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Corporate Social Responsibility and Environmentally Sound Technology in Endogenous Firm Growth

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Abstract: We have entered the "New Normal" economy, with more emphasis on economic growth driven by innovation than resource. This paper investigates the impacts of firms considering corporate social responsibility and environmentally sound technology by building a three-stage Cournot competition model with asymmetric cost. The sustainable development of economic and endogenous firm growth achieves the win–win result in the theoretical model. Using data from 31 firms in China, this paper empirically researches on the relationships among corporate social responsibility, environmentally sound technology and firm endogenous growth. The results show that: (1) Marginal cost decreased with the increase of innovation, as well as getting government research and development subsidy, which has a positive effect on firm growth. (2) Consumers respond positively to corporate social responsibility initiative, the reputation of the firm can be improved. At the same time, environmentally sound technology objectively reduces the marginal cost of competitors because of the technology spillover. (3) Profit of a firm undertaking corporate social responsibility partly decreases, which has a negative effect on firm growth. The contradiction between corporate social responsibility and profit of firm could be adjusted, such as socially responsible investment fund hosed by institutional investors.

Keywords: corporate social responsibility (CSR); environmentally sound technology; firm endogenous growth

1. Introduction

China's economy has entered into the "New Normal" stage, which requires a steady growth of economic development, while at the same time, putting more emphasis on economic growth driven by innovation rather than factors. In the 21st Century, with the rapid development of the economy, the ecological environment is deteriorating, and sustainable development calls for the innovation of green technology. Green technology innovation can not only effectively make up for the deficiencies in traditional technology innovation, that is, putting too much emphasis on the pursuit of maximizing economic benefits while ignoring resources conservation and pollution control, but can also break through the traditional mode of "high input, high consumption" in traditional technology innovation, improving the utilization rate of resources and energy. The firms can also realize the endogenous growth with green technology, moreover economic sustainable development while improving the production efficiency or optimizing the process of product at the same time. It is worth noting that the environmental related green trade barriers have become a significant non-tariff trade barrier, its emergence and implementation has caused adverse effects on the international business of Chinese firms. According to a report by the United Nations Conference on Trade and Development, 7400 million of China's export commodities are blocked every year because they do not meet environmental requirements, 2300 million of which have been influenced regarding quantity and price. Therefore, firms actively promote green technology innovation so that they can break through the green trade barriers and improve international competitiveness.

In the 1960s, the earliest research achievement of green technology, due to the emergence of environmental hazards, was achieved by some developed countries in Europe and North America, who formulated regulations on environmental pollution control, which promotes the innovation and development of the end of pipe technology. Brawn [1] proposed firstly the concept of environmental reliability technology, also known as environmentally sound technology (ESTs). Green technology innovation always refers to an activity that adopts a new knowledge of environmental protection and green technology for production and operation to create and realize new economic benefits and environmental values. Green technology innovation is not a simple technology concept; it highlights the harmony of economic benefits and the ecological benefits, and aims to achieve endogenous growth through the competitive advantage of green technology.

2. Literature Review

The firm is always seen as a "rational agent" in neoclassical economics framework, pursuing maximal profits in the condition of scarce resources. Those scholars, represented by Milton Friedman [2], held the view that the profit goals and social responsibility of firm have inherent tension, that is, two forces with opposite directions while relying on each other. The firm should earnestly fulfill their social responsibilities. At the same time, the connotation of undertaking corporate social responsibility (CSR) is merely participating in public welfare activities and regarded them as a part of the firms' expenditure. However, Chen [3] showed that the corporate social responsibility would bring long-term competitive advantage, and therefore they cannot form the endogenous thought towards corporate social responsibility.

There have been many achievements in the research on corporate social responsibility. Carroll [4] firstly put the stakeholders into the framework of social responsibility, and then established a new concept framework of corporate social responsibility. Wood [5] defined corporate social performance (CSP) and reformulates the CSP model to build a coherent, integrative framework for business and society research, so processes of social responsiveness were shown to be an environmental assessment, stakeholder management, and issues management. In this sense, Porter and Kramer [6] published an article in the Harvard Business Review, in which they made a systematic analysis of the relationship between competitive advantage and corporate social responsibility, and expounded how the firms found opportunities for corporate social responsibility through competitive strategy, and produced more products to meet the needs of the society, so as to gain long-term competitive advantage. Liu [7] and Abraham [8] found that companies who get NGO (Non-Governmental Organization) certifications have motivation to assume environmental corporate social responsibility (ECSR). As for the standards of certification, Cournot competition is higher than the Bertrand competition [9]. Cournot model refers to Simultaneous quantity competition, and Bertrand [10] criticized Cournot's model because firms compete by setting prices and not by setting quantities. More importantly, firms and consumers can both benefit from the environmental corporate social responsibility. Some scholars believe that corporate social responsibility will lead to the production and profits decline of the firm. According to Porter and Kramer, the reason may lie in that the firms consider corporate social responsibility as a part of their cost. More importantly, these companies do not regard the efforts of achieving corporate social responsibility as a part of their competitive strategy. Especially in the buyer's market, consumers' preferences will go directly into the firm's target function; in this case, if the firm competition strategy is "altruistic" or "good for consumers", we can regard corporate social responsibility as a management strategy, and analyze the potential economic effects.

