"GREEN" CORPORATE SOCIAL RESPONSIBILITY: TO BE OR NOT TO BE?

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-Abstract-

Environmental evolutions such as climate change have triggered firms' cultural behaviour in conducting businesses. With this new awakening consciousness, more attentions are demanded so that firms put its priority of generating profits hand in hand with sustaining the environment. While the environmental benefits are more evident to society, the economic benefits are still vague. Nonetheless, deciding investments on green technology are getting harder with the development of environmental regulations and policies. Limited investment valuation methods add to the complexity. Firms are facing crossroads between profits and social responsibility. This paper suggests real option valuation (ROV) as a solution that improve firms decision making process in choosing investments that deal with both issues: profitability and corporate social responsibility (CSR), focusing on climate change. ROV incorporates uncertainties and provides flexibility thus firms are able to balance up profitability and CSR. Based on a case study, it is hope that findings of this paper lighten the dilemma and none of firms' objectives is sacrificed.

Key Words: *Real Option Valuation (ROV), Corporate Social Responsibilities (CSR), Investment Decisions.*

JEL Classification: G11, G31, Q52, M14

1. INTRODUCTION

Global climate change has received a critical evaluation together with energy security issue as it widely affects human health, community infrastructure, ecosystem, agricultural and economic activity. Mainly caused by fossil fuels combustion, the emission of greenhouse gasses (GHG) has increased atmospheric carbon dioxide levels which contribute to additional absorption and emission of thermal infra-red. Intergovernmental Panel on Climate Change (IPPC), 2007 report states that "*most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations*".

Besides physical impacts describe above, the indirect impact of climate change affects businesses' reputation and investment risk profile. The impacts are material yet unpredictable (Gars & Volk, 2003; Stern, 2006), hence it causes significant result on business environment (Cogan, 2004). The impact varies depending on business activities, location, source of competitive advantage, existing assets portfolios and management capabilities (Austin & Sauer, 2003). Therefore, managers' strategic responses to climate change are important and act as additional determinant of firm's value in the future (Gars & Volk, 2003; Innovest 2005).

Nevertheless, the impact of climate change on business is highly uncertain (Austin & Sauer, 2003; Gars & Volk, 2003; Stern, 2006). Scientific and economic report has identified that climate change has increased the global temperature ranging from 1.8 to 4.0 degree Celsius (IPPC, 2007). The consequences - according to Stern (2006), that if no prevention measure being exercised, the increase in temperature will cost, on overall to be equivalent to losing at least 5% of global gross domestic product (GDP) each year, now and forever. Even worse, the risks and impacts could increase this to 20% of GDP or more.

On the other hand, the availability of policies and regulation taken by governments to handle climate change issue remain unclear. With specific reference to private sectors, strategic response to climate change is difficult when it comes to financial decisions, especially to deal with investment planning and risk mitigation. The conditions is even more complicated when private firms has no motivation as they are operated in countries outside the list of Annex 1 of Kyoto Protocol. (refer to Appendix 1 for list of countries under Kyoto Protocol).

Since the degree of uncertainty characterized by the impact of climate change is very high, strategic responses to value investment and risk mitigation become

more complicated especially in the predictions of future cash flow and investment risk profiling. A special financial valuation technique which is able to incorporate particular dimensions and challenges that presents by climate change has to be taken into valuation consideration. Capital budgeting techniques bear the responsible not only to capture future cash flow pattern of proposed investment but also to highlight risk associated with the investment and assist management in making *sound* judgments on investment strategies.

The most popular capital budgeting technique, discounted cash flow (DCF) is not sufficient in capturing the uncertainty of climate change (Austin & Repetto, 2000; Reed, 2001). Instead they suggest that the best way to handle uncertainty and strategic considerations of climate change on investment is through the analysis of real options. Real option is seen as *"the most potent emerging valuation methodology for illuminating the value of corporate sustainable strategies"* (Reed, 2001).

Consistent with the current dilemma of how uncertainties arise from climate change should be treated, this research aims to investigate the application of real option approach in providing managerial decisions towards the issue of climate change. The research intends to answer these following questions:

- How real option incorporates uncertainty arises from climate change in capital budgeting process?

