Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.4, No.13, 2013

Government Policy, Corporate Social Responsibility and Corporate Innovation Evidence from China

Xinying Yu[1] Sangaralingam Ramesh[2*]
1. University of East Anglia London, 102 Middlesex Street, London, E1 7EZ.
2. Department for Continuing Education, University of Oxford, Rewley House, 1 Wellington Square, Oxford, OX1 2JA
* E-mail of the corresponding author: r.sangaralingam@ucl.ac.uk

Abstract
The conventional literature on the regional polarisation of innovation in China suggests that based on the granting and application of patents the Coastal region is at the forefront of innovation in China. However, the results of this paper based on cement firm capitalisation and their published CSR reports suggests that market capitalisation and access to financial resources is a more significant driver of innovation to reduce environmental air pollution than government laws, regulations or CSR guidelines. This finding does not contradict with endogenous economic growth theory which is based on innovation which asserts the importance of government intervention. Rather, the results of this paper suggests that government intervention should not be based solely on laws, regulations and CSR guidelines on environmental air pollution but that these should be aligned with subsidies to cement firms to help them to fund innovation. However, the government would also be able to fund research institutes specifically linked to the cement industry.
Keywords: Cement industry, China, CSR, Government Regulations, Innovation.

1. Introduction

China's rapid economic growth since the introduction of free market economic reforms in 1978 has seen an increase in air pollution and the emission of CO_2 at a global level. The transition of the Chinese economy from a centrally planned economy to a hybrid market economy has nurtured entrepreneurial activity. The increased urbanization of cities and the rise of mega-cities such as Beijing, Shanghai and Shenzhen have increased the need for more buildings. This has increased the need for steel, cement and aluminum (Chan et al., 2008). But the production of these materials results in substantial air pollution. In China air pollution is not only a serious health hazard causing cancer and cardiovascular illnesses amongst other things but it is also getting worse despite government assurances that it is getting better (Watts, 2012). The disparity between what the governments says and the disparity in the quality of air in China may be due to the fact that the government excludes substances such as Ozone and particulate matter known as PM2.5 from its air quality index. This ensures that when air quality is measured, the result shows that it is better than it actually is (Watts, 2012).

Traditional economic theory suggests that firm's sole objective is to maximize profits. The introduction of free market reforms into China's economy since 1978 has encouraged Chinese entrepreneurs to set up firms and multinational firms to enter the Chinese market. The Chinese economy has become a hybrid free market-centrally planned economy. However, the increasing importance of corporate social responsibility (CSR) to firms suggests that this may be changing. CSR implies that firms should go beyond its traditional objectives of wealth maximization of its shareholders and mere compliance with a country's law and regulations by actively improving the welfare of third parties (Lin, 2012). In economics terms this means that firms must act to reduce and/or eradicate the negative externalities which arise as a part of its economic activities. So are national environmental legislation and company best practice through CSR related governmental directives changing firm's attitudes towards innovating to reduce air pollution? It would seem that the major driving force which has encouraged Chinese companies to embrace CSR policies appears to be tougher environmental and labour legislation by the Chinese government over the last few years (Ramesh, 2012).

China is the world's largest producer and consumer of cement. Cement production leads to significant regional and global environmental pollution due to the production of SO_2, NO_x, CO_2 and PM (Lei et al., 2011). It would be logical to deduce that as China is the largest producer and consumer of cement then China must be the biggest contributor to not only regional pollution but also to global pollution through cement production. The cement industry in China is the largest source of PM emissions as well as the largest source of CO_2 emissions due to fuel combustion and as a by-product of chemical processes during the production of cement (Lei et al., 2011). The urgency of understanding what firms, particularly cement firms in China are doing to reduce the emission of CO_2 has increased with the news that the level of CO_2 in the atmosphere has reached 400 ppm (BBC, 2013). According to the latter the earth has not seen this level of CO_2 in the atmosphere for at least 3-5 million years ago. Increasing atmospheric CO_2 will make harvests fail across whole continents as well as making hundreds of millions homeless (McKie, 2013). The movement of populations from uninhabitable places to

habitable places will lead to armed conflict and perhaps global war amongst populations. The US and Chinese governments are co-operating on the development of clean technologies and China's latest five year plan, 2011-2015, has bold objectives with regards to reducing industrial pollution (BBC, 2013). While it is clear what is happening at the macro-environmental protection level, things are not so clear at the micro-environmental protection level. CO_2 emissions, between 1928 and 2012 from other sources such as the burning of solid, liquid, gas fossil fuels has been increasing by a far greater amount than the CO_2 emissions from cement production, Boden et al (2010). However, CO_2 emissions resulting from the burning of fossil fuels to produce cement has also been steadily rising especially since 1978, the year in which China's economic reforms commenced. This paper will focus on the cement industry in the Chinese context and investigate how CSR may be related to corporate innovation which reduces air pollution.

This paper aims to extend the investigation into Chinese domestic cement companies and provide assessment on the CSR reports of these firms in terms of legislative compliance, resource saving and utilisation, waste treatment and innovation. The innovation in Chinese cement company CSR reports has been evaluated in terms of product innovation, improved technology, independent innovation, innovation achievement and management innovation. But the most pertinent aspects of innovation which will be discussed in the case study relates to improved technology and independent innovation. The methodology which will be adopted in order to analyse how government regulations and CSR is driving innovation in the cement industry in China will be a case study of Chinese (state owned and private) and foreign cement companies in China's coastal region, central region and western region. The common characteristic of all of the cement companies to be analyzed is that they listed on the Shanghai stock exchange. Among all cement companies listed on China's domestic stock market (Shanghai and Shenzhen stock exchanges), nine cement companies which published CSR reports in 2013 were selected for further analysis. This kind of analysis will facilitate an understanding of how environmental legislation and government directed CSR best practice could be facilitating innovation which may contribute towards technological change which may reduce air pollution in China. Furthermore, such an analysis may also facilitate an understanding of whether such innovation may be location dependent and whether government regulation and/or CSR is the key driver of such change.

2. The Economics of Innovation

One view of how economic growth occurs is that it is through technological change (Mokyr, 2010). There are two theoretical perspectives from which innovation and technical change occur, exogenous growth theory and endogenous growth theory. Exogenous economic growth models predict that long run economic growth can only occur due to changes in the growth of the population of a country and through improvements in labour productivity (Salvadori, 2003). So only government policies which impacted on the demographic structure of a country and on the productivity of its labour force would promote long run economic growth. The implication of accepting exogenous economic growth theory is that government fiscal and monetary policy would have no impact on long run economic growth. However, economic theory does suggest that government macroeconomic policies are important to maintain stable economic growth. Keynesian economic theory contended that when the economy was in a recession then governments should follow an expansionary fiscal policy by increasing government spending. But this depended on the relationship between inflation and unemployment being stable. The monetarist critique of this relationship, known as the Phillips Curve, proved to be a severe blow to Keynesian economic theory (Knoop, 2009). Monetarists introduced the importance of consumers' expectations on influencing government economic policy and the need for the stable growth of the money supply in order to maintain stable economic growth (Knoop, 2009). While exogenous economic growth models did not incorporate the role of government macroeconomic policy in determining long run economic growth, a new generation of economic growth models did (Salvadori, 2003). These growth models, endogenous growth models also sought to explain long run economic growth by considering factors which the exogenous models did not. These other factors included the structural characteristics of the economy as well as the role of knowledge. The way in which rationally optimising economic agents behaved determined long run economic growth as an endogenous equilibrium outcome. But the way in which rationally optimising economic agents behaved depended on government macroeconomic policy and technology. These in turn defined the structural characteristics of the economy (Salvadori, 2003). But it is more true to say that endogenous economic growth is dependent on the interaction between technological innovation and the structural characteristics of the economy (Aghion et al., 1998). The structural characteristics of an economy may simply be the size of firms and the way in which these firms produce output and engage in economic activity. Schumpeter defines two pathways for innovation in an economy (Holler, 2010). Firstly, small firms innovate through a process of creative destruction where entrepreneurs entering a market may use knowledge in the public domain to make their own innovations and capture market share. These innovations may then become accessible to imitators because the entrepreneur may not have sufficient financial resources to protect the innovation. Secondly, large firms innovate through a process

of creative accumulation whereby they are able build on existing R&D through patent protection. This is assuming that large firms have enough financial resources to prevent the expropriation of its innovations. The result is a different market structure from that in which creative destruction occurs (Holler, 2010). Schumpeter's process of creative destruction can be considered to be the same as considering the process of innovation as a distinct economic activity with its own causes and effects (Aghion et al., 1998). This theoretical viewpoint allows for an analysis of the emergence of innovation in an economy due to legal frameworks and the impact of that innovation on long run economic growth. A legal framework, such as the emerging environmental legislation in China will act as an incentive for both firms and entrepreneurs to innovate in order to comply with government laws which act to restrict environmental pollution.