Over the past twenty years, the research on CSR has received more and more attention from the government and firms. Without a doubt, the target of firms is the key factor that determines the firm behaviors. Moreover, the nature of the firm is the key factor that determines the business objectives [11–14]. Therefore, state-owned firms and private firms' social responsibility behaviors are different due to their different nature. CSR is the best embodiment of business ethics of firm owner or manager. More than half of global companies' annual financial reports include CSR information, and 59% of the multinational companies in the world need to provide corporate social responsibility reputation of its stakeholders [15]. On 16 February 2011, Social Responsibility Report of the State Grid Corporation in 2010 was issued in Beijing, the first Corporate Social Responsibility Report (CSRR) of Chinese firms after entering the period of "the 12th Five-Year Plan" [16]. Increasingly, central firms actively adopt responsibility reports as an important channel for the disclosure of social responsibility information. By the end of 2013, among 116 central firms, 114 had issued CSRR in the name of the group or the only listed corporation, accounting for about 98.3%.

Thus, can green technology innovation become a way to break through the bottleneck of firm growth? Is there an incentive for a firm or its managers to change the path of the firm growth? Is corporate social responsibility a part of the cost or the investment of a firm? Will corporate social responsibility affect the organization's economic benefits, and how does it play its role? If firms focus on broader social goals and consider green technology innovation, and CSR is born within firm production decision-making behaviors, will it bring a win-win result of improving the level of social welfare and increasing corporate profits?

It is noted that R&D activity in mixed markets is also becoming increasingly popular from a theoretical perspective [17–19]. Meanwhile, the roles of R&D subsidies as a policy instrument in a mixed duopoly with cost-reducing R&D are investigated. In that context, Mukherjee [20] built an oligopoly model with R&D investment by the more cost efficient firm, thus creating endogenous cost asymmetry, which shows that if the slope of the marginal cost of R&D is not very high, entry is socially insufficient instead of excessive. We find that the R&D subsidy may partly serve the same purpose as an output subsidy since an R&D subsidy can tackle inefficiencies related to output in addition to the ones regarding R&D. This is an interesting finding, but it also raises the question of whether the two subsidy schemes imply the same (or similar) welfare effects. In this paper, we show that an R&D subsidy is socially superior.

According to Milton Friedman, corporate social responsibility is conservative in nature; in this way, firm and society are mutually separated, and they can link together only by responsibility. This paper is a further development trend that combines the theory of firm growth with innovation theory and corporate social responsibility to explain the issue of endogenous growth, and that it is necessary to form a model to quantify the relationship among the three. The key point of this paper is to prove that it is not a zero-sum game for those firms who succeed in market competition to maximize consumer surplus and social welfare. The firm pursues not only its profits but also the recognition of consumers. The marginal contribution of this paper is to try to establish a theoretical model for the growth of firms based on corporate social responsibility, and the authors hope this will provide a theoretical basis for the firms' endogenous social responsibility and technology innovation, the performance of social responsibility and then the realization of the sustainable growth.

The rest of the paper is organized as follows: Section 3 constructs the model, Section 4 conducts an empirical test of the theoretical hypothesis, and Section 5 concludes.

3. The Model

3.1. Model Specification

Assume that there is a firm (Firm 0) which can produce a product with the marginal cost of production c and another firm (Firm 1), each of which can produce the product at the marginal cost of production d. Assume that Firm 0 invests x amount in R&D to reduce the marginal cost to

$(c - x) > 0$. We also assume that R&D is costly and the cost of R&D is $\frac{gx^2}{2}$. Firm 1 only takes imitation strategy. Obviously, there are asymmetric marginal costs. x represents the amount of investment in R&D and $g \in [0, 1]$. When g = 0, it shows that Firm 0 does not have technology innovation activities. To simplify the model, we assume g = 1 in this article. Therefore, marginal cost is a decreasing function of an amount of R&D investment; in other words, there is the effect of decrease return to scale in R&D investment [21]. At the same time, we assume that Firm 0 will allow Firm 1 to get the technology license if technical innovation is successful, so the effect of technology spillover exists. Firm 1, taking the imitation strategy, would also bring about a decline in the marginal cost $(d - \varepsilon)$, where $\varepsilon \in [0, d - c + x]$, which means that technology innovation in Firm 0 will save the marginal cost of competitors.