- How managers are able to plan for strategic considerations arising from climate change?

The objective of this research is firstly to provide strategic intuition for managers in deciding whether to invest in preventive technology to deal with climate change based on capital budgeting process with real option approach. Secondly, it aims to close the gap between financial and strategic approaches that fails to be connected by DCF. This is done by providing the element of flexibility in business activity. In order to do so, the research demonstrates how real option theory is used to obtain better understanding of climate change and its impact on firm's value. It also explores the potential of real option versus DCF valuation method in mitigating climate change.

The paper is organized as follows. The next section (Section 2) highlights literature review on financial valuation techniques and climate change. Section 3 illustrates the research design and the case. The fourth section presents the

analysis of option to switch and discusses the result. Finally, section 5 concludes the research.

2. LITERATURE REVIEW: FINANCIAL VALUATION TECHNIQUES AND CLIMATE CHANGE

In the early years, climate change valuation has been tackled with DCF valuation framework (Austin & Repetto, 2000; Austin & Sauer, 2003: Gars & Volk, 2003). DCF disregards managerial flexibility to respond to arrival of new information and changing of business environment over time (Mun, 2002). Consequently, it has proven to be short in dealing with uncertainties, fails to connect to strategic importance and flexibility (Ross, 1995). Since then, practitioners and academician start to look for alternatives.

Real option gives the owner the right but has no obligation to take up or to divest an investment in the future. The valuation technique is an extension of financial options theory, developed by Black & Scholes (1973) of European option, Merton (1973) of American option and Cox & Ross (1976) of options on real assets. Seen as alternative to DCF, real option started to gain attention. Since then, real option has appeared and being noted in academic literature with further extensions of practical application in various cases such as in Brennan & Schwartz (1985), McDonald & Siegel (1985), Kemna & Vorst (1990), Myers & Majd (1990), Schwartz & Trigeorgis (1994), Dixit & Pindyck (1994), Grenadier & Weiss (1997), and Cortazar, Schwartz & Salinas (1998). Unlike DCF based valuation techniques, real option accommodates changes and uncertainties, providing flexibility while the process of strategic planning and investment are constantly re-evaluated (Mun, 2002).

Real option valuation solutions are theoretically very complex, thus the theoretical explanation is beyond the scope of this paper. Sticking to the aim of tending practical and managerial purposes, the argument on the mathematical part is better left untouched. Real option value is derived relatively to underlying assets. Therefore, it has the same value in the actual world as in the risk free (Schwartz & Trigeorgis, 2004). The risk neutrality allows flexibility to be properly incorporated into the analysis. The easiest way to approach real option is by binomial lattice as it gives transparency and intuitive appeal (Mun, 2002).

Real option obtains its value from the principle of: (i) Real option is more valuable when the expiry date is longer. Holding the option for longer period allows firms to wait for latest information and development before making any potential investment. (ii) Option is at its higher value when the risk is greater.

128

Owning an option means the business risks is hedged against all downside outcomes. (iii) Exclusive ownership increases the value of option, for example in the case to hold an option to patent a new design, product or process. (iv) Greater importance of uncertain future cash flow to the project will also increase the option value. With these perspectives, real option is used to conceptualize and value existing option, help future creation of further options with the objectives to hedge risks, reduce business hazard and leverage investments over time (Mun, 2002).
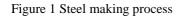
When dealing with climate change, real option carries various potential of applications. Firms may apply an *option to delay* investment in clean technology until market forces have proven its value, prices of carbon credits (CER) is justified, or new policy is further regulated. *Option to contract* is available in order to reduce carbon emissions when CER is expensive and unfeasible if operation reaches optimal level. An *option to abandon is* exercised when investment is no longer profitable due to continuously high emission and expensive penalty. When abandoning is not practical because current investment has the possibility for other usage that is related but more responsive to climate change policy, then firms may apply for *option to `scope up´*. Above all, when investment is already taken, and there are chances that firm may choose greener and cleaner technology, the first option that should come into consideration is an *option to switch*.