3. CSR and Innovation

CSR as an elusive concept has been an issue of concern in the business world in last two decades. By the end of 1990s, CSR becomes widely accepted idea by government, corporations and individual customers (Min-Dong Paul Lee, 2008), and about 90% of Fortune 500 firms considered CSR as an important part of their organizational goals and actively reported CSR activities annually (Boli and Hartsuiker, 2001). More and more companies now realized that CSR issues have potential impact on organizational performance related to innovation and diversification. Researchers believe that there has been a growing concern over CSR issues in business world. When studying CSR, the first consideration is the systematic definition of CSR from previous researches. In the past two decades, different definitions of CSR have been proposed according to researchers' own perceptions, knowledge and experiences in studying this subject. Likewise, the term 'innovation' has experienced some arguments. Researchers presented that CSR may or may not add values to the management strategies, such as 'innovation'. Some managers embraced CSR as essential elements of their strategic management programme, while others perceived it as a source of innovation (Allen & Husted, 2006). In this aspect, innovation can be regarded as auto-transformation process of the business, including new types of products and services, new technology, patents, more efficient processes of HRM and new form of organizational structure, etc. While some of the researchers perceived that new technology and new product views of innovation have outdated and the new concept can be outlined as a broad, continuous, systematic activity operates throughout the organization (Sawhney, Wolcott, and Arroniz, 2006; Hamel, 2006; Vila and MacGregor, 2007). This idea supports the sustainability view of CSR. It could be argued that CSR can lead to innovation when organization addresses its own economic sustainability and collaborates the needs of diverse stakeholders in the society.

Considering organizations in difference industries have different requirements and driver, it is complex to understand the relationship between CSR and innovation. On one hand, researchers believe there's a lack of link between two concepts. It is argued that CSR in terms of legal responsibility limits the creation and innovation of the organisation and reduce competitive advantages (Poolton and Ismail, 2000). Meanwhile, Burke and Gaughran (2006) argued that "compliance with legislation is the key driver" of the CSR activities and it is difficult to achieve economic sustainability if there are no supportive policies. Pimenova and Vorst (2004) conjectured the primary concern of CSR activities is their public image and reputation and it is the gimmick of the marketing strategy. On the other hand, researchers believe there's strong correlation between CSR and innovation. MacGregor et al. (2007) claimed that organizations may not survive as fail to promote CSR can lead to no innovation and design can build the strong relationship between CSR and innovation. Little (2006) argued that CSR initiatives can lead to innovation through the use of 'social, environmental or sustainability drivers to create new ways of working, new products, services, processes and new market space'. From various international studies, it may conclude that CSR and innovation relationship can be different in organizations in terms of different sector, size, culture, governmental policies and economic situation. Various studies have identified the relationship between CSR and innovation. Most of the CSR research has laid excessive emphasis on the business cases in western countries or western corporations in China. There's few studies outlined CSR in Chinese domestic organizations. With the fast growing of the economy and increasing concern of the environmental issues in China, there's a need to look at governmental policies, CSR and innovation.

3.1 CSR in China

Accompanying with the adoption of the open-up policy in 1978, CSR has experienced three stages of evolution in China. The first stage is from year 1978 to 1999 which focuses on economic responsibility. China has been undertaken economic system reforms which aim primarily on faster economic development and government introduced the basic legal responsibility of corporations. CSR in terms of environmental and employment issues have been overlooked to some extent. The second stage is from year 2000 to 2005 which focused on concerns of labour force. With the accession to WTO, the advent of globalisation, shortage of resources and pollution, corporation are under great pressure from government and public to behave responsibly in the society.

Favourable policy and legislations and public opinion are mainly focused on the rights of the labour force. Due to a large number of media reports of related issues, some business began to improve the working conditions of employees and increase employee wages. The third stage is from year 2006 up to now which is the integration of CSR. As the second revision of the 'Company Law' was executed on January 1st 2006, the companies were forced to take the social responsibility and the inspection from government and public. This requires companies to emphasize on not only economic responsibility for shareholders, but also responsibility for society, environment, culture and community. Government has introduced legislations to promote CSR activities. Accordingly, the Ministry of Labour, the Ministry of Commerce and the Chinese Enterprise Confederation (CEC) have all organised investigation committees to study the development of CSR in China (Zhou, 2006). The China WTO Tribune (2012) released a cross-sectorial analysis of CSR reports in mainland China from January 1st to October 31st 2012 to shed light on the latest development of CSR reporting in China. The first ten months of 2012 released 1337 CSR reports which achieve an increase of 63.6% over the same period in 2011. The report number in Eastern region accounts for 68.6% with an increase of 43.1%; Central and western regions with an increase of 18.4% and 50%. The number of CSR reports in various industries has a certain level of growth, such as the construction sector including cement industry increased by 154%. The number of reports of state-owned enterprises increased by 1.36 times, the number of reports of state-holding enterprises, foreign and Hong Kong, Macao and Taiwan enterprises and private enterprises grew 4.7%, 47.1% and 3.2%.

Correspondence with the development of CSR in China and the distinctive role of the government legislations, contextually based CSR research is advocated by a number of researchers (Gao, 2009; Moon and Shen, 2010; Noronha et al., 2012; Wang and Qin, 2010). The investigation of 100 top companies in China in 2007 (Gao, 2009) shows that only 28 companies established a CSR-like column in their official websites. CSR activities considered in this analysis including: improvement of products and services, profit and tax submitted to the government, anti-unfair competition, respect business contract, issue guideline for business, energy saving, environmental pollution control and sponsorship and donation, etc. It also revealed that economic issue is addressed 326 times, while environmental pollution control issue is only addressed 36 times in their official websites. This research concluded that economic responsibility is still regarded by corporations as first social responsibility, and environmental responsibility only attracts limited attention. Kong et al, (2012) used CSR index in China to measure firm efforts on environmental protection activities and investigated that companies in environment industry could improve their market values and gain benefits by strengthening their environmental protection activities. It also suggested that government enact appropriate legislations to improve environmental protection activities and the sustainable development of economy. The recent work by He (2011) studied cement companies listed in the Chinese stock market and found that large size firms tend to publish CSR reports and there's no correlation of CSR publication with ownership and Return on Equity. He (2011) also argued that foreign-owned company tends to released more detailed CSR report than state-owned and private companies. There's growing attention of the CSR concept by the government, but it's still limited CSR implementations from Chinese corporations. With regards to innovation in the cement industry in China, six categories of innovation have been identified, Da Qi Xu et al. (2012). But this study did not investigate the link between the CSR responsibilities and reporting of Chinese cement companies with innovation in the cement industry. The categories of non-CSR related innovation in the Chinese cement industry included management innovation capability, input innovation capability, research and development capability, manufacturing capability, marketing promotion capability and output innovation capability. Some of the non-CSR related innovations in the Chinese cement industry are shown below:

Table I: Innovations in the Chinese Cement Industry
Source: Xi et al. (2013)

Innovation	**Detail**
Vertical Mill for Raw Material Grinding	High temperature waste gas introduced to dry raw materials and increase production capacity.
Roller Press for Raw Material Grinding	Energy utilization improvement through the roll grinding effect
Co-grinding system	Roller press used in pre-grinding through roll grinding effect.
Alternative fuel technology for current production	Alternative fuels used for calcination in cement kilns.
Carbon Capture and Storage CCS for cement production	Emissions from cement kiln fed into the earth through pipe

4. Environmental Legislation in China

Increased public awareness of the effects of pollution in Chinese society and the diffusion of public opinion on the subject through mass media outlets such as the Internet has caused the Chinese government to increase environmental protection regulations. However, while central government has enacted tougher environmental protection laws which are equally applicable to the whole country, the effectiveness of the implementation of these laws at a regional level has varied (Beyer, 2006). This has led to the situation such that if the regional implementation of central governments environmental protection laws is tougher in one region of the country than in another then the polluters will tend to agglomerate in regions of the country where implementation is either lax or non-existent. In some cases firms which find domestic regulations too expensive to comply with will invest in operations in countries where environmental regulations are either very thin or non-existent.

In China the State Council is the origin of administrative rules, regulations and laws which are applicable to the whole country. Nevertheless, below the State Council lies the Commission for the Protection of Environmental and Natural Resources (CPENR). It is the role of the CPENR to co-ordinate environmental protection work as well as to formulate environmental policies and guidelines. The administrative arm of CPENR is the State Environment Protection Administration (SEPA). SEPA has a number of functions (Beyer, 2006). Firstly, it is the responsibility of SEPA to determine and issue environmental policies which relate to the protection of the air, water and soil as well as to the disposal of factory waste. Secondly, SEPA provides advice to regional government regarding environmental protection matters. Finally, SEPA is responsible for overseeing environmental protection at a national level. While environmental rules, regulations and laws may emanate from the CPENR-SEPA route it is also possible that central government ministries such as the Ministries of Agriculture, Energy, Forestry and Water Resources can also formulate environmental rules, regulations and laws (Beyer, 2006).

