Developing Environmental Accountability through Consumer Preferences: An Example from the Oil Industry

by

Yaning Zhang

A Thesis Submitted in Partial Fulfillment of the Requirements for the

Degree of Bachelor of Sciences, Honours

in the Department of Economics

University of Victoria

April 2016

Supervised by Dr. Elisabeth Gugl

for

Dr. Chris Auld, Honours co-advisor

Dr. Merwan Engineer, Honours co-advisor

Abstract

This paper models the divergent environmental strategies of two oil firms, Royal Dutch Shell and ExxonMobil. When consumers care about the environmental policies of the firm from which they purchase oil, the firms not only compete over price, but also over their environment accountability. Firm's strategies diverge when consumers are divided in how much they care for environmentally friendly policies. Then one firm may spend more on environmental friendly policies and charge a higher price than the other firm. Non-market reasons behind the divergent environmental strategies of two firms are also discussed in the paper.

Keywords: environmental accountability, consumer theory, oil industry

TABLE OF CONTENTS

1. Introduction

Since the Kyoto Protocol, the international treaty that commits governments to reduce greenhouse gas emission, was introduced to the world in 1992, climate change has become a popular, yet controversial topic to many people. The sociological, political, and economical implications drawn from climate change make many corporations adjust their business strategies accordingly. The oil industry has been criticized for its negative environmental impacts, including tremendous carbon dioxide emission and oil spill incidents. This paper is inspired by the interesting fact that two of the biggest oil companies, ExxonMobil and Royal Dutch Shell have distinct attitudes toward climate change. Specifically, although the majority of environmental scientists believe that rapid climate change due to human activity is evidential, ExxonMobil has been publicly denying climate change and financially supporting the scientists and lobby groups who hold the same opinion until very recent years. Since 2007, ExxonMobil has given millions to climate-denying lawmakers despite pledge (The Guardian, 2015). Its attitude only changed in recent years. On the other hand, Shell's attitude towards climate change is more proactive. It seeks market solutions, for example, the Shell Tradable Emission Permit System (STEPS), and also invests a significant amount of funds in renewable energy. I use these two companies as representations of proactive and reactive companies in the oil industry. Levy and Kolk (2001) argue that the disparate responses of the U.S. and European companies in the early phase of climate change were found to be related to regulatory expectations, norms concerning the conduct of business-government relationship, and cognitive assumptions on the future of fossil fuel and substitute technologies; but just like they say in their paper, these divergent strategies cannot be explained simply; they each represents a coherent blend of market

and non-market strategies. Each firm's attitude toward climate change is their environmental performance in a nutshell. In this paper I focus on the economic explanations on this divergence, and I wish to use Cournot model to answer the following questions: Why do different companies (e.g. Exxon and Shell) adopt distinct business strategies towards environmental problems; and what role do consumers play in their decision making process?

The main contribution of this paper is to find how consumers' environmental sensitivities and expectations influence firms' business strategies through their consumption behavior. I look into both demand side and supply side of this problem, and find that in a duopoly market, the firms will choose the same environmental accountability simultaneously when the proportion of consumers who exhibit environmental sensitivity is either sufficiently low or high. Moreover, the firms would choose to differentiate strategies from each other when the proportion of environmental friendly consumers in the market is in a certain intermediate range.

2. Literature Review

The relationship between corporate social responsibility and consumer preferences has been studies from many aspects in the past several decades.

Basu and Zarghamee (2005) discuss the situation when consumers have a preference over the products based on whether the products are produced by child labor. When the firms try to reduce production cost by hiring child labor, some consumers start to boycott such unethical behavior. The paper studies this case by looking into consumer's boycott behavior, firms' profit maximizing problem and labor market. It finds that when consumers boycott the products that are produced by child labor, the price of the product as well as the child labor's wage would fall,

where as adult's wage is constant. Hence, worker households suffer a welfare loss. In other words, an increased boycott could cause child worker households to be worse off and the number of child labor to rise. This paper is relevant to my paper even though the context is different. I wish to develop a model where instead of child labor; the consumer's preference is based on supplier's environmental accountability.