3. RESEARCH DESIGN

This research employed an exploratory case study (Cooper & Slagmulder, 2004) based on stylized facts as applied by various scholars in the application of real option (for example Brennan & Schwartz, 1985; Dixit and Pindyck, 1994; Trigeorgis, 1996). This approach is the best for application due to emerging nature of climate change and scarcity of prior research, difficulty to constructs principles and gathering concrete information for the purpose of achieving deduction, (Perry, 1998).

3.1. Research setting

The case refers to an operation mix of steel making process. Based on the green box of Figure 1, a plant may operate based on Blast Oxygen Furnace (BOF) alone or combine the production process with Electrical Arc Furnace (EAF).

Figure 1 Steel making process

(Source: Kawasaki Steel)

Generally, BOF allows bigger profit margin compared to Electrical Arc Furnace (EAF). However, with the aim to reduce carbon emission and spending of CER, EAF proves to be cleaner and greener. The disadvantage; EAF depends 100% on supply of scrap which is more limited compares to iron ores and coal that are needed in BOF process. Due to this, a firm may not depend solely in EAF but has to mix their steel making production process. The average efficient production mix ratio between BOF and EAF in percentage is 60-40.

In order to decide whether it is beneficial to add EAF into the production system, a feasibility study is conducted. This study compares the condition of producing based on BOF alone (**method A**) or to combine with EAF (the combination between two processes with ratio of 60-40 ratio is **method B**). For illustrative purpose, method B is rigid in the sense that once EAF is employed, the plant has to continuously producing based on 60-40 ratio. However, if scrap is not available, the plant could not produce 100% on method A, and have to rely on producing at only 60% of the full capacity. If this is happening, the firm will lose sales. For a plant with capacity of producing 4 285 000 tonnes, the net cash flow for 5 years based on method A and method B are as follows.

Figure 2 Five-year net cash flows projection for method A versus method B in good and bad condition (in ´000 €)

Method A

t0	t1	t2	t3	t4	t5
					10209
				7194	
			5069		5069
		3572		3572	
	2517		2517		2517
1774		1774		1774	
	1250		1250		1250
		881		881	
			621		621
				437	
					308

Method B

t0	t1	t2	t3	t4	t5
					6509
				4919	
			3718		3718
		2810		2810	
	2124		2124		2124
1605		1605		1605	
	1213		1213		1213
		917		917	
			693		693
				524	
					396

Environmentally wise, the uncertain future of CER prices affect the amount of CER saving or spending and net profits. If the manufacturer relies on method A, for every tonne of steel produced emits 1.987 tonne carbon into the air. For full production of 4 285 000 tonnes of steel, the total amount of carbon produced as by-product is 8 514 295 tonnes. According to the current CER price of 12€ per tonne, at this point, the manufacturer has to spend 102 172€ for emitting carbon dioxide. Meanwhile, employment of method B produces 5 720 475 tonnes of carbon by-product. With the same CER price of 12€, the manufacturer is able to save 33 525€ (round up as≈ 34 000€) on carbon spending.

The manufacturer has to choose whether to continue on production method A, emitting 102 172€ worth of carbon emission, or save 34 000€ but has to forgo surging extra sales of 40% from total output if method B is chosen. The parameters of the case are as follows:

Time steps

A time step of 1 year for each node, thus $\delta t = 1$.

Option time frame

Bearing the assumption that t_0 is 2011; the time period for the analysis is 5 years. In principle CER market will expire at 2012. However, due to current policy and regulations development on climate change and increase participation from countries all over the world, together with human realization towards climate change impact, it is assumed that the policy will continue into practice and become more stringent. Therefore the CER market is expect to resume in existence.

Uncertainty

Only uncertainty and volatility of CER prices are considered in the analysis. Other sources of uncertainty, such as cost and availability of iron ores, coal and scrap are ignored. Uncertainty and volatility of CER prices affect firm's decision towards investment in green technology. The relationship between uncertainty and volatility of CER prices is applied to derive towards more transparent and understandable valuation method which later assist understanding on how CER price is incorporated into the valuation.