Table II: Evolution of Environmental Protection Regulatory Framework in China: 1978 - 2002
Source: Beyer (2006)

Year	**Law**
1978	States responsibility for the environment added to constitution
1979	**Environmental Protection Law**
1982	Marine Environmental Protection Law
1984	Forest Law
1985	Grassland Law
1987	Air Pollution Prevention and Control Law
1989	**Environmental Protection Law amended**
1991	**Water and Soil Conservation Law**
1995	**Solid Waste Pollution Prevention and Control Law**
1997	**Criminal Law revised - Chapter 6 of Chapter IV**
1998	Forest Law amended
2000	**Law on the Prevention and Control of Atmospheric Pollution**
2002	Grassland Law amended
2002	**Cleaner Production Promotion Law**
2011	**Water and Soil Conservation Law Amended**

At the local regional level Environmental Protection Bureau's, which are funded by local governments, are responsible for issuing local regulations and laws as well as supervising and monitoring environmental work. In China civil claims brought against polluting firms are usually done so under the Law of Civil Procedure. Compensation claims brought by Plaintiffs for any loss caused by pollution are codified in Article 41 of the Environmental Protection Law. However, the majority of cases are settled through a process of mediation involving local Environmental Protection Bureaus (Beyer, 2006). Table II above shows the chronological evolution of environmental protection legislation in China since the start of the country's economic reforms in 1978. In the context of water pollution the most important aspects of environmental legislation in China relates to the Environmental Protection Law, Solid Waste Pollution Prevention and Control Law, revised Criminal Law, Cleaner Production Promotion Law; and the Water and Soil Conservation Law. Article 5 of the amended Environmental Protection Law, adopted in December 1989, states that (PRC, 2013):

'The state shall encourage the development of education in the science of environmental protection, strengthen the study and development of the science and technology of environmental protection, raise the scientific and

technological level of environmental protection and popularise scientific knowledge of environmental protection.'

Table III: Major Environmental Objectives – 10th, 11th and 12th Five Year Plans
Source: Compiled from (Ramesh, 2012) and (Wang, 2011)

Five Year Plan	Major Environmental Objectives
2001-2005 (10th Five Year Plan)	Collect fees from polluting firms to finance environmental protection
2006-2010 (11th Five Year Plan)	Reduce energy consumption per unit of GDP by 10% and pollutant discharge by 10% by 2010.
	Restructuring of industry to reflect environmental protection
	Improve environmental protection law enforcement
	Use technology and innovation to improve environmental protection i.e. clean coal technologies
	Improving public education with regards to environmental protection
	Improving co-operation between local and national governments regarding environmental protection
2011-2015 (12th Five Year Plan)	Improve quality of economic growth
	Lay foundations of a modern and prosperous society
	Non-fossil fuel consumption to increase to account for 15% of nation's total fuel consumption.
	£370 bn devoted to information technology, clean energy, environmental protection and scientific research and innovation.
	Bids for various research projects on environmental protection

The most important law which was applicable to Air Pollution was the Law of the People's Republic of China on the Prevention and Control of atmospheric pollution. The pertinent sections of this law are Article's 3, 8, 9, and 24. Article 3 stipulates that (MEP, 2000):

'The state takes measures to control or gradually reduce, in a planned way, the total amount of the main atmospheric pollutants discharged in local areas. The local peoples governments at various levels shall be responsible for the quality of the atmospheric environment under their own jurisdictions, making plans and taking measures to make the quality of the atmospheric environment under their own jurisdictions meet the proscribed standard,'

Article 8 of the law states that local provincial governments should reward units or individuals who have made outstanding progress in the prevention and control of atmospheric pollution (MEP, 2000). Moreover, according to the latter Article 9 of the law stipulates that the state should support scientific and technical research which facilitates the use of clean technologies such as solar energy, wind energy and water energy. Article 24 of the law prohibits the extraction of coal which has either a high sulphur content or a high ash content (MEP, 2000).

The Solid Waste Pollution Prevention and Control Law (SWPPCL) was adopted by China in October 1995 and amended in December 2004, while becoming effective in April 2005 (PRC, 2005). This law deals with pollution caused by the illegal dumping of solid waste by 'units or individuals in rivers, lakes, canals, channels, reservoirs and bottomlands, banks and slopes below the highest water lines of such sites and other sites' (PRC, 2005). The eradication of pollution due to solid waste through innovation is enshrined in Article 6 and Article 19 of the law. Articles 6 and 19 of SWPPCL is very similar to Article 5 of the Environmental Protection Law because it emphasises the role of the state in facilitating and supporting research which is innovative enough to result in technologies or processes which either reduce or eradicate environmental pollution due to solid waste. The National Development and Reform Commission (NDRC) is responsible for the implementation of the Cleaner Production Promotion Law (CPPL). The CPPL was adopted by China in June 2002. The main provisions of the CPPL which are pertinent to this paper are Articles 6, 19 and 20. While Articles 6 and 20 state the need for the state to act as a facilitator of innovation for cleaner production, Article 19 states the need by firms to recycle waste water (NDRC, 2002). The most important part of the Water and Soil Conservation Law is the stipulation that county level water administration units should draw and implement plans to conserve water loss and reduce and eliminate soil erosion. This is on the basis that China loses 3.5% of its annual GDP due to water loss and soil erosion (CB, 2011).

Table III above shows the major environmental objectives which can be associated with the 10th, 11th and 12th Five Year Plans. While the 10th Five Year Plan has a very narrow focus with regards to environmental protection

the 11th and 12th Five Year Plan have a broader focus with regards to environmental protection. However, it can be seen from Table III above that the 12th Five Year Plan lays more emphasis on research into technologies and processes which may reduce or eliminate environmental pollution. More specifically the Chinese government is inviting bids from third parties to conduct research on various aspects of innovation with regards to the reduction or the elimination of environmental pollution.

Table IV: CSR Initiatives in China
Source: Compiled from (Lin, 2012) and (USCC, 2012)

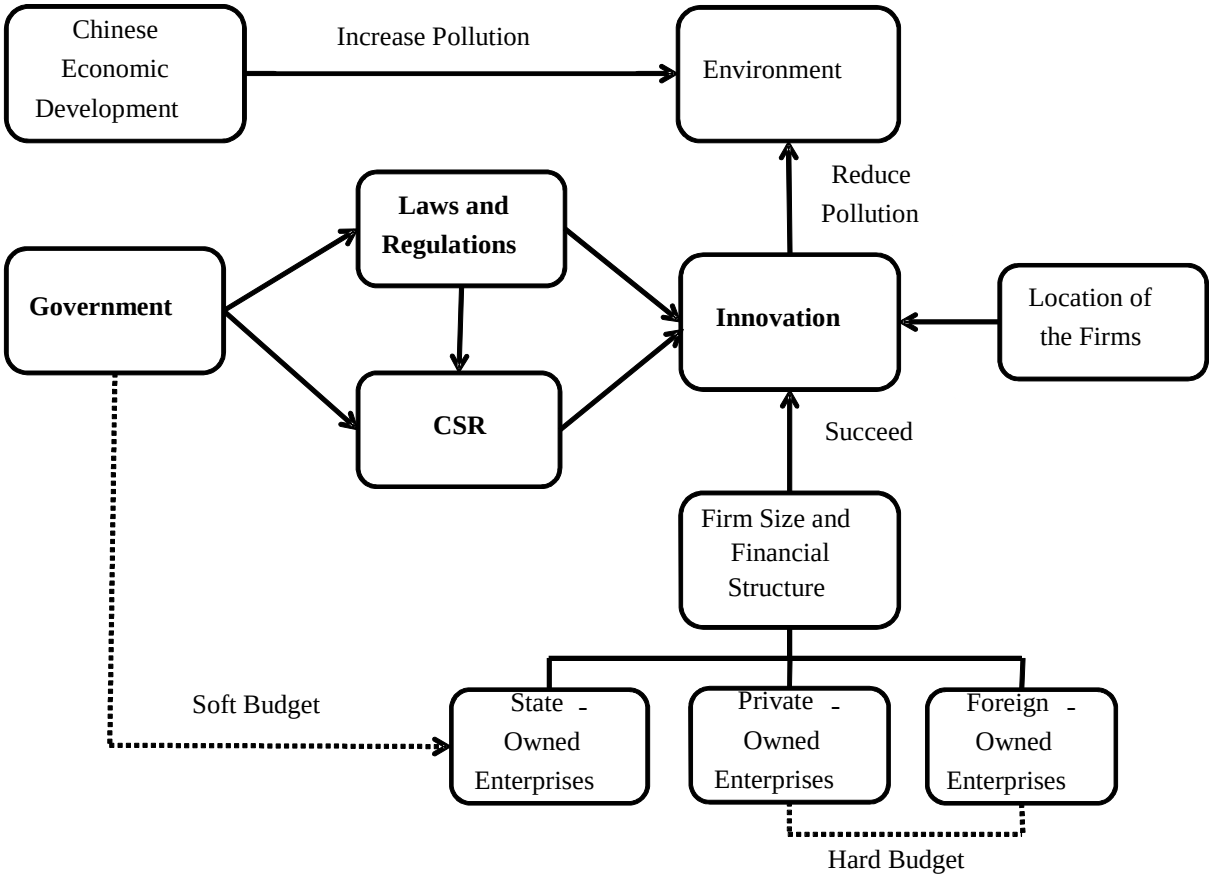
Year	CSR Initiative
2005	Responsible Supply Chain Associations CSC9000T
2006	Article 5 of Chinese Company Law
2007	Circular on Enhancing Environmental Surveillance on Exporting Industries
2008	CSR Principles for State Owned Companies