We also assume that the inverse market demand for the goods is $P = a - Q$, where P is price and Q is the total output, expressed as $Q = q_0 + q_1$, in which q_0 and q_1 represent the outputs of Firm 0 and Firm 1, respectively.

First, the two firms do not take corporate social responsibility into consideration, so the profits function can be, respectively, given as follow:

$$\pi_0(q_0, q_1, x) = (a - q_0 - q_1 + s)q_0 - (c - x)q_0 - \frac{x^2}{2} \quad (1)$$

$$\pi_1(q_0, q_1, x) = (a - q_0 - q_1)q_1 - (d - \varepsilon)q_1 \quad (2)$$

In the above equations, technology innovation brings about not only the reduction of the marginal cost of either Firm 0 or Firm 1, but also the effect of alleviation of environmental pollution, which will receive green innovation subsidies from the government, represented as s. Then, according to whether the endogenous social responsibility will be included in the competition strategy, we can get the following objective functions of firms:

$$O_0 = (a - q_0 - q_1 + s)q_0 - (c - x)q_0 - \frac{x^2}{2} + \alpha_0 CS - K \quad (3)$$

$$O_1 = (a - q_0 - q_1)q_1 - (d - \varepsilon)q_1 + \alpha_1 CS - K \quad (4)$$

We assume that consumers respond positively to CSR initiative of firms. α_0 and α_1 represent the weight of firm consumer benefits in the production decision-making, respectively. If $\alpha_i = 0$, then the factor of consumers benefit is fully considered by the firm, vice versa. $\alpha_i CS$ $(i = 0, 1)$ can be indicated as CSR. If the firm managers include consumers into the production decision-making, then the firm owners have to pay for the cost, which is indicated as K, namely the cost of CSR taken by the firm. The consumer surplus is given by $CS = \frac{Q^2}{2}$. Thus, the social welfare function can be represented as:

$$SW = CS + O_0 + O_1 - sq_0 \quad (5)$$

Thus, we construct a three-stage game in this paper. In the first stage, the government decides whether to provide green innovation subsidies to maximize social welfare; in the second stage, Firm 0 and Firm 1 decide whether to carry out technology innovation activities; and, in the third stage, both firms are in Cournot competition to maximize their objective function. The backward induction is used to derive the sub-game perfect Nash equilibrium (SPNE).

3.2. Theoretical Analysis

In this section, both firms are in Cournot Competition with Knowledge Spillover. The quantity of Firm 0 and Firm 1 is obtained by partially differentiating Equations (6) and (7) with respect to q_0 and q_1, respectively, and we obtain the first-order condition as follows:

$$\underset{q_0}{Max}O_0 = (a+s) - (c-x) + q_0(\alpha_0 - 2) + q_1(\alpha_0 - 1) \quad (6)$$

$$\underset{q_1}{Max}O_1 = a - (d-\varepsilon)q_1(\alpha_1 - 2) + q_0(\alpha_1 - 1) \quad (7)$$

$$q_0 = \frac{[a-(d-\varepsilon)](\alpha_0 - 1) + [a+s-(c-x)](\alpha_1 - 3)}{2(4-\alpha_0-\alpha_1)} \quad (8)$$

$$q_1 = \frac{s-2a-(c-x)+3(d-\varepsilon)+[a-(d-\varepsilon)]\alpha_0 - [a+s-(c-x)]\alpha_1}{2(\alpha_0+\alpha_1-4)} \quad (9)$$