Conrad (2004) discusses consumer's choice when facing products with horizontal differentiation, which is defined as the difference in the products in the features that can't be ordered in an objective way, for example, some consumers value environmental friendliness of the firm more than others, and even though the products may be perfect substitute, a consumer may still prefer one product over another because of the firm's environmental friendliness. In this paper, Conrad develops a two period model where the two firms first choose environmental characteristics, and then compete over profit. He uses backward deduction to find sub game perfect Nash equilibrium. In the paper, Conrad assumes the consumers have a spectrum of environmental sensitivity, and can only choose one supplier; whereas in my paper, I assume a consumer is either environmental friendly or not, and he can choose to buy products from both firms. Conrad's paper finds that the location of the social welfare maximizing characteristics is not the same as the one chosen by private firms in the three Nash equilibria. Even if there is no real environmental damage, the social optimal location differs from the private one.

3. Divergent Climate Policies

Climate policies the two firms committed vary in many aspects. The table below best illustrates the differences between ExxonMobil and Shell (Pulver, 2007).

A Comparison of ExxonMobil and Shell's

Climate Policies

New Policy	ExxonMobil	Shell 1998
Climate science	Critical of scientific assessment of Intergovernmental Panel on Climate Change	Current state of climate science merits precautionary action
Kyoto Protocol Emissions target	Oppose No target	Support 10% by 2002
Internal emissions trading system	No	Yes
Renewable Energy Investments	No	$500 million for 5 years
Nongovernmental organization partners	No	Yes

Table 1. A Comparison of ExxonMobil and Shell's Climate Policies

Note: adapted from Making Sense Of Corporate Environmentalism: An Environmental Contestation Approach to Analyzing the Causes and Consequences of the Climate Change Policy Split in the Oil Industry. Pulver, S (2007)

We can from the table see that when it comes to environmental issues, ExxonMobil is reactive to the policies and do not pursue any environment improvement that is not mandatory to the firm. Shell, on the other hand, is more proactive regarding to environmental issues. I wish to find the causes of the dispersion in this paper.

4. Consumer's preference

In many situations, consumer's well-being is not only depends on the quantity of goods they consume, but also whether the goods are produced ethically; when consumers start to choose suppliers based on their ethic, they can influence the companies behavior. This is especially true in countries with weak regulatory environment. For example, cut flower export is a major business in Columbia, and the main consumers are from the European Union (EU) and North America. "Social and environmental standards have become mainstream for flowers imported into the EU" (Riisgaard, 2011). As a result of the preference of more environmental friendly products, in 1998 FlorVerde program was created, which encourages members to reduce the usage of pesticides. There are also examples such as consumers choosing their coffee based on whether the coffee beans are fair-traded, or choosing clothing brand base on whether its clothes is produced by child labor. Creyer (1997) argues that although it is important to understand the factors influencing how business decision makers respond to an ethical dilemma, it is equally important to understand how consumers interpret, and react to the outcome of that corporate decision. Since most business strategies are profit-driven, this paper will first analyze how the consumer preferences are related to the firms' social responsibility; and then study how the company's environmental accountability is reflected in the profit maximizing problem.

5. Model

5.1 Monopoly Model

In this section I wish to find how the companies' environmental accountability is related to the consumers' environmental consciousness if there is only one firm in the market. See the appendix for calculation steps that are not included in this section. The consumers' utility function are given as:

$$U_1 = X + \lambda g - \frac{g^2}{2}$$

$$U_2 = X + \lambda \beta g - \frac{g^2}{2}$$

$$s.t.\ Y = X + pg$$

In the equations, g is the gas the consumer purchases, X is the goods other than gas that the consumer purchases. Y and p represents the consumer's income and the price of gas. λ is a large enough constant that would ensure we have a positive demand. β is the firm's environmental accountability, which includes but not limited to the environmental policies the firm adopts, the research and development on technology improvement, the investment in renewable energy and the political stand on environmental issues. The two utility functions represent two types of consumers, the first type of consumer's utility depends on the products alone whereas the second type of consumer also consider the firm's environmental accountability when consumer gas. I sometime refer to type 1 consumers as environmental conscious consumers and type 2 consumers as environmental unconscious consumers in the paper. We assume that the consumers

can distinguish between what the firm says and what the firm actually do, so that β represents more than just the reputation of the firm, and the firms cannot mislead consumers through media or campaign.