Table IV above shows CSR specific initiatives by the Chinese government and sectors of Chinese industry. Such initiatives began with the issuing of CSC9000T by the China National Textile and Apparel Council in 2005. However, the CSC9000T was quite limited in its scope towards CSR because of its sole emphasis on management responsibility towards labour. However, the Chinese government enacted China's Company Law in 2005 and Article 5 of this law referred specifically to a firms; compliance with laws, administrative regulations, social morality and business morality, acts of good faith, acceptance of supervision by the general public and government and the acceptance of social responsibilities' (CD, 2006). It can be seen from this that the legal requirements of CSR for Chinese companies as stipulated by Chinese Company Law is vague and lacks focus. There is no specific requirement that Chinese companies should have any environmental responsibilities to society and to third parties. On the other hand, in 2007 China's Ministry of Commerce issued a 'Circular on Enhancing Environmental Surveillance on Exporting Industries'. The purpose of this was to prevent Chinese firms which were environmentally unfriendly from exporting goods (USCC, 2012).
In 2008 China's State Assets Supervision and Administration Commission (SASAC) issued mandatory CSR guidelines for China's State owned Enterprises. Furthermore, since then the SASAC has encouraged China's State owned Enterprises to issue CSR reports and 26 did issue CSR reports in 2009 (CCSR, 2009). The most important aspects of the CSR guidelines with regards to the environment are Articles 3, 6, 7, 9, 11 and 12. Article 3 stipulates that fulfilling CSR requirements will allow the goal of sustainable development to be attained. The goal of sustainable development is emphasised by Article 9 which states that state owned enterprises should strive to make profits which are sustainable. Article 6 stipulates that the heads of state owned enterprises should set CSR requirements which will act as a model for development of the legal framework with regards to environmental protection. But Article 7 stipulates that state owned enterprises should integrate CSR development with corporate restructuring. The theme of Article 9 is also supported by the requirements of Article 11 which states that state owned enterprises should strive towards resource conservation and environmental protection through their CSR related policies by adopting technological innovation in order to reduce harmful emissions and save energy. However, although harmful emissions should be reduced and energy consumption in production reduced, the technology adopted should increase production efficiency so that output and profits increase. Finally, article 12 stipulates that the heads of state owned enterprises should facilitate the development of the mechanisms of innovation in their enterprises while also increasing investment spending in research and development of new technologies so that corporate restructuring can be driven by technological innovation.

5. Conceptual Framework

It could be argued that there's a significant connection between China's rapid economic growth and environmental pollution since the free market economic reforms in 1978. However, the increasing concern of CSR and government regulations drives companies to consider more on organisational performance in terms of innovation and diversification than profit maximisation.

Figure 1: Conceptual Framework
Source: Author

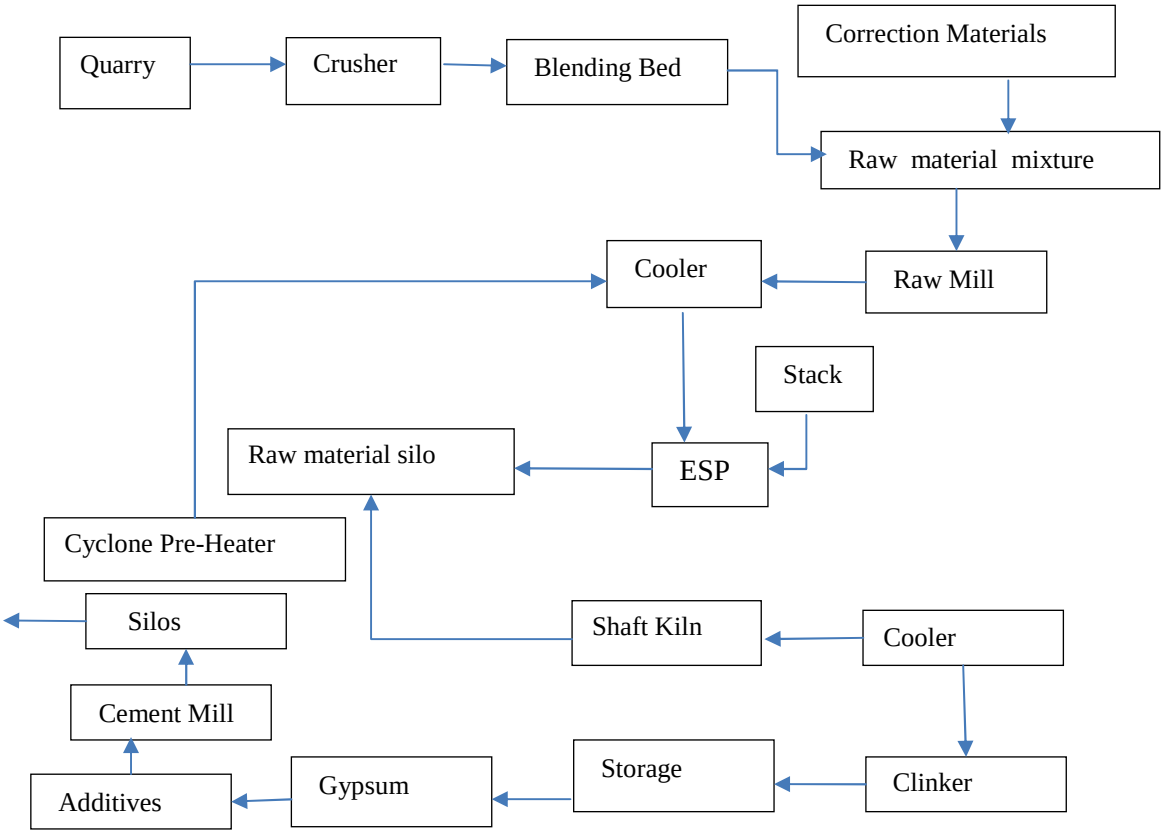


This paper fills the gap in previous literature and argues relationship between government laws, CSR and innovation. In addition, the conventional literature on the regional polarisation of innovation in China suggests that coastal region is at the forefront of economic development and innovation in China. However, the findings of this paper based on case study of nine cement companies' financial size and published CSR reports suggests that market capitalisation and access to financial resources is a more significant driver of innovation to reduce environmental pollution than government laws, regulations or CSR guidelines. Furthermore, as the literature indicates (Lin and Tan, 1999; Chow, C.K.M. et al. 2012), China's state-owned enterprises are under soft budget constraints. Chow, C.K.M. et al. (2012) examined China's listed companies from 1997-2003 and found that firms with larger shares of state ownership show less investment cash flow sensitivity than firms with lower shares of state ownership. This implies that state-owned enterprises under soft budget constraint has less motivation to innovate as excess of expenditure over earnings will be paid by the government; while private-owned and foreign-owned are more likely to be involved in innovation as they are under hard budget constraint. To sum up, a conceptual framework (Figure 1) is developed to support the findings and discussions of this paper.

6. Case Study: CSR, Government Policy and Innovation in the Chinese Cement Industry

Figure 2: Stages in the Production of Cement

Source: (Lamas et al., 2013)



The main component of concrete is cement and while the former is the second most used material on earth, the latter is the first most consumed (Lamas et al., 2013). China accounts for 50% of the world's output of cement (Alun et al., 2013). In order to produce one ton of cement, 60-130kg of fuel is required or 110kWh of electricity (Lamas et al., 2013).

The high energy consumption for the production of cement can be accounted for by the fact that high temperatures needs to be reached. The production of cement has involved the burning of fossil fuels such as coal, fuel oil, coke and petroleum. However, this is now changing with the emergence of techniques such as co-processing in which either part of the fuel or the raw material is replaced by waste. Without co-processing energy consumption accounts for 30% of the cost of production of cement (Lamas et al., 2013). The Chinese cement industry is characterised as being the biggest energy consumer as well as the biggest air pollutant in China (Alun et al., 2013). Moreover, 90% of cement kilns in China are not of the rotary type but are of the shaft type. The shaft type kilns are less energy efficient than the rotary type kilns. Furthermore, another problem with the Chinese cement industry is that it is dominated by state owned enterprises and small scale operations (Shimoda et al., 2012). This means that by their nature these enterprises will have access to less financial resources and less innovation compared to a non-state owned firm. This is the conventional held view which also suggests that inward foreign direct investment may also force Chinese cement companies to merge with foreign ones leading to a diffusion of management and technical innovation into the Chinese cement industry (Shimoda et al., 2012). Figure 2 above shows the various stages in the production of cement. While rotary kilns which cause less pollution are used by cement companies in developed countries, this is not the case in China where environmentally polluting shaft kiln and wet kilns are used. These cause substantial environmental air pollution due to dust emissions which attribute to substantially increased PM measures (Baxi et al., 2005).