In the second stage, Firm 0 decides whether to carry on the green technology innovation to reduce the marginal cost and maximize its profit function $\underset{x}{Max}\pi_0$. We put the equilibrium output q_0^* into Equation (6), and take the partial derivative of R&D investment. The first order condition of R&D investment can be deduced as:

$$\frac{\partial \pi_0}{\partial q_0}\frac{\partial q_0}{\partial x} + \frac{\partial \pi_1}{\partial q_1}\frac{\partial q_1}{\partial x} + \frac{\partial \pi_0}{\partial x} = 0 \quad (10)$$

$$\begin{aligned}\underset{x}{Max}\pi_0 = &\frac{\alpha_0^2[(d-\varepsilon)-a-2x]-2\alpha_0[(a+3s-8x)+2(d-\varepsilon)-3(c-x)]}{2(\alpha_0+\alpha_1-4)} \\ &+\frac{\alpha_1^2[a+s-(c-x)]+\alpha_1[a+2s+(d-\varepsilon)-2(c-x)-4x]}{2(\alpha_0+\alpha_1-4)}\end{aligned} \quad (11)$$

where $\frac{\partial \pi_0}{\partial q_0}\frac{\partial q_0}{\partial x} = 0$ refers to the market equilibrium conditions for R&D investment. $\frac{\partial \pi_1}{\partial q_1}\frac{\partial q_1}{\partial x}$ represents the strategic effect of green technology innovation. $\frac{\partial q_1}{\partial x} = -\frac{\alpha_1 - 1}{2(\alpha_0+\alpha_1-4)} < 0$; that is, with the increase of R&D investment of Firm 0, its competitor Firm 1 will reduce production so that the profit of Firm 0 will increase. Therefore, $\frac{\partial \pi_1}{\partial q_1}\frac{\partial q_1}{\partial x} > 0$ represents the scale effect of green technology innovation, R&D investment increases with the increase of profit, while the undulation of R&D investment decreases with the increase of firm profit. By the result of Equations (10) and (11), we can get the optimal level of R&D investment.

$$\begin{aligned}x^* &= \frac{\alpha_0(-2(a-3c+2d+3s-2\varepsilon))-\alpha_0^2(a-d+\varepsilon)-8\alpha_1(a+c-s)+2\alpha_1^2(a-c+s)}{2(\alpha_0+\alpha_1-4)^2} \\ &= \frac{2\alpha_1^2(a-c+s)+8\alpha_1(s-a-c)-B\alpha_0^2-A\alpha_0}{2(\alpha_0+\alpha_1-4)^2}\end{aligned} \quad (12)$$

where , $A = 2(a+3s-3c+2(d-\varepsilon))$, $B = a-(d-\varepsilon)$.

In the first stage, the R&D investment x of Firm 0 was plugged into Equation (5) social welfare function to get the partial derivative of R&D investment with respect to s, obtaining the optimal subsidy rate:

$$\frac{\partial SW^*}{\partial s} = \frac{8(a-c)-4s-\alpha_1(4a-5c-2s+(d-\varepsilon))+\alpha_1^2(a-c)+\alpha_0(c-d+2s+\varepsilon+\alpha_1(a-c))}{2(\alpha_0+\alpha_1-4)^2} = 0 \quad (13)$$

$$s^* = \frac{8(a-c)+4a\alpha_1+\alpha_0(d-\varepsilon-c)+\alpha_1(d-\varepsilon-5c)+\alpha_1(a-c)(\alpha_0+\alpha_1)}{2(\alpha_0+\alpha_1-2)} \quad (14)$$

Next, this paper discusses the relationship between corporate social responsibility and firm growth in three cases:

(1) If $\alpha_0 = \alpha_1 = 0$, neither of the two firms undertake social responsibility, then

$$s_1^* = 2(a-c) \quad (15)$$

(2) If $\alpha_0 = \alpha_1 = \alpha$, both of them assume social responsibility, then

$$s_2^* = \frac{(8+2\alpha^2)(a-c)+4\alpha a+2\alpha(d-\varepsilon)-6\alpha c}{4(\alpha-1)} \tag{16}$$

(3) If $\alpha_0 = \alpha$, $\alpha_1 = 0$, Firm 0 carries out green technology innovation and undertake social responsibility, then

$$s_3^* = \frac{8(a-c)+\alpha(d-\varepsilon-c)}{2(\alpha-2)} \tag{17}$$

To sum up, there are two firms in the market producing homogeneous products, they have asymmetric marginal costs and make the different decision to take corporate social responsibility, and then we can get the following hypotheses (H1 and H2):

Hypothesis 1 (H1). *Firm takes EST into account to reduce the marginal cost; at the same time, they can get additional R&D subsidies from the government, which exert a positive effect on firm growth.*

Hypothesis 2 (H2). *Firms can improve the social recognition through undertaking a certain social responsibility in the long term, which has a positive impact on firm growth; however, CSR leads to the drop of firm's profits, which has a negative impact on firm growth in the short term.*

4. Empirical Analysis

4.1. Sample Selection

Sample data are collected from the 2014 China statistical yearbook on science and technology [22], the 2014 China statistical yearbook of the tertiary industry [23], and the 2014 China Yearbook on intellectual property [24]. The corporate social responsibility reports of 31 listed companies (including sustainable development report, environmental report and so on). In total, 31 sample firms and 682 samples are selected.