We set $\beta \in$ (o,1), high β indicates high environmental accountability. When β=1, the firms is extremely environmental friendly, and the two type of consumers exhibit the same consumption behavior. This is highly unlikely and I do not consider this situation in my model.

We can derive their demand by solving the Lagrange function:

$$D_1 = \lambda - p$$

$$D_2 = \lambda\,\beta - p$$

Since $\beta \in$ (o,1), we can see here type 2 consumer would always buy less gas than type 1 consumer, which is reasonable when we consider gas as a product that always bring negative externalities to the environment. In a market, we assume there is α percent of people who don't care about the environment and (1-α) who do. We also assume α does not change over time. The aggregate demand of this market is:

$$D = \alpha D_1 + (1-\alpha)D_2 = \alpha(\lambda - p) + (1-\alpha)(\lambda\beta - p)$$

The firm's profit maximizing problem is:

$$Max\ \pi = (p - c\beta)D$$

c is a constant, and $c\beta$ is the per unit cost of production. Here we assume the per unit cost is a linear function of β, as usually the cost would be higher for producing more environmental friendly products.

When can find the FOCs for this problem, substituting price as a function of demand:

$$wrt\ g: [\alpha\ +\ (1-\alpha)\beta]\lambda\ -\ 2g\ -\ c\beta\ =\ 0$$

$$wrt\ \beta: \{(1-\alpha)\lambda\ -\ c\}g\ =\ 0$$

There is a corner solution for β. If the LHS of the equation is smaller than 0, i.e. $(1-\alpha)\lambda < c$, then the firm would always choose the smallest β possible, and if $(1-\alpha)\lambda > c$, then the firm would always choose the highest β possible. Which means as share of consumers who care about the firm's environmental accountability goes up constantly, at some point the firm would switch from adopting no environmental accountability to adopting full environmental accountability.

Proposition 1:

When the firm optimizes profit through choosing price and environmental accountability (β), there exist a threshold where the firm would switch from low β to a high β as the proportion of population who care about the environment increases.

5.2 Duopoly Model

In this section, we now consider an introduction of a new firm, and now there are two types of consumers, consumer 1 and consumer 2; and two firms, firm i and firm j.

Similar to the last section, the consumer's utility functions are:

$$U_1 = X + \lambda(g_i + g_j) - \frac{(g_i + g_j)^2}{2}$$

$$U_2 = X + \lambda \sum \beta_j g_j - \frac{(g_i + g_j)^2}{2}$$

$$s.t.\ Y = X + p_i g_i + p_j g_j$$

Type 1 consumer do not take the oil supplier's environmental accountability into consideration when consume, thus we can see β is not a part of their utility function. When there is a price difference, type 1 consumer would always choose to purchase from the supplier with lower price. If $p_i - p_j > 0$, the demand for firm i is :

$$g_i = \lambda - p_i$$

As for the consumers who care about the environment:

Consumer is indifferent when $\lambda(\beta_2 - \beta_1) = p_2 - p_1$

If the price difference was much greater than the difference in β, then the firm with higher price would exit the market, because neither environmental conscious consumers nor environmental unconscious consumers would purchase from them. If the price difference is not as larger, i.e. $0 < p_i - p_j < \lambda(\beta_i - \beta_j)$, then the demand for firm i is:

$$g_i = \lambda\beta_i - p_i$$

5.3 Cournot Game

Now we consider the Cournot game between the two firms. First, I assume the firms can only choose high or low environmental accountability, denoted by β^H and β^L.