6.1 Chinese Cement Companies with CSR Report

The companies chosen for analysis were all cement companies listed in Chinese stock market (both Shanghai and Shenzhen stock market). Among 24 cement firms listed 17 are state-owned, 5 are private-owned and two are foreign-owned. Up to May 2013, 9 out of 24 firms have released CSR reports and they are presented in the Table V on the basis of size in terms of the capital. From this table we can see that large cement firms are more likely to publish CSR reports. It can be seen from Table V that seven of the firms are state owned, one privately owned and one foreign owned. Figure 3 below shows the map of China with the provincial locations of the cement companies with CSR report to be analysed in the case study.

Figure 3: Map of China Showing Cement Companies to be analysed

Source: Compiled by authors

It can be clearly seen that from Figure 4 that of the cement companies CSR reports is to be studied, one (Xinjiang Tianshan) is in the Western region, two (Guangdong Tapai and Fujian) are in the South Coastal region, three (Anhui Conch, Huaxin and Henan Tongli) are in the Central region. Another three cement companies are in Northern China, (BBMG, Jilin Yatai and Tangshang Jidong). It is these nine companies CSR reports which have been analysed to evaluate the extent of the innovation which has taken place within these companies to reduce air pollution, with CO_2 emissions particularly in mind.

regarding environmental pollution since the start of economic reforms in 1978.

Table V: General Information of Cement companies listed in Chinese Stock Market

Source: Compiled and Translated by Authors from Company CSR Reports.

Name	Capital 2013 Billion RMB	Size Ranking	Ownership	Registered date	location	Province	Registered Capital (million)	ROE (%)	Ranking on ROE	2012 turn over (million)	Ranking on Turnover 2012
1.Anhui Conch Cement Co.,Ltd.	87.524	1	State-owned	07/02/2002	Central	Anhui	5299.3	8.51	3	32247	1
2.BBMG Corporation	83.162	2	State-owned	17/07/2009	North	Beijing	4283.74	8.35	4	23920	2
3.Jilin Yatai (Group) Co.,Ltd.	43.25	3	State-owned	15/11/1995	North	Jilin	1894.73	4.92	9	8285	5
4.Tangshan Jidong Cement Co.,Ltd.	41.504	4	State-owned	14/06/1996	North	Hebei	1347.52	2.05	13	11099	3
5.Huaxin Cement Co.,Ltd.	23.291	5	Foreign-owned	03/01/1994	Central	Hubei	935.3	3.23	12	8814	4
6.Xinjiang Tianshan Cement Co.,Ltd.	19.157	6	State-owned	07/01/1999	West	Xinjiang	880.101	5.31	7	6096	6
7.Henan Tongli Cement Co.,Ltd.	5.218	12	State-owned	19/03/1999	Central	Henan	426.799	8.58	2	3130	9
8.Guangdong Tapai Group Co.,Ltd.	5.118	13	Private-owned	16/05/2008	South Coastal	Guangdong	894.656	3.68	11	2407	10
9.Fujian Cement Inc.	4.34	15	State-owned	03/01/1994	South Coastal	Fujian	381.874	-18.85	23	1149	16

The cement sector in China is high on yield but low on innovation (Alun et al., 2013). Improving energy efficiency and cutting down on energy consumption will lead to a reduction in the emission of greenhouse gases such as nitrogen oxides (NO_x), sulphur dioxide (SO_2), Carbon Dioxide (CO_2) and particulate matter (PM) (Xi et al., 2013), The reduction in the emission of greenhouse gases and reducing the climate change effects of atmospheric pollution is now a prime objective for the Chinese government. This has been evidenced by the Chinese government's formulation and implementation of laws and regulations

The laws and regulations have been supplemented by the objectives of the 12th Five Year Plan and the coding of firm level environmental responsibility in the Corporate Social Responsibility criteria stipulated by the SASAC for state owned firms in China. Some of the innovations in the Chinese cement industry were shown in Table I above. The analysis of the nature and kind of innovations made by each of the 9 cement companies to be analysed was conducted on the basis of analysing the latest CSR report for each of the companies. These were written in Chinese and were translated into English by the authors. Furthermore, the analysis is divided into four sections. The CSR report of each of the 9 companies was analysed on the basis of each companies responsiveness to legislation [Table VI], resource saving and utilisation [Table VII], the emission, effluents and waste attributes of cement production [Table IX] as well as specific innovations relating to the reduction of pollution [Table X, XI, XII].

6.2 Findings and Discussion

6.2.1 Legislations mentioned in CSR reports

Table VI below shows the legislation mentioned in 9 cement companies' CSR reports. Only one company (Huaxin) which is foreign owned didn't refer to any legislation. In the contrast, private owned company (Guangdong Tapai) considered different environmental policies and laws most, and it is the only company which mentioned payment for sewage charges. Five out of nine companies identified their environmental emissions meet national standard and another two companies expressed that pollution emission achieve 100% compliance rate which is similar as meeting national standard. Five out of nine companies stated that they passed the ISO14001 environmental management system. Four out of nine companies concerned to protect environment in accordance with relevant laws. Two companies disclosed no penalties from the government and no

environmental accident. It is apparent from Table VI that cement firms nearest the Coastal region of China are more likely to implement central government laws and regulations than are cement firms in either the Central or the Western region. For example, both Guangdong Tapai and Fujian present legislation compliance in their CSR reports in a much more comprehensive way than do cement firms located in other regions of China. Fujian especially mentions its compliance with the Water and Soil Conservation Law, Environmental Protection Law as well as its ISO14001 certification. On the other hand cement firms such as Henan Tongli (Central China) and Xinjiang Tianshan (Western China) are not informative as to fulfilling the requirements of any specific laws but only that the firms have ISO14001 certification. It has been previously discussed that Article 5 of the Environmental Protection Law stipulates the importance of science and technological education and innovation in order to reduce environmental pollution. Moreover, the Water and Soil Conservation Law stipulates the need for water administration departments at county level to be the primary drivers in both water and soil conservation. Furthermore, Article 6 and Article 20 of the Cleaner Production Promotion Law stipulates that the state should act as the primary facilitator of innovation towards cleaner production. The emphasis on the role of the state in order as the driver of innovation in order to reduce environmental pollution is underlined in the 12th five year plan which emphasises research into technologies and processes which may reduce or eliminate environmental pollution. The role of the state as the driving force in the reduction of environmental pollution through legislation is in sharp contrast to the free market model. This states that the market works more efficiently if there is no government intervention. However, it has already been noted that environmental pollution and more specifically water loss and soil erosion causes China's GDP to fall by 3.5% annually. It is easy to see, therefore, that without government intervention firms may have no need to reduce environmental pollution. None of the nine cement firms whose CSR reports were analysed made no mention of compliance with the Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution. Nevertheless, Article 3 of this law states that the government shall take gradual steps to reduce atmospheric pollution at the national as well as at the local levels.

Table VI: Legislations mentioned in the CSR reports

Source: Compiled and Translated by Authors from Company CSR Reports.

Cement Firms	Region	Legislations
2.BBMG	**Northern**	Implement the principles and policies of the national and local energy saving and environmental protection Did not occur penalties for violations of environmental protection law and the environmental pollution accident Various forms of pollution emissions reaches 100% pass rate
3.Jilin Yatai	**Northern**	In 2012, annual environmental management discharge is up to the national standards
4.Tangshan Jidong	**Northern**	Passed the ISO14001 environmental management system
5.Huaxin	**Central**	N/A
1.Conch	**Central**	Emission targets are up to or even better than the national standard Follow the national environmental standards for environmental labeling products technical requirements cement (HJ2519-2012) which is issued by Ministry of Environmental Protection Reduce nitrogen emissions in accordance with national policies in 2012
	Central	Various discharges completely up to national standards Passed the ISO14001 environment certification
8.Guangdong Tapai	**Coastal**	Passed the ISO14001 environmental management system Strict implementation of national environmental policy, laws, regulations, and achieve compliance rate 100% of emissions of major pollutants Zero environmental incidents, zero public complaints of the environment; no government administrative penalties Evaluation process in accordance with the "Law of the People's Republic of China on Environmental Impact Assessment" Pay sewage charges more than 3.68 million RMB in 2012 Carry out clean production in accordance to the "People's Republic of China Cleaner Production Promotion Law"
9.Fujian	**Coastal**	Environmental emission meet the national standards in 2012 Earnestly implement the "Environmental Protection Law", "Water and Soil Conservation Law", and passed ISO14001 environmental certification
6.Xinjiang Tianshan	**Western**	Passed the ISO14001 environmental management system and ISO9001 quality management system Clinker product quality and emission meet the national standard

Following on from this law, the Ministry of Environmental Protection released an update in 2013 that cement plants would be placed under greater scrutiny for compliance with the various environmental laws and regulations by increased monitoring and inspection (MEP, 2013a). Furthermore, the latter states that lower thresholds for PM2.5, or particles less than 2.5 micrometres in diameter, would be specified. But it has been recognised that the reduction in atmospheric pollution could take decades with a relatively short term impact (MEP, 2013a).