This paper researches on the CSR with green technology innovation to account for the firm endogenous growth. Given the validity and availability of data, we adopt the innovation ability (including innovation input and output) to describe the green innovation in the firm. The humanity funds input of Colleges a proxy variable to use to describe the CSR. We use the revenue from core operations to describe the firm endogenous growth, which is the dependent variable in the paper. The meaning of each variable can be seen in Tables 1 and 2.

Table 1. Variable Setting.

Variables	
Dependent Variable	Firm Growth (Y)
Independent Variable	Innovation input (Z_1)
	direct innovation output (Z_3)
	indirect innovation output (Z_4)
Control Variable	Innovation environment (Z_2)

Table 2. Variable Description.

First-Class Indicator	Second-Class Indicator	Third-Class Indicator	Factor
Innovation input (Z_1)	Informationalized level and Input ICT	Traffic volumes of telecom service	X1
		Users accessing the Internet broadband	X2
		Internet popularizing rate	X3
	Research grant input	The humanity funds input of Colleges	X4
		The ratio of college input of R&D funds in the whole regional R&D funds	X5
	Human capital input	Arts college research personnel input	X6
		The ratio of college R&D research personnel input in the whole research personnel	X7
		The ratio of college R&D research personnel input in the firm employees	X8
	Customers involvement	Per capita income level	X9
		The ratio of population above the junior-college level	X10
Innovation environment (Z_2)	Policy innovation	Firm's fixed assets investment	X11
		Government funds in the Arts college R&D research	X12
	Intellectual property protection	Number of infringement cases investigated by the patent agency	X13
		Number of trademark violation cases investigated by administrative organization	X14
		Number of intellectual property cases accepted by the court	X15
	Industry-study-research cooperation	Firm funds in the Arts college R&D research	X16
	Entrepreneurial environment	Firm foreign direct investment (FDI)	X17
		Number of business entity	X18
		The ratio of numbers of business entity	X19
Direct innovation output (Z_3)	Patent	Number of firm's patents application	X20
Indirect innovation output (Z_4)	Industry GDP	Firm's added value	X21
		The ratio of firm's added value in the regional total output value	X22

4.2. Data Processing

Standard processing: Due to the original data involving different units and the wide differences between the value of numbers or the order of magnitudes, we will firstly standardize them. Inspection results can be obtained after the standard processing of relevant data, as detailed in Table 3. The value of KMO (Kaiser-Meyer-Olkin) is 0.736, and that of Bartlett's test of sphericity is 1099.852, whose probability of accompanying is 0, which is less than 0.5. It can be seen from the correlation coefficient matrix between each relevant indicator that the majority of coefficients are greater than 0.3, suitable for conducting factor analysis.

Descriptive statistics: We used Stata11.0 (Stata Corp.: College Station, TX, USA) to conduct descriptive statistics on 682 samples in four aspects in 2014, i.e., innovation input, innovation environment, innovation output and so on, mainly calculating the indicator's range, minimum value, maximum value, average value, standard deviation and variance, as detailed in Table 4. It is not hard to see that: (1) the standard deviation of firm social responsibility is extremely rare, which illustrates that this variable is relatively stable; (2) the maximum and minimum values of innovation input are 3 and −3, respectively, the greater difference of which may be related to many factors, such as the different life cycles of firms; (3) the direct innovation output has a minimum value of 0.75, a maximum value of 1.83 and an average value of 1.0026, which reflects that the sample firms' control of innovation environment remains to be improved; and (4) the indirect innovation output has reached a maximum value of 45.64 and has a rather big standard deviation, which shows that it remains to be improved for firms to fulfill social responsibility. Overall, the explained variable, the explaining variable and the control variable are comparatively stable. Thus, correlation test can be carried out next.

Correlation test: In this paper, we use Pearson correlation on current CSR indicator and current period, passing the two-tailed significance testing. This paper has taken into consideration the fact that the social responsibility assumed by the firm in current period may cause the fluctuation of current green technology system innovation. Whether the inspecting financial performance indicator of this part is related to the social responsibility indicator, sample data are the overall data of four years and two-tailed significance testing is adopted; analysis results can be seen in Table 5. According to the correlation analysis results, it can be seen that Y had a positive correlation with Z_1, Size and ROA-1 with a 0.01 level of significance, an unremarkable positive correlation with Z_2 and a remarkable negative correlation with Z.