Firm1/Firm2	β^H	β^L
β^H	Situation 1	Situation 2
β^L	Situation 2	Situation 3

Table 2. Cournot duopoly model

The table above illustrates all the possible situations. Since the game is symmetric, situation 2 represent one firm chooses β^H and the other chooses β^L. I start with situation 3, when two firms both agree to have low environmental accountability, and check whether it is Nash equilibrium.

When $\beta_i = \beta_j = \beta^L$, the prices are implied to equal, denoted p^L; and the aggregate demand is equal to the aggregate supply:

$$D = \alpha(\lambda - p^L) + (1-\alpha)(\lambda\beta^L - p^L) = g_i + g_j$$

The explicit price is: $p^L = \alpha\lambda + (1-\alpha)\beta^L\lambda - D$

In this situation, two firms are facing the same profit maximizing problem:

$$max\pi_{gi}[\alpha\lambda + (1-\alpha)\beta\lambda - g_i - g_j]gi - c\beta g_i$$

We can then find the equilibrium:

$$g_i = g_j = \frac{\alpha\lambda + (1-\alpha)\beta\lambda - c\beta}{3}$$

$$\pi_i = \frac{2(\alpha\lambda + (1-\alpha)\beta\lambda - c\beta)^2}{9}$$

Now, if one firm knows that the other firm would choose low environmental accountability, would it choose otherwise to maximizing its profit by attracting more environmental conscious consumers?

We consider the situation where firm i chooses low β, and firm j chooses high β. Again, because the game is symmetric, we also automatically consider when the opposite situation, so I omitted it in the model. Now firm j's price goes up. Firm j give up all the consumers who do not care about the environment, but also attract more consumers who care about the environment.

In situation 2, when $\beta_i = \beta^L,\ \beta_j = \beta^H,\ p_i = p^L, p_j = p^H$, and $0<P_j—P_i<\lambda(\beta_j - \beta_i)$. In this situation, type 1 consumer would only purchase from firm i, as firms i has lower price, and type 2 consumer would only purchase from firm j, since the price difference is not big enough to make environmental conscious consumer to purchase from an environmental unfriendly supplier. Thus $D_1 = g_i$ and $D_2 = g_j$

The demand in the market is

$$g_i = \alpha(\lambda - p_i)$$

$$g_j = (1-\alpha)(\lambda\beta^H - p_j)$$

The firms' profit functions are:

$$\pi_i = (p_i - c\beta^L)\alpha(\lambda - p_i)$$

$$\pi_j = (p_j - c\beta^H)(1-\alpha)(\lambda\beta^H - p_j)$$

Solve the profit maximizing problem:

$$p_i = \frac{\lambda + c\beta^L}{2}$$

$$\pi_i = \alpha(\frac{\lambda - c\beta^L}{2})^2$$

$$p_j = \frac{(c+\lambda)\beta^H}{2}$$

$$\pi_j = \frac{(1-a)\beta^{H^2}(c-\lambda)^2}{4}$$

The difference in the profit for firm j before and after choosing a higher β is:

$$difference = \frac{(1-a)\beta^{H^2}(c-\lambda)^2}{4} - \frac{(\alpha\lambda + (1-\alpha)\beta^L\lambda - c\beta^L)^2}{9}$$

If the difference was positive, firm j would choose to increase its environmental accountability. To simplify the problem, we can substitute some numbers for the exogenous constants. In a case of λ=10, β^L=0.1, β^H=0.9, c=1:

