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Interactive Cross-period Impact between Corporate Social Responsibility and Corporate Value-- Empirical Study for Listed Companies in Chinese Chemical Industry

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In this paper, the chemical companies were taken as research samples by adopting the data from 2015 and 2016 of 134 chemical companies listed in China. The multiple regression model was applied to analyse the interactive cross-period impacts between corporate social responsibility (CSR) and corporate value. Through empirical study, it's concluded in this paper that the current-period CSR of chemical companies has a positive effect on the corporate value; while the current-period CSR has a reverse effect on the corporate value of the lag-period companies. This has certain implications for us to understand the mechanism of chemical companies' CSR and corporate value, and also provides a theoretical reference for promoting chemical companies to actively fulfil their social responsibilities in the current period.

1. Introduction

Research on the relevance of corporate social responsibility (CSR) and corporate value has been always an important topic of theoretical research and practical concern, especially for the chemical companies which are mostly the heavily polluting companies. With the increase in public concern and environmental protection supervision, chemical companies are urgently required to actively perform social responsibilities, change their image, increase their influence, reduce financing costs, open up new markets, and ultimately promote their corporate value. The research on CSR and corporate value mostly focuses on one-way impact analysis, but without making any consistent conclusions. Generally, the impact of the CSR fulfilment by companies is lagging, and fewer researches have been made on this topic in the current academic circle. Based on this, for us, there come the assumptions whether the fulfilment of social responsibility by chemical companies will have interactive cross-period impact on the corporate value or what's the relationship between these two? Through the exploration of the above questions, it is helpful to clarify the motivation of chemical companies to fulfil their social responsibilities and to provide a theoretical reference for companies to actively fulfil their CSR.

2. Literature review

2.1 Positive correlation

(Zang and Deng, 2013) selected domestic heavy-pollution chemical companies as research samples, and finally found that CSR has a positive effect on corporate value. (Li et al., 2014) by taking the petrochemical companies as examples, analysed the impact of CSR on corporate value, and the results show that corporate environmental responsibility has a positive impact on corporate value. (Hu and Li, 2016) analysed the relationship between corporate environmental performance and corporate performance; finally, it was found that the amount of CSR investment was less than the increased value by corporate performance.

2.2 Negative correlation

Some scholars have pointed out that chemical companies, as heavily polluting industries, have relatively larger investment in fulfilling their CSR. Therefore, the cost of fulfilling CSR is greater than the benefits by

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increasing corporate value. Based on this, the CSR of chemical companies is negatively correlated to corporate values. (Shao, 2009) through research and analysis of the listed chemical companies' data from 2002 to 2004, it was found that the fulfilment of CSR by chemical companies was negatively correlated to corporate values. (Chen et al., 2015) under the current circumstances where environmental impact was more important, companies need to invest more in environmental responsibility, which greatly exceeded the value increased it brings. Therefore, CSR was negatively correlated to the corporate value.

2.3 Uncertainty

(Inoue and Lee, 2011) analysed the 367 companies involved in five different industries and found that the relationship between CSR performance and corporate value was uncertain. (Liu, 2009) conducted research on 115 listed companies and found that there was neither positive correlation nor negative correlation between the fulfilment of CSR investment and the benefits of increasing corporate value.

From the above research literature, it can be seen that many scholars have studied the relationship between CSR and corporate value but achieving different results (Tarlacı, 2017).The existing researches have the following deficiencies: First, most of the existing studies are about the one-way relationship; no attention has been paid to the cross-period impact of indicators, and the lagged effects of CSR is ignored; Second, for the research about chemical companies, most are focused on the fulfilment of CSR for the environment, but the impact of chemical companies on other stakeholders is ignored.

3. Theoretical analysis and research hypothesis

3.1 Current-period one-way relationship analysis

Now more and more companies begin to attach importance to the impact of corporate value; in their actual operation and management, the social responsibility commitment can release the positive signals of good corporate operations to the outside world and has become a powerful tool for companies to obtain external financing and enhance their competitiveness. Therefore, the chemical companies can set up the reliable images through fulfilling the CSR and gain the support of various stakeholders, so as to obtain social capital at a low cost and maintain the competitive advantages of the companies. Based on this, this paper makes the following hypothesisI: Current-period CSR has a positive effect on the current-period corporate value.

