*	0.047**	0.035*	0.087	-0.054
	(0.022)	(0.021)	(0.022)	(0.021)	(0.063)	(0.076)
lngross_w			0.243***	0.200***	0.243***	0.200***
			(0.037)	(0.039)	(0.037)	(0.039)
intercsr_GCF					-0.007	0.014
					(0.011)	(0.012)
tobinq_w	0.0238**	0.042***	0.060***	0.070***	0.060***	0.070***
	(0.0112)	(0.013)	(0.016)	(0.018)	(0.016)	(0.018)
leverage_w	0.121	0.129	-0.061	-0.035	-0.059	-0.040
	(0.135)	(0.143)	(0.169)	(0.177)	(0.169)	(0.177)
interRDintensity_w	-0.881**	-1.060***	0.150	-0.539	0.146	-0.530

	(0.342)	(0.374)	(0.627)	(0.571)	(0.626)	(0.570)
currentratio_w	-0.022**	-0.013	-0.014	0.004	-0.014	0.004
	(0.009)	(0.009)	(0.014)	(0.015)	(0.014)	(0.015)
CAPX_w	-0.220	-0.248	-0.044	0.066	-0.042	0.060
	(0.400)	(0.436)	(0.493)	(0.543)	(0.491)	(0.546)
ROA_w	-0.101	-0.120	-2.373***	-2.013***	-2.378***	-2.002***
	(0.177)	(0.203)	(0.431)	(0.464)	(0.431)	(0.463)
_cons	0.781***	0.763***	-0.067	0.058	-0.067	0.057
	(0.082)	(0.097)	(0.167)	(0.177)	(0.167)	(0.177)
N	8846	8846	7994	7994	7994	7994
adj. R^2	0.160	0.094	0.193	0.108	0.193	0.108

Panel B: ICSR-innovation						
	Dependent variable= innovation					
	(1)	(2)	(2-1)	(2-2)	(3-1)	(3-2)
	patent_icsr1	citation_icsr1	patent_icsr1	citation_icsr1	patent_icsr3	citation_icsr3

intericsr	0.192***	0.165***	0.189***	0.163***	0.212**	0.050
	(0.030)	(0.029)	(0.031)	(0.030)	(0.094)	(0.117)
lngross_w			0.232***	0.191***	0.232***	0.189***
			(0.036)	(0.038)	(0.036)	(0.038)
intericsr_GCF					-0.004	0.019
					(0.017)	(0.020)
tobinq_w	0.023**	0.041***	0.057***	0.068***	0.057***	0.068***
	(0.011)	(0.013)	(0.015)	(0.017)	(0.015)	(0.017)
leverage_w	0.117	0.125	-0.066	-0.041	-0.064	-0.050
	(0.133)	(0.142)	(0.168)	(0.176)	(0.167)	(0.175)
interRDintensity_w	-0.832**	-1.018***	0.167	-0.524	0.168	-0.529
	(0.334)	(0.371)	(0.607)	(0.562)	(0.607)	(0.562)
currentratio_w	-0.021**	-0.012	-0.014	0.004	-0.014	0.004
	(0.009)	(0.009)	(0.013)	(0.015)	(0.013)	(0.015)
CAPX_w	-0.204	-0.233	-0.037	0.070	-0.034	0.054
	(0.392)	(0.427)	(0.482)	(0.532)	(0.480)	(0.531)
ROA_w	-0.110	-0.128	-2.278***	-1.930***	-2.279***	-1.925***

	(0.168)	(0.195)	(0.414)	(0.452)	(0.414)	(0.451)
_cons	0.748***	0.735***	-0.061	0.063	-0.063	0.071
	(0.081)	(0.097)	(0.163)	(0.173)	(0.163)	(0.173)
N	8846	8846	7994	7994	7994	7994
adj. R^2	0.181	0.105	0.213	0.119	0.213	0.119

Panel C: TCSR-innovation						
	Dependent variable= innovation					
	(1)	(2)	(2-1)	(2-2)	(3-1)	(3-2)
	patent_tcsr1	citation_tcsr1	patent_tcsr1	citation_tcsr1	patent_tcsr3	citation_tcsr3
intertcsr	-0.106***	-0.122***	-0.088**	-0.112***	-0.119	-0.292**
	(0.034)	(0.034)	(0.035)	(0.036)	(0.114)	(0.139)
lngross_w			0.241***	0.197***	0.241***	0.198***
			(0.037)	(0.039)	(0.037)	(0.039)
intertcsr_GCF					0.005	0.029
					(0.020)	(0.022)

tobinq_w	0.023**	0.041***	0.057***	0.067***	0.058***	0.068***
	(0.011)	(0.013)	(0.016)	(0.016)	(0.016)	(0.018)
leverage_w	0.136	0.142	-0.044	-0.019	-0.045	-0.022
	(0.134)	(0.143)	(0.168)	(0.177)	(0.168)	(0.177)
interRDintensity_w	-0.857**	-1.030***	0.159	-0.525	0.166	-0.484
	(0.338)	(0.366)	(0.625)	(0.560)	(0.618)	(0.558)
currentratio_w	-0.021**	-0.011	-0.013	0.0049	-0.013	0.004
	(0.009)	(0.009)	(0.013)	(0.015)	(0.013)	(0.015)
CAPX_w	-0.193	-0.217	0.0038	0.120	0.007	0.141
	(0.399)	(0.434)	(0.494)	(0.545)	(0.494)	(0.547)
ROA_w	-0.094	-0.112	-2.355***	-1.983***	-2.355***	-1.987***
	(0.172)	(0.197)	(0.436)	(0.463)	(0.436)	(0.465)
_cons	0.761***	0.741***	-0.075	0.050	-0.077	0.037
	(0.082)	(0.097)	(0.165)	(0.175)	(0.164)	(0.174)
N	8846	8846	7994	7994	7994	7994
adj. R^2	0.162	0.098	0.193	0.111	0.193	0.112

Table 19: CSR dimensions summarize of referred papers.

Paper	Author	Year	CSR measurement	CSR dimensions						
				Environment stewardship	Community involvement	Human rights	Employee relationship	Diversity	Product quality	Corporate governance
Post-innovation CSR Performance and Firm Value	Dev R. Mishra	2017	CSR	✓	✓	✓	✓	✓	✓	
The relationship between corporate social responsibility and shareholder value: An empirical test of the risk management hypothesis	Paul C. Godfrey, Craig B. Merrill and Jared M. Hansen	2009	CSR	✓	✓		✓	✓	✓	✓
			ICSR		✓			✓		
			TCSR				✓		✓	✓
The Heterogeneous Impact of Corporate Social Responsibility Activities That Target Different Stakeholders	Chang, Kim and Li	2014	CSR	✓	✓		✓	✓	✓	
			ICSR		✓			✓		
			TCSR				✓		✓	
			Alternative ICSR	✓	✓			✓		
			Alternative				✓		✓	✓

			TCSR							

Essay Two: How does corporate social responsibility affect corporate innovation activities at different levels?

Abstract:

This essay explores the relationship between innovation and different CSR activity types for firms on different innovation performance level. We hypothesize that firms with higher innovation output counts or better-quality innovation performance tend to be affected by firms' CSR activities with 'insurance function'. Using the sample for the period 1991 to 2007, we apply panel quantile regressions to study the effect of CSR, institutional CSR (ICSR) and technical CSR (TCSR) on different innovation level. Our results show that CSR have positive effect for firms with better innovation performance. After classifying CSR to ICSR and TCSR, ICSR have positive effect on innovation for firms with higher innovation counts or better innovation quality, but TCSR have negative effect for those firms. CSR, ICSR and TCSR do not have any significant effect on innovation for firms with lower innovation outputs either on quality or quantity levels which suggests some management policy implications.

1. Introduction

Quantile regression (QR) will be used in this essay to study the following relationships: corporate social responsibility activities (CSR) and innovation, institutional corporate social responsibility activities and innovation, and technical social responsibility activities (TCSR) and innovation on different quantile levels. The classical least-squares regression focuses on the mean value of dependent variable to detect the relation between dependent variable and independent variables. The classical least-squares regression can be seen as the conditional mean function that illustrates how the mean of response variable changes with the independent variables. Frisch (1934) and Koopmans (1937) describe the error in least square regression is supposed to have precisely the same distribution whatever values may be taken by the independent variables.

Quantile regression is also called least absolute deviation (LAD) estimator or median regression, as cases of quantile regression. It estimates the conditional quantiles of the dependent variable distribution in the linear regression model. Quantile regression can be viewed as an extension of classical least squares estimation of conditional mean models to the estimation of an ensemble of models for conditional quantile function (Koenker and Bassett, 1978). Koenker and Hallock (2001) further detect quantile regression that consider the errors are Gaussian based on the view of Frisch (1934) and Koopmans (1937). They argue that the least square methods deliver a dreamt location shift model because of it displays the maximum likelihood estimates of the conditional mean function and achieve a well-publicized optimality. However, there is more than a dreamt model in econometric research due to the effect of covariates on the conditional distribution of dependent variable through expanding its dispersion or stretching one tail and compressing the other tail. By estimating a quantile regression model (QR hereafter), we can identify some interaction effects which cannot be revealed by standard conditional mean linear

regressions. Although the standard conditional mean linear regressions are mostly applied in previous research. Specifically, quantile regression presents several advantages. Firstly, they are not sensitive to outliers (Li et al., 2015). Secondly, they allow to appropriately fit data with skewed distributions (Li, 2015) such as those presented by the variables used in the present research. And thirdly, they allow capturing non-monotonous and non-uniform impacts of the independent variables on the dependent one (Coad and Rao, 2006).

For the objectives of our research, the most interesting feature of quantile regression is that they have the potential to uncover differences in the response of the innovation quality (the number of citations) and quantity (the number of patents) across its different quantiles with respect to change in CSR performance. Thus, it allows us to test the working hypotheses across all of them. Quantile regression is also particularly useful when the conditional distribution does not have a standard shape, such as an asymmetric, fat-tailed, or truncated distribution. According to Hall (2005), one of the most important problems to be solved when measure citation is the citation truncation problem. Therefore, using mean regression alone is not accurate enough to draw reliable conclusions, and quantile regression may perform more efficiently and robustly than OLS estimations on study (Wang et al., 2015). Therefore, we apply quantile regression to study the effect on innovation performance on different quantile levels.

Nowadays quantile regression method is widely used in different research area, such as ecology, economics or finance. In ecology field, Cade and Noon (2003) find that there may be a weak or no predictive relationship between the mean of the dependent variable and independent variables. However, there may be obviously relationship with other parts of the dependent variable distribution on ecology research (Cade et al., 2003). In economics, Koenker and Hallock (2001) investigate the influence of demographic characteristics and maternal behavior on infant's birthweight in the U.S. They find that quantile regression estimates give a very different picture with OLS estimates and they get specific coefficient of covariates on different percentile parts. In finance field, Chamberlain (1994) indicates that the union wage of manufacturing workers premium at the lower decile while declines at the upper decile, while the results through least square only captured the effects mainly by the lower tail of the conditional distribution. It can be seen that, quantile estimation is good at capture more complete picture of the set.

Quantile estimation is also used in corporate finance research relating to the topic about CSR and firms' innovation activities. For the applying of quantile estimation on CSR related topics, Wang et al. (2015) examine the relations among corporate social responsibility, brand equity, and firm performance by quantile regression and structural equation model in Taiwanese high-tech companies over the period 2010–2013. In addition, Kang et al. (2014) test the influence of CSR on firm performance by quantile regression method and indicates that sensitivity of a company's performance to its engagement in corporate social responsibility activities does not vary with the quantile location of the firm's performance level, and the engagement in corporate social responsibility activities has a significant positive relation with corporate performance across all quantiles. Besides, Ortas et al. (2015) employ a quantile regression that unfolds certain interesting effects of financial drivers on the intensity of CESR.

For the applying of quantile estimation on innovation related topics, Wang et al. (2013), Yu (2011), and Yu et al. (2015) apply quantile regressions to provide better analysis results for R&D spending, information and communication technology adoption, as well as health expenditure. Coad et al. (2016) apply panel quantile regressions to study the effect of R&D activities on firm growth. Furthermore, Love et al. (2009) study the relation between innovation, ownership and profitability for a panel of manufacturing plants in Ireland and Northern Ireland. Innovation also have influence on market value dramatically across the market value distribution (Coad and Rao, 2006). Besides, Kesidou and Demirel (2012) apply the Heckman selection model and quantile regression analysis to shed light on the drivers of eco-innovations.

Although quantile regression method is used in the studies about CSR (Wang et al., 2015; Ortas et al., 2015; Kang et al., 2014) or innovation (Yu et al., 2015; Wang et al., 2013; Yu, 2011; Love et al., 2009) separately, it is not applied in investigating the effect of CSR and innovation area, see for example Mishra (2017), Bocquet (2017), MacGregor (2008). What is more, quantile method is not applied in the research about ICSR and TCSR, see for example Mattingly and Berman (2006), Chang (2014), Godfrey (2009). Previous studies about CSR and innovation give suggestion on the average influence, but the results may not apply to the whole distribution of the relationship between dependent and independent variables which means the results may not always consistency. To detect the hide important features of the underlying relationship, our paper investigates the relationship between CSR/ICSR/TCSR and innovation outputs on both quantity level and quality level for different percentiles.

From the perspective of theoretical, some of the papers argue that CSR investment minimize shareholders' wealth upon shareholder wealth maximizing theory. While maximizing shareholder wealth strategies may conflict with other stakeholder's benefits due to the conflicting priorities. Engaging with social responsibility activities is imperative for corporates to mitigate the conflicts (Freeman, 1984; Makni et al., 2009; Jo and Harjoto, 2011, 2012).

The shareholder primacy strategy has led to a number of unfavourable outcomes for firms, economies, and society (Stout, 2012). On the other hand, the stakeholder theory espoused that an organization has a wider stakeholder rather than the shareholders and investors of the company. Further, Donaldson and Preston (1995) categorize stakeholder theory into three approaches: normative, descriptive, and instrumental. In detail, the normative approach presents the function of corporations and the identification of the philosophical guidelines necessary for the operation and management of corporations (Valentinov and Hajdu, 2019). The descriptive approach describes corporate behaviors, including the nature of the firm, the ways managers are managing, and how board members view the interests of corporate constituencies. The instrumental approach explains the role of trust and cooperation in creating organizational wealth and competitive advantage. Nevertheless, when stakeholders are dimensioned according to their legitimacy, power, and urgency, some stakeholders may exhibit both normative and instrumental tendencies. This is also one of the reasons of why technical CSR driven by primary stakeholders restrain innovation activities on both quantity and quality levels.

Moreover, Mowery, Oxley, and Silverman (1998) argue about the resource-based view that an enterprise can best be described as a collection of difficult-to imitate resources and capabilities.

These resources and capabilities are unique to the business, and that a business could explore these resources instead of focusing on the competitive environment. Similarly, Hart (1995) came up with the natural resource-based view that extends the resource-based view and identifies pollution prevention, product stewardship, and sustainable development as a means of achieving competitive advantage.

From the perspective of technique, quantile regression method can mitigate the effect from outliers and considers the impact of independent variables on the entire distribution. Those merits of QR method makes the results more reliable when observing the research effect on low and high innovation activity levels. The bulk of the previous literature consistent with the view of the importance of CSR in achieving sustainable development (Abbas, 2020; Shirasu and Kawakita, 2020). For example, Bernal-Conesa et al. (2017) found that CSR's adoption as a strategy can improve the performance, competitiveness, and sustainability of tech companies operating in Spain. Besides, a growing number of firms in the U.S in the technology industry believe they have the duty to contribute to economic growth in a sustainable manner (Anthony et al., 2021). Thus, we are interested in how CSR initiatives could be a way to conduce to the innovation performance in different innovation output levels. Our paper not only use quantile regression method to fill the gaps above but also gives more evidence on the research about CSR and innovation areas.

We estimate QR models at five different quantile levels which are 0.05, 0.25, 0.5, 0.75 and 0.95. The robustness check includes two tests with different tuning parameters and propensity scores matching approach to address potential endogeneity concerns. We find that the effects will be stronger for those firms that mainly engage in more innovation activities counts (higher patent counts) and better innovation quality (higher citation counts). However, the relationship between different types of CSR and innovation is not significant for the firms engaging in less innovation activities (fewer patent counts) or with low innovation quality (fewer citation counts).

This essay extends the area that using quantile regression method to study the topic about CSR and innovation. What is more, this essay offers a new and more reliable perspective on the relationship between different types of CSR and firms' innovation activities on different percentiles. By applying OLS estimation, we find that CSR and ICSR have a positive influence on firm's innovation activities on both the quantity level which is proxied by the number of patents and the quality level which is proxied by the number of citations. While TCSR has negatively effect on the number of patent and the number of citations through OLS fixed effect model. However, by applying quantile regression method, the effects only significant on higher percentile which means CSR/ICSR/TCSR only have influence on the firms with larger number of patent and number of citations. The results are consistency in robustness checks. Our work contributes to the literature by presenting new evidence on the moderating role of CSR on innovation activities by specifying CSR into ICSR and TCSR to test their effect on different innovation activity quantile levels. Besides, our work promotes the critical thinking in CSR study that not all type of corporate social responsibility activity conducive corporate's sustainable development. Public should also initiate to participate in firms' CSR events.

The rest of the essay is organized as follow. Section 2 is the literature review about quantile estimation used in economic and finance area. Section 3 shows the data and variables. Section 4

introduce the methodology. Section 5 discuss the empirical results and robustness checks. Section 6 give the conclusion.

2. Literature review and hypothesis

2.1. Quantile regression method for extending research.

Quantile regression is widely applied in economics topics and financial area. It is used in investigating house prices (Ziets et al., 2008), equity markets (Baur, 2013), exchange rates (Nikolaou, 2008; Clements et al., 2008), silver and gold prices (Scheweikert, 2018), risks (Baruník and Čech, 2020), and stock return (Chuang et al., 2009; Baur et al., 2012).

It is believed that the data in economic topics and corporate finance area is quite different sometimes not only on the dominant variables but also the characteristics of the data constructure. Quantile regression estimation have a good performance on predicting economic trends, describe corporate finance variables distribution and capturing various relationship. For example, it is applied in investigating the volatility of the financial return (Clements et al., 2008), the effects in panel data (Baruník and Čech, 2020), and causal or non-causality relationship in different quantile ranges (Chuang et al., 2009). A key advantage of the methodology involves in quantile regression on one hand is the ability to control for otherwise unobserved heterogeneity among financial assets. Such, it is possible to disentangle overall market risk into its systemic and idiosyncratic components. One the other hand, the advantage is the dimensionality reduction. These estimates translate into better forecasting performance compared to traditional benchmarks (Baruník and Čech, 2020). The successful of innovation is also influenced by economic environment. The talented labor in research and development department, the domestic and foreigner resources, developing part of the location are affected by economic environment and those elements have effect on innovation activity (Fagerberg et al., 2010). Therefore, we apply quantile regression estimation to help us have a better prediction on innovation performance at different quantile levels.

Quantile regression is applied flexibly on various distribution. The quantile regression approach is particularly useful in cases where the distribution of returns is characterized by large skewness, kurtosis, fat tails, or in general deviates from normality. In those cases, the conditional mean regression method may not be adequate, while the quantile regression

approach provides more robust and more efficient estimates and results (Meligkotsidou et al., 2009). Decomposing the dependence by quantile regression provides a detailed picture of dependence including asymmetric and non-linear relationships, like cointegration relationship (Sim and Zhou, 2015; Scheweikert, 2018). The changes in the degree or structure of dependence can be modeled and tested for each quantile of the distribution (Baur, 2013). Thus, quantile estimation is suitable to study innovation which the proxy measures the affair coming over long periods of time.

Quantile regression can also apply flexibly in different type of tests. In unit root test, compared to previous models, the quantile framework makes no assumptions about the underlying distribution of the key variable thereby providing a flexible and detailed investigation. It allows for different (symmetric or asymmetric) persistence patterns (Nikolaou, 2008). In novel quantile-on-quantile (QQ) approach which to construct estimates of the effect that the quantiles of independent variable have on the quantiles of dependent variable. Generalizes the quantile regression approach by shedding light on how the asymmetric economic relationship happens in the conditional quantile (Sim and Zhou, 2015). In binary quantile regression (BQR) model, it is used to trace the entire distribution of the dependent variable (Li and Miu, 2010). In fixed effect tests for panel data, which is also the data type of our study, quantile-specific individual fixed effects that account for unobserved heterogeneity and represent the idiosyncratic part of market risk (Baruník and Čech, 2020; Oware et al., 2021). There are also quantile autoregression method (Baur et al., 2012), quantile regressions with factor-augmented regressors (Aslanidis and Christiansen, 2014) and Bayesian approach to inference on regression quantiles (Meligkotsidou et al., 2009) in empirical finance area.

Extending previous work on CSR and innovation, we introduce the idea of modelling the conditional quantiles to test the effect of CSR on innovation. Unlike the standard conditional mean regression method, which only examines how the CSR or innovation effects on average, quantile regression analysis provides a way of understanding how the relationship changes across the distribution. The approach provides useful insights into the distributional dependence of CSR on innovation.

From a mathematical point of view, quantile describes a division of observations into certain defined intervals based on the values of the data in our paper, and the innovation quantile for a specific company could show the relative magnitude of innovation of this specific firm in comparison with the entire set of firms in the sample. Using the median

value of innovation for the entire firm sample as a benchmark, that is, the 50 per cent quantile; higher and lower than this can be defined as a firm with better and worse innovation performance, respectively. In the specific case of this research, companies comprised by lower/higher quantiles than the median value (i.e., 50th percentile) can be identified as firms with low/high innovation quality and quantity. According to the previously literature that the results from OLS estimation may not apply to the entire distribution of the dependent variable and the normal distribution of the error terms in OLS is not guaranteed, we suppose that the estimation results based on median value may give more results.

2.2. Quantile regression on CSR and innovation.

Quantile regression unveil more information about the effects of entire distribution (Isabel and Ortas, 2017). By applying quantile estimation, we capture the effect changing on different innovation quantile levels. Middle quantiles are explainable by observable covariates while tail events which rather driven by unobservable random events (Krüger and Rösch, 2017). What is more, the median quantile in quantile regression estimator shows different results (Aslanidis and Christiansen, 2014).

The results from OLS which is only estimating the conditional mean of the response variable vis-à-vis the results of quantile regression. In this condition, OLS is not able to support us to detect the effect changing on different quantile levels. While the conditional quantile regression estimator extends the classical least squares estimation of the conditional mean to a collection of models running for different quantile functions. It permits the effect of a regressor to differ at different points of the conditional dependent-variable distribution, allowing us to examine the effect of CSR on entire distribution of dependent variables (Kang and Liu, 2014). In this chapter, we investigate CSR activities and innovation for higher and lower innovation productive forces by quantile regression.

Since the 21st century, the high speed of development on technology arouses the technology industries across the world especially for U.S who is the largest economic entity in the world. In the U.S, the account of technology companies represents the largest components of the Nasdaq Composite and Nasdaq-100 indices (Anthony et al., 2021). Technology firms as the significant participants and witnesses of the rapid growth directing the economic trajectory over the last decades. High-tech firms affect different strata of the society on both allocation of resources and income distribution in the U.S (Lloret, 2016).

With the 4th industrial revolution, the high speed of development of technology and wealth creating is causing environmental and social issues. Especially for high energy-dependent firms, they involve a considerable cost to the environment and society (Lloret, 2016). This phenomenon emphasizes the demand for social responsibility and accountability for firms in high-tech industry. Therefore, the nexus of corporate social responsibility, sustainable development and innovation performance of high-tech firms is becoming a core theme of businesses in the industry.

According to previous paper, more innovative firms demonstrate high corporate social responsibility (CSR) performance subsequent to a successful innovation. These high-CSR innovative firms enjoy significantly higher valuation post-innovation (Mishra, 2017). Even though CSR may not be automatically considered in the search for value, it is believed that CSR leads to a more sustainable, less risky approach through taking closer account of employee, customer and supply chain actions (MacGregor and Fontrodona, 2008). CSR may help signal firms' commitment to quality in markets in which quality is difficult to observe (e.g., experience goods) (Fishman et al., 2006). Firms with successful innovations, in particular those in the business of experience goods, have greater incentive to enhance CSR performance in anticipation of the future commercialization of their innovations. (McWilliams and Siegel, 2001; Fishman et al., 2006).

Firms with higher R&D spending related to higher levels of corporate environmental reporting than firms with lower R&D spending. Higher R&D spending means that firms input more asset and resource on innovation activity (Ortas et al., 2015). CSR can provide opportunities for innovation through the use of social, environmental, and sustainability drivers, creating not only new ways of working but also new products, services, and processes (Barbieri et al., 2010). In addition to, innovative firms require adequate access to capital not only for investment in R&D initiatives (pre-innovation) but also post-innovation capital investment to commercialize innovations. By promoting stakeholder engagement and transparency, CSR improves access to finance. Good CSR performance promotes a firm's commitment to stakeholder engagement and cooperation (Andriof and Waddock 2002). Therefore, we hypothesize that:

H1: CSR have positive effect on innovation and the influence is emphasized for the firms with more innovation product and better innovation quality.

The small but growing literature on how innovation activity changes with CSR but seldomly study how different types of CSR activities effect innovation. Our study follows the CSR construction of Mattingly and Berman (2006) that differentiates CSR activities as institutional CSR (ICSR) which targets secondary stakeholders and technical CSR (TCSR) which targets primary stakeholders. ICSR are more likely to be viewed as voluntary acts of social beneficence and reflect the firm's moral characteristics (Godfrey, 2009).

As secondary stakeholders such us regulators, general public or communities who defined as secondary stakeholders recognize the ''altruistic'' and pure nature of ICSR, they grant moral capital, which belongs to reputational capital for doing social good, to the firm for its engagement in CSR activities. Positive moral capital will provide 'insurance-like' benefits when the firm is subject to negative events and face sanctions from stakeholders (Godfrey, 2005). As we have mentioned above that high- CSR related to more innovation (Mishra, 2017), we suppose that the 'insurance like' benefit is very important when firms in exposure to innovation failure risks, especially for high-tech firm with more innovation activities. Therefore, we hypothesize:

H2: ICSR have positive impact on innovation and the influence is emphasized for the firms with more innovation product and better innovation quality.