6.2.2 Resources saving and utilization mentioned in CSR report

Table VII shows resources saving and utilization mentioned in cement company CSR reports. Eight out of nine cement companies emphasized the treatment of the industrial solid waste, either recycle it or maximize the usage.

Table VII: Resources saving and utilization mentioned in CSR report

Source: Compiled and Translated by Authors from Company CSR Reports.

Resources saving and utilisation	Region	Materials	Energy
2.BBMG	Northern	Use Calcium carbide residue to produce cement Recycle the solid waste	Saving standard coal, water and electricity
3.Jilin Yatai	Northern	Use industrial tailings and solid waste to produce cement	Saving standard coal Develop waste heat power generation
4.Tangshan Jidong	Northern	Maximize the use of industrial solid waste	Use pure low temperature waste heat power generation Saving standard coal
1.Conch	Central	Emphasis on the treatment of industrial solid waste. Use aluminum ore tailings to produce cement.	Develop waste heat power generation. Saving standard coal
5.Huaxin	Central	Improved waste resource utilization rate Improved fossil fuel substitution rate	Use waste heat power generation Reduced Clinker coal consumption Reduced cement power consumption
7.Henan Tongli	Central	Maximize the use of industrial solid waste	Lower energy consumption Use waste power generation
8.Guangdong Tapai	Coastal	Use industrial solid waste to produce cement	Reduce energy and resource consumption Saving standard coal Use waste heat power generation
9.Fujian	Coastal	Increase the use of admixtures Comprehensive utilization of resources	Use waste heat power generation Saving standard coal and electricity
6.Xinjiang Tianshan	Western	Use industrial solid waste and carbide slag to produce portland cement clinker Use industrial solid waste to replace natural resources	Use low-temperature waste heat power generation

Six out of nine firms have used tailings or residue to produce cement to replace the usage of natural resources. Eight out of nine companies developed waste heat power generation and seven of them have saved the usage of standard coal. The materials and energy characteristic of each cement firm can be broken down by region and this is shown in Table VIII below.

Table VIII: Regional Characteristics: Resources saving and utilization mentioned in CSR report

Source: Compiled and Translated by Authors from Company CSR Reports.

Region	Material/Energy Characteristic
Northern	Solid waste recycling Saving standard coal Use of industrial solid waste Low temperature heat power generation
Central	Improve waste resource use utilisation Improve fossil fuel substitution rate Reduced clinker coal consumption Lower energy consumption
Coastal	Use of industrial waste to produce cement Increased use of admixtures Waste heat power generation
Western	Use of industrial waste Low temperature waste heat power generation

Table VIII above shows the materials and energy characteristic with regards to resource saving and utilisation mentioned in each cement firm's CSR report by region. While across regions the common factor is the increased use of solid waste there are differences between regions. For example, in the Coastal region the emphasis is on the increased use of admixtures and the use of waste to generate power. However, the emphasis in the Central region is on improved fossil fuel substitution rate and improved waste resource use utilisation. In Northern and Western China the emphasis is on low temperature power generation.

6.2.3 Emissions, Effluents, and Waste mentioned in CSR reports

Table IX shows air waste mentioned in cement company CSR reports by region.

Table IX: Air Pollution mentioned in CSR reports

Source: Compiled and Translated by Authors from Company CSR Reports.

Cement Firm	Region	Air Pollution
2.BBMG	Northern	· Reduce SO_2 dust, COD and ammonia emissions · Reduce nitrogen oxide emission
3.Jilin Yatai	Northern	· Install dust collector for each pollutant discharge port · Reduce nitrogen oxide, CO_2 , SO_2 and dust emissions
4.Tangshan Jidong	Northern	· Air waste treatment · Reduce CO_2 emissions · Reduce nitrogen oxide emissions
5.Huaxin	Central	· Use low sulphur coal to reduce SO_2 emissions · Reduce NO_x emissions · Optimized dust collector operation Reduce CO_2 emissions
1.Conch	Central	· Maintain dust collection equipment · Reduce CO_2 emissions · Reduce NO_x emissions
7.Henan Tongli	Central	· Air waste treatment · Reducing dust emissions · Reduce CO_2 emissions
8.Guangdong Tapai	Coastal	Reduce NO_x , SO_2, dust and other emissions
9. Fujian	Coastal	· Dust, SO_2, NO_x emissions meet the national standard · Control dust and harmful gas emissions · Reduce CO_2 and SO_2 emissions
6.Xinjiang Tianshan	Western	Strictly control SO_2 and dust emissions performance and reduce NO_x emissions

From Table IX it is clear that there is not much if any difference in cement firms objectives with regards to air pollution. Nevertheless, there is a variation in the CSR objectives of cement firms within regions. For example, in the Northern region only Jilin Yatai focuses on the reduction in dust emissions by the installation of a dust collector. In the Central region only Huaxin aims to reduce SO_2 emissions by using coal with a low sulphur content. However, in the Coastal region both forms, Guangdong Tapai and Fujian, focus on the same if not the same objectives with regards to controlling and reducing air pollution by reducing SO_2 , NO_x , CO_2 and dust emissions. The fact that cement firms in the Coastal region of China have very similar CSR objectives may suggest that these cement firms face greater scrutiny because of their location in China's manufacturing and increasingly urbanised heartland. It is in the Coastal region of China that the national government has introduced tough environmental legislation (Ramesh, 2012). This has tended to increase the manufacturing costs of firms due to them having to buy plant and machinery to reduce emissions or to invest more money into research and development into new methods, processes or machinery to reduce environmental pollution due to fossil fuel emissions.

6.2.4 Innovation mentioned in CSR reports

Table X shows innovation mentioned in cement companies CSR reports for China's Central region.

Table X: Innovation mentioned in CSR reports: Central region.

Source: Compiled and Translated by Authors from Company CSR Reports.

Cement Firms	Region	Product innovation	Improved technology	Independent innovation	Innovation achievement	Management innovation
5.Huaxin	**Central**	N/A	Optimize sewage treatment technology Optimize dust collector operation Optimize production process Improve waste heat power generation technology	Independently developed new burners	Granted 12 patents for cement kiln co-process treatment technology	Built an energy management center Built internal environment assessment and risk analysis system Developed new packing workshop configuration and management system
1.Conch	**Central**	N/A	Improve low nitrogen staged combustion technology Improve waste heat power generation technology	Developed a 4th generation grate cooler, energy efficient vertical mill and efficient preheater Innovated cement kilns co-processing of municipal sludge waste technology	N/A	On-line monitoring
7. Henan Tongli	**Central**	N/A	Upgraded the grate cooler, firing system Replaced the electrostatic precipitator on the production line	N/A	N/A	Improve environmental management rules and carry out environmental impact assessment Clean production audit, real-time online waste monitoring network Launch national cement industry energy saving standards contest

The extent of the innovation in the three cement firms in the Central region can be analysed on the basis of product innovation, improved technology, independent innovation, innovation achievement and management innovation. In terms of innovation to reduce air pollution due to the burning of fossil fuels during the cement production process, it can be seen that Huaxin has been the most innovative of the three firms. This is because it has been granted 12 patents for cement kiln co-process treatment technology. It is fifth out of the nine cement firms analyzed in terms of market capitalization. As previously noted it is the use of the type of kiln in cement production, rotary or shaft, which will dictate the extent of the burning of fossil fuels. Nevertheless, Anhui Conch developed a 4th generation grate cooler, energy efficient vertical mill and efficient preheater. The firm also innovated cement kilns co-processing of municipal sludge waste technology. Anhui Conch is first out of the nine cement firms to be analyzed in terms of market capitalization in this study.

Table XI: Innovation mentioned in CSR reports: Northern region.

Source: Compiled and Translated by Authors from Company CSR Reports.