Volatility Estimate of CER

The volatility of CER prices has been calculated based on historical data and represented by $\sigma = 56.5\%$. The data is obtained from EU ETS price from 11 February 2005 to 6 September 2006 from Reuters. EU ETS is used as proxy of CER price because CER price is seldom disclosed. Furthermore, Emission Reduction Purchase Agreements links CER prices to EU Emission Trading Scheme, suggesting that the volatility of these two units (EU ETS and CER) is comparable. Once CER has been issue, it has to fulfil the technical requirements of International Transaction Log of Kyoto Protocol, 1997, which is theoretically fully fungible with an EU ETS unit.

Up and Down Factors

The up and down steps in the lattice presents neutral probabilities and determined by volatility. The up and down factors affect assets value. These values are required in order to calculate the lattice of projected CER following:

Up step, $u = e^{\sigma\sqrt{\delta t}}$ [1]

Down step, $d = \dfrac{1}{e^{\sigma\sqrt{\delta t}}}$ [2]

Risk-free Rate
Risk-free rate, r_f is 5%.

Probability Factor
Probability factor for good and bad condition are represented by *p* and *q* respectively. *P* is calculated as:

$$p = \frac{e^{\delta t\, r_f} - e^{-\sigma\sqrt{\delta t}}}{e^{\sigma\sqrt{\delta t}} - e^{-\sigma\sqrt{\delta t}}}$$ [3]

Using this equation, the probability factor *p* is 0.4054 ($\approx$ 0.4) and 1- *p* = *q* = 0.5945 ($\approx$ 0.6).

3.2 Decision Rule of DCF

According to DCF rule, the decision is made based on the highest total present value (PV) of net revenue (in round up figures) of the available methods. In this case:

PV method A = 1774000 + 1690000 + 1323000 + 883000 + 792000+ 733000
           = 7 195 000 €

PV method B = 1605000 + 1529000 +1236000 + 826000 + 739000 + 678000
           = 6 614 000

Therefore, method A: producing on single production process of BOF is profitable compared to proposal of employing production process with reduced emission. Production process mix of method B shall be ignored.

4. ANALYSIS AND RESULT OF OPTION TO SWITCH

Following the DCF result in previous section, method A is more profitable compared to method B. However, by employing this method the firm will have to spend 102 172€ for carbon emission. At current state, the price of CER of 12€ is not a liability but the realization that environmental laws are getting stringent; an early approach to reduce emission seems beneficial. The firm is interested in reducing CER spending. At the same time, the firm is aware that scrap supply is limited and they are not ready to forgo the potential sales of 40% if method B is chosen. Therefore, a switch between production process method A and B is evaluated.

The cost of switching between method A to B, and vice versa is calculated as the different between the amounts of CER spending on each method. From method A to B, the firm will have CER saving of 34 000€ while to switch back to method A, the firm has to incur additional 34 000€ again. In short, the switching costs are:

S(A→B) = + 34 000€ (CER saving)
S(B→A) = - 34 000€ (CER loss)

Figure 3 shows the result of the analysis for option to switch. From Figure 3, the switching option from method A to B is valued as 72 260€ while switching from method B to A is 916 790€. However, these are individual switching values. In order to identify the flexibility switching from one option to another and switch again, the interaction between two methods need to be excluded. As information is limited, one way to do this is by finding the difference between both total value of rigid method plus option and compares it with total value of option identified. The difference of 7 267 260 – 7 529 790 = (-) 262 350€ is the negative interaction between two methods. So, total flexibility option to switch is 72 260 + 916 790 – 262 350 = 726 700€.

The option to switch from method A to B and vice versa, gives operational flexibility to the manufacturer. On a surface, for a manufacturer with initial process of method A would be able to increase the present value of net revenue by 10% with flexibility provided by continuous switching.

