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Why companies tend to postpone the CSR investments: An explanation using a real option framework

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Motivaton

- Demand for sustainable investment opportunities is increasing: Volume of sustainable investments among institutional investors in Germany increased from 20.3 billion in 2012 to 232.8 billion in 2021 (Forum Nachhaltige Geldanlagen (2022))
- Companies still have not taken enough action to engage in Corporate Social Responsibility (CSR): In a survey (BMUV & Umweltbundesamt (2021)) only 16% of respondents agreed with the statement that business in Germany is doing enough for environmental and climate protection
- Many cases where companies could have invested in CSR early on, but hesitated only to later revise there decision

Why does it take them so long?

Structure

1. Theory
   - 1.1 Model setup
   - 1.2 Main results
     - Valuation of CSR investments
     - Optimal time to invest in CSR
   - 1.3 Numerical example
2. Application: Case study
3. Conclusion

Notation

- $\mathcal{T}$: Set of possible investment times $t_0, \ldots, t_n$
- V_t: Expected benefits of CSR investment at time t
- I_t: Investment cost at time t
- a_i: Opportunity costs to postpone investment from t_i to t_{i+1}
- C_t: Value of the option to invest in CSR at time t

Assumptions

- Company can invest into CSR at certain timepoints
  $0 = t_0 < t_1 < \ldots < t_n = T < \infty$
- Expected CSR benefits follow $dV_t = V_t\,(r dt + \sigma dW_t)$ under risk-neutral measure $\mathcal{Q}$
- Postponing the CSR investment from t_i to t_{i+1} generates opportunity costs such that

$$V_{t_i} = (1 - a_i)\, V_{t_i -}, \quad i = 1, \ldots, n$$

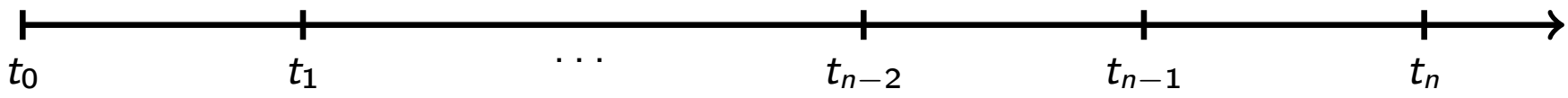
  which can be modeled as a discrete dividend.
- Investment cost at t is given by the deterministic function $I_t = e^{-r(T-t)} I_T$

Real options

How should CSR investment opportunities be valued and when is the best time to make the investment?

- First approach: Value equals benefits from investment minus investment cost
  $\Rightarrow$ Only true in **now or never** situation!
- Instead: Follow Husted (2005) and Cassimon *et al.* (2016) and use a **real option** framwork
- Interpret the investment opportunity as a financial option the company posseses with maturity T and **possible exercise times** $t_i \in \mathcal{T}$
  $\Rightarrow$ Takes strategic flexibilty of the company into account and incorporates the possibility to invest at a later timepoint on better terms
  $\Rightarrow$ Use option pricing to value the CSR investment opportunity
  $\Rightarrow$ Results in a **Bermudan call** on underlying with discrete dividends

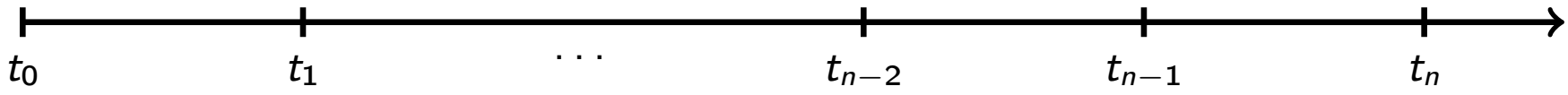
Determine option value by backward induction



- At t_{n-1} the company has to choose between:
  1. Exercise the option by making the investment
  2. Keep the option alive and wait until t_n
- Value of exercising $V_{t_{n-1}} - I_{t_{n-1}}$
- Value of waiting coincides with value of a European call with payoff $(V_{t_n} - I_{t_n})^+$ at t_n
- At t_{n-1} the value of the option to invest must equal the maximum of both values

$$h_{n-1}(V_{t_{n-1}}) := \max\left\{\left(V_{t_{n-1}} - I_{t_{n-1}}\right)^+, c_n\left(t_{n-1}, (1-a_n)V_{t_{n-1}}\right)\right\}$$