TCSR which targets primary stakeholders like employees, consumers, shareholders, etc. Those stakeholder group have direct economic exchange with a firm and the firm cannot survive as a going concern without continuing participation of primary stakeholders (Chang, 2014). Employee as one of the important stakeholders of TCSR are the key resource of high-tech companies, and for this reason, they are at the management's focus. High-tech companies tend to choose CSR based on the importance of crucial resources (Grabinska et al., 2021). TCSR is also viewed as the activities that result from satisfy manager short-sighted and take advantages needs, since manager have urgent demands to prove their ability in a short-term. However, patent given and the increase of citation counts need a long-term. Comparing to the profit that can be seen immediately, primary stakeholders tend to unwilling to see the investment on high risk and high uncertainty affair. Therefore, we suppose that TCSR has negative affect on firm's innovation. Therefore, we hypothesize:

H3: TCSR have negative effect on innovation and the influence is emphasized for the firms with more innovation product and better innovation quality.

Although ICSR and TCSR are specific concept based on CSR, their measurement from different CSR dimensions. In order to detect the solely independent effect of ICSR and TCSR on innovation, we also hypothesize:

H4: The impact of ICSR and TCSR on firms' innovation is solely and will not change compared to separated regressions.

Two robustness tests are also applied to make the findings constancy. The first robustness test is to control firm size to observe whether the scale of the firm have influence on the relation between covariates and the dependent variables. The second robustness test is to control cash flow to observe whether the internally financial scale have influence on the relation between covariate and the dependent variables.

3. Data and variables

The estimation in this essay involves in one dependent variable (innovation) which is proxied by two measures, three independent variables (CSR, ICSR and TCSR) and seven control variables (Tobin's Q, leverage, R&D intensity, current ratio, CAPX, ROA and book value of total asset). The dataset we use in essay two is same as essay one but to detect different research questions.

Rao and Cao (2006) through quantile regression get the relation between Tobin's q and innovation. They indicate that firms with a low value of Tobin's q, the stock market will barely recognize their attempts to innovate. For firms with the highest values of Tobin's q, their market value is particularly sensitive to innovative activity. In addition, it is also proved that correct Tobin's q has significant effect on the predict the value of innovation assets (Potepa and Welch, 2018).

The most widely studied leverage influence on innovation through studies of leveraged firm buy-outs (LBOs). Since innovation investments are always long-term focused which increase current cash flow for debt service. Thus, managers unwilling to invest in it. Several evidence from empirical studies about LBOs have documented that innovation related investment substantially decrease following an LBO (Long and Ravenscraft 1993, Smith 1991). For this study, we measured leverage as a firm's debt and assets ratio.

Several methods have been employed to measure R&D intensity by previous researchers. A common method is using R&D spending divided by firm sales. While a number of researchers have employed R&D spending per employee and argued that their measurement is more stable than common method (Baysinger et al. 1991, Hill and Snell 1989, Scherer, 1984). Besides, relative R&D

spending is also used to generate a normal distribution of R&D intensity. Like the studies (Daellenbach et al. 1999, Barker and Mueller, 2002), relative R&D spending is calculated by subtracting from an individual firm's R&D spending a weighted industries in which the firm operated.

Current ratio as the indicator of firm's liquidity ratio is also controlled (Kochhar and David, 1996). Since a firm's short-term resources may also affect available funding (Hansen and Hill, 1991). Besides, Short-term oriented business may focus on efficiency-related innovative activities (Wu et al., 2015). Singh and Kota also indicate that higher liquidity ratios (or current ratios) reduce the probability to develop/adopt a radical eco-innovation. Thus, current ratio is controlled.

Capital expenditure (CAPX) as one of the items to measure firm's investment activities is necessarily to be controlled. As before 1996, CAPX is the larger component of corporate investment (Dong and Teoh, 2017). What is more, CAPX effects firm life cycle that may impact innovation rates--- such as younger firms investing more in innovation and older firms investing more in factories to deploy their innovations (Au and Tan, 2022).

ROA refers to return on assets which is one of the major firm characteristics that may affect innovation. (Bernstein 2015; Chemmanur and Tian 2018; Li et al 2017; Au and Tan, 2022; Acharya and Xu, 2017)

A number of researchers have examined about the influence of firm size on innovation. On one hand, several empirical studies have found a positive effect of firm size on innovation (Baysinger and Hoskisson 1989, Baysinger et al. 1991). As larger firms may have greater resources to exploit innovations (Schumpeter, 1942). On the other hand, contrasting findings emerged that larger firm size may provide managers less incentive to invest in innovations (Graves 1988, Hansen and Hill, 1991). For his study, firm size is measured as the book value of total asset. A natural logarithm is applied due to a skewed distribution.

4. Methodology

4.1. Quantile regression models

Our quantile regression models can be expressed as follows:

$$Q_\tau\ (y_i) = \beta_{\tau,0} + x_i^T \beta_\tau \qquad (1)$$

y_i is the dependent variable which is measured by the number of patents and the number of citations; *i= 1, 2, …,* n and n is the number of data points; τ is the quantile level which refers to 0.05, 0.25, 0.5, 0.75 and 0.95 in essay two; β is the parameter at the quantile level; x is the independent variable group including time, firm and industry fixed-effect variables.

In order to enhance the prediction accuracy and interpretability of the resulting model, we combine the QR models with the LASSO method, which requires us to estimate the parameters of model (1). Such that:

$$\min_{\beta} \sum_{i=1}^{n} \rho_\tau(y_i - x_i^T \beta_\tau) + \sum_{j=1}^{p} \lambda \left|\beta_{\tau,j}\right| \quad (2)$$

With i= 1, …, n and $\rho_\tau(.)$ is following:

$$\rho_\tau(y_i - x_i^T \beta_\tau) = \begin{cases} (y_i - x_i^T \beta_\tau)(\tau - 1) & if\ (y_i - x_i^T \beta_\tau) < 0 \\ (y_i - x_i^T \beta_\tau)\tau & if\ (y_i - x_i^T \beta_\tau) \geq 0 \end{cases} \quad (3)$$

The first part of expression (2) shows the quantile regression and second part of the expression shows the Lasso method which add the penalties on the parameters. Quantile regression predict the model using the median value of dependent variable for the entire firm sample as a benchmark. Since the symmetry of the absolute value yields the median, minimizing a sum of asymmetrically weighted absolute residuals which is simply giving different weights to positive and negative residuals would yields the quantiles. ρ_τ is the tilted absolute value function that yields the τth sample quantile as its solution (Koenker and Bassett, 1978).

Lasso is the abbreviation of least absolute shrinkage and selection operator which is a type of linear regression with shrinkage in the regression. Shrinkage in regression refers to the data values shrinking towards to a central point, such as the mean value. This kind of procedure adapts to the models with less parameters which also called a sparse model. There are 9 independent variables in the regressions in maximum, so Lasso procedure is applied in this chapter. This kind of regression is also adopted when the model with high levels of multicollinearity, with automate variable selection procedure or involves in parameter elimination issue. In order to address over-fitting and feature selection issues, the regularization technique is used. Lasso estimator uses the regularization technique that adds a penalty equals to the absolute value of the magnitude of the parameters. And this type of regularization can make the sparse models with few parameters by eliminating or becoming zero. A larger penalty results in a coefficient value that much closer to zero. Thus, the larger of

the penalties the better of the procedure to create a simpler model (Bühlmann, Peter; Van De Geer, Sara., 2011).

4.2. Model selection

The final selected model depends on the tuning parameter λ. We use the following method to select the model.

The second term of model (2) is a sum of the absolute coefficient values penalized by λ. λ as a tuning parameter which controls the strength of the penalty and it is basically the amount of shrinkage. Theoretically, when λ equals to 0, no parameters are eliminated so the estimation is equal to the results of linear regression. When λ increases, more and more coefficients are set to zero and eliminated. When λ equals to infinite, all coefficients are eliminated. With the increasing of λ, the bias will increase as well. With the decreasing of λ, the variance tends to increase. (Agresti A., 1990) (Kotz, S.; et al., eds., 2006).

To obtain the estimated model, we first let 0< $\lambda_1 < \lambda_2 < \cdots < \lambda_M$, and $\lambda_i - \lambda_{i-1} = 0.1$ and λ_M=10. Then, at a given level τ, we let $\lambda = \lambda_i$, and estimated model (2), resulting in M models. The best model in the M models corresponds to the minimum value of the Akaike Information Criteria (AIC). Repeat the above procedure, we can obtain all models at levels $\tau = 0.05, 0.25, 0.5, 0.75, 0.95$.

AIC is come up by Japanese statistician--- Hirotugu Akaike in the early 1970s. He formulated this criterion for the model selection and is widely used now. The basic notion of the Akaike information criteria is that by continually adding parameters to model we will always get a little bit better. But it is also a trade-off against overfitting and losing the information about the real underlying pattern. In other words, it represents a trade-off between the number of parameters which is added in the models and the increase of incremental amount of error which is also known as the penalty of the model. According to the criterion, the better fit model has the lower AIC value. AIC is an estimator of the relative quality of statistical models for a given set of data. It tells nothing about the absolute quality of a model but the quality relative to other models. As the following equation shows the definition of AIC:

$$\text{AIC} = \log\left(\frac{SSE}{n}\right) + \frac{n+2*p}{n} \qquad (4)$$

n is sample size, p is the number of parameters, log is the natural logarithm, SSE is the sum of squared estimate of errors. According to AIC, the best model corresponds to the minimum value of AIC.

5. Empirical results

The empirical results are related to the effect of different CSR types on the innovation distribution. Innovation is measured by the number of patent and the number citation which are focus on the quantity level and the quality level respectively. For each test in this section, we

estimated model (1). There are 6 control variables in the regression including $Tobin's\ Q_{i,t-1}$ which is the ratio of market value of total asset to the book value of total asset, $Leverage_{i,t-1}$ which is total debt divided by the book value of asset, $RD\ intensity_{i,t-1}$ which is research and development expenses over the book value of total asset, $Current\ ratio_{i,t-1}$ which is the ratio of current asset to current liability, $lnCAPX_{i,t-1}$ which equals to capital expenditure divided by the book value of total asset and $ROA_{i,t-1}$ which is earnings before interest, tax, depreciation and amortization divided by the book value of total asset (Chang, K., Kim, I., & Li, Y. (2014). For setting the λ value with Lasso estimator, λ is set a changing value which means λ taking values between 0 to 10 by adding up 0.1 each time for all independent variables. The estimation results of different CSR types will be discussed in detail following.

5.1. The impact of different types of corporate social responsibility on innovation activities at different levels

5.1.1. The impact of CSR on innovation activities at different levels

The model of this part is manifested on expression (1) to correspond to hypothesis 1. x_i^T represents for seven independent variables which CSR scores is the first independent variable and following six control variables.

Panel A and panel B of Table 1 shows the effect of CSR in innovation on quantity level and quality level respectively. The results are quite different with the OLS estimator which shows significant positively influence on innovation activities on both levels. With QR estimator, CSR have positively effect on the innovation quantity level on higher quantile (0.75). This finding imply that CSR have positively influence on innovation if the firm involves in large number of innovation activities. While CSR does not have any significant influence on firm's number of citations which CSR activities do not have any effect on firm's innovation quality.

5.1.2. The impact of ICSR on innovation activities at different levels

The model of this part is manifested on expression (1) to correspond to hypothesis 2. x_i^T represents for seven independent variables which ICSR scores is the first independent variable and following six control variables.

Panel C and panel D of Table 1 shows the effect of ICSR in innovation on quantity level and quality level respectively. After specifying CSR types, ICSR have a positively effect on the number of patents on higher level (0.5 and 0.95) which means ICSR promote more innovation activities when firm with higher innovation quantity. And ICSR also have a positively effect on the number of citations on higher level (0.5, 0.75 and 0.95) which implying ICSR activities have positively influence on the quality of innovation activities for the firms with high innovation quality.

5.1.3. The impact of TCSR on innovation activities at different levels

The model of this part is manifested on expression (1) to correspond to hypothesis 3. x_i^T represents for seven independent variables which TCSR scores is the first independent variable and following six control variables.

Panel E and panel F of Table 1 shows the effect of TCSR in innovation on quantity level and quality level respectively. TCSR activities have negatively significant effect on the number of patents on 0.5 percentile and also have negatively significant effect on the number of citations on high percentile (0.5, 0.75 and 0.95). The findings suggest that TCSR activities have negatively influence on firm's innovation quantity for the firms with average innovation quantity in the entire distribution while have negatively influence on firm's innovation quantity for the firms with high quality innovation product.

5.1.4. The joint impact of ICSR and TCSR on innovation activities at different levels

The model of this part is manifested on expression (1) to correspond to hypothesis 4. x_i^T represents for eight independent variables which ICSR and TCSR scores is the first two independent variables and following six control variables.

Panel G and panel H of Table 1 shows the effect of TCSR in innovation on quantity level and quality level respectively. To observe the solely effect of ICSR and TCSR on innovation clearly and to mitigate the effect of CSR activity types on each other, ICSR and TCSR is tested in the same regression. The results shows that different CSR types do not affect each other. ICSR still have positively effect on innovation activities on quantity and quality levels on higher percentiles (0.5, 0.75 and 0.95). TCSR still have negative effect on innovation activities on quantity and quality levels on higher percentiles (0.5, 0.75 and 0.95).

5.1.5. Summary discussion

As the results showing that there is not obviously tendency on lower percentile for all the regressions but on higher percentiles. Higher CSR scores promote more innovation activities on quantity level for the firms with higher number of patents. When talking about the CSR activities from different types which are technical CSR and institutional CSR, ICSR activities have positive influence on both quantity and quality levels of innovation product on higher quantiles. However, TCSR have negative influence on innovation activities on both quantity and quality levels. The influence of quantity shows on the middle percentile (0.5) and the influence of quality shows on the higher percentiles (0.5, 0.75 and 0.95). The findings imply that CSR/ICSR/TCSR activities have influence on firm's innovation product only for the firms with large number of innovation quantity or better innovation quality. Only for those firms, different types of CSR activities are meaningful.

6. Robustness checks

The results so far suggest a relation between firm's CSR/ICSR/TCSR and innovation on 5 different quantiles. There is no significant influence on lower quantiles (0.05 and 0.25) but have significant influence on higher quantiles (0.75 and 0.95). CSR and ICSR have positive effect on firm's innovation on two levels which are quantity level and quality level, while TCSR has negative effect on innovation on the two levels. However, this finding could be biased due to other elements like the firm size or investment ability. Thus, we further control firm size and cash flow to test whether the results get above is influence by the total asset of the firms and the investment amount on innovation. More details about the robustness checks are shown following.

6.1. Whether the firm size affects the correlation on different distribution level of innovation performance

Previously studies suggested that firm size is corelated with the innovation activities, see for example Roger (2004), Cao and Rao (2007), Shefer and Frenkel (2005) and Stock et al. (2002), because larger firms have ability or source to participate more on their innovation activities. Thus, larger firms tend to have more innovation product on both quantity and quality level. In order to test that the different relationship between better innovation performance firms (higher quantiles) and less innovation performance firms (lower quantiles) is influenced by CSR activities rather than firm size, we add one more control variable which is $BV_{i,t-1}$, the logarithm of book value of total asset, to estimate model (1) with the same dataset.

As the results is shown in table 2. CSR have positively affect firms' innovation on the number of patents and the number of citations on high percentile (0.75). After classifying CSR types, the results have same tendency as investigated in section 5.2.1. The correlation between ICSR and two innovation dimensions are positively higher quantiles levels (0.5, 0.75 and 0.95). The correlation between TCSR and two innovation dimensions are negatively on higher quantile levels which are 0.5 and 0.75 for quantity level, 0.75 and 0.95 for quality level. Even containing two CSR types in the same regression, the effect remains on these three quantile levels. For the regressions that contain both ICSR and TCSR, ICSR still have positively influence on innovation activities and TCSR have negatively influence on innovation activities on higher quantile levels (0.5, 0.75 and 0.95). However, not significant relationship between CSR/ICST/TCSR and innovation on lower quantiles.

The correlation between CSR and innovation when lambda equals to 5 and 20 are similar with lambda set to the same changing. Thus, the mainly findings are convincible that the influence of CSR/ICSR/TCSR on firms' innovation activities is significant when the firms are high innovation activity firms. If the firms do not mainly rely on innovation activities, the influence is not important for them.

6.2. Whether cash flow affects the correlation on different distribution level of innovation performance

According to the previously research on innovation, it is found that firm's cash flowing rate significantly affect the output of innovation activities. Zhang et al., (2020) indicate that cash flow exhibits a more significant effect in investment compared with Tobin's Q in empirical study. Brown et al., (2009) argue that US has experienced a finance-driven cycle in research and development investment. Kraft (1989) suggest that innovation must be largely financed internally and the possibilities of internal financing are taken account of by the cash flow rate. Moreover, Mulkay (2001) find that cash flow impacts are much larger in US for research and development costs. Christensen et al., (2008) indicate that most executives will control the cash flow to cut down innovation activities to persisting the present healthy company. What is more, Brown (1997) argues that the investment of innovative firms is more sensitive to cash flow.

To investigate that the relation between CSR/ICSR/TCSR and innovation on different percentiles is not affected by other elements like the investment condition, we involve cash flow ratio into the controlling variables. If the results are consistent with before adding it, it can be concluded that our results are robust.

The results are shown in Table 3. The estimation follows model (1) but add cash flow in control variables. The penalty term of the coefficient, λ, is set as have the same changing at each regression. After controlling cash flow, the OLS estimation gives the consistency results that CSR, ICSR and TCSR have significant effect on innovation. Moreover, quantile regression with Lasso with lasso estimation give the consistency results as well that CSR, ICSR and TCSR have significant effect on innovation on higher percentiles but not significant corelation on lower percentiles. This phenomenon implies that CSR and ICSR activities promote innovation output on both quantity and quality levels for the firms with larger innovation counts and better innovation quality. TCSR have negative effect on those firms with better innovation performance. However, for the firms with less innovation output on both quantity and quality levels, CSR, ICSR and TCSR does not have significant effects. The relationship between different types of CSR and innovation will not affect by the investment ability on innovation which is proxied by cash flow. Thus, our conclusion is robust.

6.3. The propensity scores matching method in quantile regression

6.3.1. The propensity scores matching process

Build on previous work on CSR studies, the measurement of CSR can lead to omitted variable bias. Our CSR scores are calculated based on the classification of KLD database which adopts single and specific constructure. When the measurement of CSR using a single and specific CSR construct, the scores can only reflect limited information which is either not available or not meaningful for firms on other industries (Stevan and Yurtoglu, 2018). In this case, the different aspect of CSR is not clearly separated which

result in correlated issue. For example, the firm with good performance in one of the aspects, e.g., in employee working environment, are likely to have good performance as well as on other dimensions, e.g., employee diversity. Since the characteristics of our data resource, this chapter is not able to study the impact of only one isolation aspect from others. The real driver of the good performance can be omitted. To overcome the misleading policy recommendations, we address propensity score matching approach to address the issue.

Besides, selection bias arises in CSR study is also one the reasons that we adopt PSM approach. Although substantial fraction of empirical studies related to the effect of CSR on firm performance in various aspects, they are generally subject to sample selection bias. For this chapter, the endogenous variable is CSR, the bias arises due to confounding factors are not controlled for he influences both the decision to implement CSR initiatives and corporates innovation amount and output quality. In other words, selection bias concern as one of the mainly endogeneity issues in that an innovative firm may have higher profitability and be more likely to self-select to conduct CSR initiatives (Flammer, 2015). It is indicated that the implementation of the PSM approach in the field of management can strengthen researcher's ability to draw causal inferences based on observational data (Li, 2013).

This chapter implements PSM to estimate the difference in firm level factors between good CSR performance firms and matched negative CSR scores firms. Since firms with CSR initiatives are different in many aspects comparing to those without (Takahashi & Nakamura, 2010). We calculate the propensity score of each observation and group them to two groups for positive CSR scores and negative CSR scores for another. Propensity scores represent a weighted index of firm characteristics. The matched firms comparing to all firms have a similar effect distribution implies that the propensity score matching ameliorates the sample selection concern (Stevan and Yurtoglu, 2018).

So far, we have discussed the effect of CSR, ICSR and TCSR on different innovation quantile level. To address the potential endogeneity problem result from matching concern, we employ propensity score matching (PSM) based on observable firm characteristics. We use propensity score matching to compare firms that have positive scores (treatment group) on CSR, ICSR and TCSR with otherwise firms that have negative scores (control group) on CSR, ICSR and TCSR. There are several different classes and methods of matching, we construct the control group using the nearest-neighbour method with propensity scores derive from a logit model where the dependent variable is a dummy variable that takes the value one for firms with a positive score according to the definition above. In the matching, each treated unit is paired with an available control unit which has the closest propensity score to it. Any remaining control units are left unmatched and excluded from further analysis. According to Rosenbaum and Rubin (1983), propensity score matching can be an effective way to achieve covariate balance in the treatment groups. The explanatory variables include the same firm characteristics included in the baseline regression (like Table 1) as well as industry and year effects. To ensure that the matching is in a good

balance, we capture the maximum value of empirical cumulative density function (eCDF-Max). An eCDF-Max statistics close to zero indicates good balance (Ho et al. 2007, Stuart 2010, Austin 2011).

In the last step, we estimate the treatment effect and its uncertainty in quantile regression. In baseline regression, we get the results: CSR only has positive effect on the number of patent (75% quantile level) for firms with a relative higher innovation quantity level; ICSR promote the number of patent (50% and 95% quantile level) and the number of citation (50%, 75% and 95%); TCSR inhibit innovation on both quantity (50% quantile level) and quality (50%, 75% and 95% quantile level) aspect; for co-effect of ICSR and TCSR, ICSR promote innovation on both aspect (50%, 75% and 95% quantile level) while TCSR inhibit innovation on both aspect on same quantile levels. Our PSM approach addresses the endogeneity concerns based on above baseline results.

6.3.2. The propensity scores matching results

As the result is presented in Table 4, it shows the comparison of pre-match propensity score regression and post-match diagnostic regression which verify the observations in the treatment and control groups are sufficiently indistinguishable in terms of observable characteristics. The post-match columns of panel A to panel D show that none of the coefficient estimates is statistically significant, suggesting that there are no distinguishable trends in innovation between the two groups. Table 5 shows the different of the maximum value of empirical cumulative density function. It can be read from the table that the maximum value of eCDF-Max of each variable for matched data is closer to zero which indicate a good balance. In addition, the difference in panel A to panel D implies the difference between treated group and control group which indicate an effective matching. Finally, Table 6 reports the propensity score matching estimated. The results indicate that there are significant differences in innovation – for two measures – between firms with higher CSR, ICSR, and TCSR scores and those without. In detail, CSR impose the number of patent for firms with a relative higher innovation quantity (75% quantile level); ICSR promote firms innovation on quantity perspective for firms at 50% and 95% quantile level of the number of patent; ICSR also promote firms citation counts for firms at 50%, 75% and 95% quantile level of the number of citation; TCSR does not have a significant effect on innovation quantity aspect while have positive effect on innovation quality for firms at 50%, 75% and 95% quantile level of the number of citation which is an opposite results with the results of baseline regression; there is no significant effect of ICSR and TCSR on innovation under the two measurements for co-effect regression.

For the difference results of PSM and the result of baseline regression, here is our explanation. Through compare the observation number of all data and patched data, it can be found that matching process drop lots of data which may cause the sample years periods shrink. This shrink only present the effect in a short-term which result in different result with baseline regression, because the baseline regression based on 15 years which allow us to observe a long-term effect. In short term, TCSR could have

positive effect on innovation quality, since TCSR is seen as driven by short-term profit acquiring. For the result of co-effect model, which is shown in panel D of Table 6, the results no longer show a significant effect. The reasons can be as following: the first reason can be the decrease observation of sum-sample after matching which not enough to observe a co-effect of ICSR and TCSR on innovation; the second reason can be inferred that the effect of ICSR and TCSR on innovation is diluted in the firms with similar situations on firm's level, therefore, it is unnecessary to consider whether the two different CSR types affect each other in detecting the their individual effect on innovation.

6.4. Further discussion

By applying quantile regression method with Lasso estimation, we find that the relationship between different types of CSR and innovation by OLS estimation can is biased. OLS estimation suggests that CSR and ICSR have positive effect on innovation, while TCSR have negative effect on innovation activities. However, quantile regression shows that the results by OLS estimation cannot reflect the true relationship. Those relationship only apply on higher quantiles rather than the entire distribution of the patent counts and the citation counts. The effect of different types of CSR activities is not significant for the firms with lower innovation products (lower quantiles). In order to support the findings, we further control the firm size which is proxied by the book value of total assets and cash flow which is proxied by the gross cash flow and we get the consistency conclusion with the findings of section 5.1. Through the robustness test, we can exclude the possible that firms with different percentiles innovation outputs result from their firm size and cash flow amount. Since larger firms have ability to involve more on innovation outputs such as recruiting more employee, acquiring mature innovation product from other institutions, have more opportunities to endorsed by the government or any other resource that can be used in innovation. In addition, firms with larger cash flow tends to invest more on innovation. Furthermore, we through PSM approach to address the potential endogeneity concerns result from matching problem. The results of PSM approach confirm the impose effect of CSR and ICSR on innovation. Thus, our findings imply that CSR and ICSR activities promote firm's innovation product on both quantity and quality levels quality but TCSR have negative effect on firm's innovation activities on both levels. Those influence only apply on the firms with higher innovation counts or higher innovation rather than the firms with lower performance on both levels.