Figure 3 Summary of switching option results (in '000 €)

Time	Rigid Method A	Option A→B[1]	Rigid Method B	Option B→A[2]
0	1774	0	1605	105
1	1690	0	1529	138,5
2	1323	22,86	1236	164,43
3	883	19,78	826	163,24
4	792	17,88	739	173,67
5	733	11,74	678	171,95
	7195	72,26	6613	916,79
Total value of rigid + option	**7267,26**		**7529,79**	

5. DISCUSSION AND CONCLUSION

Climate change has showed a significant effect in business environment which later has an impact on business value and reputation (Austin & Sauer, 2003; Gars & Volk, 2003; Innovest, 2005). With a very high uncertainty, there is a need for valuation method that able to incorporate this factor into capital budgeting, strategic planning and risk mitigation.

Kyoto Protocol 1997 proves that climate change should be taken seriously. With target to reduce GHG emission starting with countries listed in Annex 1, public and privates parties are committed to reach the target. The introduction of carbon credit also contributes to such motivation. Industries and firms who emit more GHG than allowable are required to fund development of green technology that aims to reduce carbon emission and energy saving projects. Even though this is voluntary, they are further encouraged with the existence of CER and EU ETS markets where carbon credits are tradable. As the target GHG reduction is set, steel industry, being major contributor of GHG in form of carbon emission (Gelen & Moriguchi, 2001) is motivated to innovate on new technology and production process so that the target is achievable.

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[1] Refer to Appendix 2
[2] Refer to Appendix 3

Improvement from BOF to EAF is able to reduce carbon emission around 80%. However, with the scarcity of scrap as the main input in the EAF production of crude steel, manufacturer still relying on BOF to cope with world demand. On the other hand, the scarcity of scrap should not form a barrier for steel manufacturer to perform their social responsibility to reduce carbon emission. Through the approach of real option, steel producers are able to switch from rigid mode of BOF to combine mode of BOF and EAF.

The analysis shown in this paper has proved that incorporating the uncertainties of climate change being proxy to carbon credit, manufacturers are able to have an initial quantitative intuition that switching option has positive impact on profitability. The flexibility to switch from one state to another and able to switch back namely as from method A to B and to A again, increase additional return value of 726 700€. This amount accounts for additional 10% of net revenue compared to single employment of method A.

The total present value of net revenue plus flexibility option of both individual states in the calculation should be able to reach to the same final amount. From the result in Figure 3, it is observed that the amounts differ. This is due to the interaction between the two individual options, consistent with findings of Trigeorgis (1993). In order to identify the accurate value of combined flexibility option of method A and B, an extensive calculation based on which option has being exercised over time is required. The option is not a simple call option anymore, but has a compounded nature (Kulatilaka & Trigeorgis, 1994).

The research approach is conducted in a simplistic way to enhance transparency and easy understanding. Relying only on uncertainty and volatility of CER prices, climate change proxy variables are able to be incorporated in the valuation process. Further thorough analysis is required to identify the accurate interaction among the two methods of production.

It is also noted that with uncertainty and volatility of CER prices as representative of climate change in the valuation technique as a whole is insufficient. In reality, holding the same focus and objective laid in this research, there are other variables that worth considering to be included in the model. As prices and availability of iron ores, coal and scrap embed uncertainty and volatility, a more comprehensive model that iterate these variables would bring deeper and more meaningful quantitative intuition. Nevertheless, the approach is capable to trigger managers´ realization that real option is able to incorporate variables relevant to strategic

concern when it comes to climate change. Uncertainty is transferred to flexibility of switching between production processes.

The application of real option analysis and the way it responses to the many uncertainties surrounding climate change have contribute to economic and policy perspective towards the issue (Toman, 1998; Heal & Kristom, 2002; IEA, 2006). Many analysts have started to incorporate the real option analysis in the valuation of climate change impact, for example in energy sector analysis (IEA, 2006). Supported with findings from this research, together with the statement above, real option bears the potential to address climate change issue and connects to environmental strategic responses.

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APPENDIX 1
List of Countries under Annex 1 of Kyoto Protocol.