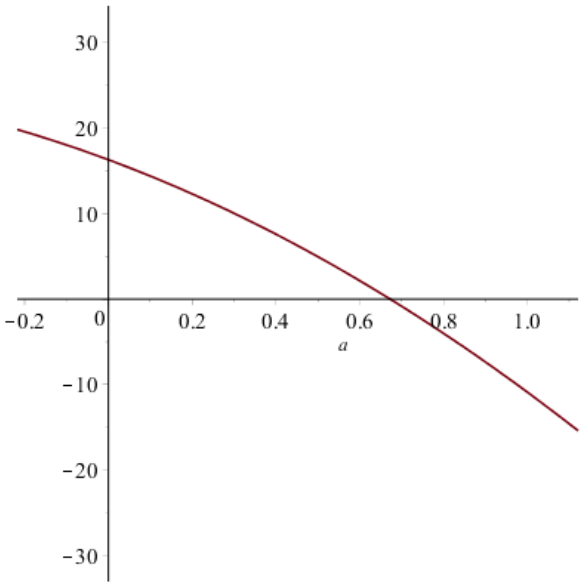

Figure 1. Profit difference for firm j

Here we can find a that makes the difference positive, in my case, $\alpha < 0.67$. With a small a, the difference is positive, which means firm j would gain more profit if chosen a high β when firm i chooses a low β. Which is equivalent to say if in a country there is a large proportion of

people who care about the environment, then the firm would be more profitable to choose a high environmental accountability.

Now we ask, since both firms have perfect information, would firm i now choose a different strategy knowing firm j will switch to high β.

We can do the same calculation as last part.

The profit the firm make when both firms choose high β is:

$$\pi_i = \frac{2(\alpha\lambda + (1-\alpha)\beta^H\lambda - c\beta^H)^2}{9}$$

Comparing this to the profit firm 1 makes when two firms deviate strategies and the difference is:

$$difference = \frac{(\alpha\lambda + (1-\alpha)\beta^H\lambda - c\beta^H)^2}{9} - \alpha(\frac{\lambda - c\beta^L}{2})^2$$

Again, we can substitute some numbers: $\beta^L = 0.1$, $\beta^H = 0.9$, $\lambda = 10$, c =1:

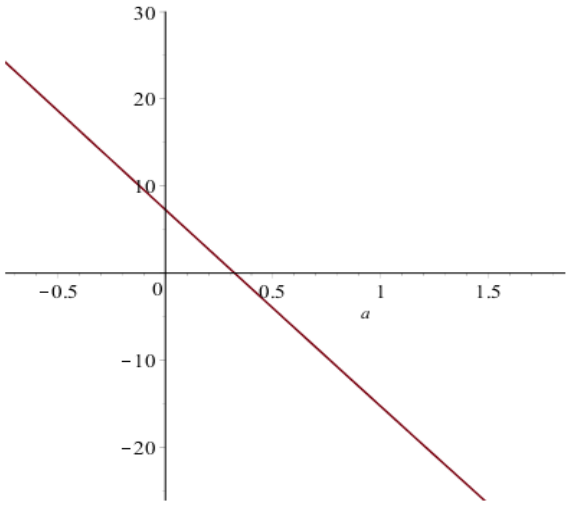

Figure 2. profit difference for firm i

The situation is very similar to the decision firm j made, if α is low (smaller than 0.32), it is most likely firm i will make more profit if choosing a high β.

The profit each firm makes under different situations are shown below:

Firm1/Firm2	β^H	β^L
β^H	$\frac{2(\alpha\lambda + (1-\alpha)\beta^H\lambda - c\beta^H)^2}{9}$, $\frac{2(\alpha\lambda + (1-\alpha)\beta^H\lambda - c\beta^H)^2}{9}$	$\frac{(1-a)\beta^{H2}(c-\lambda)^2}{4}$, $\alpha(\frac{\lambda - c\beta^L}{2})^2$
β^L	$\alpha(\frac{\lambda - c\beta^L}{2})^2$, $\frac{(1-a)\beta^{H2}(c-\lambda)^2}{4}$	$\frac{2(\alpha\lambda + (1-\alpha)\beta^L\lambda - c\beta^L)^2}{9}$, $\frac{2(\alpha\lambda + (1-\alpha)\beta^L\lambda - c\beta^L)^2}{9}$

Table 2. Cournot duopoly result

If α is large enough in a market (in my case, α >0.67), situation 1 is the Nash Equilibrium, both firms would choose a high environmental accountability, and if α is small enough ($\alpha < 0.32$), the Nash Equilibrium is situation 3. With an intermediate α ($0.32 < \alpha < 0.67$), only one firm would benefit from choosing a high β, so situation 2 is the Nash Equilibrium in that case. When two firms choose different strategies, note that the firm that chooses a high environmental accountability would always gain less profit than the other firm.