Table 3. Kaiser-Meyer-Olkin (KMO) and Bartlett Test.

KMO		0.736
Bartlett Test	chi-square	1099.852
	df	231
	Significance	0.000

Table 4. Descriptive Statistic Table of Each Variable.

Variable	Maximum	Minimum	Mean	SD
Y	0.060	−0.280	−0.005	0.054
Z_1	3.000	−3.000	0.000	0.675
Z_2	0.100	0.000	0.019	0.018
Z_3	1.830	0.750	1.003	0.133
Z_4	0.580	−0.030	0.046	0.066

Table 5. Correlation Coefficient Table.

Variable	Y	Z_1	Z_2	Z_3	Z_4	Nat	Size	Gro	ROA^{-1}
Y	1	0.434 **	0.121	−0.820 **	−0.005	0.005	0.350 **	−0.092	0.722 **
Z_1	0.434 **	1.000	0.000	−0.105	0.007	0.011	0.255 *	−0.037	0.275 **
Z_2	0.121	0.000	1.000	−0.103	0.394 **	0.482 **	−0.252 *	−0.098	0.078
Z_3	−0.820 **	−0.105	−0.103	1.000	0.168	0.070	−0.403 **	0.055	−0.579 **
Z_4	−0.005	0.007	0.394 **	0.168	1.000	0.431 **	−0.278 **	−0.072	−0.091

Note: ** correlation with a 0.01 level of significance (two-tailed); * correlation with a 0.05 level of significance (two-tailed).

4.3. Principal Component Analysis

As we can see from the total variance explained in Table 6, the information reflected by the whole indicators can be obtained simply by extracting four principal components (extracting on the basis of the characteristic value greater than 1, they are 11.379, 5.020, 1.488 and 1.006, respectively).

Four indicators can be seen in the results in Table 7. The first principal component reflects the firm innovation, mirroring the input, environment and output situation of firm innovation, which is defined as comprehensive indicators in innovation evaluation system. All the factors have a high load in Principal Component 1: X1, traffic volumes of telecom service; X2, numbers of users accessing the Internet broadband; X3, Internet popularizing rate; X4, the internal spending of arts college R&D funds; X6, arts college research personnel; X7, the ratio of arts college R&D research personnel in the whole research personnel; X18, the number of institutional shareholders; X13, the number of infringement cases investigated by the patent agency; X14, the number of trademark violation cases investigated by administrative organization; X15, the number of intellectual property cases accepted by the court; X16, firm funds in the arts college R&D research; X11, firm FDI; X17, firm's fixed assets investment; X12, government funds in the arts college R&D research; X20, the number of firm's patent application; and X21, firm's added value.

Table 6. The Total Variance Explained by Principal Component Analysis (PCA).

Component	Initial Characteristic Value			Extraction of Sum of Squares Loaded		
	Sum	Variance %	Sum %	Sum	Variance %	Sum %
1	11.379	51.723	51.723	11.379	51.723	51.723
2	5.020	22.819	74.542	5.020	22.819	74.542
3	1.488	6.765	81.307	1.488	6.765	81.307
4	1.006	4.571	85.878	1.006	4.571	85.878
5	0.722	3.281	89.160			
6	0.615	2.795	91.954			
7	0.424	1.926	93.880			
8	0.319	1.449	95.329			
9	0.238	1.082	96.411			
10	0.207	0.942	97.353			
11	0.165	0.750	98.103			
12	0.130	0.592	98.695			
13	0.100	0.456	99.151			
14	0.073	0.331	99.482			
15	0.041	0.187	99.669			
16	0.027	0.125	99.794			
17	0.020	0.092	99.886			
18	0.012	0.055	99.941			
19	0.006	0.027	99.968			
20	0.004	0.019	99.988			
21	0.003	0.012	99.999			

Principal component 2 is the structural indicator of firm innovation, reflecting the innovation environment. These factors include: X8, the ratio of art college R&D research personnel in the firm employees; X9, per capita income; X10, the population above the junior-college level in every 10 thousand people; X19, the ratio of the number of institutional shareholders; and X22, the ratio of firm's added value.

The following indicators have rather high load in principal component 3, which can basically reflect the information of above indicators: X5, the ratio of arts college R&D funds in the whole regional R&D funds; X7, the ratio of arts college R&D research personnel in the entire research personnel; X8, the ratio of arts college R&D research personnel in the firm employees; X14, the number of trademark violation cases investigated by administrative organization; and X15, the number of intellectual property cases accepted by the court. Thus, we consider principal component 3 as the support indicator of firm innovation.