Determine option value by backward induction



- At t_{n-2} the company has to choose between:
  1. Exercise the option by making the investment and gain $V_{t_{n-2}} - I_{t_{n-2}}$
  2. Keep the option alive and wait until t_{n-1}
- Postponing the investment has the value

$$c_{n-1}(t, V_t) := \mathbb{E}^Q \left[e^{-r(t_{n-1}-t)} h_{n-1}\left(V_{t_{n-1}}\right) | \mathcal{F}_t \right], \qquad t_{n-2} \leq t < t_{n-1},$$

which equals the price of a European option with payoff $h_{n-1}\left(V_{t_{n-1}}\right)$ at t_{n-1} and therefore has to fullfill the Black-Scholes PDE under terminal condition

$$c_{n-1}\left(t_{n-1}, V_{t_{n-1}}\right) = h_{n-1}\left(V_{t_{n-1}}\right).$$

Option value

Theorem

The value of the option to invest in CSR follows the price of a Bermudan call on the underlying V. For $i = 1, \ldots, n-1$, the price is recursively given by $C_t = c_i(t, V_t)$, $t_{i-1} < t \leq t_i$, where $c_i(t, V_t)$ is the solution of the Black–Scholes partial differential equation (PDE)

$$\frac{\partial}{\partial t} c_i(t, V_t) + rV_t \frac{\partial}{\partial V_t} c_i(t, V_t) + \frac{1}{2}\sigma^2 V_t^2 \frac{\partial^2}{\partial V_t^2} c_i(t, V_t) = r c_i(t, V_t)$$

with the terminal condition

$$\begin{aligned} c_i(t_i, V_{t_i}) &= h_i(V_{t_i}) \\ &:= \max\left\{ (V_{t_i} - I_{t_i})^+, c_{i+1}(t_i, (1 - a_{i+1})V_{t_i}) \right\}, \end{aligned}$$

with x^+ denoting $\max\{x, 0\}$. For $i = n$, the function c_n is given by the Black–Scholes formula.

Investment timing

Theorem

The optimal time to invest in the CSR project is given by

$$\tau^* = \min\left\{t_i \in \mathcal{T} | \left(V_{t_i} - I_{t_i}\right)^+ \geq C_{t_i+}\right\},$$

where C_{t_i+} denotes the value of the option to invest immediately after the possible exercise time t_i.

Note that the statement of this Theorem is completely intuitive. It advises exercising the option as soon as

Value of immediate investment $\geq$ Value of waiting

Numerical example

- Company evaluates once a year if it is worth to invest in a CSR project and has 10 years in total to make the investment
- Project generates an expected benefit of $V_0 = 100$ for the company
- Future value of the project evolves according to a geometric Brownian motion with average growth rate $r = 0.01$ and volatility $\sigma = 0.2$
- Cost of investment is currently $I_0 = 99.533 = e^{-rT} I_T$ and amounts to $I_T = 110$ after 10 years
- Not investing leads to opportunity costs of anually 5% of the expected benefits from the project