Cement Firms	Region	Product innovation	Improved technology	Independent innovation	Innovation achievement	Management innovation
2.BBMG	**Northern**	N/A	Improve existing production lines, new dry process clinker production line technology Cement mill energy-saving technological transformation Complete the SNCR denitrification projects for six subsidiaries	Developed new dry process cement kiln high temperature chromium-free refractory bricks Developed and owned independent intellectual property rights of cement kilns co-processing of waste incineration fly ash technology Set up innovation studio with universities	Granted 10 national science and technology projects, 61 patents application	Set up precise management of production and operation Implement the responsibility system and control assessment
3.Jilin Yatai	**Northern**	N/A	Complete improvement of low-NOx combustion technology for clinker production line and flue gas denitrification facilities Improve waste heat power generation technology Installed dust collector	N/A	N/A	N/A
4.Tangshan Jidong	**Northern**	N/A	15 clinker production line started to construct denitrification projects Improve waste heat power generation technology	N/A	N/A	Introduced comprehensive environment management methods and improve management content Established environmental information exchange board through internet

Table XI above shows innovation which has been mentioned in the CSR reports for BBMG, Jilin Yatai and Tangshan Jidong in terms of product innovation, improved technology, independent innovation, innovation achievement and management innovation. It is clear to see that BBMG has been the most innovative of all three cement firms in the Northern region. This is due to the fact that BBMG has been granted 10 national science and technology projects and has 61 patents application. Furthermore, BBMG has developed a new dry process cement kiln high temperature chromium-free refractory bricks, developed and owned independent intellectual property rights of cement kilns co-processing of waste incineration fly ash technology; and it has set up innovation studio with universities.

Table XII: Innovation mentioned in CSR reports: Coastal and Western Regions.

Source: Compiled and Translated by Authors from Company CSR Reports

Cement Firms	Region	Product innovation	Improved technology	Independent innovation	Innovation achievement	Management innovation
8.Guangdong Tapai	**Coastal**	N/A	Improve new dry process rotary kiln production with denitrification, the precipitator of the ingredients of the cement clinker conveying system, waste heat for power generation, fan inverter Develop and implement cement calcining technology with industrial waste gas	N/A	N/A	Establish the Environmental Management Committee Set up four levels environmental management and supervision network Environmental education training and information exchange
9.Fujian	**Coastal**	N/A	Renew and upgrade precipitator Complete the SNCR denitrification projects Complete waste heat power generation technology Improve kiln exhaust gas processing technology	N/A	N/A	Precise management On-line monitoring Establish rules and regulations Strengthen the assessment and supervision
6.Xinjiang Tianshan	**Western**	Develop high-performance cement products Implement mix of high quality aggregate R&D	Improve 3 production lines by using the SNCR method of denitrification Improve advanced production technology	Developed Xinjiang's first rotary kiln co-processing of municipal sewage sludge and solid waste technology Developed large-scale industrial processing device	Apply the patent-based intellectual property to establish the core proprietary technology system	Improve environmental management rules and regulations Standardize management processes to improve environmental management quality

The reason why BBMG may have been more innovative with respect to its CSR objectives in contrast to the other two firms whose CSR objectives and associated innovation were analyzed may have been due to the fact that BBMG is the second largest of the nine cement firms analyzed in terms of market capitalization. This would

clearly indicate that despite government laws and objectives, the financial resources available to a cement company will dictate the extent to which it can be innovative with regards to innovating for reducing fossil fuel emissions and reducing environmental pollution.

Table XII above shows innovation which has been mentioned in the CSR reports for Guangdong Tapai, Fujian and Xinjiang Tianshan in terms of product innovation, improved technology, independent innovation, innovation achievement and management innovation. The first two cement firms are in the Coastal region of China and the last cement firm is in the Western region of China. It is clear to see from Table XII that neither cement company in China's Coastal region has been innovative in the context of either independent innovation or innovation achievement. This may be due to the fact that in terms of market capitalisation, Guangdong Tapai and Fujian are eighth and ninth in terms of market capitalisation out of the nine firms studied in this paper. This may indicate that despite the fact that national government has legislated with regards to reducing environmental air pollution and it has also provided CSR guidelines for state owned cement firms, the financial resources available to a firm is the most important determinant of the firm's ability to innovate. On the other hand Xinjiang Tianshan is in sixth place out of the nine cement firms analysed in this study in terms of market capitalisation. Due to the fact that it has more financial resources in comparison to the two Coastal cement firms, Xinjiang Tianshan has been able to innovate. In this case the firm has been able to apply the patent-based intellectual property to establish the core proprietary technology system. Furthermore, Xinjiang Tianshan has been able to develop Xinjiang's first rotary kiln co-processing of municipal sewage sludge and solid waste technology; and to develop large-scale industrial processing device.

7. Conclusion

This paper has sought to contribute to the literature by evaluating the development of environmental protection laws, regulations and voluntarily adopted CSR objectives associated with environmental protection in the People's Republic of China. Furthermore, this paper has also sought to determine whether such laws, regulations and CSR objectives relating to environmental protection and specifically air pollution will contribute towards cement firm innovation to reduce environmental air pollution. This arises mainly from the use of fossil fuels for cement production and the type of kiln used. China has the largest share of cement production and so contributes the most to air pollution with respect to this industry. Therefore any type of innovation, process or machinery, which reduces environmental air pollution due to cement production would be of use not only to China but also to the whole world. Figure 1 shows that CO_2 emissions from the burning of fossil fuels have increased from cement production especially after 1978. This year is quite significant because it is the year in which China started its free market economic reforms. One direct result of the economic reforms is the increased urbanisation which has characterised the development of China's spatial economy. This increased urbanisation has required more and more buildings. This has necessitated the increased production of concrete for the buildings, the basic component of which is cement. The increased production of cement has resulted in significant increases in CO_2, NO_x, SO_2 and PM matter. The effect has been increasing smog in Chinese cities resulting in its citizens developing cancer and cardiovascular illnesses. The costs of these diseases to the Chinese economy from lost production and damage caused to the citizens of the country are incalculable. Moreover, China's environmental pollution is not only its problem but it is also a problem for the entire world. Furthermore, increasing levels of CO_2 in the earth's atmosphere will mean that the sun's rays are captured into the earth's atmosphere. This will increase the heating of our planet and contribute towards climate change. The ice at the earth's North and South poles will melt and ocean currents disrupted. This could lead to dramatic shifts in the earth's climate to the extent that another ice age maybe imminent. Therefore, it is of global interest that China finds away to reduce atmospheric air pollution, the cement industry being the main contributor. The results of this paper are in contrast with conventional views regarding the regional polarisation of innovation in China and the driving forces of innovation in the cement industry. The conventional literature on the regional polarisation of innovation in China suggests that based on the granting and application of patents the Coastal region is at the forefront of innovation in China (Ramesh, 2012a). However, the results of this paper based on cement firm capitalisation and their published CSR reports suggests that market capitalisation and access to financial resources is a more significant driver of innovation to reduce environmental air pollution than government laws, regulations or CSR guidelines. This finding does not contradict with endogenous economic growth theory which is based on innovation which asserts the importance of government intervention. Rather, the results of this paper suggests that government intervention should not be based solely on laws, regulations and CSR guidelines on environmental air pollution but that these should be aligned with subsidies to cement firms to help them to fund innovation. However, the government would also be able to fund research institutes specifically linked to the

cement industry. These research institutes could innovate on behalf of the cement industry and such innovations to reduce environmental air pollution would not have to be patented but government owned and enforced on cement firms. Furthermore, the government could assist cement firms to merge so that the merged firms will have accumulated financial resources which could be used for environmental air pollution reduction process and machinery innovation. The Chinese cement industry could also be opened up so that foreign multinational cement firms could enter the Chinese market and contribute new technology and management processes from which Chinese cement firms and the global environment would benefit.

References

Aghion, P. and Howitt, P. (1998). *Endogenous Growth Theory*. The MIT Press.

Allen, D.B. and Husted, B. W. (2006). 'Corporate social responsibility in the multinational enterprise: Strategic and institutional approaches'. *Journal of International Business Studies*, 37(6): 838.

Alun, G. and Xiusheng, X. (2013). 'The Potential and Cost Analysis of Emission Reduction in China's Cement Sector'. *Advanced Materials Research*, Vol. 664, pp.1200-1209.

Baxi, C. et al. (2005). *Corporate Social Responsibility: Concepts and Cases: The Indian Experience*. Excel Books India.

BBC (2013). Scientists call for Action to Tackle CO_2 Levels. http://www.bbc.co.uk/news/science-environment-22491491 (accessed on 9th May 2013).

Beyer, S. (2006). 'Environmental Law and Policy in the People's Republic of China'. *Chinese Journal of International Law*, Vol.5, No.1, pp.185-211.

Boden et al. (2010). Regional and National Fossil Fuel CO2 Emissions. http://cdiac.ornl.gov/CO2_Emission/timeseries/global (accessed on 19th May 2013).

Boli, J. and Hartsuiker, D. (2001). *World culture and transnational corporations: sketch of a project*. Paper presented at the International Conference on Effects of and Responses to Globalization. Istanbul.

Burke, S. and W. F. Gaughran (2006). 'Intelligent environmental management for SMEs in manufacturing'. *Robotics and Computer-Integrated Manufacturing*, **22**, 566-575.