7. Conclusion

Essay two investigates the relationship between CSR/ICST/TCSR and innovation on different quantile levels by applying quantile regression with Lasso estimator. We find that the effect of CSR/ICSR/TCSR on innovation does not have any significant relationship on the lower percentiles but it does have significant relationship on the upper percentiles. The conclusion is different with the findings from the estimation with OLS that CSR/ICSR/TCSR have significant

influence on entire innovation distribution. This phenomenon implies that the effect is stronger for the firms mainly engaging in innovation activities, while there is no effect for the firms less engaging in innovation activities. Thus, we could get the conclusion that CSR and ICSR could offer an insurance protection for the firms engaging in large scale or better-quality innovation activities. And those firms could convert the potential benefit from ICSR activities to a kind of intangible asset for innovation activities. For the effect of TCSR on the upper percentiles show a consisting result that it has negative influence on firms' innovation activities on both quality and quantity dimensions. The results are robustness by controlling the effect of firm size and by setting different penalties to the regression. Comparing to quantile regression, the ordinary least square method only captured the effect on upper percentiles which so not give a precisely prediction.

This paper provides a new dimension to the literature of the QR method in corporate finance area, also filling the gap that the influence of different types of CSR activities is not significant on the different innovation percentiles. These promote the critical thinking in CSR study that not all type of corporate social responsibility activity conducive corporate's sustainable development. Public should also initiate to participate in firms' CSR events.

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Appendix:

Table 1. How CSR/ICSR/TCSR effect on innovation activities on both quantity and quality level.

Table 1 shows the results of the effect of CSR/ICSR/TCSR on innovation in 5 different percentiles (0.05, 0.25, 0.5, 0.75 and 0.95). intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX and ROA_w is the winsorized value of firm's ROA. Industry fixed effect and time fixed effect considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression; τ is the quantile level; λ is the penalty of the regression; AIC is the smallest value based on the model selection criteria in the software which shows the quality of the model. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
CSR	0.043**	2.25E-13	2.56E-14	1.95E-14	1.63E-02***	1.97E-02
Tobinq_w	0.028**	8.13E-14	3.10E-15	2.91E-15	1.63E-02***	2.63E-02***
Leverage_w	0.135	1.03E-12	4.60E-14	6.72E-16	-1.09E-02	1.42E-02
interRDintensity_w	-0.687**	-5.32E-12	-2.86E-13	-8.72E-14	3.01E-12	-2.05E-01**
Currentratio_w	-0.014*	-1.13E-13	-7.73E-15	-9.15E-16	-5.40E-04	3.50E-04
CAPX_w	0.169***	9.67E-13	5.00E-14	2.09E-14	2.29E-02	1.47E-02**
ROA_w	-0.313*	-1.66E-12	-5.00E-14	-4.38E-14	-3.08E-12	-9.68E-02*
constant	0.156	-4.95E-12	-4.55E-14	1.05E-13	-2.34E-02	5.23E-01***

Panel B: CSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
CSR	0.035*	3.51E-15	3.75E-11	4.48E-14	2.56E-12	2.64E-02**
Tobinq_w	0.045***	6.91E-15	1.54E-14	1.27E-14	8.34E-13	1.05E-02
Leverage_w	0.141	7.78E-14	2.24E-13	9.21E-15	-4.79E-13	7.36E-03
interRDintensity_w	-0.904**	-3.49E-13	-8.38E-13	-2.51E-13	-6.79E-12	-6.38E-02
Currentratio_w	-0.005	-5.76E-15	-4.31E-14	-2.83E-15	8.60E-14	6.90E-04
CAPX_w	0.148***	7.84E-14	1.65E-13	6.52E-14	2.03E-12	5.89E-03
ROA_w	-0.307	-1.53E-13	-8.69E-14	-1.23E-13	-4.84E-12	-3.20E-02
constant	0.213*	-5.48E-13	-3.73E-13	8.52E-14	3.45E-12	1.11E-01**

Panel C: ICSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.187**	1.68E-13	2.89E-13	9.90E-02***	1.09E-01	8.26E-02***
Tobinq_w	0.027**	2.37E-14	1.41E-15	1.09E-13	5.65E-13	1.61E-02***
Leverage_w	0.131	-4.07E-15	6.04E-14	-3.10E-14	1.68E-13	2.21E-03
interRDintensity_w	-0.646**	-4.46E-13	-2.13E-13	-3.17E-12	-5.79E-12	-1.34E-01
Currentratio_w	-0.014*	-1.78E-15	-7.19E-15	-4.86E-14	1.84E-14	4.44E-04
CAPX_w	0.163***	1.52E-13	4.64E-14	8.48E-13	1.24E-12	9.95E-03*
ROA_w	-0.313*	-3.89E-13	-7.14E-14	-1.80E-12	-3.69E-12	-6.86E-02
constant	0.147	-1.04E-12	-4.50E-14	4.29E-12	1.88E-12	4.54E-01***

Panel D: ICSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.161***	6.58E-13	7.61E-14	1.54E-01***	2.08E-01***	2.82E-01***
Tobinq_w	0.044***	7.66E-14	7.94E-16	2.95E-15	5.05E-13	1.12E-02***
Leverage_w	0.137	3.45E-13	1.50E-14	6.13E-17	-3.68E-13	4.38E-03
interRDintensity_w	-0.868**	-3.39E-12	-7.49E-14	-8.17E-14	-2.26E-12	-6.40E-02
Currentratio_w	-0.005	-4.35E-14	-2.01E-15	-1.29E-15	3.70E-14	5.78E-04
CAPX_w	0.143***	6.68E-13	1.54E-14	1.79E-14	1.02E-12	5.06E-03
ROA_w	-0.308	-1.99E-12	-3.36E-14	-5.01E-14	-2.10E-12	-2.68E-02
constant	0.205*	-4.33E-12	-2.38E-14	1.72E-13	8.20E-13	9.22E-03

Panel E: TCSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
TCSR	-0.102**	-2.69E-13	-1.12E-13	-2.08E-02***	-9.90E-03	-2.80E-02
Tobinq_w	0.027**	5.45E-14	2.05E-15	2.16E-12	3.02E-11	0.000232
Leverage_w	0.149	7.65E-14	2.91E-14	-1.31E-12	1.51E-11	8.49E-05
interRDintensity_w	-0.665**	-1.21E-12	-1.78E-13	-2.10E-11	-2.31E-10	-0.00203
Currentratio_w	-0.013	-6.33E-15	-4.99E-15	-1.25E-13	3.53E-12	3.78E-06
CAPX_w	0.167***	3.31E-13	3.09E-14	1.06E-11	6.20E-11	1.45E-04

ROA_w	-0.302*	-8.48E-13	-3.94E-14	-1.32E-11	-1.80E-10	-1.18E-03
constant	0.146	-2.48E-12	-2.13E-14	-5.89E-12	4.64E-11	7.20E-01***

Panel F: TCSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
TCSR	-0.119***	-9.91E-14	-5.65E-13	-3.85E-02***	-1.13E-01***	-1.23E-01***
Tobinq_w	0.044***	1.67E-14	1.23E-14	1.27E-13	1.14E-12	1.38E-02***
Leverage_w	0.154	2.22E-13	9.98E-14	1.50E-13	-1.63E-13	5.72E-03
interRDintensity_w	-0.876**	-1.26E-12	-8.56E-13	-1.90E-12	-8.48E-12	-8.14E-02
Currentratio_w	-0.004	-2.17E-14	-2.02E-14	-1.88E-14	1.61E-13	5.80E-04
CAPX_w	0.146***	2.07E-13	1.52E-13	6.30E-13	2.50E-12	5.77E-03
ROA_w	-0.295	-4.56E-13	-2.88E-13	-1.04E-12	-5.70E-12	-3.62E-02
constant	0.202	-8.74E-13	-2.39E-13	4.05E-13	3.56E-12	1.09E-01**

Panel G: ICSR-TCSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.181**	5.36E-13	4.80E-12	1.00E-01***	1.04E-01***	9.03E-02***
TCSR	-0.083**	-2.67E-13	-3.32E-12	-9.78E-02***	-4.79E-02***	-4.78E-02**
Tobinq_w	0.026**	3.82E-14	1.30E-14	8.11E-15	1.56E-12	1.33E-02***
Leverage_w	0.136	4.81E-13	7.50E-13	-7.47E-16	8.19E-13	4.33E-03
interRDintensity_w	-0.624**	-2.38E-12	-2.82E-12	-2.17E-13	-1.72E-11	-1.05E-01
Currentratio_w	-0.013	-5.33E-14	-1.08E-13	-3.71E-15	7.18E-14	3.95E-04
CAPX_w	0.161***	4.75E-13	5.44E-13	6.03E-14	3.81E-12	8.68E-03
ROA_w	-0.306*	-9.90E-13	-1.07E-12	-1.30E-13	-1.09E-11	-5.17E-02
constant	0.141	-2.39E-12	-6.56E-13	1.27E-13	7.38E-12	4.31E-01***

Panel H: ICSR-TCSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.153***	1.31E-13	4.66E-13	1.18E-01***	2.06E-01***	2.91E-01***
TCSR	-0.103***	-7.81E-14	-3.56E-13	-1.12E-01***	-2.00E-01***	-1.68E-01***
Tobinq_w	0.043***	1.50E-14	1.43E-15	3.18E-13	4.75E-14	3.84E-02***

Leverage_w	0.144	4.63E-14	4.14E-14	-1.85E-13	-1.36E-14	2.24E-02
interRDintensity_w	-0.840**	-2.00E-13	-2.24E-13	-8.67E-12	-1.78E-13	-2.28E-01*
Currentratio_w	-0.004	-2.74E-15	-7.53E-15	-1.61E-13	5.54E-15	1.92E-03
CAPX_w	0.141***	9.12E-14	4.24E-14	1.85E-12	9.24E-14	1.70E-02**
ROA_w	-0.299	-1.89E-13	-1.10E-13	-5.16E-12	-1.52E-13	-8.64E-02
constant	0.198	-6.45E-13	-5.26E-14	1.30E-11	5.32E-14	3.64E-02

Table 2. Robustness test of the effect of firm size.

Table 2 shows the results of the effect of CSR/ICSR/TCSR on innovation in 5 different percentiles (0.05, 0.25, 0.5, 0.75 and 0.95). intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX and ROA_w is the winsorized value of firm's ROA, Lnbvota_w is the winsorized value of firm's book value of total assets. Industry fixed effect and time fixed effect considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression; τ is the quantile level; λ is the penalty of the regression; AIC is the smallest value based on the model selection criteria in the software which shows the quality of the model. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
CSR	0.0421**	2.43E-14	1.75E-14	1.80E-14	1.12E-02***	1.36E-02
Tobinq_w	0.0436***	2.75E-14	5.22E-15	5.97E-15	1.07E-02***	1.80E-02**
Leverage_w	0.0394	-9.42E-14	3.77E-15	-2.09E-14	-2.16E-02*	5.02E-04
interRDintensity_w	0.296	1.33E-13	1.62E-14	1.10E-14	1.15E-02	-9.50E-02
Currentratio_w	-0.0202***	-4.70E-15	-6.81E-15	-1.87E-15	-6.90E-04	2.62E-04
CAPX_w	0.000210	-2.46E-14	-3.88E-15	2.28E-15	-4.20E-04	2.61E-03
ROA_w	-0.220	-2.41E-13	-3.03E-14	-4.68E-14	-3.07E-11	-5.68E-02
Lnbvota_w	0.332***	2.28E-13	8.06E-14	4.41E-14	1.89E-02	2.75E-02
constant	0.0436***	-1.81E-12	-4.22E-13	-1.56E-13	-8.57E-02***	5.77E-01***

Panel B: CSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
CSR	0.0340*	5.14E-13	1.08E-14	1.67E-14	8.83E-03***	4.34E-02

Tobinq_w	0.0588***	5.05E-13	4.41E-15	6.91E-15	1.04E-02***	6.26E-03
Leverage_w	0.059	-1.71E-13	-4.70E-15	-1.62E-14	-2.14E-02*	1.40E-03
interRDintensity_w	-0.0595	1.59E-12	1.12E-14	1.31E-14	1.40E-03	-2.33E-02
Currentratio_w	-0.0106	-4.41E-13	-4.18E-15	-1.73E-15	-1.05E-03*	7.08E-04
CAPX_w	0.00314	-4.72E-13	-4.44E-15	-1.23E-15	-1.44E-03	5.98E-05
ROA_w	-0.228	-4.97E-12	-4.00E-14	-4.27E-14	-9.19E-14	-1.41E-02
Lnbvota_w	0.285***	7.96E-12	6.02E-14	4.43E-14	2.11E-02***	1.03E-02
constant	-1.151***	-5.14E-11	-2.97E-13	-1.55E-13	-9.11E-02***	2.62E-01**

Panel C: ICSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.183***	5.30E-14	1.52E-12	9.90E-02***	5.36E-01***	7.89E-02***
Tobinq_w	0.0418***	9.79E-15	4.15E-14	4.04E-13	1.53E-04	1.43E-02***
Leverage_w	0.0384	-4.16E-14	9.17E-14	-1.36E-12	-2.70E-04	1.17E-11
interRDintensity_w	0.301	7.46E-14	2.96E-13	7.40E-13	1.77E-04	-8.78E-02
Currentratio_w	-0.0196***	-1.76E-15	-4.86E-14	-1.60E-13	-1.17E-05	5.27E-04
CAPX_w	0.000282	-1.00E-14	-2.62E-14	3.29E-13	-6.78E-06	2.91E-03
ROA_w	-0.224	-9.68E-14	-4.05E-13	-3.90E-12	-1.80E-05	-5.31E-02
Lnbvota_w	0.320***	8.65E-14	5.94E-13	3.14E-12	2.49E-04	2.12E-02**
constant	-1.384***	-6.27E-13	-3.07E-12	-5.55E-12	-1.15E-03	6.24E-01***

Panel D: ICSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.157***	9.32E-14	1.43E-13	1.54E-01***	2.08E-01***	2.81E-01***
Tobinq_w	0.0573***	1.52E-14	3.55E-15	1.19E-14	3.06E-12	1.72E-02***
Leverage_w	0.0578	-1.06E-14	3.45E-15	-3.50E-14	-5.69E-12	9.17E-03
interRDintensity_w	-0.0553	1.14E-13	2.54E-14	1.67E-15	1.20E-12	-4.16E-02
Currentratio_w	-0.0101	-5.34E-15	-4.13E-15	-4.66E-15	4.74E-15	2.24E-03
CAPX_w	0.00321	-1.34E-14	-3.62E-15	5.23E-15	5.24E-13	-2.79E-03
ROA_w	-0.231	-1.09E-13	-5.30E-14	-1.25E-13	-1.01E-11	-4.29E-02

Lnbvota_w	0.274***	1.34E-13	5.72E-14	8.34E-14	7.30E-12	3.48E-02***
constant	0.157***	-1.18E-12	-2.91E-13	-3.31E-14	-2.46E-11	-6.18E-14

Panel E: TCSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
TCSR	-0.0964***	-5.00E-12	-6.75E-14	-2.08E-02***	-4.72E-01***	-3.28E-02
Tobinq_w	0.0422***	2.35E-12	2.72E-15	4.70E-14	1.39E-02***	1.94E-02
Leverage_w	0.0538	-5.37E-12	3.25E-15	-1.41E-13	-2.58E-02*	-2.00E-03
interRDintensity_w	0.301	9.70E-12	5.19E-15	1.59E-13	1.00E-02	-9.98E-02
Currentratio_w	-0.0193**	-5.50E-13	-3.70E-15	-5.93E-15	-7.90E-04	3.45E-04
CAPX_w	0.000963	-2.24E-12	-2.02E-15	1.93E-15	-1.68E-03	3.96E-03
ROA_w	-0.212	-3.12E-11	-2.17E-14	-1.92E-13	-1.34E-13	-6.46E-02
Lnbvota_w	0.327***	2.36E-11	4.19E-14	2.56E-13	2.68E-02***	2.50E-02**
constant	-1.417***	-1.61E-10	-2.23E-13	-1.10E-12	-1.21E-01***	5.57E-01***

Panel F: TCSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
TCSR	-0.114***	-9.73E-13	-2.41E-13	-3.85E-02	-1.13E-01***	-1.21E-01***
Tobinq_w	0.0572***	2.81E-13	1.16E-14	2.19E-12	8.08E-11	2.96E-02***
Leverage_w	0.0735	8.14E-13	-1.23E-14	-4.57E-12	-1.17E-10	6.52E-03
interRDintensity_w	-0.0517	5.04E-13	2.49E-14	8.14E-12	-9.59E-12	-3.73E-02
Currentratio_w	-0.00960	-2.28E-13	-1.12E-14	-4.34E-13	3.90E-12	3.46E-03
CAPX_w	0.00408	-2.28E-13	-1.14E-14	-7.62E-13	9.28E-12	-4.12E-03
ROA_w	-0.218	-2.33E-12	-1.17E-13	-1.16E-11	-2.93E-10	-4.87E-02
Lnbvota_w	0.278***	3.57E-12	1.52E-13	1.38E-11	2.21E-10	6.00E-02***
constant	-1.131***	-2.46E-11	-7.67E-13	-5.23E-11	-6.90E-10	-1.39E-01*

Panel G: ICSR-TCSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.177***	7.06E-14	1.11E-11	1.00E-01***	1.04E-01***	7.83E-02***

TCSR	-0.0781**	-3.53E-14	-7.60E-12	-9.78E-02***	-4.79E-02***	-3.74E-02
Tobinq_w	0.0408***	1.27E-14	1.28E-13	4.96E-13	2.06E-11	1.35E-02***
Leverage_w	0.0449	-3.99E-14	8.29E-13	-1.58E-12	-1.98E-11	-1.30E-04
interRDintensity_w	0.308	1.02E-13	6.12E-13	1.33E-12	-2.92E-11	-5.04E-02
Currentratio_w	-0.0191**	-2.48E-15	-3.02E-13	-1.91E-13	-2.29E-13	2.80E-04
CAPX_w	0.000992	-1.18E-14	-6.14E-14	3.19E-13	7.39E-12	2.13E-03
ROA_w	-0.219	-1.27E-13	-2.38E-12	-4.71E-12	-1.03E-10	-4.44E-02
Lnbvota_w	0.315***	1.09E-13	2.86E-12	3.78E-12	5.87E-11	1.89E-02*
constant	-1.368***	-8.14E-13	-1.49E-11	-1.22E-11	-1.73E-10	6.12E-01***

Panel H: ICSR-TCSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.150***	1.20E-12	1.33E-13	1.18E-01***	2.06E-01***	2.9E-01***
TCSR	-0.0986***	-5.97E-13	-1.07E-13	-1.12E-01***	-2.00E-01***	-1.68E-01***
Tobinq_w	0.0561***	1.78E-13	2.56E-15	1.41E-13	2.79E-13	3.10E-02***
Leverage_w	0.0659	3.98E-13	3.20E-15	-4.56E-13	-3.81E-13	1.58E-02
interRDintensity_w	-0.0457	8.26E-13	1.18E-14	4.71E-14	1.57E-13	-5.07E-02
Currentratio_w	-0.00942	-1.61E-13	-3.73E-15	-6.02E-14	8.58E-15	3.80E-03
CAPX_w	0.00411	-1.32E-13	-2.66E-15	3.16E-14	2.54E-14	-4.91E-03
ROA_w	-0.224	-1.79E-12	-4.75E-14	-1.44E-12	-7.33E-13	-5.77E-02
Lnbvota_w	0.269***	2.38E-12	4.35E-14	9.97E-13	6.68E-13	6.50E-02***
constant	-1.089***	-1.66E-11	-2.14E-13	-1.08E-12	-2.36E-12	-1.70E-01*

Table 3. Robustness test of the effect of cash flow.

Table 5 shows the results of the relationship between CSR/ICSR/TCSR and innovation in 5 different percentiles (0.05, 0.25, 0.5, 0.75 and 0.95). intercrs is the scores of CRS, intericsr is the scores of ICSR, intertcsr is the scores of TCSR, tobinq_w is the winsorized value of Tobin's Q, leverage_w is the winsorized value of firm's leverage, interRDintensity_w is the R&D intensity, currentratio_w is the winsorized value of firm's current ratio, CAPX_w is the winsorized value of CAPX, ROA_w is the winsorized value of firm's ROA, Lnbvota_w is the winsorized value of firm's book value of total assets and lngrosscf_w is the winsorized value of firm's gross cash flow taken ln value. Industry fixed effect and time fixed effect considered in the regression. Industry effects are constructed based on the Fama-French 12-industry classification. _cons is the constant of the regression; τ is the quantile level; λ is the penalty of

the regression; AIC is the smallest value based on the model selection criteria in the software which shows the quality of the model. * p<0.1, ** p<0.05, *** p<0.01.

Panel A: CSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
CSR	0.0466**	1.66E-14	2.72E-14	1.48E-14	4.22E-03***	1.59E-02
Tobinq_w	0.0562***	1.65E-14	6.59E-15	4.97E-15	4.83E-03**	3.58E-02***
Leverage_w	-3.64	-1.18E-13	-5.75E-14	-2.27E-14	-2.69E-03	-9.31E-03
interRDintensity_w	-0.0785	2.32E-13	6.23E-14	8.48E-15	-1.68E-14	-8.09E-02
Currentratio_w	0.475	-5.14E-15	-4.52E-15	-3.76E-16	-2.46E-04	6.15E-04
CAPX_w	-0.0141	6.01E-15	1.95E-15	2.74E-15	3.96E-04	8.34E-03
ROA_w	0.0185	2.09E-13	2.37E-13	8.11E-14	1.92E-15	-9.15E-02
Lnbvota_w	0.537	3.07E-13	1.52E-13	4.47E-14	3.99E-03	4.79E-02**
lngrosscf_w	0.475***	-4.87E-14	-3.76E-14	-1.54E-14	-1.55E-03	-9.92E-03
constant	-0.136**	-1.96E-12	-7.54E-13	-1.67E-13	-1.98E-02	3.78E-01**

Panel B: CSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
CSR	0.0351*	2.41E-12	7.83E-13	2.11E-14	1.28E-02***	3.17E-02
Tobinq_w	0.0664***	1.99E-12	2.37E-13	7.74E-15	3.98E-02***	8.65E-03
Leverage_w	-3.76	-6.25E-12	-2.35E-12	-2.61E-14	-1.82E-02	5.55E-03
interRDintensity_w	-0.044	1.74E-11	2.33E-12	-9.23E-15	-2.29E-12	-8.17E-03
Currentratio_w	-0.314	-4.23E-13	-8.94E-14	-6.41E-16	-2.00E-03	2.84E-03
CAPX_w	0.00484	5.26E-13	-2.99E-14	3.84E-15	3.43E-11	4.38E-04
ROA_w	0.0409	3.49E-11	4.34E-12	1.20E-13	-1.34E-13	-8.80E-03
Lnbvota_w	0.523	3.18E-11	4.91E-12	7.22E-14	3.67E-02***	1.71E-02
Lngrosscf_w	0.395***	-6.87E-12	-1.01E-12	-2.57E-14	-1.05E-02	-3.54E-03
constant	-0.135**	-2.10E-10	-2.61E-11	-1.78E-13	-1.79E-01***	2.33E-01

Panel C: ICSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.187***	3.29E-13	2.23E-13	1.10E-01***	4.68E-01***	6.50E-02***

Tobinq_w	0.0540***	5.16E-14	3.90E-15	1.83E-12	1.86E-03	2.27E-02***
Leverage_w	-3.66	-2.37E-13	-3.12E-14	-8.04E-12	-6.24E-04	-9.28E-09
interRDintensity_w	-0.0841	8.07E-13	7.68E-14	6.07E-12	-4.33E-15	-4.10E-02
Currentratio_w	0.49	-1.16E-14	-2.98E-15	-1.02E-13	-7.62E-05	2.12E-04
CAPX_w	-0.0136	2.62E-14	3.55E-15	1.74E-12	7.70E-05	5.87E-03
ROA_w	0.0173	1.02E-12	2.06E-13	5.02E-11	-2.74E-15	-7.19E-02
Lnbvota_w	0.587	8.33E-13	1.13E-13	1.98E-11	1.37E-03	2.97E-02
Lngrosscf_w	0.469***	-1.97E-13	-3.40E-14	-8.11E-12	-5.98E-04	-6.21E-03
constant	-0.141***	-5.51E-12	-5.35E-13	-7.35E-11	-6.93E-03	4.93E-01***

Panel D: ICSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.162***	3.34E-12	1.14E-13	1.67E-01***	5.24E-01***	2.39E-01***
Tobinq_w	0.0645***	5.37E-13	1.49E-15	5.24E-14	8.66E-03***	1.79E-02*
Leverage_w	-3.79	-2.14E-12	-1.55E-14	-1.97E-13	-3.55E-03	1.32E-02
interRDintensity_w	-0.0499	7.22E-12	2.66E-14	-7.82E-14	-1.56E-12	-8.15E-03
Currentratio_w	-0.3	-1.11E-13	-7.23E-16	-5.16E-15	-4.48E-04	5.98E-03
CAPX_w	0.00519	1.73E-13	6.75E-18	4.65E-14	-2.29E-12	-3.51E-04
ROA_w	0.0398	9.02E-12	4.35E-14	9.77E-13	-1.19E-12	1.78E-12
Lnbvota_w	0.568	8.56E-12	3.71E-14	5.01E-13	7.89E-03*	3.63E-02
Lngrosscf_w	0.390***	-1.95E-12	-9.37E-15	-2.02E-13	-2.78E-03	-7.68E-03
constant	-0.139**	-5.66E-11	-1.79E-13	-1.61E-12	-3.79E-02**	1.89E-02

Panel E: TCSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
TCSR	-0.0859**	-3.62E-13	-2.84E-13	-4.94E-03***	-3.47E-01***	-1.79E-02
Tobinq_w	0.0538***	1.32E-13	1.01E-14	4.82E-15	4.24E-03**	3.21E-02***
Leverage_w	-3.59	-4.95E-13	-7.47E-14	-1.89E-14	-2.00E-03	-8.55E-03
interRDintensity_w	-0.0619	1.59E-12	1.61E-13	5.99E-15	-8.93E-14	-7.00E-02
Currentratio_w	0.477	-3.12E-14	-7.81E-15	-1.57E-16	-1.93E-04	-1.28E-03
CAPX_w	-0.013	5.16E-14	8.10E-15	1.80E-15	2.67E-04	8.01E-03
ROA_w	0.0212	1.58E-12	3.52E-13	6.76E-14	8.00E-15	-9.76E-02