Proposition 2:

If the proportion of people who care about the environment is either high or low enough, the firms would always choose the same strategy in a market; and there exist a range of α where the Nash equilibrium is the firms choosing different strategies.

In my case, with the chosen exogenous constants, the range of α that would make two firms deviate their strategies is (0.32, 0.67). Different numerical inputs would result in different ranges, but there would always be a range where the two firms would choose to deviate their strategies. Using this proposition, we can explain the change in Exxon's strategy in recent years. The raising environmental awareness among consumers may have forced Exxon to commit to a high environmental performance, and the market is slowly transiting from situation 2 to situation 3.

6. Discussion

6.1 Further discussion on the model

A further consideration of the situation when two firms choose different environmental accountability is the contestable market. A contestable market is defined as an entrant has access to all production techniques available to the incumbent, in not prohibited from wooing the incumbent's consumers, and entry decisions can be reverse without any cost (Baumol, 1982). In our case, the two firms could be seen as two monopolists in the same market: the environmental unfriendly company would target the consumers that do not care about the environment by charging a lower price than the other company—the costs of their products are lower. Thus it becomes a monopoly to all the consumers with low environment consciousness. They can gain an abnormal profit by producing where MC=MB; however, the abnormal profit would attract the

other firm, who previous targets the environmental conscious consumers with higher environmental accountability, to compete. Whether the other firms threat to have a long term competition or a "hit and run" competition, it would force the environmental unfriendly firm to charge a price as in a competitive market.

The activities of oil and gas industry are usually divided into two major sectors: upstream and downstream. Upstream sector includes exploration and production process such as drilling, searching for potential underground natural gas field. Downstream sector includes refinery and product distribution. In the last section, I mainly discuss the downstream aspect through analyzing how consumer preferences influence the firms' decision. I address the upstream aspect by including the term $c\beta$ as the per unit production cost into the firm's cost function, since it usually costs more to produce more environmental friendly products. Assessing environmental impacts before drilling, implementing hydrogenation catalyst to remove all the sulfur and nitrogen impurities, and installing scrubbers are all possible ways to improve oil production process; however, these all increase the per unit production cost for the firm. Another aspect of the factor $c\beta$ in the cost function is the cost comes from regulation. The cost also includes the regulatory cost. For example, carbon tax and carbon permits are parts of per unit production cost for oil companies since they are large carbon emitters and carbon permit buyers. The model assumes they are the same for both firms.

The model pointed out that when two firms choose to differentiate their strategies, there would be a bounded price difference in their products. This may not be obvious in the daily oil market. To simplify the model, I used two firms to represent the oil industry, however, in the real world, there are more than two firms competing. Further research is needed for an oligopoly game to address this issue.

6.2 Non-market Perspective

The business strategy a firm makes is an integration of both market and non-market considerations. Besides the market factors that I demonstrate in the last section, it is also worthwhile to look into non-market drivers to grasp the full picture of this problem. While I explain why I think consumer preferences play a role in the two profit-driven oil companies' decision making process, Pulver (2007) believes that the divergent climate policies are best explained by the different scientific networks and different regulatory environment where they are embedded. Although both ExxonMobil and Shell are multinational corporations that operate in more than 100 countries, when making decisions, the firms take special interests in the political and cultural environment at where the companies' headquarters are located. Levy and Kolk (2002) identify this as "home-country effect". The differences in national climate policy discussions in the United States and Europe lead to different assessments by ExxonMobil and Shell executives of the potential future environmental regulation. "ExxonMobil executives were confident that regulation was unlikely and that opposition to regulation was a viable political strategy. In contrast, for Shell managers, regulation was considered a foregone conclusion, and the strategy choice centered on the extent to which the companies would participate in shaping the regulation" (Pulver, 2007, p.63).