Carroll, Archie B. (1991, July-August). 'The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders'. *Business Horizons*, pp. 39-48. http://www-rohan.sdsu.edu/faculty/dunnweb/rprnts.pyramidofcsr.pdf (Accessed on 7th July 2009).

CB (2011). China Revises Law on Water and Soil Conservation. http://www.china-briefing.com/news/2011/01/06/china-revises-law-on-water-and-soil-conservation.html (Accessed on 7th May 2013).

CCSR (2009). SASAC Encourages Chinese SoE's to Release CSR Reports. http://www.chinacsr.com/en/2009/05/18/5261-sasac-encourages-chinese-soes-to-release-csr-reports/ (Accessed on 7th May 2013).

CD (2006). Company Law of the People's Republic of China. http://www.chinadaily.com.cn/bizchina/2006-04/17/content_569258.htm (Accessed on 7th May 2013).

Chan, C. and Yao, X. (2008). 'Air Pollution in Mega Cities in China'. *Atmospheric Environment*, 42, pp. 1-42.

China WTO Tribune (2012). Golden Bee Research on Corporate Social Responsibility Reporting in China 2011. http://www.csrchina.net/FILES/CSRREPORT2012/%E9%87%91%E8%9C%9C%E8%9C%82%E4%B8%AD%E5%9B%BD%E4%BC%81%E4%B8%9A%E7%A4%BE%E4%BC%9A%E8%B4%A3%E4%BB%BB%E6%8A%A5%E5%91%8A%E7%A0%94%E7%A9%B62012.pdf (Accessed on 4th May 2013).

Chow, C.K.M., Song, F.M. and Wong, K. P. (2010). 'Investment and the soft budget constraint in China'. *International Review of Economics & Finance*, Vol. 19, Issue 2, pp. 219-227.

Crane, A., Matten, D. & Spence, L. J. (2008). *Corporate Social Responsibility: Readings and Cases in a Global Context*. Abingdon, England: Routledge.

Da Qi Xu et al. (2012). 'Research on the Evaluation Index System of Technological Innovation Capability in the Cement Industry'. *Applied Mechanics and Materials*, 268-270, 2075.

Gao, Y. (2009). 'Corporate Social Performance in China: Evidence from Large Companies'. *Journal of Business Ethics*, 89, 23–35.

Hamel, G. (2006). 'The Why, What, and How of Management Innovation'. *Harvard Business Review*, 84(6), pp. 72-84.

He, L (2011). 'Corporate Social Report of Cement Companies Listed in Chinese Stock Market'. *Finance and Accounting Communication*, 1, p. 7 (Translated from Chinese Journal).

Holler, M. (2010). *Schumpeter for Our Century*. BoD Books on Demand.

Knoop, T. (2009). *Recessions and Depressions: Understanding Business Cycles*. ABC-CLIO.
Kong, D., Liu, S. and Dai, Y. (2012). 'Environmental Policy, Company Environment Protection, and Stock Market Performance: Evidence from China'. *Corporate Social Responsibility and Environmental* Management, doi: 10.1002/csr.1306.
Lei, Y., Zhang, Q., Nielsen, C. and He, K. (2011). 'An Inventory of Primary Air Pollutants and CO_2 Emissions from cement production in China, 1990-2020'. *Atmospheric Environment*, 45, pp. 147-154.
Lin, J. Y., and G. Tan. (1999). 'Policy burdens, accountability, and the soft budget constraint'. *American Economic Review Papers and Proceedings*, 89(2): 426-431.
Lin, Li (2012). 'Corporate Social Responsibility in China: Window Dressing or Structural Change'. *Berkeley Journal of International Law*, Vol 28, Issue 1.
Little, A. D. (2006). 'The Innovation Highground - Winning tomorrow's customers using sustainability-driven innovation'. *Strategic Direction*, **22**(1).
Lamas, W., Palau, J. and Camargo, J. (2013). 'Waste Materials Co-processing in Cement Industry: Ecological Efficiency of Waste Re-Use'. *Renewable and Sustainable Energy Reviews*, 19, pp. 200-207.
MacGregor S. P, Spinach, X. and Fontrodona. J. (2007). *Social innovation: Using design to generate business value through corporate social responsibility*. IESE Business School, University of Gerona, Spain.
McKie, R. (2013). Climate Change will make Hundreds of Millions Homeless. http://www.guardian.co.uk/environment/2013/may/12/climate-change-expert-stern-displacement (Accessed on 7th May 2013).
MEP (2000). Chapter 1: General Provisions,' in 'Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution. http://www.china.org.cn/english/government/207464.htm (Accessed on 9th May 2013).
MEP (2013a). China Strengthens Air Pollution. http://english.mep.gov.cn/News_service/media_news/201306/t20130608_253576.htm (Accessed on 17th May 2013).
Min-Dong Paul Lee (2008). 'A review of the theories of corporate social responsibility: Its evolutionary path and the road ahead'. *International Journal of Management Reviews*, Vol. 10, Issue 1 pp. 53–73.
Mokyr, J. (2010). 'The Contributions of Economic History to the Study of Innovation and Technical Change: 1750-1914', in Hall, B. and Rosenberg, N. (Eds), *Handbook of the Economics of Innovation*. Elsevier.
Moon, J. and Shen, X. (2010). 'CSR in China Research: Salience, Focus and Nature'. *Journal of Business Ethics*, Vol. 94, pp. 613-629.
NDRC (2002). Cleaner Production in China. http://www.chinacp.org.cn/eng/ (Accessed on 7th May 2013).
Noronha, C., Tou, S., Cynthia, M.I. and Guan, J. (2012). 'Corporate Social Responsibility Reporting in China: An Overview and Comparison with Major Trends'. *Corporate Social Responsibility and Environmental* Management, pp. 1-14.
Poolton, J. and Ismail, H. (2000). 'New developments in innovation'. *Journal of Managerial Psychology*, **15**(8), 795-811.
Pimenova, P. and R. V. D. Vorst (2004). 'The role of support programmes and policies in improving SMEs environmental performance in developed and transition economies'. *Journal of Cleaner Production*, **12**, 549-559.
PRC (2005). Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste. http://www.chinaenvironmentallaw.com/ (Accessed on 15th May 2013).
PRC (2013). Environmental Protection Law of the People's Republic of China. http://www.china.org.cn/english/environment/34356.htm (Accessed on 15th May 2013).
Ramesh, S. (2012). 'Continental Shift: China and the Global Economic Crisis' in *Wang*, L. (Eds). *Rising China in the Changing World Economy*. Routledge/Taylor and Francis Group.
Ramesh, S. (2012a). 'China's Transition to a Knowledge Economy'. *Journal of the Knowledge Economy*, Vol. 2, No.2,
SASAC (2008). Guidelines to the State Owned Enterprises Directly under the Central Government on Fulfilling Corporate Social Responsibilities. http://www.sasac.gov.cn/n2963340/n2964712/4891623.html (Accessed on 7th May 2013).
Salvadori, N. (2003). *Old and New Growth Theories: An Assessment*. Edward Elgar Publishing.
Sawhney, M., Wolcott, R.C. and Arroniz, I. (2006). 'The 12 Different Ways for Companies to Innovate'. *MIT Sloan Management Review*, 47(3), pp. 74-81.
Shimoda, Y., et al. (2012). 'Meso-Level Research towards a Low Carbon Society', in Matsumoto et al. (Eds). *Design for Innovative Value towards a Sustainable Society*, Springer.

USCC (2012). Corporate Responsibility and Sustainable Economic Development in China: Implications for Business. National Chamber Foundation. http://www.uschamber.com/sites/default/files/international/files/17296_China%20Corp%20Social%20Responsibility_Opt.pdf (Accessed on 7th May 2013).

Vila, J. and MacGregor, S. P. (2007). *Business Innovation: What it brings, what it takes*. IESE Alumni Magazine.

Wang, J. and Qin, S. (2010). 'Problems and Prospects of CSR System Development in China'. *International Journal of Business and Management*, Vol. 5, No. 12, pp. 128-134.

Wang, S. (2011). What does China's new five year plan address? http://www.bbc.co.uk/news/world-asia-pacific-12639898 (Accessed on 17th May 2013).

Watts, J. (2012). Air Pollution Could Become China's Biggest Health Threat Expert Warns. http://www.guardian.co.uk/environment/2012/mar/16/air-pollution-biggest-threat-china (Accessed on 19th May 2013).

Xi, Y., Fei, T. and Gehua, W. (2013). Incorporating Environment Co-Benefits into Climate Policies: A Regional Study of the Cement Industry in China. http://dx.doi.org/10.1016/j.apenergy.2013.03.040 (Accessed on 7th May 2013).

Zhou, W. D. (2006). Will CSR work in China? China-CSR. http://www. chinacsr.com/en/2006/08/10/653-will-csr-work-in-china/ (Accessed on 7th April 2013).