3.2 Cross-period relationship analysis

Based on the above analysis, considering the lag and long-lasting of CSR impact, it impacts the corporate value not just for a certain point in time, but for a time period, that is, the lagged effect of social responsibility, mainly because there is a time difference between the impact of social responsibility and different impact levels, e.g., the impact on costs may be realized in the current period, but the improvement in performance may be extended to the lagging period; the impact on employees and suppliers may be realized in the current period. However, the impact on the environment and shareholders may be delayed. Therefore, this paper makes the following hypothesis2: Current-period CSR has a positive effect on the lag-period corporate value.

3.3 Interactive cross-period impact analysis

Combined with the hypothesis of resource supply, the fulfilment of CSR requires financial support. With enough funds, the companies shall be able to assume social responsibilities on the basis of normal operations. The environmental governance costs required by chemical companies are relatively high, so the relevant financial support must be provided to ensure the fulfilment of social responsibility under certain capital investment. Therefore, the good operation and increased value of companies are the basis for fulfilling CSR. For this, the paper further takes the cross-period impact between CSR and corporate value into consideration, and then examines their impact on lag-period corporate value according to the data of the current-period and lag-period CSR and current-period corporate value. Based on this, this paper proposes the following hypothesis3: Current-period CSR and corporate value has a positive effect on the lag-period corporate value.

4. Model setup and data source

4.1 Index construction

As the social responsibility disclosure of listed companies in the Rankins CSR Ratings Report is voluntary, the companies' willingness to disclose is not high, so there is relatively little relevant data. Therefore, based on the formula of social contribution value per share, and the modified index by (Li and Xiao, 2012), this paper sets the social contribution rate as a measure of CSR.

In related research, Tobin's Q is commonly used to measure corporate value. This indicator, combined with replacement value, can effectively combine corporate financial data with market data; so, the calculated

results are more accurate, close to reality, and conducive to the stability of final research results.
This paper also selects other control variables: SIZE, LEV, PSO, EXE, TOP2_10, and ZINDEX, and GROW (Song, 2017; Manner, 2010). The related variable definition and calculation method are shown in the table 1.

Table 1: Variable definition and calculation method

Variable	Calculation method
TobinQ	Tobin Q
CSR	Social contribution
SIZE	Natural logarithm of total assets
LEV	Asset-liability ratio
PSO	Number of circulating shares/total number of shares
EXE	Executive shareholdings/total shares
TOP2_10	Shareholding ratio of the second to the tenth largest shareholder
ZINDEX	number of shares held by the largest shareholder/shares held by the second largest shareholder
GROW	Growth rate of net profit

4.2 Model set-up

4.2.1 One-way impact of current-period CSR on corporate value

To test the impact of current-period CSR on corporate value, the following model was established:

$$TobinQ = a_0 + a_1 CSR + a_2 LEV + a_3 SIZE + a_4 PSO + \varepsilon_1 \quad (1)$$

4.2.2 Impact of lag-period CSR on corporate value

Considering the lagging effect of social responsibility, based on the research method of Yin et al., this paper increases the lag-period variable of social responsibility, analyses the cross-period impact of social responsibility on corporate value, and finally establishes the following model:

$$TobinQ = b_0 + b_1 CSR_t + b_2 CSR_{t-1} + b_3 LEV + b_4 EXE + b_5 SIZE + b_6 TOP2\_10 + b_7 GROW + \varepsilon_2 \quad (2)$$

4.2.3 Interactive cross-period impact of CSR on corporate value

Taking into account the impact of the lag period of corporate value on the current period, according to the research method of Zhang Zhaoguo et al., the following interactive cross-period model was established.

$$TobinQ_t = c_0 + c_1 CSR_t + c_2 CSR_{t-1} + c_3 TobinQ_{t-1} + c_4 LEV + c_5 ZINDEX + c_6 SIZE + \varepsilon_3 \quad (3)$$

In this paper, multiple control variables were selected on the basis of the existing studies, but they were gradually screened as required in the model set-up. Finally, the optimal control variables were selected to establish the model above. The t-period data is represented by 2016 data, and the t-1 period is 2015 data.

4.3 Research samples and data sources

In this paper, the data of chemical companies listed were selected as research samples. The CSR indicator was calculated manually based on the data, while the remaining data were derived from the CSMAR database; Some missing data were obtained through manual statistics of the companies' annual report (Hari S. D., 2017).