Lnbvota_w	0.534	2.00E-12	2.28E-13	3.17E-14	3.22E-03	4.13E-02*
Lngrosscf_w	0.469***	-4.06E-13	-6.14E-14	-1.16E-14	-1.10E-03	-7.82E-03
constant	-0.136**	-1.31E-11	-1.13E-12	-1.31E-13	-1.69E-02	4.37E-01***

Panel F: TCSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
TCSR	-0.111***	-2.91E-13	-1.13E-13	-3.85E-02***	-4.67E-01***	-1.14E-01*
Tobinq_w	0.0635***	9.53E-14	4.21E-15	1.61E-14	5.15E-03**	2.53E-02***
Leverage_w	-3.68	-6.25E-13	-3.48E-14	-4.92E-14	-2.52E-03	1.25E-02
interRDintensity_w	-0.0274	7.67E-13	5.83E-14	3.17E-14	-9.39E-14	-1.80E-02
Currentratio_w	-0.308	1.25E-14	-2.29E-15	-6.87E-16	-2.54E-04	7.40E-03
CAPX_w	0.00599	3.53E-14	1.29E-15	4.15E-15	4.20E-12	3.16E-04
ROA_w	0.0441	7.48E-13	7.76E-14	2.01E-13	-4.39E-14	-1.73E-02
Lnbvota_w	0.526	1.56E-12	8.18E-14	1.19E-13	4.74E-03	4.35E-02
Lngrosscf_w	0.388***	-3.04E-13	-1.87E-14	-3.99E-14	-1.43E-03	-8.90E-03
constant	-0.135**	-1.10E-11	-4.00E-13	-4.48E-13	-2.32E-02*	-5.19E-02

Panel G: ICSR-TCSR-patent						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.183***	3.04E-13	3.14E-13	1.37E-01***	4.88E-01***	7.05E-02***
TCSR	-0.0699**	-1.48E-13	-2.00E-13	-7.55E-02***	-4.59E-01***	-1.61E-02
Tobinq_w	0.0525***	7.16E-14	1.24E-15	6.09E-13	4.86E-03*	1.98E-02***
Leverage_w	-3.64	-5.60E-13	-1.26E-14	-2.49E-12	-2.50E-03	1.61E-08
interRDintensity_w	-0.0775	8.22E-13	3.22E-14	2.22E-12	-2.72E-13	-3.73E-02
Currentratio_w	0.497	1.80E-14	-1.83E-15	-1.84E-14	-2.58E-04	-5.34E-04
CAPX_w	-0.0131	1.26E-14	1.93E-15	4.00E-13	6.69E-05	5.55E-03
ROA_w	0.019	5.30E-13	8.16E-14	1.40E-11	-2.61E-13	-7.05E-02
Lnbvota_w	0.593	8.92E-13	4.14E-14	5.84E-12	4.11E-03	2.60E-02
Lngrosscf_w	0.465***	-2.10E-13	-1.35E-14	-2.29E-12	-1.26E-03	-6.19E-03
constant	-0.141***	-5.53E-12	-1.96E-13	-2.30E-11	-2.05E-02	5.29E-01

Panel H: ICSR-TCSR-citation						
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
ICSR	0.155***	8.97E-13	1.20E-13	1.58E-01***	1.91E-01***	2.83E-01***
TCSR	-0.0972***	-4.04E-13	-8.34E-14	-8.59E-02***	-1.63E-01***	-1.63E-01*
Tobinq_w	0.0625***	1.48E-13	4.31E-16	1.27E-14	9.58E-11	2.05E-02**
Leverage_w	-3.73	-5.96E-13	-7.97E-15	-5.69E-14	-1.03E-10	1.26E-02
interRDintensity_w	-0.0406	2.24E-12	2.36E-14	-2.39E-14	-1.18E-10	-1.83E-02
Currentratio_w	-0.29	-3.40E-14	-7.88E-16	-6.82E-16	1.76E-12	6.49E-03
CAPX_w	0.00591	4.84E-14	4.72E-16	1.06E-14	2.04E-11	-5.69E-04
ROA_w	0.0422	2.69E-12	2.81E-14	2.99E-13	1.17E-12	9.56E-03
Lnbvota_w	0.576	2.35E-12	2.21E-14	1.31E-13	2.03E-10	4.51E-02
Lngrosscf_w	0.384***	-5.73E-13	-6.14E-15	-5.51E-14	-7.40E-11	-9.45E-03
constant	-0.140**	-1.55E-11	-1.16E-13	-4.81E-13	-7.08E-10	-1.18E-08

Table 4. The logistic regression model for the propensity scores.

Table 4 reports the parameter estimates from the logit model used to estimate the propensity scores. Industry effects are constructed based on the Fama-French 12-industry classification. Statistical significance is based on the heteroscedasticity-robust firm-clustered standard errors. The dependent variable is an indicator variable for the presence of CSR for panel A, ICSR for panel B, TCSR for panel C and both ICSR and TCSR for panel D. Panel D is the tests considering the combination effect of ICSR and TCSR on responsible variable. ***, **, and * indicate significant at the 1%, 5%, 10% levels, respectively.

Panel A: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have positive CSR scores and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	-9.43E-03	-2.36E-02
leverage_w	1.46E+00**	-3.99E-01
interRDintensity_w	-6.29E+00***	-2.43E-01
currentratio_w	6.09E-03	-5.92E-02

CAPX_w	1.19E+00	6.13E-01
ROA_w	4.90E-03	-1.04E+00
constant	-1.58E+00*	2.56E-01
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	8062	784

Panel B: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have positive ICSR scores and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	6.91E-03	-7.45E-03
leverage_w	6.48E-01	-4.98E-01
interRDintensity_w	-3.79E+00**	1.03E+00
currentratio_w	2.00E-02	-5.24E-03
CAPX_w	-1.50E+00	-4.53E-01
ROA_w	1.15E+00	-3.05E-01
constant	-9.81E-01	-5.81E-01
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	7992	854

Panel C: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have positive TCSR scores and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	-8.20E-02	5.65E-02

leverage_w	1.27E+00*	-4.10E-01
interRDintensity_w	-9.19E-01	6.89E+00
currentratio_w	9.38E-02	4.35E-02
CAPX_w	-1.63E-01	-1.13E+00
ROA_w	-9.62E-01	7.26E-02
constant	-2.24E+00**	-1.21E+00
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	8451	395

Panel D: Pre-match propensity score regression and post-match diagnostic regression

	Dependent variable: Dummy equals 1 for firms have both positive ICSR scores and positive TCSR scores and 0 for firms have both ICSR and TCSR scores smaller and equal to 0	
Variables	**Pre-match**	**Post-match**
tobinq_w	-2.75E-02	2.29E-02
leverage_w	1.31E+00	3.81E-01
interRDintensity_w	-3.48E-01	-1.38E+00
currentratio_w	6.28E-02	7.47E-02
CAPX_w	-7.71E+00	-5.05E+00
ROA_w	8.00E-01	3.16E-01
constant	-1.55E+00	-3.95E-01
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	7798	201

Table 5. Difference the maximum value of empirical cumulative density function for each observable characteristic.

Table 5 examines the difference in the maximum value of empirical cumulative density function (eCDF-Max) for each observable characteristic between all data and matched data. Panel A shows the comparisons of firm characteristics between firms with negative CSR and positive CSR scores and the eCDF-Max statistics. Pane B shows the comparisons of firm characteristics between firms with negative ICSR and positive ICSR scores and the eCDF-Max statistics. Panel C shows the comparisons of firm characteristics between firms with negative TCSR and positive TCSR scores and the eCDF-Max statistics. Panel D shows the comparisons of firm characteristics between firms with both ICSR and TCSR scores negatively and both ICSR and TCSR scores positively and the eCDF-Max statistics. Industry effects are constructed based on the Fama-French 12-industry classification.

Panel A. Difference in the eCDF-Max value for each observable characteristic of the CSR regression

Variables	eCDF-Max value for all data (N=8,062)	eCDF-Max value for matched data (N=784)	Difference
tobinq_w	0.104	0.046	0.058
leverage_w	0.068	0.034	0.033
interRDintensity_w	0.093	0.091	0.002
currentratio_w	0.090	0.043	0.047
CAPX_w	0.064	0.078	-0.014
ROA_w	0.139	0.034	0.104

Panel B. Difference in the eCDF-Max value for each observable characteristic of the ICSR regression

Variables	eCDF-Max value for all data (N=7,992)	eCDF-Max value for matched data (N=854)	Difference
tobinq_w	0.098	0.055	0.043
leverage_w	0.069	0.025	0.044
interRDintensity_w	0.112	0.056	0.056
currentratio_w	0.117	0.036	0.081
CAPX_w	0.067	0.052	0.015

ROA_w	0.136	0.059	0.078

Panel C. Difference in the eCDF-Max value for each observable characteristic of the TCSR regression

Variables	eCDF-Max value for all data (N=7,798)	eCDF-Max value for matched data (N=201)	Difference
tobinq_w	0.093	0.104	-0.011
leverage_w	0.081	0.063	0.017
interRDintensity_w	0.097	0.106	-0.009
currentratio_w	0.084	0.051	0.034
CAPX_w	0.066	0.063	0.002
ROA_w	0.133	0.066	0.067

Panel D. Difference in the eCDF-Max value for each observable characteristic of the ICSR& TCSR regression

Variables	eCDF-Max value for all data (N=7,798)	eCDF-Max value for matched data (N=201)	Difference
tobinq_w	0.167	0.080	0.088
leverage_w	0.078	0.045	0.033
interRDintensity_w	0.104	0.095	0.010
currentratio_w	0.116	0.080	0.037
CAPX_w	0.105	0.070	0.035
ROA_w	0.166	0.095	0.072

Table 6. PSM estimate result

Table 6 presents the propensity score estimate results in different quantile levels. Panel A shows the average treatment effect estimates for CSR. Panel B shows the average treatment effect estimates for

ICSR. Panel C shows the average treatment effect estimates for TCSR. Panel D shows the average treatment effect estimates for considering ICSR and TCSR at the same time. The variable fpatent and fcitation are the number of patents and the number of citations. Industry effects are constructed based on the Fama-French 12-industry classification. ***, **, and * indicate significant at the 1%, 5%, 10% levels, respectively.

Panel A: CSR-patent	
	τ= 0.75 patent
CSR	3.15E-02**
Tobinq_w	4.79E-02
Leverage_w	4.96E-01
interRDintensity_w	-7.25E-02
Currentratio_w	8.28E-02
CAPX_w	-9.08E-01
ROA_w	2.39E-01
constant	1.93E+00

Panel B: ICSR-patent/citation					
	τ= 0.5 patent	τ= 0.95 patent	τ= 0.5 citation	τ= 0.75 citation	τ= 0.95 citation
ICSR	1.11E-01***	2.86E-02*	1.13E-01***	9.15E-02***	1.48E-01**
Tobinq_w	3.78E-02	1.26E-02	2.64E-02	3.21E-02	8.13E-02
Leverage_w	-3.96E-01	1.94E-01	-5.81E-13	2.36E-01	1.20E+00
interRDintensity_w	2.12E+00	5.29E-01	7.18E-14	-1.00E+00	-1.79E-02
Currentratio_w	-7.52E-02	6.86E-03	-6.44E-02	-4.40E-02	-2.12E-02
CAPX_w	-1.05E+00	-4.27E-01	-5.80E-14	-5.28E-13	-5.99E-01
ROA_w	7.53E-02	8.66E-01	4.30E-13	-4.62E-13	5.90E-03
constant	1.64E+00	2.43E+00	1.78E+00***	2.30E+00	2.91E+00

Panel C: TCSR-patent/citation

	τ= 0.5 patent	τ= 0.5 citation	τ= 0.75 citation	τ= 0.95 citation
TCSR	4.33E-02	1.24E-01**	1.58E-01***	1.95E-01**
Tobinq_w	1.24E-01	1.47E-01	1.84E-01	1.37E-01
Leverage_w	-1.33E-01	-6.95E-01	3.43E-01	-8.26E-01
interRDintensity_w	2.43E+00	-2.74E-11	-7.05E+00	-5.26E+00
Currentratio_w	-1.64E-01	-1.17E-01	1.52E-01	7.44E-02
CAPX_w	-1.14E-10	4.27E+00	7.64E+00	4.38E+00
ROA_w	-2.45E-01	-5.30E-01	-4.98E-01	-1.58E-09
constant	1.83E+00	9.97E-01	1.59E+00	2.73E+00

Panel D: ICSR& TCSR-patent/citation

	τ= 0.5 patent	τ= 0.75 patent	τ= 0.95 patent	τ= 0.5 citation	τ= 0.75 citation	τ= 0.95 citation
ICSR	9.11E-02	7.00E-02	4.95E-02	5.53E-02	4.78E-02	7.65E-02
TCSR	8.47E-02	-4.36E-03	1.47E-02	2.47E-01	1.83E-01	1.54E-01
Tobinq_w	9.30E-02	5.18E-02	6.36E-02	1.22E-01	2.29E-03	-1.44E-01
Leverage_w	-2.02E-01	4.00E-01	1.63E+00	-3.01E-01	3.61E-12	-1.02E+00
interRDintensity_w	-1.20E+00	-2.58E+00	-4.41E+00	-1.02E-11	9.22E-12	-1.95E+00
Currentratio_w	-2.09E-01	-1.56E-01	-7.55E-02	-1.87E-01	-2.59E-01	2.34E-02
CAPX_w	3.92E+00	6.25E-10	4.20E-02	9.67E-13	5.16E-11	1.85E+00
ROA_w	6.47E-01	7.00E-01	1.57E+00	1.78E-12	1.97E-11	2.31E+00
constant	1.39E+00	2.37E+00	1.98E+00	1.18E+00	2.62E+00	2.44E+00

Essay Three: Impact of CEO educational traits on firm CSR and innovation

Abstract:

This essay focuses on the impact of CEO master business administration (MBA) degree on corporate social responsibility (CSR), CEO bachelor's awarded year on CSR, CEO MBA degree awarded year on innovation and CEO bachelor's awarded year on innovation. This research deconstructs CSR into ICSR and TCSR to reveal the relationship of different types of CSR and CEO educational related traits. Based on the sample of USA listed firms between 1991 to 2007 through quantile regression estimation, we find four significant results: CEO with MBA degree promote CSR and ICSR activities for the firms with higher CSR scores; CEO with later bachelor's degree awarded year tend to choose TCSR activities for the firms with lower TCSR scores; the earlier CEO has MBA awarded year the better for firm have a good innovation quality; and the earlier CEO has bachelor awarded year the better innovation performance for the firms with good innovation condition on both quality and quantity level. The major contribution of our study is that it provides a contribution to the existing literature by deconstructing CSR into ICSR and TCSR, enriches the study in the context of CSR and innovation from a point of view of the CEO educational traits, and introduce instrumental variable test in quantile regression in corporate finance area.

Key words: corporate social responsibility, innovation, CEO, MBA, graduation year

1. Introduction

Hambrick and Mason (1984) have claimed that organizational outcomes are partially predicted by managerial background characteristics of the top-level management team which is also called "upper echelons" theory. According to the "Upper Echelon theory" of Hambrick and Mason (1984), top executives view their situations through their own highly personalized lenses. This individualized construal of strategic situations arises because of differences among executives in their experiences, values, personalities and other human factors, so firm outcomes can be partially predicted by managerial personal characteristics. Plenty of previous studies have confirmed the basic of upper echelons theory and point out the conclusion that it is necessary to understand strategists before understand strategy (Finkelstein et al., 2009; Child, 1974; Thomas et al., 1991; Tyler and Steensma, 1998; Chaganti and Sambharya, 1987). Since it is the CEO who makes the final decision to investment innovation project and corporate social responsibility activities, his or her personal characteristics and past education may exert considerable affect corporate development.

Prior literature has studied the important influence of CEO education on CSR. CEOs with an educational background in business or economics, engineering, and natural science have no

significant impact on ESG performance. Based on German data, education has no significant effect on ESG performance, suggesting that the educational background of CEOs has little to no impact on the strategic decisions towards firms more pronounced CSR engagement. investigation of the antecedents of CSR practices needs to focus on the top managers' personality (Kutzschbach et al. 2020).

There has been a fierce debate in previous literature about the motivations of CEO on corporate social responsibility. On the one hand, the conflict resolution point posits that managers participants in CSR to mitigate the conflicts among different stakeholders. On the other hand, the agency problem view indicates that CSR takes about private benefits to managers but do not necessarily enhance shareholder's wealth (Bernea and Rubin, 2010). Based on these two main contrary logit, bulk of papers get the conclusion as following. Davidson et al (2019) find that firms led by materialistic CEOs have lower CSR scores, fewer strengths, and more weaknesses. They also find that CSR scores in firms with non-materialistic CEOs are positively associated with accounting and stock price performance. Jiraporn and Chintrakarn (2013) suggest when the CEO is relatively less powerful, an increase in CEO power leads to more CSR engagement. In contrast, as the CEO becomes substantially more powerful, he is more entrenched and no longer invests more in CSR. Yuan et al (2019) point out that more able CEOs have less career concerns so that these CEOs are more willing to undertake long-term investments in socially beneficial activities, leading to better CSR performance. Scott et al (2017) come up with that CSR has a hedging feature and more confident CEOs underestimate firm risks, which, in turn, leads them to undertake relatively less hedging. In other words, CEO confidence is negatively related to the level of CSR. What is more, this effect is stronger in the institutional aspects of CSR, such as community and workforce diversity, rather than in the technical aspects of CSR, such as corporate governance and product quality. Al-Shammari, Rasheed and Al-Shammari (2019) study the motivation from the perspective of narcissism CEO and find that narcissist CEOs are more attracted to externally oriented CSR actions. While CEO narcissism is negatively but not significantly related to internally oriented CSR actions.

CSR is viewed as a competitive strategy that is heavily dependent on executives' perceptions and decision making and of growing demand to meet stakeholders' interests (e.g., Bhardwaj et al., 2018; Price & Sun, 2017; Wood, 1991; Freeman, 1984). Wood (1991) recommended, inter alia, that an evaluation of the principles of CSR requires analysis at the individual level with an emphasis on the causes that motivate human behavior. Additionally, Velte (2019) stated that an essential factor for developing a successful CSR strategy might be the role of the CEO itself.

Given the revealed importance of the CEO education in the CSR of the organization, Villalba-Ríos et al (2021) consider that CSR should be an essential part of the education of tomorrow's leaders. They conclude that there is a CEO profile based on the basic attributes of education, CEO appointment, and legal environment that is related to the CSR performance of the organization. Additionally, it is important to hold an MBA.

The influence of CEO characteristics on firm's strategy is always one of the most prevailing topics in corporate finance. Because CEO with different background have different cognize and reflections for corporate development strategy which significant for driver future competitive advantage and productivity (Chaganti and Sambharya, 1987, Finkelstein and Hambrick, 1996). Firms in high technology industries that R&D expenditures in greater have different CEO profiles than firms in low-technology industries (Hambrick et al. 1992). For example, firms in high industries tend to employ top managers with higher educations and technical backgrounds (Hambrick et al. 1992). However, Daellenbach et al. (1999) through examined how top manager team (TMT) characteristics varied with innovation related investments in two industries concluded that higher innovation related investments have no effect for CEOs education levels. Although Daellenbach et al. have examined the association of CEO education background with different R&D spending level, there is also a number of limitations.

Prior literature has also given evidence on the important influence of CEO education background on innovation. CEOs who are willing to make greater investments in R&D due both to their educational background (Barker & Mueller, 2002; Gottesman & Morey, 2010). Given that green R&D projects are recognized as the drivers for corporate future competitiveness, highly educated CEOs are willing to increase green R&D investment for corporate productivity consideration (Lewis et al., 2014; Zhang et al., 2020). Moreover, highly educated CEOs prefer to embrace R&D spending (Barker and Mueller, 2002). Additionally, corporate innovation can be obtained via internal resources whether in terms of R&D investments or employee training (Cainelli et al. 2015). Regarding the educational background, Hambrick and Mason (1984) argued that engineering CEOs use cognitive models in decision-making that differ from other CEOs specializing in the arts or business. Zhou et al (2021) investigates whether and how the education levels of chief executive officers (CEOs) promote corporate environmental innovation based on the sample of China from 2008 to 2017. They found that enterprises with highly educated CEOs are likely to engage in environmental innovation, especially when they operate in regions with strict environmental pressures. The promotion effects of CEO education on

corporate environmental innovation are driven by corporate green research and development investment and environmental responsibility.

Innovation is widely regarded as a crucial source of competitive advantage for firms' survival and success (Crossan and Apaydin, 2010). Since it processes and outputs support firms on developing and producing services, markets, new products, and management system. Innovation is driven by CEOs on the force of their different behavior characteristics, such as proactive personality, overconfidence, quest for gaining future attention or self-directive values (Kickul and Gundry, 2002; Galasso and Simcoe, 2011; Yadav, Prabhu and Chandy, 2007; Berson, Oreg and Dvir, 2008; Zhang et al., 2017). Previous literature shows the evidence of different CEO behavior style bring different effects for firms. Overconfidence CEO who tends to take risks are positively associated with firm innovation success (Hirshleifer, Low and Teoh, 2012). Humble CEOs are subject to empower top and middle managers, prefer pay parity, use ambidextrous strategies, and deliver sustainable firm performance (Collins, 2009; Ou et al., 2014). While they may lack charisma and fail to perform in dynamic industries (Chatterjee and Hambrick, 2007; Collins, 2009). Narcissism CEOs tend to prefer dynamic strategies and extremely risky investments (Chatterjee and Hambrick, 2007). They pay more focus on social praise but less on focus on objective performance (Zhu and Chen, 2015).

Innovation is risky, unpredictable, long-term, multistage, labor intensive, and idiosyncratic, posing serious challenges to the design of incentive contracts (Holmstrom, 1989). Other CEOs personality traits as intrinsic factor also affect innovation to some extent, like sensation taking and sentiment. Zuckerman (2007) indicates that sensation seekers differ from pure risk takers since their willingness to tolerate risk stems from their desire to seek novel ideas and experience. Sensation seeking has been shown to be positively correlated with openness to experience and sensation seekers are receptive to new ideas (Roberti, 2004). Receptive to new ideas is significant for firms exploring on innovation activity.

Unlike above study, we detect effect of CEO characteristics on innovation by adopt two measurements which are the number of patent and the number of citations. Our study improves from following aspect comparing to previous paper: first, R&D spending can only capture the input of a firm to innovation but not innovation output which reflect the real innovation level of a firm. As more capital a firm invest in research and development activity does not a sign for a firm have a strong innovative capability. The number of patent and the number of citations is the direct quantitative measurement for a firm's innovation quantity and quality. Second, Daellenbach et al. does not consider the firm-level's factor which also affect the investment to

innovation related activity such as firm size, leverage and firm financial performance. Finally, Daellenbach et al. only involved two industries which obviously lack of convincible to a broadly content.

Most of the previous studies have look at the CEO education level with firm's performance and strategy through ordinary least square model, and this could be the reason for the mixed evidence regarding relationship on different CSR and innovation performance level (Kingston & Lewis, 1990; Hillman and Keim, 2001; Zhang, 2012; Jo and Harjoto, 2011, 2012). If our research show that CEO MBA degree and degree awarded year can predict an important variable like the number of patents, the number of citation and CSR scores, new evidence is added to supporting the argument that individual top executives matter in determining organization outcomes (Thomas, 1988). Therefore, it is necessary to exploring whether CEO MBA degree and degree awarded years associated with greater or lower levels of the important innovation and CSR performance.

Given the promising foundations but also the limitations of earlier research, we set out to design a study that could test our main proposition---that CEO education background will be associated with different quantile level of innovation and CSR---while avoiding the limitations of previous studies. Th section below will outline hypotheses about the association between CEO MBA background, MBA awarded year and bachelor's degree awarded year and innovation and CSR.

Researchers have studied how CSR (Sun et al., 2021), R&D spending (Barker and Mueller, 2002), firm's industry (Daellenbach et al., 1999) and corporate strategy (Baysinger and Hoskiss, 1989) is influenced by CEO characteristics to name just a few factors. Despite this extensive line of research, little has been done to study the association of CSR and innovation with degree awarded year and focus on the influence on different quantile levels.

One of the interesting features of this study is that it draws inferences about the relations between CSR and MBA, CSR and bachelor awarded year, innovation and MBA awarded year, and innovation and bachelor awarded year through quantile regression which fill the research gap that imply quantile regression in corporate finance area about the effect of CEO education background on firm's performance. The characteristics of main dependent variables show a large difference between the minimum values, the maximum values and the mean values. This large range indicates that the distributions of CSR scores, ICSR scores, TCSR scores, patent counts and citation counts are heavily skewed across firms. This suggests that the performance of firms on CSR and innovation activities can be very different for firm with low, average and high levels of

CSR and innovation activities. Most of the existing research in the literature only focused on the average level of firm performance on these activities which cannot capture the performance of each quantile level very well (Mattingly and Berman, 2006; Chen, 2020; Yang and Wang, 2021). Therefore, this is also one of the reasons for this study implying quantile regression model to answer our research questions: (i) CEO with MBA degree motivate higher CSR and ICSR scores for the firms with high CSR and ICSR scores while motivate lower TCSR scores; (ii) CEO bachelor's degree awarded year have negative impact on CSR and ICSR activities while positive impact on TCSR activities; (iii) CEO MBA awarded year have negative effect on innovation and (iv) CEO bachelor degree awarded year have negative effect on innovation.