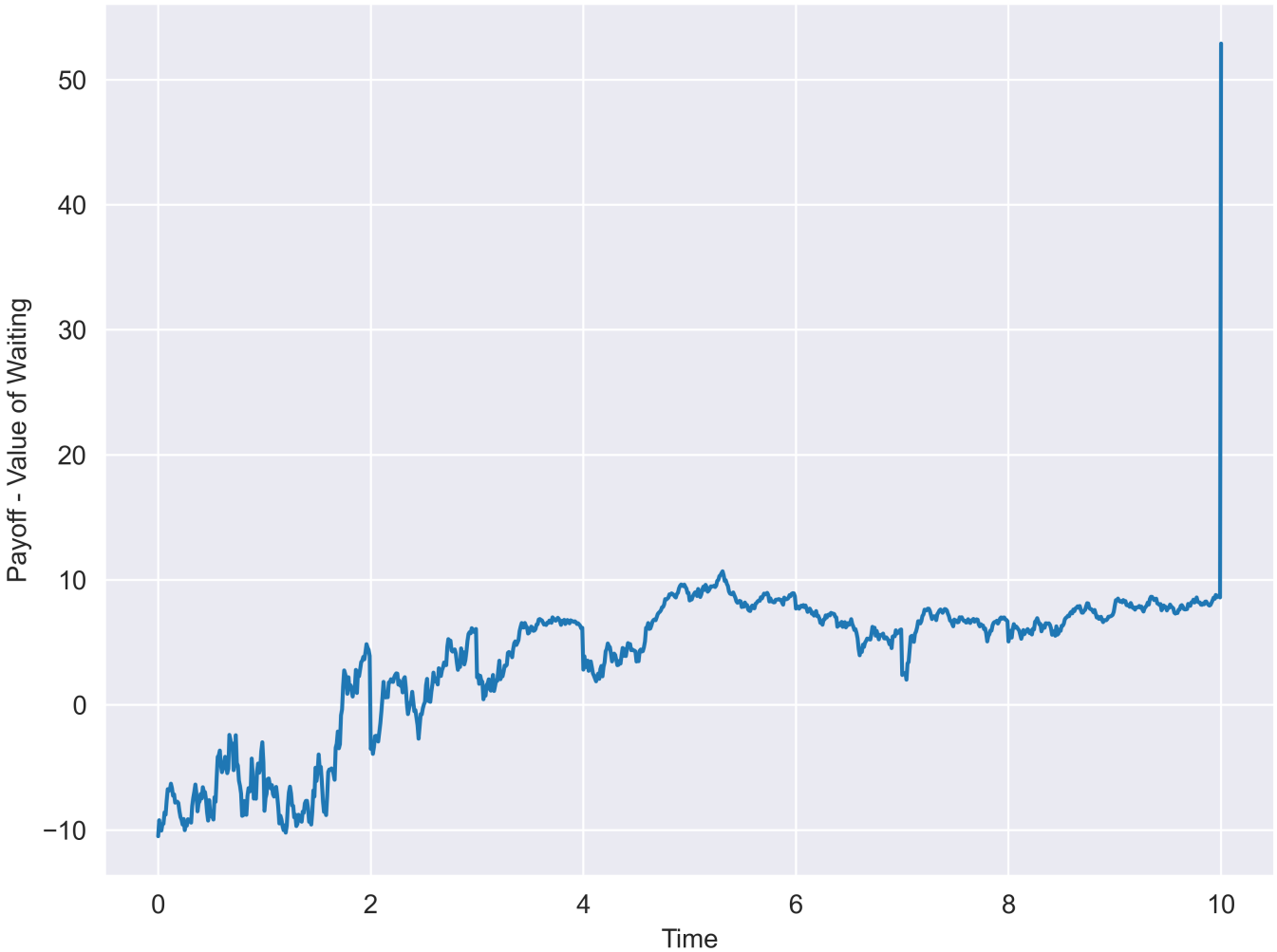
Taken together we have the following parameters:

$$V_0 = 100,\ \sigma = 0.2,\ r = 0.01,\ T = 10,\ I_T = 110,\ a_i = a = 0.05,\ i = 1, \dots 10.$$

Numerical example

Time t	Benefits from investment V_t	Payoff $(V_t - I_t)^+$	Value of waiting (Bermudan) C_{t+}
0	100.000	0.468	10.963
1	104.639	4.106	12.569
2	116.188	14.645	18.156
3	**135.320**	**32.757**	**30.549**
4	138.690	35.096	32.269
5	190.617	85.982	77.627
6	180.396	74.709	67.001
7	136.473	29.724	27.325
8	149.874	42.052	36.978
9	165.597	56.692	48.750
10	162.883	52.883	0.000

Numerical example



Nestlé: Sustainable palm oil

- Sinar Mas large conglomerat involved in palm oil production and supplier of Nestlé
- History of deforestation and other environmental damages
- Greenpeace ran campaigns against Sinar Mas and Nestlé as one of their customers
- Took a very long time for Nestlé to give in to the pressure and remove Sinar Mas as a supplier

Real Option Framwork	Nestlé case
CSR Investment	Termination of contract with Sinar Mas
Investment costs	Costs for finding a new supplier
CSR benefits	Avoidance of reputational damage
Opportunity costs	Reputational damage until next possible exercise time

Phase I: Prior to first report

- Several scandals caused by Sinar Mas already known (deforestation, environmental damages, ...)
- Greenpeace approached Nestlé to reconsider collaboration with Sinar Mas (Chaudhari (2011))