In the book *"Climate Change and the Oil Industry: Common Problem, Varying Strategies",* Skjaerseth and Skodvin (2003) analyzed three non-market aspects that may result in firms choosing different environmental strategies. The first aspect is the different intrinsic characteristics of the oil companies, for example, for a firm facing high environmental risk, no negative public scrutiny, and a low capacity for organizational learning would lead to a reactive

climate strategy. The other two aspects are domestic politics and international regime. All three aspects are potential drivers of their divergent climate strategies.

Another difference between the two firms is their past experience regarding to environmental problems. ExxonMobil has a history of oil spill in Alaska in 1989. "Cleaning up after *Exxon Valdez* ultimately cost Exxon about $4 billion, much less than had seemed likely at first, because a Supreme Court decision in 2008 allowed punitive damages to be slashed from $2.5 billion to $507.5m" (The Economist, 2010). Comparing to other companies who also have oil spill incidents such as BP, Exxon' stock price did not fall as nearly much. The low expectation of financial cost of environmental damage and shareholders' response may create an impression to Exxon that the environmental problems are not a concern to the company. Shell, on the other hand, does not have large oil spill incidents; however, it has a long history of dealing with environment groups and lawyers. For example, when Shell UK was trying to dispose an abandoned oil storage buoy Brent Spar, in deep Atlantic water. The operation was opposed by a green group Greenpeace, followed by widespread boycott and campaign. Because the falling sales and drop in share price, Shell finally abandoned the operation and decided to seek only onshore disposal options (Ahmed 2006). "… [A]lthough Shell had made considerable efforts to safeguard the smooth operation of their planned action … the company still faced a situation where its planned action became controversial and ignited criticism of the company" (Ahmed, 2006, p.111). Even though it has been proven Greenpeace has vastly overestimated the damage Shell would cause, experiences like this can make Shell very cautious about the environmental issues it may face in the future.

7. Conclusion

In this paper, I try to explain the causes of the difference between Shell and ExxonMobil's climate strategies, and use the two companies to represent proactive and reactive companies in the oil industry. I find that in a duopoly market, the firms would choose to differentiate strategies when the proportion of environmental friendly consumers in the market is in a certain range. When the number of consumers who choose the suppliers partially on their environmental accountability is large or small enough, the firms would choose the same strategy. We need to keep in mind that Shell and ExxonMobil are two independent companies that are not owned or partially owned by the states. Oil companies such as Petro China face different problems from what we have discussed.

A variation of my model can be considered is making α an endogenous variable. Due to the cross-country differences in environmental policy, education, geographic characteristics, etc., there is a wide dispersion in gasoline buyer's environmental sensitivity and the size of population who care about suppliers' environmental characteristics in a particular region. To address this problem, we can discuss how the firms are trying to convince people that the environmental problems are exaggerated (eg. climate change denial), and by doing so, they are increasing α—the proportion of people in a market that do not consider firm's environmental accountability when purchase. So making α an endogenous variable can help us get a better understanding of this issue. Although it is hard to quantify people's environmental awareness in a country, we can use indicators such as economic performance and education level to estimate this variable. In this aspect, if we look at the two firms' balance sheet, not surprisingly, the largest proportion of Shell's revenue comes from Asia; nearly a third of their revenue is gained in this most populated

continent. USA and Europe are two markets following Asia where Shell gains another third of its revenue (Shell annual report, 2014). Interestingly, ExxonMobil gains most of its revenue from Africa, exceeding USA, where it originally started, and Asia, where there is the largest oil market (ExxonMobil annual report, 2014). Further research is needed to access this issue.