Australia	Lithuania
Austria	Luxembourg
Belarus	Malta
Belgium	Monaco
Bulgaria	Netherlands
Canada	New Zealand
Crotia	Norway
Czech Republic Denmark	Poland
Estonia	Portugal
European Union	Romania
Finland	Russian Federation
France	Slovakia
Germany	Spain
Greece	Sweden
Hungary	Switzerland
Iceland	Turkey
Ireland	Ukraine
Italy	United Kingdom of Great Britain and
Japan	Northern Ireland
Latvia	United States of America
Liechtenstein	

(Source: Kyoto Protokol)

APPENDIX 2
Value of switching option from S(A→B) from t_0 to t_5.

The intermediate values are derived from a backward induction technique and risk-free probability, thus calculates as:

$$intermediate\ value = \frac{p(e^{\sigma\sqrt{\delta\tau}}) + 1 - p^{-\sigma\sqrt{\delta\tau}}}{e^{-r_f(\delta\tau)}}$$

$S_0 (A→B) = \max (1213 - 1774 + 34, 0) = 0$

$$\max (2124 - 2517 + 34, 0) = 0$$

$S_1(A→B)$
[0]

$$\max (1213 - 1250 + 34, 0) = 0$$

140

$S_2(A \rightarrow B)$
[22.86]

Max (2810 – 3572 + 34, 0) = 0

Max (1605 – 1774 + 34, 0) = 0

Max (917 – 881 + 34, 0) = 70

0

40

$S_3(A \rightarrow B)$
[18.78]

Max (3718 – 5069 + 34, 0) = 0

Max (2124 – 2517 + 34, 0) = 0

Max (1213 – 1250 + 34, 0) = 0

Max (693 – 621 + 34, 0) = 106

0

0

0

34.61

60.6

$S_4(A \rightarrow B)$
[17.88]

Max (4919 – 7194 + 34, 0) = 0

Max (2810 - 3572 + 34, 0) = 0

Max (1605 – 1774 + 34, 0)= 0

Max (917 – 881 + 34, 0) = 70

Max (524 – 437 + 34, 0)=121

0

0

0

0

0

0

31.28

54.75

95.81

$S_5(A \rightarrow B)$
[11.74]

Max (6509 – 10209 + 34, 0) = 0

Max (3718 – 5069 + 34, 0) = 0

Max (2124 – 2517 + 34, 0) = 0

Max (1213 – 1250 + 34, 0) = 0

Max (693 – 621 + 34, 0) = 106

Max (396 – 308 + 34, 0) = 122

0

0

0

0

0

0

0

0

0

0

20.54

35.95

62.91

110.09

APPENDIX 3
Value of switching option from S(B→A) from t_0 to t_5.

$S_0 (B \rightarrow A) = \max (1774 - 1605 - 34, 0) = 105$

$S_1 (B \rightarrow A)$
[138,5]

Max (2517 – 2124 - 34, 0) = 359

Max (1250 – 1213 - 34,0) = 3

S₂ (B→A)
[164.43]

354.48

51.43

Max (3572 – 2810 - 34, 0) = 728

Max (1174 – 1605 - 34, 0) = 135

Max (881 – 917 - 34, 0) = 0

S₃ (B→A)
[163.24]

348.41

53.41

706.86

134.48

1.143

Max (5069 – 3718 – 34, 0) = 1317

Max (2517 – 2124 -34, 0) = 359

Max (1250 – 1213 – 34, 0) = 3

Max (621 – 693 – 34, 0) = 0

S₄ (B→A)
[173.67]

355.29

67.07

686

164.43

7.84

1269.71

354.48

51.43

0

Max (7194 – 4919 – 34, 0) = 2241

Max (3572 – 2810 – 34, 0) = 728

Max (1774 – 1605 – 34, 0) = 135

Max (881 – 917 – 34, 0) = 0

Max (437 – 524 – 34, 0) = 0

S₅ (B→A)
[171.95]

343.49

71.91

662.16

159.67

19.4

1222.59

343.72

50.28

0.435

2124.14

706.86

130.27

1.143

0

Max (10209 – 6509 - 34, 0) = 3366

Max (5069 – 3718 - 34, 0) = 1317

Max (2517 – 2124 - 34, 0) = 359

Max (1250 – 1213 -34, 0) = 3

Max (621 – 693 - 34, 0) = 0

Max (308 – 394 - 34, 0) = 0