5. Empirical analysis

5.1 Descriptive statistics

According to the data in the above table, it can be seen that the difference between the maximum value and the minimum value of social contribution rate is relatively large, indicating that there are great differences in their efforts to fulfil their CSR among the companies, with the mean value of 32.65% and low overall social contribution rate. In terms of business growth, the difference between maximum and minimum values were relatively large, and the minimum value was negative, indicating that some individual chemical companies didn't run well, but some grew rapidly. The average Z-INDEX was 9.5924, and the average of TOP2_10 was 22.0258, indicating that the ownership concentration is not high.

Table 2: Description statistics of sample variable

	N	Min	Max	Mean	Standard deviation
2016 TobinQ	134	0.1648	7.1535	2.2925	1.5258
2015 TobinQ	134	0.2181	14.3520	2.7859	2.0250
2016 CSR	134	0.0205	0.8614	0.3265	0.1763
2015 CSR	134	0.0160	0.9637	0.3388	0.2001
SIZE	134	20.3120	25.1415	22.2610	1.0780
LEV	134	0.0351	0.9498	0.4087	0.1983
GROW	134	-29.8783	55.1952	0.8143	6.5867
EXE	134	0.0000	0.4624	0.0869	0.1376
PSO	134	0.1267	1.0000	0.8209	0.1968
ZINDEX	134	1.0039	86.6435	9.5924	14.5401
TOP2_10	134	2.4397	53.6649	22.0258	11.8866

5.2 Correlation analysis

Table 3: Correlation coefficient matrix of main variables

		CSR	SIZE	TobinQ	LEV	GROW	EXE	PSO	ZINDEX	TOP2_10
CSR	Pearson	1								
SIZE	Pearson	-.386**	1							
TobinQ	Pearson	.450**	-.764**	1						
LEV	Pearson	-.419**	.598**	-.619**	1					
GROW	Pearson	.010	-.040	.014	-.088	1				
EXE	Pearson	.177*	-.247**	.324**	-.266**	-.046	1			
PSO	Pearson	.053	-.105	-.089	.162	.079	-.589**	1		
ZINDEX	Pearson	-.009	-.014	-.056	.085	.349**	-.225**	.266**	1	
TOP2_10	Pearson	.053	.026	.125	-.182*	.056	.267**	-.421**	-.616**	1

The above table lists the correlation coefficient matrix between variables. The corporate value is significantly negatively correlated to the SIZE and LEV at the level of 1%. Combining with the actual situation of chemical companies, they are mostly large-scale heavy asset companies, thus having a higher correlation coefficient with the corporate value. The correlation coefficient of the remaining variables does not exceed 0.7, and there is no serious multicollinearity, which can be included in the model for analysis.

5.3 Analysis of regression results

5.3.1 Current-period one-way relationship analysis

Table 4: Regression results of current-period social responsibility and corporate value Dependant variable: 2016 Tobin's Q

	Non-standardized coefficient		Standardized coefficient	t	Sig.	Statistics of co-linearity	
	B	Standard error	Trial version			Tolerance	VIF
(Constant)	22.930	2.151		10.658	.000		
2016 CSR	1.287	.503	.149	2.559	.012	.790	1.266
SIZE	-.884	.096	-.625	-9.257	.000	.585	1.708
LEV	-1.239	.536	-.161	-2.310	.022	.548	1.824
PSO	-1.058	.421	-.136	-2.510	.013	.903	1.108

R^2=0.656 Durbin-Watson=2.023 F-statistic=61.527(0.000)

The F value was significant at the level of 1%, with better fitting degree of model; the DW value was 2.023, close to 2, and there was no autocorrelation between the residuals; the variable VIF value was less than 3, and the tolerance value was greater than 0.3, without any serious multicollinearity between variables. According to the above tests, it can be seen that the CSR coefficient was positive in 2016, and also passed the significant test, indicating that the CSR fulfilment by the chemical company in the current period can positively impact the corporate value, so the hypothesis I was verified. In addition, the control variables all have passed the significance test and had a certain impact on the corporate value.