To help establish causality and address exogenous concerns, we adopt instrumental variable (IV) approach. To alleviate the biased due to exogenous factors of CEO acquire their MBA degree or different year economic condition in different degree awarded year, we constructed percentage of peer company CEO hold MBA degree as the IV of CEO with MBA degree. To the alleviate the influence related to the economics, we constructed the GDP growth rate of the degree awarded year as the IV of graduation year. And combine the IV method with quantile regression as our robustness test which is also one of our contributions in CEO education area relating to the research method. To help address potential matching concerns, we employ propensity scores matching (PSM) approach. We give evidence about the significant estimation results in PSM model and the reasons about the non-significant estimation results though PSM. We also construct one interaction item to provide an effective channel for later MBA degree awarded year enhance the effect of MBA degree on ICSR for firms with high ICSR scores. Moreover, CEO level variables which are CEO age and gender are also controlled to all regressions based on the significant result of baseline regression.

We define 0.05 and 0.25 percentile as low level of innovation productivity and low level of CSR activity, 0.5 percentile as moderate level, and 0.75 and 0.97 as high level of innovation outputs and CSR scores. These five levels represent for three typical conditions of the entire distribution. Therefore, we can observe the effect on innovation and CSR. Consistent with our prediction, we find that (i) CEO with MBA degree motivate higher CSR and ICSR scores for the firms with high CSR and ICSR scores, (ii) the later CEO get the bachelor degree the higher firm's TCSR scores for the firms with low TCSR scores, (iii) the earlier CEO get the MBA degree the higher citation counts for the firms with a high innovation quality, and (iv) the earlier CEO get the bachelor degree the better innovation performance for the firms with high patent and citation counts. Specifically, our quantile regression estimation emphasis the effect on different percentiles of

dependent variables. Our study complements previous literature on the role of CEO education in foresting innovation and corporate responsible activity. Existing findings demonstrate that innovation and CSR are related to various CEO characteristics, such as CEO managerial skills (Chen, 2020), CEO overconfidence (Galasso, A et al., 2011; Tang et al., 2015), CEO tenure and gender (Huang, 2013). Further, our study contributes to a better understanding of how the CEO degree condition influences on different CSR type and decision making. Our work also contributes on two sides. On the one hand, this study provides more evidence on stakeholder theory, upper echelon theory, and human capital theory. On the other hand, this study rich the literature on both research method and research topic about firm long-term sustainability, CEO's education-related issues, CSR-related issues, and innovation-related issue.

The rest of the essay is organized as follow. Section 2 is literature review about CEO education characteristics and CSR or innovation and the hypothesis development. Section 3 shows the empirical results. Section 4 discuss the robustness check. Section 5 is the conclusion. Section 6 is limitation and future works.

2. Literature review and hypothesis development

2.1. Effect of CEO with MBA degree on firm CSR activities

Previous research has shown that education background is significantly important for shaping an individual's values, cognitive model, and behavioral beliefs (Frank et al., 1993). Once cognitive model becomes entrenched, it is difficult to change them (Bartunek, 1984; Reger et al., 1994). According to prior studies on corporate finance area, it is argued that the background of executives has a significant effect on corporate behavior and results (Finkelstein et al., 2009). MBA program is widely seen as the most relevant training for a management career and is also one of the most important determinants for executive promotions (Useem and Karabel, 1986). The statistics show that the majority of executives at 500 largest American companies have MBA degree (Sun et al., 2021). MBA degree provides a pragmatic, complex and applies high-level management training which addresses the needs of senior managers of business and economics management departments by combining theory with practice. The popularity of a business education in America, has made an MBA degree a signal of a good management ability, and has promoted existing executives to undertake MBA education to improve their management skills.

MBA education was first come up by the Harvard Business School and has become prevailed in major business schools around the world, and it is the most relevant formal business management training (Felicelli, 2008). The curriculum is targeting to reduces the traditional disconnection between theory and practice. This target provides a positive environment for training students' thinking and management behaviors, which can foster the students with a broader perspective on organizational strategy (Geletkanycz and Black, 2001). In addition, CSR, stakeholders' theory, and social entrepreneurship are key components of the MBA curriculum (Evans and Robertson, 2003). Moreover, at least one or two topics among ethics, sustainable development and CSR has been covered in MBA curriculum in most of the business schools in world's top 50 MBA programs, one third covering all three topics (Christensen et al., 2007).

Corporate social responsibility activity is considered as one of the key determinants of sustainability (Epstein, 2008). MBA CEOs, as vigilant observers on the institutional trends, are more responsive to the environmental trends (Finkelstein et al., 2009). They superior understand the important of CSR and tend to consider it as a strategic opportunity rather than a cost. What is more, MBA CEOs tends to see CSR as an opportunity to improve corporate's reputation and value (Hillman and Keim, 2001; Jo and Harjoto, 2011, 2012). Consequently, we suppose that MBA CEOs is more likely to participate in CSR which leading to better CSR performance. Therefore, we hypothesize:

Hypothesis 1a: CEO with an MBA degree have a positive impact on CSR activities.

Given the previous foundations, CSR activities are not inherently different but that because stake-holder recipients of CSR activities differ in critical ways, the perception of other-regarding motivations for the behaviors should also differ according to the preceding logic (Godfrey, 2009). Therefore, we set out the hypothesis about CEO MBA degree on different corporate social responsibility activity types and we involve quantile regression to illustrate the effect between response variables and interested variables.

Our study follows the CSR construction of Godfrey (2009) that differentiates CSR activities as institutional CSR (ICSR) that target secondary stakeholders and technical CSR (TCSR) that target primary stakeholders. Secondary stakeholders, like government legislation authorities or public media, lack the urgency to pursue short-term achievement so they tend to have a sustainability vision. ICSR are more likely to be viewed as voluntary acts of social beneficence and reflect the firm's moral characteristics (Godfrey, 2009). While primary stakeholders who

have direct economic exchange with the firm and their demand is likely to receive immediate attention. Therefore, TCSR tend to be seen as one of the methods for primary stakeholders to achieve their urgency demand to proving their ability. CSR activity is considered as one of the key determinants of sustainability (Epstein, 2008). Consequently, we propose that MBA CEOs are more likely to participate in ICSR while unlikely to participate in TCSR. Therefore, we hypothesize:

Hypothesis 1b: CEO with MBA degree have positive impact on ICSR activities.

Hypothesis 1c: CEO with MBA degree have negative impact on TCSR activities.

2.2. Effect of CEO bachelor's degree awarded year on firm CSR activities

Human capital theory asserts that individual skills represent an important source of economic productivity, and that those skills can be enhanced by training and education (Becker, 1964; Zhang, 2012). CEO education have been linked to superior levels of cognitive complexity, more sustained investment in a firm, and a facility to make valuable alliances (Wally and Baum, 1994; Bertrand and Schoar, 2003; Palmer and Barber, 2001). Until 1960[1], social connections and wealth of the parents of the applicants is one of the base criteria for university admission (Farnum, 1990; Hernández, 1997; Kingston & Lewis, 1990; Palmer and Barber, 2001). This admission criteria not only offer a university prestige but would attract potential donors and prominent entrants to enhance social mobility. However, in the beginning of 1960s, admission criteria became more reliant upon applicants' intelligence and achievement especially in Ivy schools (Kingston & Lewis, 1990; Zhang, 2012). It can be excepted that students admitted in undergraduate before 1960s with a different performance with the students admitted after 1960s.

It is talent and competency to be more important to performance rather than social connections in business (Miller et al., 2015). Especially for less-seasoned CEOs, may have to rely more on their natural talent as they often lack the reputation, connections, and political clout accruing to older executives (Hambrick and Fukutomi, 1991). Therefore, the latest graduated students more likely to have talent cognitive bias. If an individual overestimation of one's own talent that will be overconfidence (Lindbeck and Weibull, 2015). A leader who

[1] The first school to offer an MBA program was Harvard University in Cambridge, MA. It was established at the Harvard University Graduate School of Administration in 1908. While the literature evidence is about the situation before and after 1960 which is far later than the beginning year of the first school to offer MBA program.
The History Of The MBA - MBA Central

holds an overly confident view of their own capabilities and to abuse power for their own selfish goals, sometimes with disastrous consequences for organizations (Berger et al. 2020). Moreover, behave with irrational self-confidence in their own abilities when put in positions of immense power, with harmful results for the wider population (Owen, 2012; Owen & Davidson, 2009). Therefore, later graduated students have higher possibility with talent cognitive bias of themselves. And this bias personal characteristic may lead them pursing self-goals which may bring harmful to other wider population.

Following the CSR construction of Godfrey (2009), we classify CSR into two different types which are institutional CSR (ICSR) targeting secondary stakeholders and technical CSR (TCSR) targeting primary stakeholders. Secondary stakeholders, like government legislation authorities or public media, lack the urgency to pursue short-term achievement so they tend to have a sustainability vision. While primary stakeholders who have direct economic exchange with the firm and their demand is likely to receive immediate attention. CSR activity is considered as one of the key determinants of sustainability (Epstein, 2008). Since if both firms and communities work together towards a sustainable live hood, the community could be empowered to become an important driver of CSR practices and contributing to a better atmosphere which is a virtue circle (Amran et al., 2013). As we inferred above that later graduated students tend to have higher possibility talent cognitive bias which is also recognized as overconfidence, those students may targeting more TCSR to bring more benefits to themselves. Those egoism motivating CSR activities can not be seem as pure philanthropic and those egoism motivating activities may impede pure corporate social responsibility activities like targeting the community. Therefore, we expect that the later undergraduate degree awarded year, the lower CSR and ICSR scores. While the later undergraduate degree awarded year, the higher TCSR scores. Consequently, we hypothesize:

Hypothesis 2a: CEO bachelor's degree awarded year have negative impact on CSR activities.

Hypothesis 2b: CEO bachelor's degree awarded year have negative impact on ICSR activities.

Hypothesis 2c: CEO bachelor's degree awarded year have positive impact on TCSR activities.

2.3. Effect of CEO MBA degree awarded year and CEO bachelor's degree awarded year on innovation

2.3.1. The effect of MBA degree awarded year on innovation

There are handful of empirical studies that have examined the association of various CEO personal characteristics with innovation. CEO characteristics can systematically vary in different industries (Rajagopolan and Datta, 1996). In primary metal and semiconductor industries, CEO education level would not affect the relation of top management team and R&D spending (Daellenbach et al., 1999). However, there are seldomly study on the era of graduation.

1960s is a landmark decade for American education since a revolution in education took place in America during the 1960s. The federal government became increasingly education oriented. The government devoted to increased federal aid to education accompanying creation of new educational programs. During the 1960s, students in university-level began studying old subjects in new ways. The education started to emphasizing diversity which is one of the greatest movements to civil rights on American education history. Older university admission, until 1960, connected with more social connection and wealth of the patents of their applicants, while later admission criteria more connected with applicants' achievement and talent (Kingston & Lewis, 1990). CEOs MBA awarded year in our sample is from 1954 to 2006 which across 1960s. Since the earlier era have a different admission criterion which should admit student with different personal characteristics. We preliminary infer that CEO with an MBA awarded year before 1960s will have different performance in their further career path comparing to those with an MBA awarded year later than 1960s.

Since the later admitted criterion more rely on their talent and own capability, we believe that the student admitted later with more talent than earlier era which before the America education revolution. Therefore, we infer that those more and more talent student compared to earlier students tend to have higher possibility over rely on their talent tendency. According to prior literature, if an individual overestimation of one's own talent that will be overconfidence and the more talented the individual the less effort, he needs to spend in order to acquire a given level of precision in his information (Lindbeck and Weibull, 2015). What is more, overconfidence is stronger among highly skilled

individuals (Camerer and Lovallo 1999). MBA program is widely seen as the most relevant training for a management career and is also one of the most important determinants for executive promotions (Useem and Karabel, 1986). Moreover, MBA degree a signal of a good management ability, and has promoted existing executives to undertake MBA education to improve their management skills. Therefore, it can be inferred that more talent individuals tend to have higher possibility over use their talent which is overconfidence and this phenomenon is stronger among MBA students.

Some of the research argue that firms run by overconfident managers invest more in R&D expenditures (Roa García, 2013; Baker and Wurgler, 2013; Zavertiaeva et al., 2018). However, it is deserved to question that R&D expenditure only represent the investment in innovation relative affair but not the success of the investment. What is more, more investment does not mean high output amount and does not mean high quality output.

Conversely, other research argues that the extent of innovative activity, could play a crucial role in explaining how overconfident CEOs influence corporate financial policies (Chen et al. 2020). Moreover, overconfident CEOs tends to underestimate the probability of failure (Galasso and Simcoe, 2011). And the presence of overconfident CEOs leads to a higher risk of bankruptcy in innovative environments delaying the reaction to bad news (Leng et al. 2021). Innovative activity is a high failure activity, if the executives cannot insight the risk and evaluate the failure properly, it is dangerous for the firms especially for the firms in high innovative industry.

Since CEO with a later MBA admission year will have a later MBA degree awarded year and later admission students tend to have higher possibility of overconfidence personal characteristic. This overconfidence personal characteristic is not good for firm's innovation environment. Consequently, we propose that CEO with a later MBA awarded year does not help for innovation development. Therefore, we hypothesize:

Hypothesis 3: CEO MBA awarded year have negative effect on innovation.

2.3.2. The effect of CEO bachelor's degree awarded year on innovation

Researchers have found that executives characteristics are related to innovation broadly construed. Leader's education characteristic is the predictor of both types of innovation, technological and administrative (Kimberly and Evanisko, 1981).

Older university admission, until 1960, connected with more social connection and wealth of the patents of their applicants, while later admission criteria more connected with applicants' achievement and talent (Kingston & Lewis, 1990). Less-seasoned CEOs may have to rely more on their natural talent and education as they often lack the reputation, connections, and political clout accruing to older executives (Hambrick and Fukutomi, 1991). For CEO awarded their bachelor's degree more recent, they tend to more rely on their talent comparing to earlier awarded CEO which tend to more rely on social connections. While overestimation of one's talent is equivalent to overconfidence (Camerer and Lovallo 1999, Koellinger et al. 2007, Bolger et al. 2008). Overconfidence refers to "the tendency of individuals to overestimate their knowledge, abilities, and the precision of their information" (Bhandari and Deaves, 2006, p. 5). Moreover, overconfidence is stronger among the talented (Camerer and Lovallo, 1999). Based on prior literature that CEO over rely on their experience or talent in investment decision policy, their managerial overconfidence can potentially lead to over/underinvestment (Kouaib et al. 2016). Since overconfidence tends to result in excessive investment and risk-taking (Heller, 2014).

One the other hand, shareholders may carry out their pressure on the firm by shortening the CEOs' tenure or affecting their compensation schemes in order to bring short-term outcomes. Therefore, CEOs may believe that their future returns rely on satisfying the market's predictions and investors' pressure concerning current and future flow of profits. In order to satisfy the capital market's anticipations, the investors' pressure and to boost their well-being, CEOs would be based on their beliefs about the level of short-term earnings. Overconfident individuals are more likely to win the intra firm tournaments that lead to the rank of CEO (Goel and Thakor, 2008). Therefore, CEO which over rely on their talent and confidence and which acquire their undergraduate degree more recent are likely to inferred as short-term-driven opportunistic managers. Short-term-driven opportunistic managers are more motivated by short-term profits and they will reduce R&D expenditures which is one way short-term-oriented executives can enhance the bottom line, sacrificing the future prospects of the firm for immediate gains (Marginson and McAulay, 2008; Rappaport and Bogle, 2011; Miller and Xu, 2019). Temporarily reducing research and development expenditures can inflate earnings in the current period the fact that firms can lessen reported expenses and increase earnings. Therefore, in this study, we infer that CEO with recent undergraduate degree awarded year unlikely to participate in innovation activity.

Since R&D and innovation activities are typically associated with new technology and new products. High technology industry is defined by their high intensity in R&D spending (health care, telecommunications and technology) (Tylecote and Ramirez, 2006). We propose that the effect between CEO educational caused personal characteristics and innovation is emphasized in the firms with higher innovation productivity.

However, previous literature focus on R&D intensity when they talk about the CEO personal characteristics and firm innovation activity and they rarely study the relationship on different innovation percentiles. In this study, we fill this research gap through testing the relation between bachelor's degree awarded year on innovation on both quality and quantity level. We examine the relation on 5 different quantile level to study the relation in detail. Therefore, the pattern of arguments made about the CEO bachelor's degree awarded year led us to come up with the hypothesis as follow:

Hypothesis 4: CEO bachelor's degree awarded year have negative effect on innovation.

It can be viewed as an extension of classical least squares estimation of conditional mean models to the estimation of an ensemble of models for conditional quantile function (Koenker and Bassett, 1978).

3. Empirical results

3.1. Data

We start with the corporate social responsibility rating data obtained from the KLD database over the period from 1991 to 2007. To examine the effect of whether CEO with MBA degree on different CSR activity types, we then merge the corporate social responsibility rating data with the dataset about CEO education and employment conditions from BoardEx[2], by using company name as the unique identifier. The firm-level financial data are obtained from the Compustat, using procedures and definitions following the existing literature (Chen et al., 2020; Richard et al., 2014). For processing the missing variable of CSR/ICSR/TCSR and R&D intensity, we follow the method in the paper of Himmelberg et al., (1999) that create a dummy variable equals to 1 if the value of above three variable is not missing, and zero

[2] BoardEx is a proprietary database provided by Management Diagnostic Limited, which is a private research company specializing in collecting company social network data including a CEO's past or current employers, business relationships, organization affiliations, boards served, past universities attended, and degrees achieved.

otherwise (if the variable is missing). The final value of CSR, ICSR, TCSR and R&D intensity is calculated by created an intercept term to capture the mean of the missing values which are the three dummy variables multiply their real value. This method maintains sample size and reduce the risk of sample selection bias.

3.2. Summary statistics

3.2.1. CEO MBA degree and different CSR types

Table 1 reports the descriptive statistics for the variables used in our baseline regression models testing the relationship between CEO MBA degree and different CSR types. Our final sample consists of 4,095 firm-year observations, representing 523 unique firms and 1,050 unique CEOs between 1991 and 2007. The range of CSR score is large which is -8 to 14, indicating that there are large differences in the fulfilment level of CSR activities among different companies. For ICSR, since the value of 50% percentile and 75% percentile are zero, most of the firms have none-positive ICSR scores. While the mean value of ICSR is 0.2, larger than 0, it is indicating that only 25% firms have high ICSR scores and the distribution of ICSR scores should be right skewed. For TCSR, since the value of 25%, 50% and 75% are zero, most of the firms have none-negative TCSR scores. While the average value of TCSR is 0.139, smaller than 0, it is indicating that only smaller than 25% firms have low TCSR scores and the distribution of TCSR is left skewed.

The mean value of MBA is 0.335, indicating that about one-third of the companies whose CEO have MBA degree, which means that CEO with MBA degree is relatively common among USA listed companies. An average firm in our sample has Tobin's Q of 2.561 representing that the firms are valued well. The average firm's leverage is 0.202 indicating firm's asset financed condition that 20% of the assets are financed by creditors. The average R&D intensity ratio is 0.064 indicating that the expenditures by those firms on its research and development account for 6.4% of their sales. The average current ratio is 2.767 refers to that firms of our sample have ability to remain solvent in the short-term. The mean value of CAPX is 0.054 and the mean value of ROA ratio is 0.118 refers to a good accounting environment of the firms. The average value of natural logarithm of book value of total asset is 7.344 as the proxy of firm size. All these descriptive statistics are comparable to those reported by Godfrey (2009), Dong (2017), Fang et al. (2014), Chang (2014), Stock (2002), and Coad and Rao (2006).

3.2.2. CEO bachelor's degree awarded year and different CSR types

Table 2 reports the descriptive statistics for the variables used in our baseline quantile regression model testing the relationship of CEO bachelor's degree awarded year and different CSR types. The final sample consists of 3,336 firms-year observations, representing 451 unique firms and 779 CEOs between 1991 to 2007.

The average CEO bachelor's degree awarded date is in the summer of 1967 which could be infer the average CEO birth year is 1945. The average firm in our sample has a CSR, ICSR and TCSR score of 0.043, 0.224 and -0.151 respectively which refers that the sample firms have highest mean value on ICSR scores and CSR scores is not simply added by ICSR scores and TCSR scores. CSR, ICSR and TCSR scores equals to zero at 25, 50 and 75 percentiles indicting that at least 50% of the firms have 0 score and around 25% of the firms have higher CSR and ICSR scores while 25% of the firms have lower TCSR scores. The distribution of CSR, ICSR and TCSR is not close to a normal distribution.

The average firm has a Tobin's Q of 2.586 suggesting that firm's running condition is healthy, a leverage of 0.202 referring to firm's assets financed component, a R&D intensity of 0.063 indicating the expenditures related to their research and development activities, a current ratio of 2.75 showing a good condition about solvent ability, a CAPX of 0.054, a ROA of 0.113 indicating that around 11.3% of firm's investment converting into net income. The average value of natural logarithm of book value of total asset is 7.439 as the proxy of firm size. All these descriptive statistics are comparable to those reported by Godfrey (2009), Dong (2017), Fang et al. (2014), Chang (2014), Stock (2002), Miller et al. (2015), and Yang and Wang (2021).

3.2.3. CEO MBA degree awarded year and innovation

Table 3 reports the descriptive statistics for the variables used in our baseline quantile regression model testing the relationship of CEO MBA degree awarded year and innovation. The final sample consists of 1,043 firm-year observations, representing 208 unique firms and 253 unique CEOs between 1991 to 2006.

The number of patents is the proxy of innovation quantity which has the range of 0 to 7.085 and the number of citations is the proxy of innovation quality which has the range of 0 to 8.371. The range of citation number is slightly higher than the range of patent

number indicating that there are larger differences in the quality of innovation than the differences of the quantity of innovation. The number of patent and the number of citations has value zero at 25 and 50 percentiles and these two variables also have a large difference between the minimum and the maximum value. Therefore, only around 25% of the firms have high value of patent counts and citation counts.

The mean value of MBA awarded time is the spring of 1972, the earliest individual is awarded in year 1954 while the latest individual is awarded in 2006. An average firm in the final sample has a Tobin's Q of 2.825 indicating that firms have a healthy operating condition, a leverage of 0.192 suggesting a firm's assets financed component, a R&D intensity of 0.063 referring to firm's expenditures related to innovation activities, a current ratio of 2.403 showing that firms have enough financial resources to remain solvent, a CAPX of 0.054, a ROA of 0.13 telling the percentage of investment converting into net income, and the natural logarithm of book value of total asset of 7.626 indicating the firm's size. All these descriptive statistics are comparable to those reported by Godfrey (2009), Dong (2017), Fang et al. (2014), Chang (2014), Stock (2002), Miller et al. (2015), and Yang and Wang (2021).

3.2.4. CEO bachelor's degree awarded year and innovation

Table 4 reports the descriptive statistics for the variables used in our baseline quantile regression model testing the relationship of CEO bachelor's degree awarded year and innovation. The final sample consists of 1,043 firm-year observations, representing 446 unique firms and 758 unique CEOs between 1991 to 2006.

The minimum value of the patent count is 0, the maximum value of the patent count is 7.331 and the average patent count is 0.829 indicating that the mean quantity of firm innovation is close to the minimum value but a big different from the maximum value. Meanwhile, the minimum value of citation count is 0, the maximum value of citation count is 11.192 and the average value of citation count is 0.772 representing that the average quality of firm innovation is close to the minimum value but a big different from the maximum value. Moreover, the number of patent and the number of citation equals to zero at 25% and 50% percentiles. This means that only around 25% of the firms have higher patent counts and citation counts.

An average firm in the final sample has a Tobin's Q of 2.599 which represent a healthy running condition, a leverage of 0.202 representing the percentage of firm's asset financed by creditors accounts for the total assets, a R&D intensity of 0.067 indicating that the expenditures input, a current ratio of 2.756 indicating a good financial resource, a CAPX of 0.055 and a ROA of 0.114 showing the firm's investment condition. The average value of natural logarithm of book value of total asset is 7.44 as the proxy of firm size. All these descriptive statistics are comparable to those reported by Godfrey (2009), Dong (2017), Fang et al. (2014), Chang (2014), Stock (2002), Miller et al. (2015), and Coad and Rao (2006).

3.3. Estimation results

3.3.1. Specific models used

3.3.1.1. Dependent variable

This study adopt patent counts and citation counts as the measurement of innovation following the instruction from NBER to organize the innovation data files. The instruction offers patent citation data file Lessons, insights and methodological (Hall et al., 2001). *The NBER tools* (No. w8498). Following the paper of Hall (2005) to solve the citation truncation problem that citations to a given patent typically keep coming over long periods of time, the correction method is only observing the number of citations until the last date of the available data.

3.3.1.2. Independent variables

CSR scores in MSCI ESG STATS database (formerly known as KLD) is given in seven categories, including community, corporate governance, employee relations, environment, human rights, diversity, and product quality. Each category includes several dimensions with positive indicators and negative indicators. Each positive and negative is assigned the value of 1 if it meets the criteria. In this paper, following the literature of Godfrey (2009), Deng et al. (2013) and Chen et al. (2020), we calculate the CSR in four steps.

First, we calculate the total positive score and the total negative scores of each category. Second, we get the net score of each category by subtracting total negative

score from total positive score. Then, we aggregate the net score of each category to get the overall CSR score. Finally, the CSR score is derived by overall CSR multiply the dummy CSR variable to mitigate the missing variable problem.

ICSR and TCSR score are calculated in the same three steps but not the seven categories. ICSR scores is calculated based on community and product diversity categories while TCSR score is calculated based on corporate governance, employee relationships or product quality categories. A potential concern with using the actual degree awarded year is that individuals could delay get their degree or individuals in different discipline have different education length, resulting in endogenously determined career processing.

Control variables in our paper are Tobin's Q, firm leverage, R&D intensity, current ratio, CAPX, ROA and book value of total asset. The seven control variables above may have influence on firm's equity that may affect the expenses on innovation and CSR. Tobin's Q is the ratio of market value of total asset to the book value of total asset, firm leverage is total debt divided by the book value of asset, R&D intensity is research and development expenses over the book value of total asset, current ratio is the ratio of current asset to current liability, CAPX is often used to undertake new projects or investment by a company, ROA an indicator of firm's profitability which equals to earnings before interest, tax, depreciation, and amortization divided by the book value of total assets. Above control variables obtained from Compustat.