Both X5 (the ratio of Arts college R&D funds in the whole regional R&D funds) and X14 (the number of trademark violation cases investigated by the administrative organization) have the high load in the principal component 4, but the significance is not that obvious, so principal component 4 is thought to be the other indicator of firm innovation.

Table 7. Component Matrix of Principal Component Analysis.

Third-Class Indicator	Component			
	1	2	3	4
Traffic volumes of telecom service X1	0.859	−0.394	0.102	0.127
The numbers of users accessing the Internet broadband X2	0.892	−0.406	0.054	−0.015
Internet popularizing rate X3	0.723	0.484	−0.255	−0.088
The internal spending of arts colleges R&D fund X4	0.805	0.520	0.185	0.038
The ratio of arts colleges R&D funds in the whole regional R&D funds X5	−0.247	0.470	0.757	0.071
arts colleges research personnel X6	0.852	0.267	0.293	−0.194
The ratio of arts colleges R&D research personnel in the whole research personnel X7	−0.587	0.327	0.600	−0.153
The ratio of arts colleges R&D research personnel in the firm employees X8	0.292	0.700	−0.076	−0.559
Per capita income X9	0.438	0.714	−0.390	0.152
The population above the junior-college level in every 10 thousands of people X10	0.472	0.792	−0.238	−0.183
Firm FDI X11	0.768	−0.262	−0.051	−0.002
The arts colleges R&D research from government funds X12	0.772	0.530	0.170	0.032
The number of infringement cases investigated by the patent agency X13	0.661	−0.473	0.212	0.195
The number of trademark violation cases investigated by administrative organization X14	0.716	−0.282	0.073	0.063
The number of intellectual property cases accepted by the court X15	0.901	0.041	0.077	0.258
Firm funds in the arts colleges R&D research X16	0.759	0.479	0.196	0.020
Fixed assets investment in Firm X17	0.771	−0.492	0.052	−0.189
The number of institutional shareholders X18	0.933	−0.258	0.048	0.002
The ratio of the number of institutional shareholders X19	−0.551	0.535	−0.009	0.519
The number of firm's patent application X20	0.827	−0.187	−0.053	0.020
Firm's added value X21	0.954	−0.220	−0.018	0.044
The ratio of firm's added value in the regional total output value X22	0.394	0.779	−0.092	0.356

4.4. Result Analysis

Using Stata11.0 and step regression analysis (stepwise), through calculating the partial regression sum of squares of the non-random variables and testing their significance, variables are selected into the regression equation based on their importance. Thus, a regression analysis of the current social responsibility indicator, the current and later internal mechanism optimizing of green technology indicator, respectively, as shown in Table 8, is conducted. Setting the conditions for adding or removing variables based on the step regression analysis: when the probability of significance of the statistic F is less than or equal to 0.050, variables are added to the model; conversely, when the probability of significance of the statistic F is equal to or greater than 0.100, variables are removed out of the model. Thus, Z_3, Z_1 and Z_4 are added to the model five times, and none of the variables have been removed, so the model is finally made up of only three variables: Z_3, Z_1 and Z_4. As can be seen in Table 8, the final model coefficient of determination (R-squared) is 0.865, and the modified one is 0.858, which manifests that the regression equation can explain 85.8% of the total variation, with a good model-fitting degree.

As can be seen in Table 9, the observed value of statistic F in the regression model is 115.356, and its probability of significance is 0.000, taking on a remarkable regression effect. With a 0.05 level of significance, it can be assumed that Y has a linear relation with Z_3, Z_1 and Z_4.

Table 8. Regression Results.

Model	R	R^2	Adj-R^2	SE
1	0.820 [a]	0.672	0.669	0.031
2	0.892 [b]	0.795	0.791	0.025
3	0.918 [c]	0.842	0.837	0.022
4	0.926 [d]	0.858	0.852	0.021
5	0.930 [e]	0.865	0.858	0.020

[a] predictive variable: (Cons), Z_3; [b] predictive variable: (Cons), Z_3, Z_1; [c] predictive variable: (Cons), Z_3, Z_1; [d] predictive variable: (Cons) Z_3, Z_1, Z_4; [e] predictive variable: (Cons), Z_3, Z_1, Z_4.

Table 9. Variance Analysis Table.