5.3.2 Analysis of cross-period relationship

Table 5: Cross-period impact of CSR on corporate value Dependant variable: 2016 Tobin's Q

	No standardized coefficient		Standard coefficient	t	Sig.	Statistics of co-linearity	
	B	Standard error	Trial version			Tolerance	VIF
(Constant)	20.569	2.017		10.196	.000		
2016 CSR	2.765	.813	.319	3.401	.001	.294	3.399
2015 CSR	-1.754	.686	-.230	-2.558	.012	.321	3.117
SIZE	-.824	.094	-.582	-8.757	.000	.588	1.702
LEV	-1.415	.524	-.184	-2.700	.008	.559	1.788
TOP2_10	.012	.007	.093	1.694	.093	.867	1.153
EXE	.823	.615	.074	1.338	.183	.844	1.185
GROW	-.006	.012	-.028	-.536	.593	.983	1.017

R^2=0.673 Durbin-Watson=1.940 F-statistic=37.055(0.000)

It can be seen that the CSR in both the current period and the lag period passes the significant test and has a significant impact on the corporate value. The current CSR coefficient is positive, which indicates that the CSR has a positive effect on the corporate value in the current period; the CSR coefficient is negative in the lag period, being inconsistent with the second hypothesis. The reasons may include: First, the CSR based on traditional theory has a lagging effect on the corporate value, mainly because of the imperfect market system, certain irrational interference, and the transfer of social responsibility lasting for some time. However, with the great increase of network information dissemination speed and the impact of big data in recent years, the disclosure of CSR has been accelerated, so, the impact of CSR on the current-period corporate value is greater than that of the lag period. Second, based on the characteristics of chemical companies themselves, due to the relatively high cost for undertaking social responsibility in the chemical industry, more environmental governance costs, as well as additional subsidy costs for other stakeholders, are required, but the lag-period benefit out of social responsibility is progressively diminishing, leading to the reverse impact of CSR on the lag period. Thirdly, for the deviations of different analysis models, according to the analysis of Zhang Zhaoguo et al. for the lagging influence of social responsibility, it can be seen that different results may be obtained when using different models to analyse, which also provides a reference for the next-step study.

5.3.3 Interactive cross-period impact analysis

Table 6: Interactive cross-period impact between CSR and corporate value Dependant variable: 2016 Tobin's Q

	Non-standardized coefficient		Standardized coefficient	t	Sig.	Statistics of co-linearity	
	B	Standard error	Trial version			Tolerance	VIF
(Constant)	12.115	1.672		7.247	.000		
2016 CSR	2.435	.595	.281	4.095	.000	.296	3.376
2015 CSR	-1.945	.501	-.255	-3.881	.000	.323	3.091
2015TobinQ	.421	.039	.558	10.834	.000	.526	1.901
LEV	-.429	.391	-.056	-1.098	.274	.542	1.844
ZINDEX	-.002	.004	-.016	-.429	.669	.977	1.023
SIZE	-.491	.074	-.347	-6.645	.000	.512	1.953

R^2=0.822 Durbin-Watson=2.066 F-statistic=98.081(0.000)

According to the above regression results, it can be seen that the positive CSR coefficient in the current period has a positive effect on the corporate value; the negative CSR coefficient in the previous period had a reverse effect on the corporate value in the lag period; the positive corporate value coefficient of the previous period positively impacts the corporation value in the lag period. Therefore, all the hypotheses were verified.

5.4 Robustness test

To verify the robustness of the regression results, the asset net rate was used to measure the corporate value instead of Tobin's Q value in this paper. The regression results are omitted. In this way, it can be seen that there is little different of the regression results between this two test methods, and the correlation coefficients of the independent variable are also the same. Therefore, the results of this paper is of great robustness.

6. Conclusion

In this paper, taking the data from chemical companies listed in China as research samples, the analysis was conducted on the interactive cross-period impacts between CSR and corporate value. The following conclusions are drawn: the current-period CSR of chemical companies has a positive impact on the corporate value; the current-period CSR has a reverse effect on the corporate value in the lag period. The above results provide certain reference for the research on the CSR and corporate value of chemical companies, and it's of certain enlightenment significance for promoting chemical companies to actively fulfill their CSR.

In addition, the use of social contribution rate to measure CSR may have some limitations. In the further study, the factors of corporate donation, R&D investment, etc. should also be taken into consideration for the CSR measurement of chemical companies. Furthermore, the selection of the lag period in this paper only involves the one-period lag data, and the study should be expanded in the follow-up study. The deficiencies in this paper above can be adopted as the ideas for follow-up research in order to obtain more complete conclusions.

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