I_t	High Costs to replace Sinar Mas as a supplier
V_t	Almost no expected benefits
σ	Low uncertainty
a_i	Low opportunity costs

$\rightarrow$ **No action taken by Nestlé**

Phase II: First report

- Greenpeace published first report (Greenpeace (2009)) on Sinar Mas and accused them of illegal forest clearance in Indonesia to grow oil palms.
- Nestlé named as a customer of Sinar Mas

I_t	Costs to replace Sinar Mas as a supplier remained high
V_t	Expected benefits grew, still less than investment costs
σ	High uncertainty
a_i	Opportunity costs rose subsantially

$\rightarrow$ **Still no action taken by Nestlé**

Phase III: Second report

- Greenpeace published second report (Greenpeace (2010)), targeting Nestlé directly this time
- Kit Kat bar was linked with deforestation and destruction of orangutan habitat
- Unprofessional reaction of Nestlé intensified criticism

I_t	Costs to replace Sinar Mas as a supplier remained high
V_t	Expected benefits exceed costs from investment
σ	Low uncertainty
a_i	Very high opportunity costs

Due to very high opportunity costs the value of postponing the investment is low. Thus, expected benefits of the investment exceed investment costs plus the option value for the first time. Why did Nestlé not invest at this point?
$\rightarrow$ **They cannot since they have to wait for the next possible investment time** $t_i \in \mathcal{T}$**!**

Phase IV: Termination of the contract

- Due to Nestlé's lack of response, protests did not subside
- Instead: Activists dressed in orangutan costumes demonstrate at Annual General Meeting (Chaudhari (2011))

I_t	Costs to replace Sinar Mas as a supplier remained high
V_t	Expected benefits exceed costs from investment
σ	Low uncertainty
a_i	Very high opportunity costs

$\rightarrow$ **Nestlé finally invests in CSR and terminates the contract with Sinar Mas.**

Parameter Influence on option value

- Rising opportunity costs decrease the value of waiting
- Value of waiting grows with volatility
- Found out in a case study of Nestlé and Sinar Mas that at the beginning opportunity costs were rather low while volatility was high
  $\Rightarrow$ Value of waiting was high and therefore Nestlé postponed the CSR investment
- Opportunity costs grew while future development got more and more certain which decreased the volatility
  $\Rightarrow$ Value of waiting decreased and further delaying the investment was not worth it anymore

Conclusion

- Study investments in CSR projects as real options
- Possibility of investing later on even better terms is taken into account
- Determine option value by calculating the price of a Bermudan call on an underlying with discrete dividends
- Investment is made once $(V_{t_i} - I_{t_i})^+ \geq C_{t_i+}$ for the first time
- Investment needs to create a financial advantage which is not expected to be bigger if the investment is delayed
- Value of waiting causes companies to be hesitant about CSR investments, especially if opportunity costs are low and the volatility is high

Thank you for your attention!

References I

BMUV, & Umweltbundesamt. 2021. *Are the following players in Germany doing enough for environmental and climate protection?* https://www.statista.com/statistics/1323792/environment-climate-protection-opinions-germany/.

Cassimon, Danny, Engelen, Peter-Jan, & Van Liedekerke, Luc. 2016. When do firms invest in corporate social responsibility? A real option framework. *Journal of Business Ethics*, **137**(1), 15–29.

Chaudhari, Amrit. 2011. *Greenpeace, Nestlé, and the palm oil controversy: Social media driving change?* https://www.bu.edu/goglobal/a/presentations/greenpeace_nestle_socialmedia.pdf.

References II

Forum Nachhaltige Geldanlagen. 2022. *Volume of sustainable investments in Germany from 2012 to 2021, by investor type (in billion euros)*. `https://www.statista.com/statistics/1323510/sustainable-investment-volume-by-investor-type-germany/`.

Greenpeace. 2009. *Illegal Forest Clearing and RSPO Greenwash: Case Studies of Sinar Mas*.

Greenpeace. 2010. *Caught red-handed: How Nestlé's use of palm oil is having a devastating impact on rainforest, the climate and orang-utans*.

Husted, Bryan W. 2005. Risk management, real options, corporate social responsibility. *Journal of Business Ethics*, **60**(2), 175–183.

Shiryaev, Albert N. 2019. *Stochastic disorder problems*. Springer International Publishing.