3.3.1.3. Model specification

Prior studies have investigated topic about CEO personal characteristics by ordinary least square (OLS) estimation (Miller and Xu, 2020; Chen et al., 2020; Sun et al., 2021; Rong et al., 2021; Ren et al., 2020; John et al., 2011). While OLS estimation can simply provide the mean response analyses various quantiles of the dataset instead of analyses various quantiles.

After drew the distribution of our main dependent variables which are CSR scores, ICSR scores, TCSR scores, the number of patent and the number of citations, we found that those variables have obviously skewed distribution. For a skewed distribution, the OLS model is not properly because it cannot depict the complete picture of relationships between variables. Therefore, we considered to involve

quantile estimation model. Quantile regression estimation is widely used in different research area, such as ecology (Cade et al., 2003) or economics (Koenker and Hallock, 2001; Chamberlain, 1994). And it is particularly useful when the conditional distribution does not have a standard shape, such as an asymmetric, fat-tailed, or truncated distribution.

By estimating a quantile regression model (QR hereafter) which allows identifying some interaction effects which cannot be revealed by standard conditional mean linear regressions which are mostly applied in previous research.

$$Q_\tau\,(y_{it}) = \beta_{\tau,0} + z_{it}\beta_{\tau,1} + x_{it}^{T}\beta_{\tau,2} + FE \qquad (1)$$

Where i represents ith observation, and t represents year. FE represents fixed effect. In this model, we control firm, industry and year fixed effects. y_i is the dependent variable defined by CSR, ICSR, TCSR, the number of patent and the number of citation; z_{it} is the ith value of the main independent variable at time t, defined by CEO MBA degree, CEO MBA degree awarded year and CEO BSc degree awarded year, and x_{it}^{T} is a vector of the ith observation of the control variables, defied by Tobin's Q which is the ratio of market value of total asset to the book value of total asset, leverage which is total debt divided by the book value of asset, R&D intensity which is research and development expenses over the book value of total asset, current ratio which is the ratio of current asset to current liability, CAPX which equals to capital expenditure divided by the book value of total asset, ROA which is earnings before interest, tax, depreciation and amortization divided by the book value of total asset, and the book value of total asset which is the natural logarithm of the book value of total asset (Chang et al., 2014). We need to estimate the coefficients $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ for a given value of quantile level τ. $Q_\tau\,(y_i)$ gives the τth quantile of y_i. If y_i is the CSR scores, z_{it} is MBA and τ=0.95, then the model allows us to examine how MBA affect CSR activities of firms with high values of CSR scores.

3.3.2. Effect of CEO with MBA degree on firm CSR activities

Panel A, panel B and panel C of Table 5 presents baseline results of the effect of CEO with MBA degree on CSR, ICSR and TCSR respectively. In each regression, we include industry and year fixed effects to account for macroeconomic shocks in a specific industry in a given year.

3.3.2.1. Effect of CEO with MBA degree on firm CSR activity

To examining H1a, the quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by CSR and $Q_\tau(y_i)$ gives the τ^{th} quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. z_{it} is the i^{th} value of CEO MBA degree which is the main independent variable at time t. x_{it}^T is a vector of the i^{th} observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.05, the model allows us to examine how MBA affect CSR activities of firms with low CSR scores.

The comparison of OLS estimation and quantile estimation is shown in panel A of Table 5. With OLS estimation, the coefficient measures the average difference between in CSR scores for CEO with an MBA degree and without an MBA degree. Firms with an MBA educated CEO have a higher CSR score on average by 0.118 than firms' CEO without an MBA degree.

While in quantile regressions, the coefficient of MBA is positive and statistically significant at 5% level only on 95% percentile, suggesting that CEO with MBA degree have a positive effect on CSR activity for firms with high scores of CSR. In terms of economic significance, the coefficient of MBA on 95% percentile indicates that firms with CEO who awarded MBA degree have a higher CSR score by 0.156 than the firms' CEO do not have MBA education background. Comparing the result of two estimation methods, CEO with MBA degree indeed have positive effect on CSR but the influence only effective for the firms with high CSR scores.

3.3.2.2. Effect of CEO with MBA degree on firm ICSR activity

To examining H1b, y_i is the dependent variable defined by ICSR and $Q_\tau(y_i)$ gives the τ^{th} quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. z_{it} is the i^{th} value of CEO MBA degree which is the main independent variable at time t. x_{it}^T is a vector of the i^{th} observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.05, the model allows us to examine how MBA affect ICSR activities of firms with low ICSR scores.

The comparison of OLS estimation and quantile estimation is shown in panel B of Table 5. In panel B, we estimate the relation between CEO with MBA degree and ICSR. With OLS estimation, CEO MBA education does not have significant effect on firm's ICSR activity. While by quantile regression, the coefficient of MBA is positive and statistically significant at 1% significance level on 95% quantile level indicating that firms with CEO who awarded MBA degree have a higher ICSR score by 0.325 than the firms' CEO do not have MBA education background. The different results between two different estimation method emphasis that OLS is not a suitable model for our sample due to the skewed distribution.

3.3.2.3. Effect of CEO with MBA degree on firm TCSR activity

To examining H1c, quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by TCSR and $Q_\tau(y_i)$ gives the τ^{th} quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. z_{it} is the i^{th} value of CEO MBA degree which is the main independent variable at time t. x_{it}^T is a vector of the i^{th} observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.05, the model allows us to examine how MBA affect CSR activities of firms with low TCSR scores.

Panel C of Table 5 shows the estimation results of the relation between CEO with MBA degree and firm TCSR scores by OLS estimation and quantile estimation, but neither of the models show obviously statistically significant evidence between these two variables.

3.3.3. Effect of CEO bachelor's degree awarded year on firm CSR activities

Table 6 presents our baseline results of quantile regression on the relation between CEO's bachelor's degree awarded year and different corporate socially responsible activity types. Firm, year, industry fixed effect is controlled and the industry effect is constructed based on the Fama-French 12-industry classification.

3.3.3.1. Effect of CEO bachelor's degree awarded year on firm CSR activity

To examining H2a, quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by CSR and $Q_\tau\ (y_i)$ gives the τ^{th} quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. z_{it} is the i^{th} value of CEO bachelor's degree awarded year which is the main independent variable at time t. x_{it}^T is a vector of the i^{th} observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.95, the model allows us to examine how CEO bachelor's degree awarded year affect CSR activities of firms with high CSR scores.

The comparison of OLS estimation and quantile estimation is shown in panel A of Table 6. With OLS estimation, CEO bachelor's degree awarded year does not have significant statistics effect on CSR in average level. While in quantile regressions, the coefficient of bachelor's degree awarded year is positive at 1% significant level on 5% percentile of the CSR distribution, while negative at 1% significant level on 95% percentile of the CSR distribution, suggesting that CEO awarded bachelor's degree in a later year tend to encourage CSR activity for the firms with low CSR score while squelch CSR activity for the firms with high CSR score. In hypothesis development session we inferred that awarded bachelor's degree in a later year bring negative effect on CSR and ICSR while positive effect on TCSR. Since later graduated CEO have higher possibility with talent cognitive bias. The baseline results not fully confirm our inference since quantile estimation model give our more information. CEO awarded bachelor's degree awarded year does not have statistically significant effect on ICSR scores. Our inference about CSR only confirmed on the firms with high CSR scores which means the firm have more CSR activity and better CSR performance. While the coefficient sign is opposite with our inference in the firms with low CSR scores which means the firm with less CSR activity and worse CSR performance. This could happen because the firm involves in less CSR activity may be less influenced by other elements which significant influence on CSR. What is more, since later bachelor's degree awarded year students tend to have overconfidence personal characteristic and pursuing speculation CSR activity which is not real benefit to the community. Therefore, the firm get low CSR scores in the evaluation.

3.3.3.2. Effect of CEO bachelor's degree awarded year on firm ICSR activity

To examining H2b, quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by ICSR and $Q_\tau(y_i)$ gives the τ[th] quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. z_{it} is the i[th] value of CEO bachelor's degree awarded year which is the main independent variable at time t. x_{it}^T is a vector of the i[th] observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.05, the model allows us to examine how CEO bachelor's degree awarded year affect ICSR activities of firms with low CSR scores.

The comparison of OLS estimation and quantile estimation is shown in panel B of Table 6. Neither OLS results nor quantile regression results show statistically significant effect of CEO's bachelor's degree awarded year on ICSR.

3.3.3.3. Effect of CEO bachelor's degree awarded year on firm TCSR activity

To examining H2c, quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by TCSR and $Q_\tau(y_i)$ gives the τ[th] quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. z_{it} is the i[th] value of CEO bachelor's degree awarded year which is the main independent variable at time t. x_{it}^T is a vector of the i[th] observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.95, the model allows us to examine how CEO bachelor's degree awarded year affect TCSR activities of firms with high TCSR scores.

The comparison of OLS estimation and quantile estimation is shown in panel C of Table 6. With OLS estimation, CEO bachelor's degree awarded year does not have any significant effect on firms' TCSR scores. However, in quantile regressions, the significant relationship shows on 5% quantile level that the firms with low TCSR score. The coefficient of bachelor's degree awarded year is positive and statistically significant at 10% significant level, suggesting that CEO awarded their bachelor's degree in a latter year have positive effect on TCSR activity. In terms of economic significance, the coefficient of BSc_year on 5% percentile of TCSR distribution indicates that one later bachelor's degree awarded year is associated with 0.00908 increase in the TCSR scores.

In summary, the results in 3.4.3 section suggest that the latter bachelor's degree awarded CEO have positive effect on CSR for the firms with low CSR score while negative effect on CSR activity for firms with high CSR scores. Second, the latter bachelor's degree awarded CEO have positive effect on TCSR activity for firms with low TCSR scores. Thirdly, OLS estimation is not properly since it can not capture the effect on whole distribution. It is a better choice to use quantile regression estimation to detect the relationship since it gives us more comprehensive information.

3.3.4. Effect of CEO MBA degree awarded year on innovation

To examining H3, quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by patent counts and citation counts. $Q_\tau\ (y_i)$ gives the τ^{th} quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. We considered lag effect of innovation which the patent counts and the citation counts is lagged compared to the invention. Therefore, the number of patent and the number of citations are forward one year to matching fundamental information. One forward year of innovation is equivalent to one lag year of the right side of the equation. Therefore, we use t-1 when discuss the time of the right side of the equation. $z_{i,t-1}$ is the i^{th} value of CEO MBA degree awarded year which is the main independent variable at time t-1. $x_{i,t-1}^{T}$ is a vector of the i^{th} observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.95 and y_i is the number of patents, the model allows us to examine how CEO MBA degree awarded year affect innovation with high patent counts.

Table 7 presents our baseline results of OLS model and quantile model on the relation between CEO MBA awarded year and firm's innovation activity. In each regression, we include firm, year and industry fixed effect to account for macroeconomic shocks and unobservable factors at the firm level in a given year. In panel A, we estimate the relation of CEO MBA awarded year and innovation quantity. Neither OLS model nor quantile model tells significant effect.

In panel B, we estimate the relation of CEO MBA awarded year and innovation quality level. In OLS model, the estimation does not show us any significant relationship. However, the quantile regression model tells us the coefficient of MBA awarded year is negative and statistically significant at 1% significance level on 95% percentile of the citation distribution. This result suggesting that CEO's MBA graduation year has a

negative effect on firm's innovation quality for the firms with a good innovation quality. In other words, the later CEO is awarded their MBA degree the worse innovation quality for the firms with a better performance on innovation quality.

3.3.5. Effect of CEO bachelor's degree awarded year on innovation

To examining H4, quantile regression mode is manifested on expression (1). y_i is the dependent variable defined by patent counts and citation counts. $Q_\tau\ (y_i)$ gives the τ^{th} quantile of y_i. τ equals to 0.05, 0.25, 0.5, 0.75 and 0.95 respectively. The number of patent and the number of citations are forward one year to matching fundamental information. This is equivalent to one lag year of the right side of the equation. Therefore, we use t-1 when discuss the time of the right side of the equation. $z_{i,t-1}$ is the i^{th} value of CEO bachelor's degree awarded year which is the main independent variable at time t-1. $x_{i,t-1}^{T}$ is a vector of the i^{th} observation of the 7 control variables. $\beta_{\tau,0}$, $\beta_{\tau,1}$ and $\beta_{\tau,2}$ are the estimation coefficients for a given value of quantile level τ. On the other words, if τ=0.95 and y_i is the number of citations, the model allows us to examine how CEO MBA degree awarded year affect innovation with high citation counts.

Table 8 presents our baseline results of OLS model and quantile model on the relation between CEO bachelor's degree awarded year and firm's innovation activity. In each regression, we include firm, year and industry fixed effect to account for macroeconomic shocks and unobservable factors at the firm level in a given year.

It is shown in panel A that CEO bachelor's degree awarded year have negative effect on the number of patents in OLS model. The coefficient in OLS mode equals to -0.012 indicating that as the value of CEO bachelor's degree awarded year increase one then the mean of the number of patents will decrease 0.012. While in quantile model, the coefficient of BSc_year is negative and statistically significant at 1% significance level on 75% and 95% quantile level of the patent distribution, suggesting that CEO's bachelor graduation year has a negative effect on innovation quantity for the firms with a better innovation performance on quantity level.

And in panel B, we estimate the relation of CEO bachelor's degree awarded year and innovation quality level. CEO bachelor's degree awarded year have negative effect on the number of citations in OLS model. The coefficient in OLS mode equals to -0.014

indicating that as the value of CEO bachelor's degree awarded year increase one then the mean of the number of citations will decrease 0.014. While in quantile model, the coefficient of BSc_year is negative and statistically significant at 1% level on 75% percentile of the patent distribution and statistically significant at 10% level on 95% quantile level, suggesting that CEO's bachelor graduation year has a negative effect on innovation quality for the firms with a better innovation performance on quality level.

The results above suggest that CEO bachelor's degree awarded year have negative influence on CEO's attitude towards innovation on both quantity and quality level for the firms with high innovation product amount and good innovation quality.

4. Robustness check

Our results so far indicate that (i) CEO with MBA degree have positive effect on CSR and ICSR for in the firms with higher CSR and ICSR scores, (ii) the earlier CEO get the bachelor degree the higher firm's CSR and TCSR scores for the firms with relative lower CSR and TCSR scores; while for firms with relative better CSR performance, the later CEO get the bachelor degree the lower of firm's CSR scores, (iii) the later CEO get the MBA degree the worse innovation quality of the firm with high innovation quality, and (iv) the later CEO get the bachelor degree the lower innovation quantity and worse innovation quality for firms with better innovation performance on both quantity and quality level. The baseline results are consistent with our hypothesis, the estimated relationship between CSR and CEO education condition, and innovation and CEO education condition could be spurious. For instance, there could always be some unobserved factors influencing both the presence of CEO education level and the firm's CSR and innovation strategy. It could also be case that the firm with better innovation performance are less likely to appoint CEO with specialist degree or the firm with better corporate socially responsible investments are more likely to appoint CEO with specialist degree.

However, this finding could be biased due to exogenous factors of CEO acquire their MBA degree or different year economic condition in different degree awarded year. We attempt to mitigate exogenous and reverse causation concerns by adopting instrumental variable approach. Our first instrumental variable is the percentage of peer company CEO hold MBA degree, whereby the influence from peer pressure or the possibility that better CSR or innovation performance firms encourage CEO to have MBA degree could be alleviated. As a source of variation in CEO's MBA degree acquiring motivation, we use the variable the percentage of CEO

with MBA degree in peer firms. This peer firm benchmarking is defined following Bizjak et al., (2011) that firm size is an indicator of organizational complexity and scope and firm size is one of the most important factors in the selection of peer groups. They use 50% and 200% of the firm size of the sample firm. The first step is to select peer firm of the sample, so we use book value of total asset as the proxy of firm size (Dang, 2018). And examine the fraction of peer firms that between 50% of the book value of total asset and 200% of the book value of total asset.

Our second instrumental variable is the GDP growth rate of the degree awarded year, whereby the influence related to the economics could be alleviated. We use the percentage because this is better to reflect on how peers give pressure to CEO on going further for an MBA degree which could capture additional heterogeneity in the CEO's career progression and personal selection. Moreover, we use GDP growth rates as the instrumental variable to measure the economic condition of the year that CEO is awarded MBA degree and bachelor's degree. On the other hand, the economic conditions in a CEO's graduated year are plausibly exogenous to their career choices, executive style or decision-making habit, because a person's education date is a largely exogenous to the individual's life. Obviously, CEO who graduated in a year with good economic condition could differ systematically from CEO who graduated in a poor economic condition. For instance, the former individual in their attitudes towards innovation or corporate socially responsible activities or the risk preference and awareness might be optimistic while the later one might be pessimistic (Schoar and Zuo, 2017; Anthony, 2019). Consider about those view, we use IV approach to make the results more convincible.

Because we used quantile regression model in our study, the conventional IV regression method is not suitable for our quantile regression model. Therefore, we need to use the instrumental variable quantile regression model proposed by Chernozhukov and Hansen (2006, 2008) for our robustness checks. In the following, we first briefly discuss the instrumental variable quantile regression model.

We also adopt PSM approach to address endogeneity concerns result from matching problem. In addition, one channel test is provided to illustrate MBA degree awarded year affect the influence of MBA degree on ICSR scores.

To mitigate the effect of CEO characteristic, we also control the variable on CEO level which are CEO age and CEO gender. Previous literature shows that CEO managerial styles explain a large part of the variation in firm capital structure, investment, compensation, and disclosure policies (Bertrand and Schoar, 2003; Bamber, Jiang, and Wang, 2010; Graham, Li, and Qiu, 2012).

Authors are unanimous that at least part of the heterogeneity in CEOs' managerial styles reflects variation in individual life and career experiences (Graham and Narasimhan, 2005; Malmendier and Tate, 2005; Malmendier, Tate, and Yan, 2011; Schoar and Zuo, 2011; Benmelech and Frydman, 2014; Lin et al., 2014; Dittmar and Duchin, 2016). CEO bachelor's and MBA degree award years affected by certain economic environment which affect CEO risk cognition. Their behaviour depends on their cognation, therefore, result in different behaviour when they need to make the decision related to CSR and innovation.

4.1. Instrumental variable in quantile regression

In conventional estimation method of quantile regression (Koenker, 2005), the quantile regression (QR) is defined by:

$$q_{y_{i,,\tau}} = D_i\alpha_\tau + x_i^T\beta_\tau \qquad (2)$$

Where D_i is the main variable of interest in the model, and x_i is the vector of the control variables. In this model, we assume that D_i is independent of the disturbance term of the model so we can use the conventional estimation to find the conditional quantile of y conditional on (D_i, x_i) in this case. However, if D_i is affected by an instrumental variable, Z, then similar to traditional linear regression, there is endogenous problem in the model and the inferences made by using model (2) will be affected.

In order to solve the concern, we need to estimate the quantile of y conditional on $(Z_i,\ x_i)$. Following the paper of Chernozhukov and Hansen (2006, 2008), we employ their method in our study to complete the instrumental variable approach in quantile regression. The instrumental variable is also called inverse quantile regression (IVQR) estimator. In our case, there is only one instrumental variable and one main variable of interest in the study.

The main idea of the method of Chernozhukov and Hansen (2006, 2008) is given below. Instead of estimating model (2), we estimate the model.

$$q_{y_{i.\tau}} = D_i\alpha_{j\tau} + x_i^T\beta_{j\tau} + Z_i\gamma_{j\tau} \qquad (3)$$

For a sequence of values of $\alpha_{j\tau}$. We denoted these values by $\alpha_{j\tau}$, where j = 1, …, J. Since for each j, the value of $\alpha_{j\tau}$ is fixed, model (3) is easy to obtain.

The final estimated coefficient of D_i i.e., $\widehat{\alpha_\tau}$ and its significance can be determined based on the asymptotic theory proposed by Chernozhukov and Hansen (2006 and 2008)

Note that all calculations can be done by using software R. For further details, please see Chernozhukov and Hansen (2006 and 2008)

If the estimated α_τ in (2) obtained by using the method of Koenker (2005) and the estimated α_τ in (3) obtained by Chernozhukov and Hansen (2006, 2008) method are consistent, then we can confirm that the results obtained from (2) using Koenker (2005) are robust.

4.2. Robustness check of IV on each baseline regression

Based on previous literature, a crucial challenge in the empirical literature in CSR study is the endogeneity bias which impede scholars from drawing causal inferences. Firms with better CSR performance may create a better environment for innovation activity, while better innovation performance firms can afford to invest more in CSR. Therefore, it is ambiguous whether the direction of causality drives from CSR to innovation or vice versa.

One of the effectiveness techniques to mitigate above endogeneity concern is the instrumental variable approach. Instrumental variable (IV) estimation address the attenuation bias resulting from mismeasured explanatory variables which would bias coefficient estimates toward zero. Because the precisely measure of CSR is difficult, there could be measurement errors. The IV approach helps alleviate the bias attributable to these possible measurement errors (Miguel, Satyanath, and Sergenti, 2004). The mechanism of IV approach is to identify a variable which is highly correlated with CSR while does not affect innovation performance expect through CSR. Since financial variables tend to be correlated, it is not easy to find a perfect instrumental variable. CSR performance of geographic peer companies and policy factors have been used as an instrumental variable in many prior studies as they fixed and more likely to be exogenous (Jiraporn et al., 2014).

We adopt instrumental variable quantile regression panel data (IV-QRPD) model to solve endogeneity and heterogeneity issues (Powell, 2016). Comparing to PSM and IV approach implement with OLS, IV-QRPD enable to reveal 'threshold effect' that the effect of CSR on innovation changes along the quantiles of the performance distribution. This approach can alleviate the endogeneity issues as well as the perturbing effects of the sample heterogeneity (Bruna et all., 2021). Methodologically speaking, instrumental variable quantile regression (IV-QR) shows higher robustness against outliers. IV-QR estimates quantile-specific effects describing the impact of covariates not only on the center but also on the tails of conditional

outcome distribution. It enables the use of instruments in the case of endogeneity (Bruna et all., 2021).

4.2.1. Robustness check for the effect of MBA degree on CSR and ICSR

Bizjak et al. (2011) show that the managerial ability is an important factor in determining firm performance and peer group is used to motivate and attract executives. If peer group is used to evaluate the attraction to retain qualified executives, then we expect the qualification of the peer group is one of the motivations for the CEOs. Specially, an MBA degree is not only an education degree for CEOs but also a good way to link more resources from their classmates resulting from the specialist characteristics of the MBA degree. Thus, CEOs could pursue an MBA degree because of the requirement of a better CSR performance corporate or pursue an MBA degree under the pressure of their peers.

On the other hand, whether peers CEO have MBA degree is largely exogenous to firm's CSR and ICSR activity. Thus, it is plausible that the percentage of CEO with MBA degree in peer firms, as an exogenous formative event, does not directly affect the CEO's decision with respect to the current firm's CSR and ICSR activity, except through the composition of CEO education situation or the variable we control for.

Table 9 compares the results of the baseline model and the instrumental variable regression model. It is worth noting that we only check the results that are significant because they are the focus of our study. Column (1) of panel A of Table 9 presents the estimated coefficient of MBA obtained from the baseline model. Column (2) of panel A of Table 9 presents the estimated coefficient of MBA obtained from the instrumental quantile regression model. It is seen that, consistent with the prediction, the estimated coefficients are positive and significant at 5% significant level on 95% quantile level of CSR distribution.

Column (1) of panel B of Table 9 presents the estimated coefficient of MBA obtained from the baseline model. Column (2) of panel B of Table 9 shows the estimated coefficient of MBA obtained from the instrumental quantile regression model. It could be seen that, consistent with the prediction, both estimated coefficients are positive at 5% significant level on 95% quantile level of ICSR distribution. For both CSR and ICSR, its coefficient remains positive at 5% significant level on 95% quantile level of the

dependent variables, which is also reassuring CEO with MBA degree motivate more CSR and ICSR activity.

4.2.2. Robustness check for the effect of bachelor's degree year on CSR and TCSR

Miller and Xu (2020) show that the socioeconomic backgrounds have impact on the beneficial or community environment of the education year. If a CEO graduated if the poor economic condition, his or her may not have an elite educational resource around the graduation year and the individual may facing the graduation issue or facing the difficulty selection for further career or education. Although the socioeconomic backgrounds of CEO graduation year do not have directly effect on the corporate socially responsible activity, it could impact CEO decision making attitude for the society or the attitude towards risk taking. What is more, the economic background is largely exogenous for the firm's TCSR activity.

We employ an instrumental variable approach to extract the exogenous component of undergraduate degree awarded year and use it to explain the influence on CSR and TCSR. Our instrumental variable GDP growth rate exploits the variation in macro-economic environment at the beginning of a CEO's career.

The results show that the relation only remain significant on TCSR on 5% quantile level of TCSR distribution, so we only report the robustness results of TCSR in Table 10.

Table 10 compares the results of the baseline model and the instrumental variable regression model in quantile regression. Column (1) of Table 10 represents the estimated coefficient of bachelor's degree awarded year obtained from the baseline regression and column (2) represents the estimated coefficient of bachelor degree awarded year obtained from the instrumental quantile regression model. Consistent with the prediction, its coefficient remains positive and statistic significant on 5% quantile level of TCSR distribution. CEO with later bachelor's degree awarded year tend to choose TCSR activities for the firms with lower TCSR scores.

4.2.3. Robustness check for the effect of MBA graduate year on innovation

Table 11 compares the results of the baseline model and the instrumental variable regression model in quantile regression. Column (1) of Table 11 presents the coefficient of MBA degree awarded year obtained from the baseline regression and column (2)

represents the estimated coefficient of MBA degree awarded year obtained from the instrumental quantile regression model. Consistent with the prediction, the coefficient remains negative and significant on 95% quantile level of citation distribution. The earlier CEO has MBA awarded year the better for firm have a good innovation quality for the firms with a high innovation quality.

4.2.4. Robustness check for the effect of undergraduate graduation year on innovation

Table 12 compares the results of the baseline model and the instrumental variable regression model in quantile regression. We only check the significant results of baseline regression because they are the focus of our study and the table only reports the significant results which is the robustness results on 95% percentile level.