This paper contributes to understand corporate social responsibility. Using environmental issue as an example, many other implications can be drawn from this. For example, issues like child labor, fair trade, and political issues can also be discussed under this scope. Consumers have preferences over every aspect of a company; and how to maximizes profit when consumers care more than just the product is a question for all the contemporary firms.

From Kyoto to Paris, an increasing number of people ask what we can do to protect the planet we live in. In the past decade, we developed market mechanisms to reduce the carbon emission and raised awareness of the environmental problems we face today. Although the profit-driven companies do not calculate environmental cost in their cost function, but with more and more people reacting to their behaviors, we are able to make a difference.

References

Baumol, W. J., Panzar, J. C., 1947, & Willig, R. D., 1947. (1982). Contestable markets and the theory of industry structure. New York: Harcourt Brace

Creyer, E. (1997). The influence of firm behavior on purchase intention: do consumers really care about business ethics?, *Journal of Consumer Marketing,* Vol. 14 Iss 6 pp. 421 – 432

Exxon Mobil Corporation. (2014). *2014 Summary annual report,* Irving, Texas.

Goldenberg, S. (2015). ExxonMobil gave millions to climate-denying lawmakers despite pledge. *The Guardian.* Retrieved from http://www.theguardian.com/environment/2015/jul/15/exxon-mobil-gave-millions-climate-denying-lawmakers

Levy, D. & Kolk, A. (2001). Winds of change: Corporate strategy, climate change and oil multinationals. *European Management Journal*, 19(5), 501-509.

Levy, D., & Kolk, A. (2002). Strategic responses to global climate change: Conflicting pressures on multinationals in the oil industry. *Business and Politics,* 5(2), 131-151.

Ahmed, M. (2006). *The principles and practice of crisis management: The case of brent spar.* Basingstoke: Palgrave Macmillan.

Pulver, S. (2007). Making sense of corporate environmentalism. *Organization & Environment, 20*(1), 44.

Riisgaard, L. (2011). Towards more stringent sustainability standards? trends in the cut flower industry. *Review of African Political Economy, 38*(129), 435-453. doi:10.1080/03056244.2011.598344

Royal Dutch Shell Corporation. (2014). *Investors' handbook: financial and operational information, 2010-2014.* The Hogue, The Netherlands.

The Economist. (2010). BP and Exxon share prices after oil spills: All latest updates in deepwater. Retrieved from http://www.economist.com/node/16270972

8. Appendix

For monopoly model:

Solving the profit maximizing problem for the monopoly company:

$$g^*(\alpha,\beta,\lambda) = \frac{(\alpha + (1-\alpha)\beta)\lambda - c\beta}{2}$$

$$p^*(\alpha,\beta,\lambda) = \frac{\big((1-\alpha)\beta + \alpha\big)\lambda - c\beta}{2}$$

$$\pi^*(\alpha,\beta,\lambda) = \frac{(\big((\alpha-1)\beta - \alpha\big)\lambda - c\beta)^2}{4}$$

For duopoly model:

Lagrange conditions for consumers who do not care for the environment:

$$U = X + \lambda(g_1 + g_2) - \frac{(g_1 + g_2)^2}{2}$$

$$\lambda - g_1 - g_2 = p_1$$

$$\lambda - g_1 - g_2 = p_2$$

$$Y = X + p_1 g_1 + p_2 g_2$$

Lagrange conditions for consumers who do not care for the environment:

$$U = X + \lambda \sum \beta_j g_j - \frac{(g_1 + g_2)^2}{2}$$

$$\lambda\beta_1 - g_1 - g_2 = p_1$$

$$\lambda\beta_2 - g_1 - g_2 = p_2$$

$$Y = X + p_1 g_1 + p_2 g_2$$

FOC for firms' profit function:

$$\alpha\lambda + (1-\alpha)\beta\lambda - 2g_i - g_j - c\beta = 0$$

solve for g_i:

$$g_i\,(g_j) = \frac{\alpha\lambda + (1-\alpha)\beta\lambda - g_j - c\beta}{2}$$