Variance	Sum of Squares	Df	Mean Square	F	Significance Level
Regression	0.235	5.000	0.047	115.356	0.000
Residual	0.037	90.000	0.000		
Total	0.272	95.000			

To summarize, as shown in Tables 10 and 11, it can be seen that: (1) The regression coefficients of Z_1 and Z_4 are positive; that is to say, the innovation input and direct innovation output have a positive correlation with firm growth. (2) The regression coefficient of innovation environment variable Z_2 is still positive, simply due to the exclusion of multicollinearity existing between Z_2 and other independent variables, which illustrates that the innovation environment is positively related to its fulfillment of firm growth. Therefore, theoretical hypothesis H1 can be validated. Third, the coefficient of direct innovation output variable Z_3 is negative, with statistical significance. The firm's undertaking social responsibility result in lower profits and has negative effects on firm growth. Thus, there is proof for theoretical hypothesis H2.

Table 10. Regression Result.

Variable	Unstandardized Coefficients		Standardized Coefficients	*t*-Statistics Beta	Significance Level
	Beta	SD			
Cons	0.299	0.028		10.759	0.000
Z_3	−0.269	0.020	−0.671	−13.689	0.000
Z_1	0.024	0.003	0.305	7.417	0.000
Z_4	0.085	0.033	0.106	2.610	0.011

Table 11. Variables excluded.

Variable	Beta In	*t*-Statistics	Significance Level	Partial Correlation	Multicollinearity Statistics
					Capacity Volume Variance
Z_2	0.051	−1.141	0.257	−0.120	0.755

5. Conclusions

It should be more emphasized that economic growth is driven by innovation in the "New Normal" economy. In the 21st century, the ecological environment is getting worse and worse as the economy is developing rapidly. Meanwhile, the green trade barrier related to the environment has become a significant non-tariff trade barrier, whose appearance and promotion have had bad influences on the international operations of Chinese firms. EST has not only made up for the defect of ignorance of resources protection and pollution abatement caused by excessively pursuing the maximization of economic benefits in the traditional technology innovation, but also improved utilization of resources and energies and realized the firm endogenous growth and sustainable development of the economy. In the recent two decade, the research on CSR has gained more and more attention from government and firms. These issues including whether CSR is only a part of the cost or a kind of management strategy in the objective function; whether CSR will influence the economic benefit of the organization; and what is the mechanism of its influence have become the causes of disagreement in academic circles [25].

Based on the background, we construct a three-stage Cournot model with asymmetric cost in order to discuss the firm endogenous growth combining CSR with EST and hereby propose the correspondent theoretical hypothesis. Using the panel data of 31 firms in China from 2006 to 2014 as samples, we conduct empirical research on the endogenous relation between the CSR, EST and firm growth. The following major conclusions are made: (1) Firm innovation input and direct innovation output have a positive correlation with firm growth, which means the firms that made green technology innovation reduced their marginal cost and obtained extra R&D subsidy from the government, thus having positive effects on firm growth. (2) Though multicollinearity between innovation environment and other independent variables is excluded, the regression coefficient is still positive, which demonstrates that firms undertaking social responsibilities can improve their social recognition, which is beneficial to their growth. Meanwhile, the possibility of technology spillover can cause the firms adopting green technology innovation to objectively reduce the marginal cost of their competitors and improve their firm growth. (3) Direct innovation output has a prominent relation with the firm social responsibility, indicating that the firm's assuming social responsibility results in lower profits, thus having negative effects on firm growth.

Therefore, we can summarize the following implications. Innovation output is inversely proportional to CSR, that is, firms who shoulder social responsibility will reduce its value, to some extent supporting the view of "depriving social function of state-owned firms". It is noted that there are many socially responsible investment funds (SRI funds) in Western countries, such as the America SRI fund in 2003, topping 2140 billion. The investees of these funds are those firms who meet the social responsibility requirement certified by NGO or have a front ranking. Once these exist, if firms violate the CSR during business activities, such as pollute, have product quality problems or infringe on employees' benefits, the fund will undersell their firm stock, thus decreasing its value. There is currently no SRI fund in China. If individual firms' short-term acts produce negative "externality", many firms in this industry will imitate. However, when firms carrying on green technology innovation are unable to reduce their marginal cost in the short term and the subsidy granted by the government cannot make up their R&D cost, they will be forced to give up the R&D strategy. This result can not only lower the level of social welfare but will also affect the growth ability of the firms in the long run. Social capital is an important part of sustainable economic growth. All of the community relations, integrity, voluntary work, social internet and civism included in the social capital belong to profitable values and are economic resources on which we can involve our investment [26,27]. Moreover, this kind of resource can generate returns to both firm and society.

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