Column (1) of panel A in Table 12 presents the estimated coefficient of bachelor's degree awarded year from baseline regression and column (2) presents the estimated coefficient of bachelor's degree awarded year obtained from instrumental quantile regression model. Consistent with the prediction, the coefficient is negative and statistically significant on 95% quantile level of the number of patents.

Column (1) of panel B in Table 12 presents the estimated coefficient of bachelor's degree awarded year obtained from baseline regression and column (2) of panel B presents the estimated coefficient of bachelor's degree awarded year from instrumental quantile regression model. Consistent with the prediction in baseline regression, the coefficient of the interested variable is negative and statistically significant on 95% quantile level of the citation distribution. The robustness test gives more evidence that the earlier CEO has bachelor awarded year the better innovation performance for the firms with good innovation condition on both quality and quantity level.

In summary, CEO with MBA degree have positive effect on CSR and ICSR scores for firms with high CSR and ICSR scores (95% level) since CSR and sustainability development is one of the important modules in MBA curriculum. CEOs get well educated about the perspective of devoted in real corporate social responsibility activities. Besides, CEO bachelor's degree awarded year have positive impact on TCSR scores for firms with low TCSR scores (5% level), since the later graduated students are more talent students which have higher possibility with biased cognitive of their talent. This biased attitude leads selfish choice which harmful to wider population. Therefore, they CEO with later

bachelor's degree awarded year tend to choose TCSR activities. And just because those CEO's choice does not target real CSR and feel less dependent on the firm's stakeholders (Sauerwald and Su, 2019), TCSR is also one of the types of corporate social responsibility activity, so the effect is emphasized on the firms with less TCSR activities. In addition, CEO with later MBA degree awarded year and later bachelor's degree awarded year have negative effect on innovation in high innovative firms like petroleum and natural gas, commercial machinery and computer hardware, and electric and electronic equipment. Since the later graduated students have higher possibility with talent cognitive bias which as the simple of overconfidence (Lindbeck and Weibull, 2015). The presence of overconfident CEOs leads to a higher risk of bankruptcy in innovative environments, while the impact is insignificant in non-innovative environments like agricultural services, retail' food and drink products, and transit and passenger transportation. (Leng et al. 2020). What is more, Overconfident CEOs tend to increase corporate failures in innovative industries (and high R&D firms) since 'sub-optimal decision-making' aspect of CEO overconfidence dominates rather than 'effective leadership' aspect (Leng et al. 2020). And the effective leadership of overconfident CEOs is more pronounced in firms operating in innovative industries (Hirshleifer et al. 2012). Therefore, the negative influence is emphasized on high percentile level.

4.3. The propensity scores matching method in quantile regression

4.3.1. The propensity scores matching process

Above instrumental variable approach helps the study to mitigate exogenous and reverse causation concerns. As a review, here is a brief summary for the result of IV approach: (1) CEO with MBA degree have positive effect on CSR and ICSR scores for firm with high CSR and ICSR scores (95% quantile level), since CSR and sustainability development is one of the important modules in MBA curriculum; (2) CEO bachelor's degree awarded year have positive impact on TCSR scores for firms with low TCSR scores (5% quantile level), since those CEO's choice does not target real CSR and feel less dependent on the firm's stakeholders; (3) CEO with later MBA degree awarded year and later bachelor's degree awarded year have negative effect on innovation in high innovative firms, since those CEOs tend to increase corporate failures in innovative industries. Besides, in order to address potential endogeneity concerns resulting from matching concerns, we also employ propensity score matching (PSM) approach based

on observable firm characteristics according to the significant results of IV approach which is shown in section 4.2.

Besides, to overcome potential selection biased resulting from the multi-dimensional matching problem, this chapter implement a treatment-effect methodology which is propensity score matching approach. Firstly, PSM through integrates all the covariate information into estimated treatment probabilities to create propensity scores. Secondly, the process involves this single continues covariate as the matching variable. The matching technique used in this chapter is nearest-neighbor method to ensure the firms in control group are as similar as possible to the firms in treated group ex ante (Gomes, 2019).

However, except the test on the effect of bachelor's degree awarded year on TCSR, PSM approach does not provide a significant support for the results of baseline regression. The analysis for the significant PSM result and the reasons for failure PSM test are given in details as following. For the PSM test on the effect of bachelor's degree awarded year on TCSR, we compare firms that graduate before 1960 (treatment group) and after 1960 (control group). We construct the control group using the nearest-neighbor method with propensity scores derive from a logit model where the dependent variable is a dummy variable that takes the value one for bachelor's degree awarded year earlier than 1960 according to the definition above. In the matching, each treated unit is paired with an available control unit which has the closest propensity score to it. Any remaining control units are left unmatched and excluded from further analysis. The explanatory variables used in PSM approach including the same firm characteristics which are included in the baseline regression, besides, both industry effect and the year effect are considered. We capture the maximum value of empirical cumulative density function (eCDF-Max) to ensure that the matching is in a good balance which is reflect by an eCDF-Max statistics close to zero indicates good balance (Ho et al. 2007, Stuart 2010, Austin 2011). In the last step, we estimate the treatment effect and its uncertainty in quantile regression which is the effect of bachelor's degree awarded year on TCSR at 75% quantile level.

4.3.2. The propensity scores matching results

Table 13 shows the result of PSM approach as the robust test on the effect of bachelor's degree awarded year on TCSR. Panel A of Table 13 shows the comparison of pre-match

propensity score regression and post-match diagnostic regression which verify the observations in the treatment and control groups are sufficiently indistinguishable in terms of observable characteristics. The post-match columns of panel A of Table 13 shows that there are no distinguishable trends in innovation between the two groups. Panel B of Table 13 shows the different of the maximum value of empirical cumulative density function. The maximum value of eCDF-Max of each variable for matched data is closer to zero comparing to all data which indicate a good balance. Panel C of Table 13 reports the propensity score matching estimated. The result is consistency with the result of baseline regression that CEO bachelor's degree awarded year have positive impact on TCSR scores for firms with low TCSR scores (5% quantile level).

For the reason that PSM approach does not give significant evidence in testing other hypotheses, here is our analysis. The first step in propensity score matching approach is to perform matching. Although there are different methods to complete matching and adjust matching according to treatment or other confounders, like with weighting or without weighting, the matching process always discard units. Discarding units bring concerns, since it can change the smooth of the estimation target which makes inference challenge. Therefore, the quantile estimation result may change by use after matched data. According to King and Nielsen (2019)'s argument to propensity scores matching approach that PSM matching seeks to imitate a randomized experiment instead of a block randomized experiment. But block randomized experiment yields far better precision and control against confounding. Although we can choose different form of matching, the balance is achieved only on average and the balance is not exactly exist in various combinations of variables. King and Nielsen (2019) also come up PSM paradox that the more balanced the data, or the more balanced it becomes by pruning some observations through matching, the more likely PSM will degrade inferences. If one's data are so imbalanced that making valid causal inferences from it without heavy modelling assumptions is impossible, then the paradox we identify is avoidable and PSM will reduce imbalance but then the data are not very useful for causal inference by any method. This is also one of the reasons of why our PSM approach failed even under a balanced matching condition.

On the other hand, another critique about PSM is about its statistical performance. It is argued that PSM is not precise because PSM approach can vastly underperform compared to cardinality matching, which doesn't involve a propensity score (Abadie and

Imbens, 2016; De and Zubizarreta, 2016). De and Zubizarreta (2016) indicated that PSM method relies on the theoretical properties of the propensity scores to balance the covariates while cardinality matching uses constraints to require balance, thereby ensuring balance is met in the sample. Although we do not get significant evidence from propensity scores matching approach, it does not mean our results are not reliable. Firstly, we employ instrumental variable approach to address the unobserved heterogeneity concerns and reverse causality. Secondly, the absolute perfect model is not existing and model selection usually involves trade-off among generalizability, internal validity, external validity, and precision. We will work on choosing a more suitable method in future's study.

4.4. Channel for MBA degree enhance ICSR scores

One obvious channel for an MBA degree promoting ICSR for firms with higher ICSR scores (95% quantile level) is the MBA degree awarded year. We construct an interaction item which is MBA*MBA_year and add it to our quantile regression model to detect the channel. The QR model is the same as equation (1). The independent variable is MBA, interaction item and control variables which are the same as the baseline regression. The dependent variables are CSR and ICSR respectively in two separate regressions.

Businesses are experiencing a global sustainability revolution, especially as concerns about natural environment degradation, shrinking biodiversity, and resource insufficiency keep increasing (Amatucci et al., 2013). This "Sustainability Revolution" signifies a dramatic paradigmatic shift, unlike the revolutionary changes brought on by quantum physics, this movement is introduced to universities and colleges. Edwards come up with the idea in 2005 that the generation of students demonstrates increasing levels of sensitivity to social and environmental issues which appears to be the most environmentally aware cohort ever (Edwards, 2005). With the awareness awaken, business is no longer seen as "usual" which bring education institutions a paradigmatic shift in their curriculum on MBA programme. According to the theory of Amatucci et al, paradigms are defined as the systems of thought and American businesses rely on the new sustainable business model. By shifting the emphasis of business from shareholder value to stakeholder value, these companies commit to ensuring that employees, consumers, and communities, including the environment, all benefit from their economic activity.

In other words, the later CEOs get MBA courses, the more they accept sustainable management ideas. Therefore, as the results shown in Table 14, a CEO with a later MBA degree awarded year tends to conduce ICSR activity which is real social benefits activity type and involves community stakeholders. In addition, ICSR is one of the branches of CSR activity and lower ICSR scores mean the firm involves fewer CSR types of activity or the firm involves other types of CSR activity. Thus, the effect of the MBA study of environment caring CEO on ICSR tends to appear in the firms with higher ICRS scores.

4.5. Controlling CEO level effects

The application of identity theory shows how gender is a diffuse status characteristic, which is salient in person, role, and social (group) identities, and also across social situations (Michael, 2014). CEO gender is a significant determinant of a firm's policy related to innovation (Ryan, 2017). From the perspective of gender-centered, each gender has its own unique traits. Carless (1998) argued that individual attributes such as traits, cognition, and attitudes vary according to the gender of an individual (Muzhar et al., 2023). It is suggested that female leaders tend to be more innovative in their approach to firm strategy than their male counterparts (Adams and Ferreira, 2009, Torchia et al., 2011).

The executives' gender plays an important role in a company's strategic outcome (Anderson,2003). Besides, Manner (2010) also found that a CEO's educational specialization and gender do have an impact on the firm's CSR performance. Comparing to male CEO, female CEO had significant effect on CSR. Female CEOs are more effective in securing external support and reputation and are more active regarding the CSR activities for institutional stakeholders (Lim and Chung, 2021).

Thus, CEO gender should be controlled in the study of CSR and innovation.

Age is a significant indicator of a person's experience. Some scholars argue that CEO age negatively related to innovation (Barker and Mueller 2002; Bertrand and Schoar 2003; Serfling 2014; Zhang and Sun 2017). Barker and Mueller (2002) find that R&D expenditure is greater at firms with younger CEOs. However, Hambrick and Mason (1984) indicated that older CEOs might have greater commitment to the status quo of the firm and more concerns about their own financial and career security and therefore are less willing to grasp new ideas for innovation (Yim 2013).

It is reported that CEO's age is a potential determinant of CSR (Fabrizi and Michelon, 2014). Olivier and Guillaume (2021) also indicated that CEO's age affect CSR performance by acting a moderation effect. Some scholars adopt CEO's age as a proxy for succession concerns in relation with CEO career horizon problem associated with CSR (McClelland et al., 2012; Strike et al., 2015; Olivier and Guillaume, 2021). Besides, CEO age can be proxy for CEO career stage and hence their financial decisions (Demers and Wang, 2010).

Therefore, we control CEO age in detecting the effect on CSR and innovation.

I combined the current dataset with director individual file which includes CEO age and gender. CEO age in years and the age range in our sample is 44 to 94. Based on the significant result of our baseline regression, I take age and gender into account and re-run the regression as a further robustness test. Table 15 to Table 18 present the robustness results after consider CEO age and gender. Panel A of Table 15 shows the effect of MBA degree on CSR performance. After the effects of gender and age are taken into account, CEO with MBA degree still have positive effect on CSR scores and males CEO will score 0.735 lower on CSR scores than the reference group (females) on 95% quantile level. While CEO age does not show a significant effect on CSR scores. Panel B of Table 15 shows the result of effect of CEO MBA degree on ICSR performance. CEO with MBA degree still inspire on firms ICSR scores on 95% quantile level even after the effect of CEO age and gender are taken into account. Comparing to the reference group (female CEO), male CEO bring a lower ICSR scores for 0.79.

Panel A of Table 16 shows the result of the effect of CEO bachelor's degree awarded year on CSR. The baseline regression result conveys that the later CEO graduation year the higher of firm CEO scores for firms with lower innovation quality and quantity while the earlier CEO graduation year the higher of CSR scores for firms with higher quality and quantity innovation outputs. However, after controlled CEO age and gender, neither 5% quantile level nor 95% shows a significant relationship of BSc_year on CSR. Although gender is negatively correlated with CSR scores for firms on 95% quantile level. Panel B of Table 16 presents the result of the effect of BSc-year on TCSR and it is shows that there is not significant correlation between the two variables on 5% quantile level.

Table 17 presents the effect of MBA degree awarded year on innovation quality level. Column (2) reports for the relationship on 95% quantile level and shows that the coefficient of MBA awarded year, age and gender are not significant.

Panel A of Table 18 presents the results of the effect of BSc_year on innovation quality level. Column (2) and (4) report the results for the 75% quantile level and 95% quantile level and show that there is not significant result. While the result reports that the coefficient of age is positive and highly significant, thereby indicating a positive relationship between CEO age and patent number on both 75% and 95% quantile level. However, the coefficient of gender is negative and highly significant which indicates a negative relationship between CEO gender and patent number. In other words, female CEO promote innovation quantity comparing to male CEO. Panel B of Table 18 presents the result of the effect of BSc_year on innovation quality level. The baseline regression reports that the earlier CEO bachelor's degree awarded the higher of innovation quality on 75% and 95% quantile level. However, after age and gender take into account, BSc_year does not have significant effect on the number of citations. Moreover, neither the coefficient of age nor the coefficient of gender is statistically significant.

5. Conclusion

In this chapter, we investigated how CEO's education background affects CSR and innovation activities of firms with different quantile levels of CSR and innovation. The study based on the sample of USA listed firms between 1991 to 2007 through quantile regression estimation. We innovatively introduce instrumental variable model of quantile regression in innovation, CSR and CEO education topics in corporate finance. Our results are consistent through robustness test. CEO motivation on innovation is more likely related to risk management or a reaction of their cognitive of risk, while CEO motivation on CSR result from agency problem or conflict resolution based on two main contract views. This chapter highlighting a multilevel phenomenon and contributes to corporate governance literature offering main achievements on firm's long-term sustainable development. From the methodological perspective, this chapter filling the gap of the existing literature underlying the relevant of the IV as a highly effective control lever for endogeneity and sample heterogeneity concerns in a quantile regression framework.

Previous literature about the effect of CEO education background on CSR and the effect of CEO education background on innovation seldomly study through quantile regression estimation. Therefore, the evidence is lack on whether the effect is consistent on the entire distribution of the dependent variables. There is also rarely investigation on the relation between CEO education background and CSR in different CSR types. Previous literature tends to focus on R&D

intensity when they talk about the CEO personal characteristics and firm innovation activity. There is insufficient discussion from the perspective of innovation quality and quantity and insufficient evidence on different innovation percentiles. To fill the gap, we involve quantile regression model to illustrate the relation between response variables and interested variables. Besides, we discuss the CSR activities in detail which classify CSR into institutional CSR and technical CSR activities. In addition, we investigate the relation between CEO MBA degree awarded year and bachelor's degree awarded year on innovation on both quality and quantity perspective on different quantile level of innovation. The four main research questions in this essay are following: (i) the effect of CEO MBA degree is positive on CSR and ICSR while negative on TCSR activity; (ii) the effect of CEO bachelor's degree awarded year have negative effect on CSR and ICSR while positive on TCSR activity; (iii) the effect of CEO MBA degree awarded year have negative effect on firm's innovation; (iv) the effect of CEO bachelor's degree awarded year is negative on firm's innovation activity.

We document a significant relationship between CEO MBA degree, MBA degree awarded year, bachelor's degree awarded year on CSR and innovation. First, CEO with MBA degree motivate more CSR and ICSR activities for the firms with higher CSR and ICSR scores. Since CSR activity is considered as one of the key determinants of sustainability and social entrepreneurship is one of the key components of the MBA curriculum. MBA education provides a positive environment for training students' thinking and management behaviours on business sustainable development. In addition, MBA degree awarded year provide an effective channel for MBA degree promote ICSR. Since later CEOs get MBA courses, the more they accept sustainable management ideas and this trend tends to happen on the firms with high ICSR scores (95% quantile level). Second, CEO with later bachelor's degree awarded year tend to choose TCSR activities for the firms with lower TCSR scores. Since the admission criterion changed to emphasize talent in later years, the later graduated students have higher possibility to have talent cognitive bias. This biased cognitive bring self-benefit motivation for CEOs to pursing TCSR which targeting primary stakeholder's benefits rather than around community. Third, the earlier CEO has MBA awarded year the better for firm have a good innovation quality for the firms with a high innovation quality. Fourth, the earlier CEO has bachelor awarded year the better innovation performance for the firms with good innovation condition on both quality and quantity level. Since later graduated students tend to have talent cognitive bias which is also viewed as overconfident CEOs. That characteristic is stronger in highly skilled individuals and the individuals may underestimate the probability of failure which is larger in more competitive industries (Alberto

and Timothy, 2011). These findings are robust to empirical specifications, methods of clustering, and the definitions of industry dummies.

To alleviate endogeneity and causality concern, we imply instrumental variable approaches, propensity scores matching approach in quantile regression, and control more CEO level elements. Our robustness methods are also another contribution to fill the gap of quantile regression model in robustness test which is not implied in prior studies in relative topics. On the one hand, this study provides more evidence on stakeholder theory, upper echelon theory, and human capital theory. On the other hand, this study rich the literature on both research method and research topic about firm long-term sustainability, CEO's education-related issues, CSR-related issues, and innovation-related issue.

6. Limitation and further works

This study investigates the impact mechanism of CEO education background on firm's CSR and innovation activities from the theoretically developed and empirical evidence. There are still some limitations for further exploration. First, due to the limitation of the resource of data, we only focus on the impact before 2008. However, the finance crisis in 2008 have dramatically impact on finance market and we expect to acquire more data in our further study to detect whether the effects in our study consistent after the financial crisis. Secondly, this paper only conducted one lag period to address the lag of innovation which is in general terms without considering the specific features of each firm. Given the different performance and life cycles of innovation, the number of lag periods is not the same in different firms. Without considering the specific features of each firm, will influence the results of the research and fail to provide effective advice for firms to conduct innovation. This issue should be considered in future studies. Thirdly, with the development of the economic, more and more enterprise devoted to green technology innovation especially for the firms in high innovative industry. Therefore, it is worth to considering green technology elements when study relative topics. This limitation will also be improved in our further study.

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Appendix

Figure 1: Variable definitions

Variable	Description	Source
Panel A: Main variables		
intercsr	CSR_exist* CSR scores. CSR_exist=1 if the firms have CSR scores otherwise CSR_exist=0	KLD
intericsr	ICSR_exist* ICSR scores. ICSR_exist=1 if the firm ICSR scored greater than zero on any of the positive items under the community or diversity dimensions, zero otherwise. ICSR scores= ICSR strengths-ICSR concerns	KLD
intertcsr	TCSR_exist=1 if one firm TCSR scored greater than zero on any of the positive items under the governance, employee relations, or product quality, zero otherwise. TCSR scores= TCSR strengths-TCSR concerns	KLD
MBA		BoardEx
Panel B: Firm characteristics		
Tobin's Q	= market value of total asset/ book value of total asset	Compustat
Leverage	=total debt/ book value of asset	Compustat

R&D intensity	= R&D_exist * R&D value	Compustat
Current ratio	= current asset/ current liability	Compustat
CAPX	= capital expenditure/ book value of total asset	Compustat
ROA	= earnings before interest, tax, depreciation, and amortization/ book value of total asset	Compustat
Book value of total asset	ln(Book value of total asset)	Compustat
Panel C: CEO characteristics		
IV for CEO with MBA	The proportion of the number CEO with MBA degree divided by the number of CEO with MBA degree in peer firms.	BoardEx
Panel D: economic condition		
IV for degree awarded year	GDP growth rates of the degree awarded year	The world data bank DataBank | The World Bank

Table 1. Summary statistics.

This table presents the number of observations and the mean, median, standard deviation, the value at 25%, the value at 50%, the value at 75%, minimum and maximum for each variable. The sample consists of 4,095 firm-year observations between 1991 and 2007. Variable definitions are provided in the Appendix.

Variable	N	Mean	Sd	Min	p25	p50	p75	Max
Dependent variables---CSR measures								
intercsr	4,095	0.033	1.324	-8	0	0	0	14
intericsr	4,095	0.200	0 .967	-3	-2	0	0	10
intertcsr	4,095	-0.139	0 .784	-5	0	0	0	4
Independent variable								
MBA	4,095	0.335	0 .472	0	0	0	1	1
Main controls								
tobinq_w	4,095	2.561	2.098	0.836	1.356	1.808	2.888	12.397
leverage_w	4,095	0 .202	0.172	0	0.042	0.188	0.306	0.910
interRDintensity_w	4,095	0.064	0.086	0	0.006	0.035	0 .093	0.521
currentratio_w	4,095	2.767	2.662	0.531	1.356	1.942	2.964	16.977
CAPX_w	4,095	0.054	0.040	0.002	0.026	0.044	0.070	0.244
ROA_w	4,095	0.118	0.141	-0.608	0.081	0.136	0.191	0.408
lnbot_w	4,095	7.344	1.735	2.411	6.166	7.375	8.551	12.201

Table 2. Summary statistics.

This table presents the number of observations and the mean, median, standard deviation, the value at 25%, the value at 50%, the value at 75%, minimum and maximum for each variable. The sample consists of 3,336 firm-year observations between 1991 and 2007. Variable definitions are provided in the Appendix.

Variable	N	Mean	Sd	Min	p25	p50	p75	Max
Dependent variables---CSR measures								
intercsr	3,336	0.043	1.391	-8	0	0	0	14
intericsr	3,336	0.224	1.022	-3	0	0	0	10
intertcsr	3,336	-0.151	0 .802	-5	0	0	0	4
Independent variable								
BSc_year	3,336	1967.804	8.154	1944	1962	1968	1973	1993
Main controls								
tobinq_w	3,336	2.586	2.150	0.836	1.356	1.797	2.905	12.397
leverage_w	3,336	0.202	0.169	0	0.046	0.189	0.307	0.910
interRDintensity_w	3,336	0.063	0.090	0	0.007	0.036	0 .095	0.521
currentratio_w	3,336	2.750	2.653	0.531	1.331	1.923	2.965	16.977
CAPX_w	3,336	0.054	0.040	0.002	0.027	0.044	0.070	0.244
ROA_w	3,336	0.113	0.144	-0.608	0.077	0.134	0.189	0.408
lnbot_w	3,336	7.439	1.795	2.411	6.228	7.540	8.753	12.201

Table 3. Summary statistics.

This table presents the number of observations and the mean, median, standard deviation, the value at 25%, the value at 50%, the value at 75%, minimum and maximum for each variable. The sample consists of 1,043 firm-year observations between 1991 and 2007. Variable definitions are provided in the Appendix.

Variable	N	Mean	Sd	Min	p25	p50	p75	Max
Dependent variable---Innovation measures								

fpatent	1,043	0.918	1.585	0	0	0	1.386	7.085
fcitation	1,043	0.918	1.606	0	0	0	1.609	8.371
Independent variable								
MBA_year	1,043	1973.305	8.751	1954	1967	1972	1979	2006
Main controls								
tobinq_w	1,043	2.825	2.325	0.836	1.457	1.976	3.299	12.397
leverage_w	1,043	0.192	0.164	0	0.040	0.174	0.290	0.910
interRDintensity_w	1,043	0.063	0.087	0	0.009	0.035	0 .089	0.521
currentratio_w	1,043	2.403	2.261	0.531	1.255	1.923	2.581	16.977
CAPX_w	1,043	0.054	0.038	0.002	0.027	0.046	0.072	0.244
ROA_w	1,043	0.130	0.147	-0.608	0.093	0.150	0.210	0.408
lnbot_w	1,043	7.626	1.760	2.411	6.478	7.740	8.891	12.015

Table 4. Summary statistics.

This table presents the number of observations and the mean, median, standard deviation, the value at 25%, the value at 50%, the value at 75%, minimum and maximum for each variable. The sample consists of 3,240 firm-year observations between 1991 and 2007. Variable definitions are provided in the Appendix.

Variable	N	Mean	Sd	Min	p25	p50	p75	Max
Dependent variable---innovation measures								
fpatent	3,240	0.829	1.564	0	0	0	0.693	7.331
fcitation	3,240	0.772	1.494	0	0	0	1.099	11.192
Independent variable								

BSc_year	3,240	1967.642	8.109	1944	1962	1967	1973	1993
Main controls								
tobinq_w	3,240	2.599	2.164	0.836	1.358	1.798	2.928	12.397
leverage_w	3,240	0.202	0.168	0	0.046	0.189	0.306	0.910
interRDintensity_w	3,240	0.067	0.090	0	0.007	0.035	0.095	0.521
currentratio_w	3,240	2.756	2.664	0.531	1.329	1.923	2.977	16.977
CAPX_w	3,240	0.055	0.041	0.002	0.270	0.045	0.070	0.244
ROA_w	3,240	0.114	0.144	-0.608	0.078	0.134	0.190	0.408
lnbot_w	3,240	7.440	1.802	1.965	6.229	7.545	8.763	12.398

Table 5. Baseline regression result of MBA degree and different CSR types.

This table examines the effect of MBA on different CSR activity types on different quantile level. MBA is a dummy variable that equals one if CEO have MBA degree and zero otherwise. Panel A presents the effect of MBA degree on general CSR activity, panel B presents the effect of MBA degree on ICSR activity and panel C presents the effect of MBA degree on TCSR activity. Industry effects are constructed based on the Fama-French 12-industry classification. Variable definitions are provided in the Appendix. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. CSR-MBA

	Dependent variable= CSR					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
MBA	0.118*	2.15E-02	1.88E-12	1.48E-14	1.08E-12	1.56E-01**
Tobinq_w	-0.001	-1.27E-02	-7.98E-13	2.17E-16	1.73E-13	1.67E-02
Leverage_w	0.171	2.86E-12	1.39E-11	2.07E-14	-1.17E-13	-4.84E-13
interRDintensity_w	-0.188	-4.66E-01	-6.13E-12	-7.58E-15	2.86E-13	5.30E-01***
Currentratio_w	0.002	2.16E-02	1.02E-13	7.77E-16	3.53E-14	-1.30E-02*

CAPX_w	0.397	-5.72E-02	4.07E-12	1.05E-14	4.95E-13	1.46E-01***
ROA_w	0.194	3.82E-01	1.57E-11	3.26E-14	8.77E-13	6.50E-15
lnbot_w	0.003	-2.57E-01	-1.31E-11	-1.30E-14	5.02E-13	1.68E-01***
constant	-0.181	7.87E-01	2.98E-11	3.94E-14	3.02E-13	-6.51E-01***
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. ICSR-MBA

	Dependent variable= ICSR					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
MBA	0.068	1.63E-13	5.18E-15	4.66E-13	4.09E-13	3.25E-01***
Tobinq_w	0.011	-3.07E-13	-1.08E-15	6.00E-14	6.99E-14	1.03E-01***
Leverage_w	0.092	3.05E-13	2.74E-15	-2.19E-13	-1.55E-13	-5.27E-02
interRDintensity_w	-0.065	7.78E-15	5.87E-15	7.91E-13	2.89E-13	2.25E-12
Currentratio_w	-0.002	1.85E-13	1.52E-15	4.40E-14	1.67E-14	-7.35E-03
CAPX_w	-0.008	-1.24E-12	1.25E-14	4.02E-13	1.71E-13	1.70E-01***
ROA_w	0.133	8.54E-15	2.51E-15	4.56E-13	3.84E-14	-6.19E-14
lnbot_w	0.051	-1.53E-12	-1.72E-14	-3.26E-14	1.40E-13	1.25E-01***
constant	-0.077	4.34E-12	-6.12E-14	-5.19E-13	-2.18E-13	-5.67E-01***
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel C. TCSR-MBA

	Dependent variable= TCSR					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
MBA	-0.008	-5.03E-02	-1.78E-11	-2.92E-14	4.73E-12	6.01E-11
Tobinq_w	-0.010	-1.30E-02	-7.68E-12	-2.67E-14	-2.30E-12	-2.00E-11
Leverage_w	0.077	1.18E-01*	4.61E-11	1.50E-13	1.50E-12	-5.24E-14
interRDintensity_w	0.184	-8.02E-11	-1.47E-11	-6.49E-14	-1.12E-12	9.98E-12
Currentratio_w	0.001	-3.90E-13	1.36E-13	4.44E-15	1.01E-12	-2.70E-11
CAPX_w	0.136	-1.18E-01***	-1.44E-12	-8.42E-15	-1.97E-12	1.08E-10
ROA_w	0.196	4.36E-01***	1.78E-11	9.33E-14	7.28E-12	-1.36E-10
lnbot_w	-0.046*	-1.73E-01***	-3.14E-11	-9.58E-14	1.26E-12	1.69E-10
constant	-0.021	5.31E-01***	1.22E-10	5.98E-13	9.48E-11	-5.27E-12
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 6. Baseline regression result of undergraduate degree awarded year and different CSR types.

This table examines the effect of undergraduate degree awarded year on different CSR activity types on different quantile level. BSc_year is the year that CEO acquires the undergraduate degree. Panel A presents the effect of undergraduate degree awarded year on general CSR activity, panel B presents the effect of undergraduate degree awarded year on ICSR activity and panel C presents the effect of undergraduate degree awarded year on TCSR activity. Industry effects are constructed based on the Fama-French 12-industry classification. Variable definitions are provided in the Appendix. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. CSR- BSc_year

	Dependent variable= CSR					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95

BSc_year	0.007	1.10E-02***	9.13E-14	6.53E-15	7.00E-16	-4.79E-04***
Tobinq_w	-0.003	-3.47E-03	-4.30E-13	1.68E-14	9.34E-15	4.35E-02
Leverage_w	0.075	3.23E-12	3.51E-12	1.48E-13	-6.68E-15	-6.13E-03**
interRDintensity_w	-0.191	-1.18E-01**	-6.72E-12	-1.61E-13	3.59E-15	1.66E-01***
Currentratio_w	0.007	2.61E-02***	1.12E-13	1.83E-14	1.61E-15	-2.23E-02***
CAPX_w	0.632	-7.06E-12	4.30E-12	2.12E-13	1.96E-14	7.79E-02*
ROA_w	0.386	5.32E-01	1.25E-11	8.24E-13	7.90E-14	-6.47E-15*
lnbot_w	-0.009	-3.11E-01	-1.18E-11	-2.77E-13	1.47E-14	2.88E-01***
constant	-12.930	-2.07E+01**	-1.41E-10	-1.17E-11	-1.33E-12	-1.45E-14
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. ICSR- BSc_year

	Dependent variable= ICSR					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
BSc_year	0.003	1.43E-03	-7.14E-17	6.25E-14	-4.80E-14	3.72E-03
Tobinq_w	0.013	-1.35E-02*	8.52E-16	5.34E-13	1.17E-11	1.09E-01***
Leverage_w	0.149	1.96E-11	1.53E-14	4.87E-13	-6.74E-12	-1.83E-11
interRDintensity_w	0.007	-4.00E-12	8.51E-15	3.69E-12	2.95E-11	2.64E-02
Currentratio_w	-0.004	8.16E-03**	4.70E-15	3.74E-13	3.28E-12	-9.58E-03
CAPX_w	-0.371	-3.15E-03	1.05E-14	1.30E-12	1.01E-11	1.17E-01**
ROA_w	0.325	5.25E-12	3.09E-14	5.43E-12	2.00E-11	3.34E-12
lnbot_w	0.069*	-1.16E-01***	-1.52E-14	1.01E-12	3.24E-11	2.30E-01***
constant	-6.111	-2.36E+00	-8.32E-14	-1.33E-10	-7.86E-12	-8.25E+00

Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel C. TCSR- BSc_year

	Dependent variable= TCSR					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
BSc_year	0.004	9.08E-03*	2.68E-13	3.53E-15	3.91E-15	-1.25E-11
Tobinq_w	-0.011	-3.42E-02**	-3.01E-12	-2.56E-13	-1.03E-13	-6.52E-10
Leverage_w	-0.058	6.80E-05	6.82E-12	4.30E-13	-1.90E-13	8.36E-13
interRDintensity_w	0.031	-5.10E-01***	-7.23E-12	-7.44E-13	-1.70E-13	1.36E-10
Currentratio_w	0.005	-6.85E-11	4.16E-13	7.83E-14	4.44E-14	-1.43E-09
CAPX_w	0.514	-2.52E-02	1.06E-12	2.65E-14	-3.05E-14	9.28E-10
ROA_w	0.125	1.49E-10	3.24E-12	2.53E-13	1.02E-13	-1.50E-08
lnbot_w	-0.074**	-2.84E-01***	-1.52E-11	-1.06E-12	-8.31E-14	1.48E-08
constant	-8.429	-1.68E+01*	-4.61E-10	-1.96E-14	-1.95E-12	3.95E-10
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 7. Baseline regression result of MBA degree awarded year and innovation.

This table examines the effect of MBA graduate year on innovation on different quantile level. MBA_year is the year that CEOs acquire their MBA degree. Panel A presents the effect of MBA graduate year on the number of patent, panel B presents the effect of MBA graduate year on the number of citation. Industry effects are constructed based on the Fama-French 12-industry classification. Variable definitions are provided in the Appendix. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. patent-MBA_year

	Dependent variable= patent

	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
MBA_year	0.001	-3.04E-19	-1.82E-19	-2.29E-13	-5.35E-07	-1.48E-09
Tobinq_w	0.0776***	2.14E-13	3.94E-14	2.00E-08	7.52E-02***	9.21E-02***
Leverage_w	0.134	1.63E-14	-2.51E-15	8.95E-09	-4.27E-02	-8.61E-10
interRDintensity_w	0.674	-1.68E-14	-2.15E-14	-6.11E-09	-1.26E-10	1.60E-10
Currentratio_w	-0.009	1.28E-14	6.38E-15	5.84E-09	2.44E-02	5.36E-02*
CAPX_w	-2.973*	9.76E-14	-8.06E-15	-2.37E-08	8.16E-10	5.25E-01***
ROA_w	0.817*	4.50E-14	7.56E-14	6.49E-08	4.99E-01***	4.13E-11
lnbot_w	0.405***	3.19E-13	1.15E-13	1.01E-07	3.13E-01***	9.11E-02
constant	-3.029	8.46E-15	2.51E-12	3.94E-06	8.93E+00	4.24E-12
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. citation-MBA_year

	Dependent variable= citation					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
MBA_year	-0.008	-1.76E-18	-1.81E-19	-6.56E-14	-6.50E-08	-4.02E-06***
Tobinq_w	0.085***	7.06E-13	4.86E-14	4.93E-08	9.98E-02***	3.61E-01***
Leverage_w	0.438	-2.38E-14	1.89E-14	5.13E-09	-3.38E-09	1.29E-10
interRDintensity_w	-1.605	-2.92E-14	-3.39E-14	-8.35E-09	-6.22E-10	3.07E-11
Currentratio_w	-0.028	6.06E-13	1.05E-14	9.38E-09	2.82E-02	-6.73E-02***
CAPX_w	-2.888	9.23E-13	-1.85E-14	-3.54E-08	5.74E-03	7.29E-10
ROA_w	0.802	2.26E-13	1.16E-13	1.95E-07	9.21E-09	1.95E-10
lnbot_w	0.278***	1.64E-12	1.89E-13	1.78E-07	3.07E-01***	3.40E-01***

constant	15.410	3.74E-12	2.01E-12	1.80E-07	1.49E-08	7.93E+01***
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 8. Baseline regression result of bachelor's degree awarded year and innovation.

This table examines the effect of undergraduate graduation year on innovation on different quantile level. BSc_year is the year that CEOs acquire their undergraduate degree. Panel A presents the effect of undergraduate graduation year on the number of patent, panel B presents the effect of undergraduate graduation year on the number of citation. Industry effects are constructed based on the Fama-French 12-industry classification. Variable definitions are provided in the Appendix. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. patent-BSc_year

	Dependent variable= patent					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
BSc_year	-0.012***	-1.10E-15	-5.68E-15	-2.18E-15	-7.38E-03***	-1.52E-02***
Tobinq_w	0.051***	3.91E-14	3.87E-14	1.43E-13	8.78E-02***	5.14E-02***
Leverage_w	0.246	-1.51E-14	-7.29E-14	-2.10E-13	-1.73E-01*	-4.56E-01***
interRDintensity_w	0.556	8.10E-15	4.00E-14	3.92E-13	6.23E-01***	2.30E+00***
Currentratio_w	-0.023**	1.48E-14	-6.52E-16	-1.65E-15	-4.78E-04	1.32E-02
CAPX_w	-1.020	4.61E-15	-2.10E-14	-1.17E-13	-2.07E-02	2.84E-01***
ROA_w	0.338	1.41E-14	6.76E-14	1.09E-13	7.34E-12	-2.99E-12
lnbot_w	0.373***	1.57E-13	1.64E-13	6.42E-13	3.09E-01***	4.19E-01***
constant	22.910***	2.18E-16	9.79E-12	9.27E-13	1.30E+01***	2.84E+01***
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B. citation- BSc_year

	Dependent variable= citation					
	OLS	τ= 0.05	τ= 0.25	τ= 0.5	τ= 0.75	τ= 0.95
BSc_year	-0.014***	-7.15E-16	-1.64E-14	-1.17E-15	-6.11E-04***	-1.67E-02*
Tobinq_w	0.063***	1.57E-14	1.13E-13	3.23E-14	7.04E-02***	2.52E-01***
Leverage_w	0.176	-1.63E-14	-2.18E-13	-5.52E-14	-1.96E-01***	-2.54E-02
interRDintensity_w	0.074	5.22E-16	1.08E-13	8.35E-14	4.48E-01***	4.30E-11
Currentratio_w	-0.018	1.39E-14	-1.09E-15	-1.66E-16	-6.37E-03	-1.18E-02
CAPX_w	-0.437	2.14E-15	-6.21E-14	-2.42E-14	-4.81E-02*	-9.54E-13
ROA_w	0.0367	3.47E-14	1.84E-13	1.98E-14	7.14E-12	-3.73E-01***
lnbot_w	0.326***	9.12E-14	4.82E-13	1.41E-13	2.89E-01***	5.02E-01***
constant	26.940***	3.77E-15	2.83E-11	1.56E-12	1.17E-12	3.14E+01*
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 9. Instrumental variable approach in quantile regression.

This table presents estimates of instrumental variable method using quantile regression. The dependent variable in panel A is CSR and the dependent variable in panel B is ICSR. Following Bizjak et al. (2011), we identify peer's MBA degree holding situation, based on the BoardEx database. The instrumental variable is then defined as the percentage of CEO's MBA degree in peer firms. The other control variables are the same as table 5. For the sake of brevity, we report only the coefficient of the main variable of interest. Industry and year effects are included. Industry effects are constructed based on Fama-French 12-industry classification. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. CSR-MBA

	Dependent variable= CSR	
Variables	(1)	(2)
	τ= 0.95	τ= 0.95
MBA	0.156**	0.316**
Controls	Yes	Yes

Industry effects	Yes	Yes
Year effects	Yes	Yes
N	4080	4080

Panel B. ICSR-MBA

	Dependent variable= ICSR	
Variables	(1)	(2)
	τ= 0.95	τ= 0.95
MBA	0.325***	0.833**
Controls	Yes	Yes
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	4080	4080

Table 10. Instrumental variable approach in quantile regression.

This table presents estimates of instrumental variable method using quantile regression. The dependent variable is TCSR. The instrumental variable is then defined as the GDP growth rates of the awarded year. The other control variables are the same as table 6. For the sake of brevity, we report only the coefficient of the main variable of interest. Industry and year effects are included. Industry effects are constructed based on Fama-French 12-industry classification. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: TCSR- BSc_year

	Dependent variable= TCSR	
Variables	(1)	(2)
	τ= 0.05	τ= 0.05
BSc_year	9.08E-03*	0.684**
Controls	Yes	Yes
Industry effects	Yes	Yes
Year effects	Yes	Yes

N	3,364	3,364

Table 11. Instrumental variable approach in quantile regression.

This table presents estimates of instrumental variable method using quantile regression. The dependent variable is fcitation. The instrumental variable is then defined as the GDP growth rates of the awarded year. The other control variables are the same as table 7. For the sake of brevity, we report only the coefficient of the main variable of interest. Industry effects are constructed based on Fama-French 12-industry classification. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Citation-MBA_year		
	Dependent variable= fcitation	
Variables	(1)	(2)
	τ= 0.95	τ= 0.95
MBA_year	-4.02E-06***	-1.000**
Controls	Yes	Yes
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	1,043	1,043

Table 12: Instrumental variable approach in quantile regression.

This table presents estimates of instrumental variable method using quantile regression. The dependent variable is CSR. The instrumental variable is then defined as the GDP growth rates of the awarded year. The other control variables are the same as table 7. For the sake of brevity, we report only the coefficient of the main variable of interest. Industry and year effects are included. Industry effects are constructed based on Fama-French 12-industry classification. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Patent- BSc_year		
	Dependent variable= fpatent	
Variables	(1)	(2)
	τ= 0.95	τ= 0.95
BSc_year	-1.52E-02***	-1.000**

Controls	Yes	Yes
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	3,240	3,240

Panel B. Citation- BSc_year		
	Dependent variable= fcitation	
Variables	(1)	(2)
	τ= 0.95	τ= 0.95
BSc_year	-1.67E-02*	-0.158**
Controls	Yes	Yes
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	3,240	3,240

Table 13. Propensity scores matching in quantile regression.

Panel A reports the parameter estimates from the logit model used to estimate the propensity scores. The dependent variable is an indicator variable for BSc degree awarded year. Panel B shows the difference the maximum value of empirical cumulative density function (eCDF-Max) for each observable characteristic between all data and matched data. Panel C presents the propensity score estimate results in different quantile levels. It shows the average treatment effect estimates for BSc_year which is the bachelor's degree awarded year. Industry effects are constructed based on the Fama-French 12-industry classification. Statistical significance is based on the heteroscedasticity-robust firm-clustered standard errors. ***, **, and * indicate significant at the 1%, 5%, 10% levels, respectively.

Panel A: Pre-match propensity score regression and post-match diagnostic regression		
	Dependent variable: Dummy equals 1 for BSc degree awarded year earlier than or in 1960 and 0 otherwise	
Variables	**Pre-match**	**Post-match**
tobinq_w	-1.48E-01***	-6.39E-02
leverage_w	-4.65E-01	3.90E-01

interRDintensity_w	-4.22E-01	1.47E+00
currentratio_w	1.81E-03	6.69E-02*
CAPX_w	6.02E+00***	2.27E-02
ROA_w	2.21E+00***	8.46E-01
Lnbvota_w	-1.70E-01	-1.54E+00**
constant	-2.24E+00	-3.53E-01
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	2722	614

Panel B. Difference in the means for each observable characteristic of the TCSR-BSc_year regression

Variables	eCDF-Max value for all data (N=2,722)	eCDF-Max value for matched data (N=614)	Difference
tobinq_w	0.058	0.025	0.033
leverage_w	0.042	0.019	0.023
interRDintensity_w	0.094	0.040	0.054
currentratio_w	0.061	0.020	0.041
CAPX_w	0.127	0.024	0.103
ROA_w	0.0945	0.015	0.080
Lnbvota_w	0.076	0.024	0.052

Panel C: TCSR-BSc_year

	τ= 0.75
	TCSR
BSc_year	3.41E-02***

Tobinq_w	-8.02E-02**
Leverage_w	-8.22E-13
interRDintensity_w	-1.95E-13
Currentratio_w	9.90E-03
CAPX_w	-2.15E-13
ROA_w	3.99E-14
Lnbvota_w	-2.69E-01***
constant	-6.63E+01

Table 14. Channel for MBA degree affect ICSR

Pre-match propensity score regression and post-match diagnostic regression		
Variables	**CSR**	**ICSR**
MBA	5.00E-13	9.20E-03
Interaction term	-1.70E-16	5.49E-05*
tobinq_w	2.07E-14	1.26E-02
leverage_w	6.92E-13	1.42E-11
interRDintensity_w	-2.69E-12	1.51E-01
currentratio_w	-5.77E-14	-2.67E-03
CAPX_w	2.30E-13	-9.55E-02
ROA_w	2.95E-13	1.09E+05
Lnbvota_w	4.27E-12	4.87E-13
constant	4.70E-10	-4.06E-01
Industry effects	Yes	Yes
Year effects	Yes	Yes
N	4095	4095

Table 15. Controlling CEO age and gender for the effect of MBA on CSRs

Panel A. CSR-MBA		
	Dependent variable= CSR	
	(1)	(2)
	τ= 0.95	τ= 0.95
MBA	1.56E-01**	1.54E-01**
Tobinq_w	1.67E-02	5.03E-02
Leverage_w	-4.84E-13	-7.57E-14
interRDintensity_w	5.30E-01***	3.90E-01***
Currentratio_w	-1.30E-02*	-2.13E-02**
CAPX_w	1.46E-01***	-2.64E-14
ROA_w	6.50E-15	5.22E-15
lnbot_w	1.68E-01***	3.29E-01***
Age_w		-2.38E-03
Gender_w		-7.35E-01***
constant	-6.51E-01***	-2.66E-01
Industry FE	Yes	Yes
Year FE	Yes	Yes

Panel B. ICSR-MBA		
	Dependent variable= ICSR	
	(1)	(2)
	τ= 0.95	τ= 0.95
MBA	3.25E-01***	3.70E-01***
Tobinq_w	1.03E-01***	1.06E-01***
Leverage_w	-5.27E-02	-5.65E-02
interRDintensity_w	2.25E-12	3.06E-13

Currentratio_w	-7.35E-03	-1.39E-02**
CAPX_w	1.70E-01***	3.79E-14
ROA_w	-6.19E-14	2.40E-15
lnbot_w	1.25E-01***	3.22E-01***
Age_w		-2.76E-03
Gender_w		-7.90E-01***
constant	-5.67E-01***	-2.79E-01
Industry FE	Yes	Yes
Year FE	Yes	Yes

Table 16. Controlling CEO age and gender for the effect of BSc-year on CSRs

Panel A. CSR-BSc_year

	Dependent variable= CSR			
	(1)	(2)	(3)	(4)
	τ= 0.05	τ= 0.05	τ= 0.95	τ= 0.95
BSc_year	1.10E-02***	1.37E-02	-4.79E-04***	-2.69E-05
Tobinq_w	-3.47E-03	-6.79E-03	4.35E-02	4.97E-02*
Leverage_w	3.23E-12	2.09E-13	-6.13E-03**	-3.43E-12
interRDintensity_w	-1.18E-01**	-7.01E-02	1.66E-01***	1.94E-11
Currentratio_w	2.61E-02***	2.58E-02***	-2.23E-02***	-2.86E-02***
CAPX_w	-7.06E-12	5.47E-01***	7.79E-02*	-9.60E-13
ROA_w	5.32E-01	1.09E-14	-6.47E-15*	1.03E-13
lnbot_w	-3.11E-01	-3.20E-01***	2.88E-01***	3.58E-01***
Age_w		3.23E-03		-2.23E-03
Gender_w		-3.56E-02		-8.91E-01***
constant	-2.07E+01**	-2.63E+01	-1.45E-14	9.90E-14
Industry FE	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes

Panel B. TCSR- BSc_year		
	Dependent variable= TCSR	
	(1)	(2)
	τ= 0.05	τ= 0.05
BSc_year	9.08E-03*	-3.83E-03
Tobinq_w	-3.42E-02**	-3.44E-02**
Leverage_w	6.80E-05	1.82E-12
interRDintensity_w	-5.10E-01***	-3.82E-01***
Currentratio_w	-6.85E-11	2.07E-13
CAPX_w	-2.52E-02	1.13E-12
ROA_w	1.49E-10	2.50E-14
lnbot_w	-2.84E-01***	-3.00E-01***
Age_w		-1.77E-02
Gender_w		-3.03E-13
constant	-1.68E+01*	-2.79E-01
Industry FE	Yes	Yes
Year FE	Yes	Yes

Table 17. Controlling CEO age and gender for the effect of innovation on MBA-year

citation-MBA_year		
	Dependent variable= citation	
	(1)	(2)
	τ= 0.95	τ= 0.95
MBA _year	-4.02E-06***	-2.02E-02

Tobinq_w	3.61E-01***	3.83E-01***
Leverage_w	1.29E-10	2.45E-11
interRDintensity_w	3.07E-11	1.77E-11
Currentratio_w	-6.73E-02***	-4.05E-02
CAPX_w	7.29E-10	2.96E-02
ROA_w	1.95E-10	6.17E-11
lnbot_w	3.40E-01***	2.74E-01***
Age_w		4.02E-02
Gender_w		8.49E-11
constant	7.93E+01***	3.72E+01
Industry FE	Yes	Yes
Year FE	Yes	Yes

Table 18. Controlling CEO age and gender for the effect of innovation on BSc-year

Panel A. patent-BSc_year

	Dependent variable= patent			
	(1)	(2)	(3)	(4)
	τ= 0.75	τ= 0.75	τ= 0.95	τ= 0.95
BSc_year	-7.38E-03***	8.96E-03	-1.52E-02***	1.98E-02
Tobinq_w	8.78E-02***	8.90E-02***	5.14E-02***	5.96E-02***
Leverage_w	-1.73E-01*	-2.48E-01***	-4.56E-01***	-5.11E-01***
interRDintensity_w	6.23E-01***	3.24E-01***	2.30E+00***	2.39E+00***
Currentratio_w	-4.78E-04	1.57E-03	1.32E-02	1.97E-02
CAPX_w	-2.07E-02	-1.38E-02	2.84E-01***	3.13E-01***
ROA_w	7.34E-12	-9.46E-13	-2.99E-12	-1.47E-12
lnbot_w	3.09E-01***	3.09E-01***	4.19E-01***	4.01E-01***

Age_w		2.06E-02**		4.18E-02**
Gender_w		-3.76E-01***		-1.92E-01***
constant	1.30E+01***	-2.03E+01	2.84E+01***	-4.34E+01*
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Panel B. citation-BSc_year

	Dependent variable= citation			
	(1)	(2)	(3)	(4)
	τ= 0.75	τ= 0.75	τ= 0.95	τ= 0.95
BSc_year	-6.11E-04***	-9.33E-04	-1.67E-02*	-1.32E-03
Tobinq_w	7.04E-02***	7.34E-02***	2.52E-01***	2.57E-01***
Leverage_w	-1.96E-01***	-2.46E-01**	-2.54E-02	-6.98E-02
interRDintensity_w	4.48E-01***	3.11E-01***	4.30E-11	2.67E-12
Currentratio_w	-6.37E-03	-6.20E-03	-1.18E-02	-1.46E-02
CAPX_w	-4.81E-02*	-3.79E-02*	-9.54E-13	5.84E-14
ROA_w	7.14E-12	-4.93E-02	-3.73E-01***	-4.59E-01***
lnbot_w	2.89E-01***	2.82E-01***	5.02E-01***	4.95E-01***
Age_w		9.22E-03		1.81E-02
Gender_w		4.39E-14		-1.77E-13
constant	1.17E-12	4.17E-12	3.14E+01*	8.99E-11
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes