TECHNISCHE UNIVERSITÄT DRESDEN

UNIVERSITY of VIRGINIA

Faculty of Business and Economics, Chair of Business Administration, esp. Environmental Management and Accounting

„Application of real options thinking for the management of climate change risks “

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“Blueprints for Sustainable Infrastructure“
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Content

Introduction


Mit GOtt!
SYLVICVLTVRA OECONOMICA,
Oder
Haußwirthliche Nachricht und Naturmäßige
Anweisung
Zur
Wilden Baum-Zucht,
Nebst
Gründlicher Darstellung/
Wie zu förderst durch Göttliches Benedeyen dem allenthalben und insgemein einreissenden
Grossen Holtz-Mangel/
Vermittelst Säe- Pflantz- und Versetzung vielerhand Bäume zu prosperiren/
Alles zu nothdürfftiger Versorgung des Hauß- Bau- Brau- Berg- und Schmelz-Wesens/
Worbey zugleich eine gründliche Nachricht von den in Churfl. Sächs. Landen
Gefundenen Turff
Dessen Natürliche Beschaffenheit/ grossen Nutzen/ Gebrauch und nützlichen Verkohlung.
Von
Hannß Carl von Carlowitz/
Königl. Pohl. und Churfl. Sächs. Cammer-Rath/ und Ober-Berg-Hauptmann.
Mit Königl. Pohl. und Churfürstl. Sächs. allergnädigsten PRIVILEGIO.
LEIPZIG/
verlegts Johann Friedrich Braun 1713.

Hans Carl von Carlowitz (1713) Sylvicultura oeconomica, first written reference of sustainability (German: Nachhaltigkeit)

CO2-Navigator

Corporate Management in a Climate Change Environment

klimazwei
reducing risks · seizing opportunities

Federal Ministry of Education and Research

nzier
authoritative analysis

Advantages of Real Options

1. **Real options approach offers a richer framework for designing a project. (Alessandri 2004: 758)**

2. **A real option analysis can add significant value through the procedure of thinking about project flexibility and project design in a more structured way. (Triantis 2005: 10)**

3. **Real options thinking has a strong future scope and embraces uncertainty as well as flexibility and therefore is a promising heuristic for risk management. (Miller and Waller 2003)**

Few authors discuss the integration of real options thinking in risk management:
(Adner and Levinthal 2004a, 2004b; Alessandri et al. 2004; De Schryver and Asselbergh 2003; Fichman, Keil, Amritt 2005; McGrath 2000; Miller and Waller 2003; Steffens and Douglas 2007)

Disadvantages of Real Options

1. **The quantified value of real option analysis is not always intuitively obvious. (Fichman, Keil, Amritt 2005: 87)**

2. **Financial options requirements are sometimes hard to fullfill: the price of the asset ought to be known, and the asset has to be liquid or tradable.**

3. **The real options value could be markedly different from one company to another depending on business objectives and the other assets in the portfolio. (Jacob and Kwak 2000: 294)**

4. **Real option valuation techniques provide a sophisticated treatment of market risks, but not do deal with firm-specific risks. (Steffens and Douglas 2007)**

5. **Real options are difficult to identify; multiple types are mixed up together.**

$$E^t(\alpha_t) = \delta(1-\alpha_t p)E(\alpha_{t+1}) = \delta(1-\alpha_t p)\sum_{\tau=t+1}^{T}\delta^{\tau-(t+1)}\frac{\alpha_{t+1}}{\alpha_\tau}cp,$$

after using Eqs. (A.9) and (A.10). Rewritten in terms of α_t, we obtain

$$E^t(\alpha_t) = \delta(1-p)\sum_{\tau=t+1}^{T}\delta^{\tau-(t+1)}\frac{\alpha_t}{\alpha_\tau}cp.$$

The value function in $t-1$, with monitoring in period t, can be obtained by backwards induction:

$$E^t(\alpha_{t-1}) = cp + \delta^2(1-\alpha_{t-1}p)\frac{\alpha_t}{\alpha_{t+1}}\sum_{\tau=t+1}^{T}\delta^{\tau-(t+1)}\frac{\alpha_{t+1}}{\alpha_\tau}cp. \qquad (A.17)$$

For the general recursion we would like to write all numerators in terms of α_{t-1} and obtain with $\alpha_t(1-\alpha_{t-1}p) = \alpha_{t-1}(1-p)$, the following expression for (A.17):

$$E^t(\alpha_{t-1}) = \frac{\alpha_{t-1}}{\alpha_{t-1}}cp + \delta^2(1-p)\sum_{\tau=t+1}^{T}\delta^{\tau-(t+1)}\frac{\alpha_{t-1}}{\alpha_\tau}cp.$$

The general recursive value function is then obtained by

$$E^t(\alpha_0) = \sum_{\tau=0}^{t-1}\delta^\tau\frac{\alpha_0}{\alpha_\tau}cp + (1-p)\sum_{\tau=t+1}^{T}\delta^\tau\frac{\alpha_0}{\alpha_\tau}cp,$$

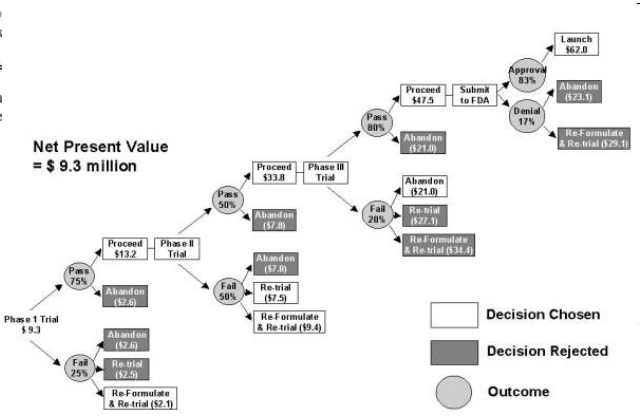
and hence the gains from monitoring are

$$B(t) = \delta^t\frac{\alpha_0}{\alpha_t}cp + p\sum_{\tau=t+1}^{T}\delta^\tau\frac{\alpha_0}{\alpha_\tau}cp,$$

or equivalently, b
then need to max

$$\max_t \frac{B(t)}{C(t)} +$$

We shall show th
crete, it is sufficie



Content

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Corporate Management in a Climate Change Environment

Research question

- **How can real options thinking be used for the assessment of investment opportunities to mitigate carbon emissions?**

- **How can managers identify climate change adaptation strategies by real options thinking?**

- **What are the benefits of real options thinking in dealing with climate change uncertainties?**

Content

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Corporate Management in a Climate Change Environment

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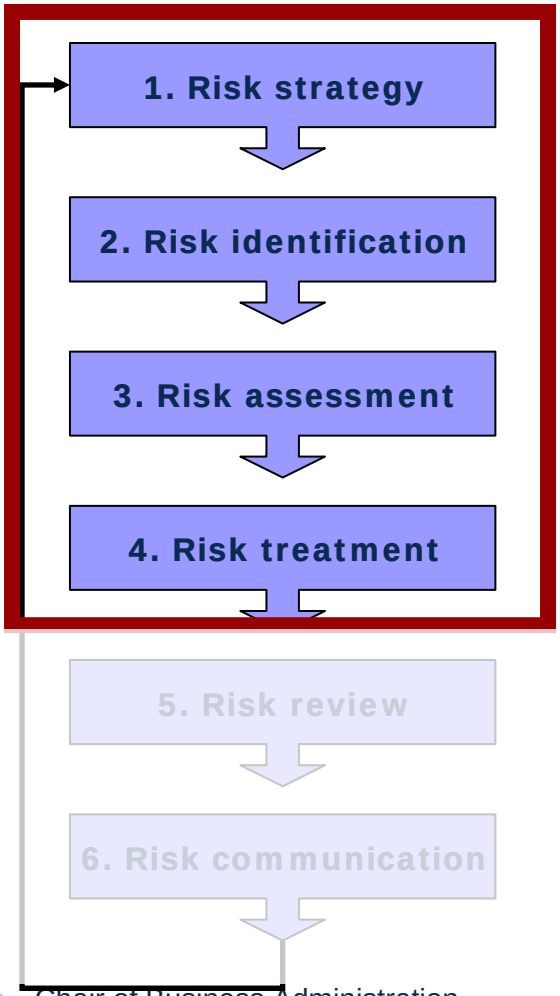
2. Research Question

3. Integration of Real Option Thinking in the Risk Management Process

   1. Risk Strategy
   2. Risk Identification
   3. Risk Assessment
   4. Risk Treatment

4. Conclusion

Risk Management



- **ISO 31000 Risk Management (coming 06/2009)**
- **AS/NZS 4360:2004 Risk Management:**

"Risk management is the term applied to a logical and systematic method of establishing the context, identifying, analyzing, evaluating, treating, monitoring and communicating risks associated with any activity, function or process in a way that will enable organizations to minimize losses and maximize opportunities."

Risk Strategy

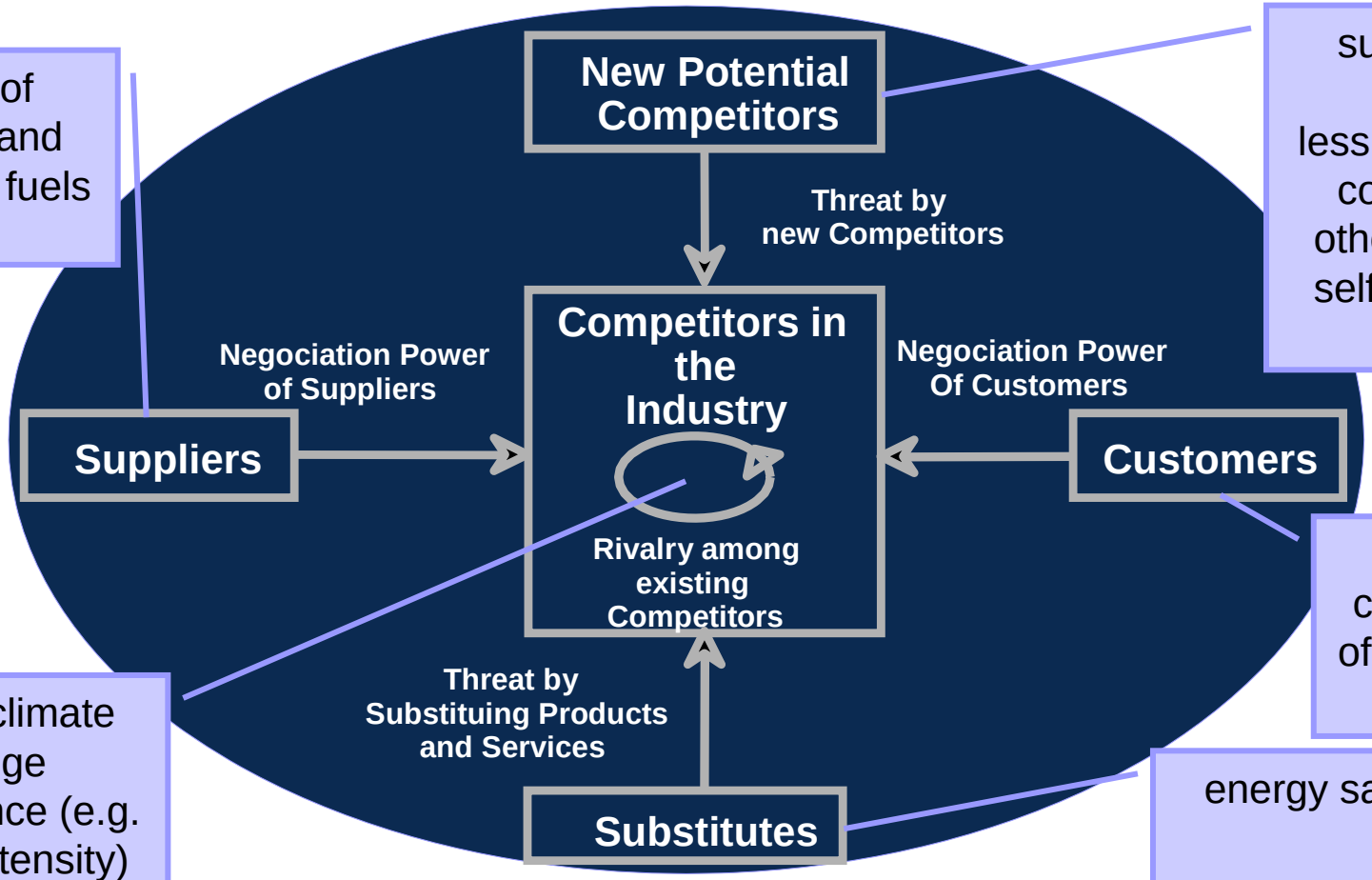
1. Risk strategy

- Every entrepreneurial activity is associated with a certain level of risk.
- In the risk strategy the corporation has to decide how much risk it is willing to accept and how much risk the corporation can take.
- Corporate decision makers have to evaluate the role that a real option thinking could play within their risk management.

Risk Identification

- In this step the company sets up an inventory of all relevant risks.
- A risk is relevant for a corporation when the achievement of its objectives could be affected.
- An unidentified risk is an incalculable risk.
- A structured and standardized approach is helpful.
- In risk identification, decision makers can identify and structure climate change risks in a qualitative manner.

Porter's five forces in the energy sector



suppliers of alternative and regenerative fuels

supplier of green electricity, less carbon-intensive competitors from other EU-countries, self supply (cement industry)

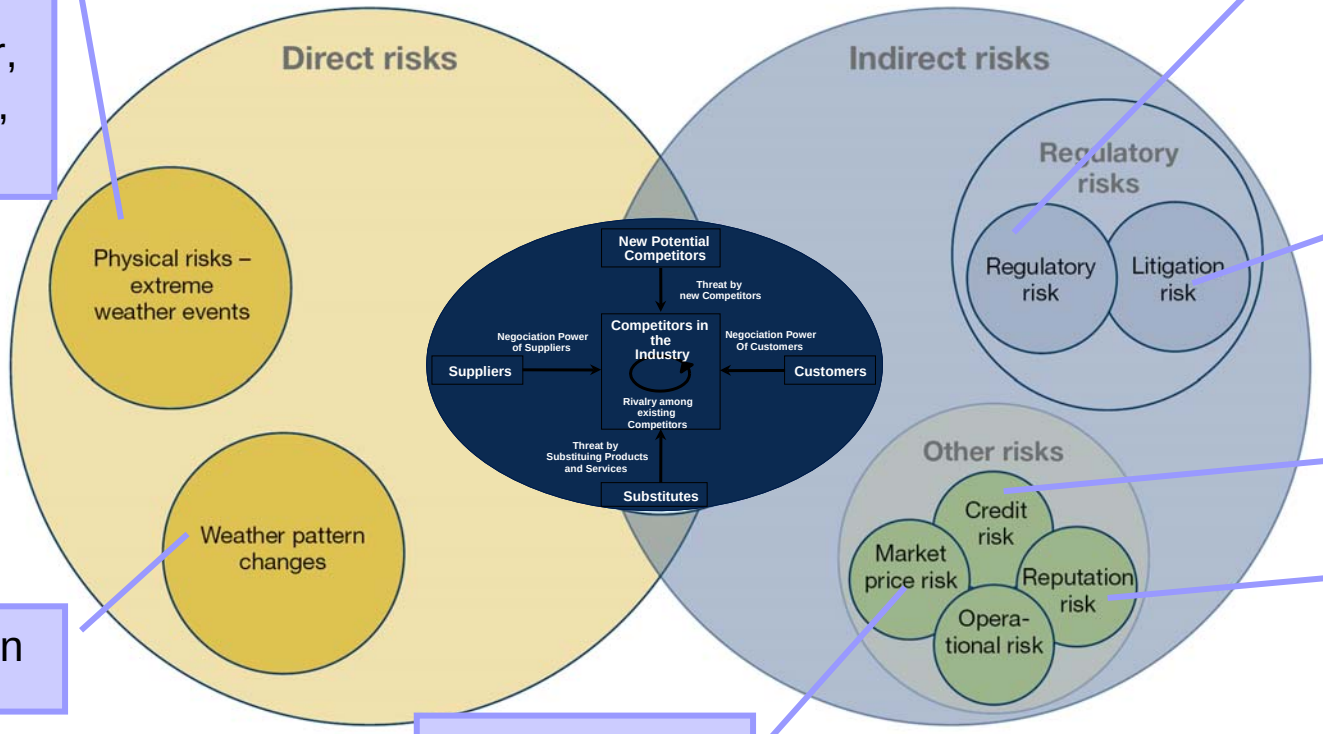
willingness to change because of growing climate concerns

relative climate change performance (e.g. carbon intensity)

energy savings

Direct and indirect climate risks

Hurricanes, heat waves, cooling water, hydro power, wind power



Design of the EU-ETS and post-Kyoto uncertainties

Increasing number of law suits in the US

CDP

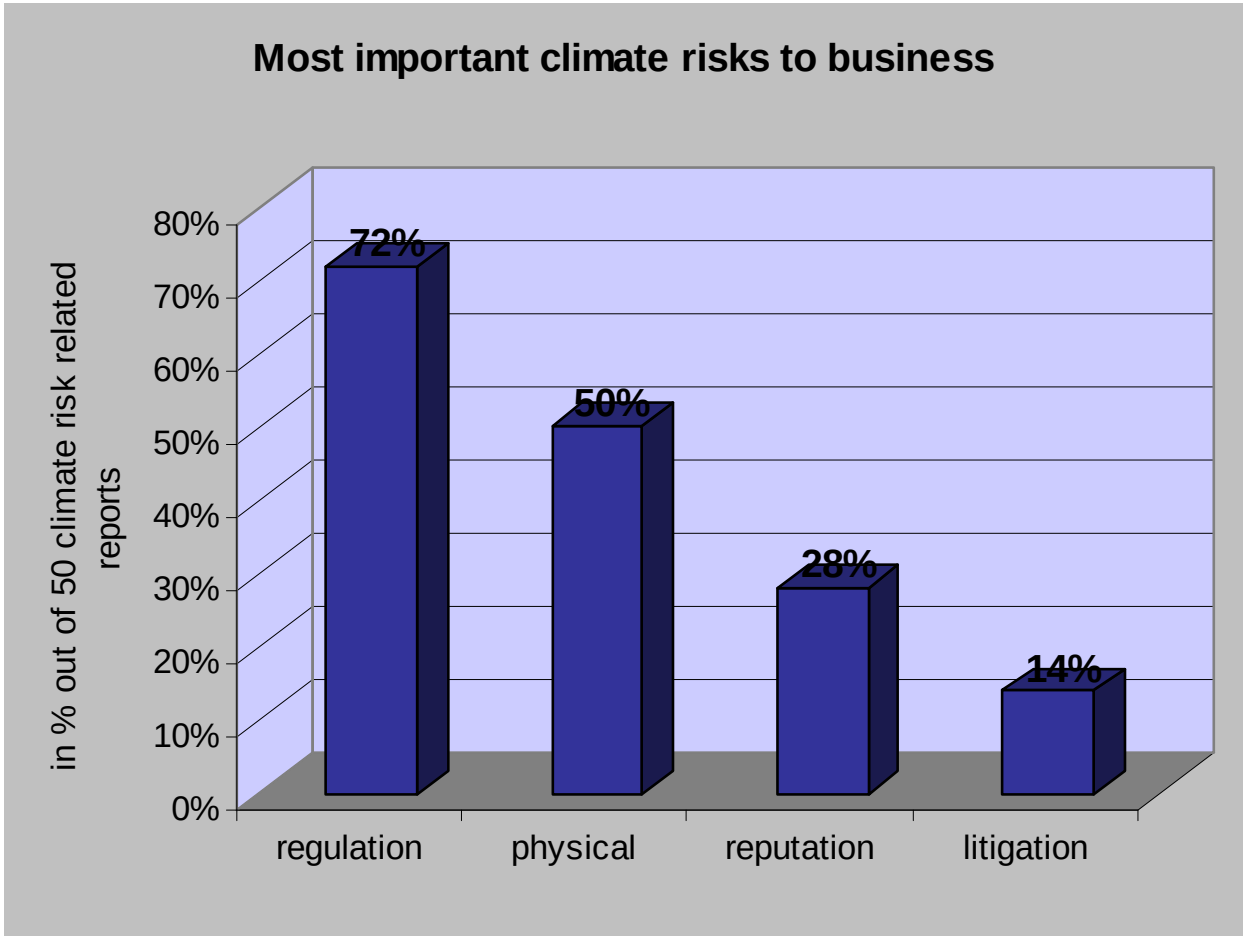
"Climate killer"

Site selection

Fuel price, CO_2-price

Source: CDP 5 Carbon Disclosure Project Report 2007 Germany On behalf of 315 investors with assets of 41 trillion US Dollar, WWF Germany, Bundesverband Investment und Assest Management, available online: http://www.cdproject.net/download.asp?file=CDP5_German_Report_English_version.pdf status: 7.04.2008

Risk Identification

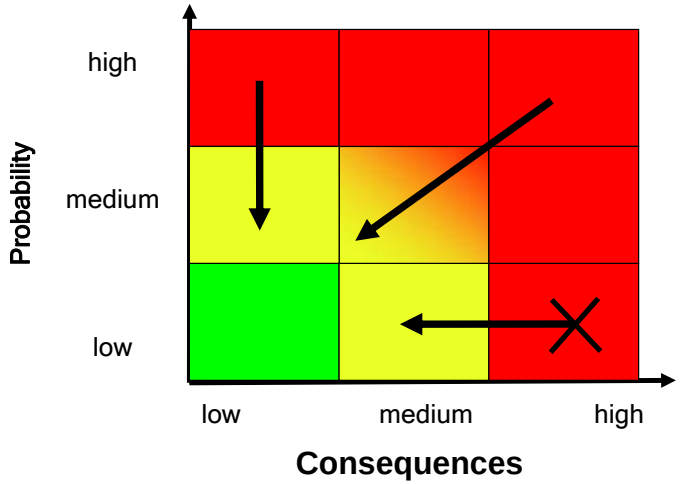


Source: KPMG (2008) Climate Changes Your Business KPMG's review of the business risks and economic impacts at sector level, available online: http://www.kpmg.de/docs/Climate_change_risk_report.pdf, status: 10.04.2008.

Risk Assessment

1. Risk strategy
2. Risk identification
3. **Risk assessment**

- Risk assessment identifies the level of exposure and the probability of occurrence.
- Consequences could be expressed in quantitative terms or in qualitative terms as negligible, minor, moderate, major, critical or catastrophic.
- Also the probability could be expressed in quantitative probabilities or in qualitative terms as certain, likely, possible, unlikely, rare.



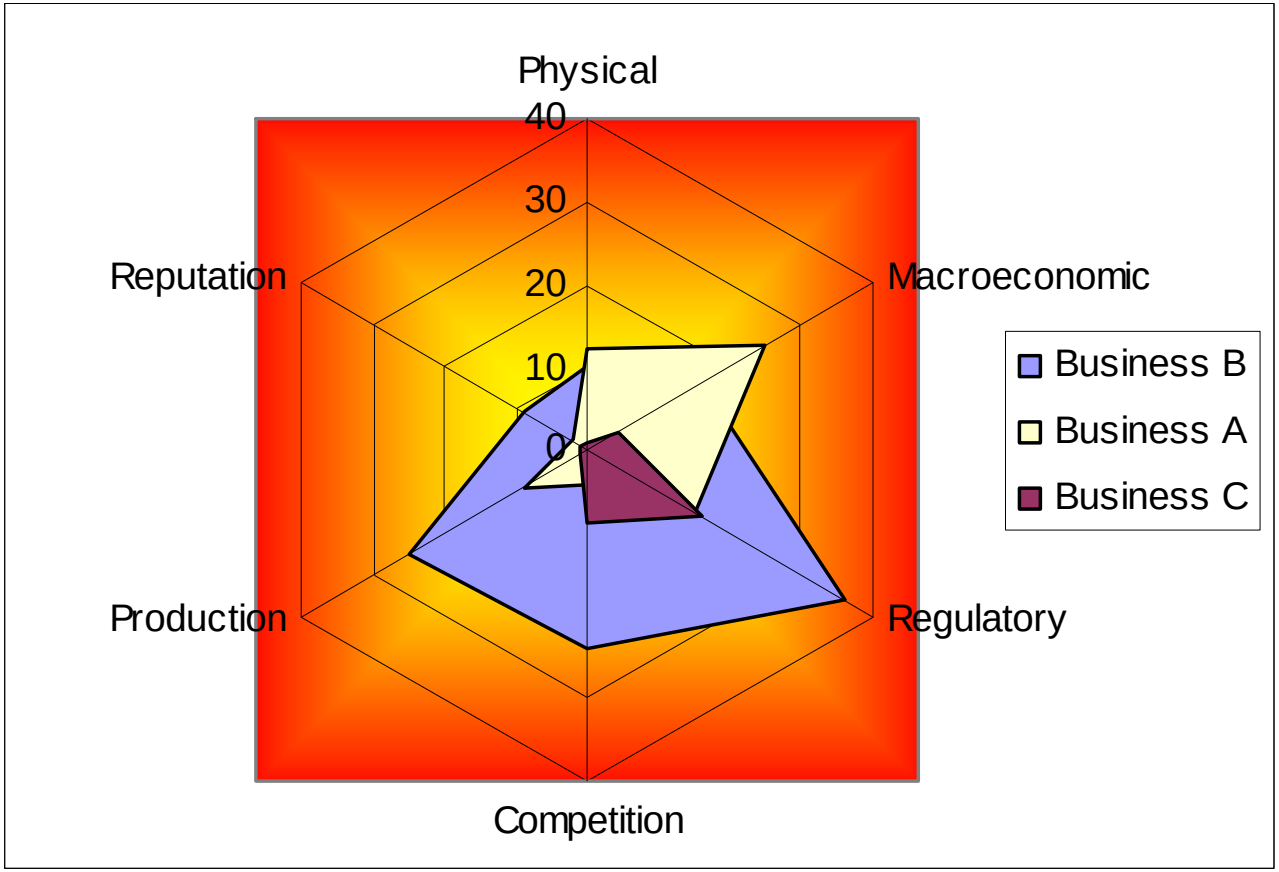
Risk Assessment

1. Risk strategy
2. Risk identification
3. Risk assessment

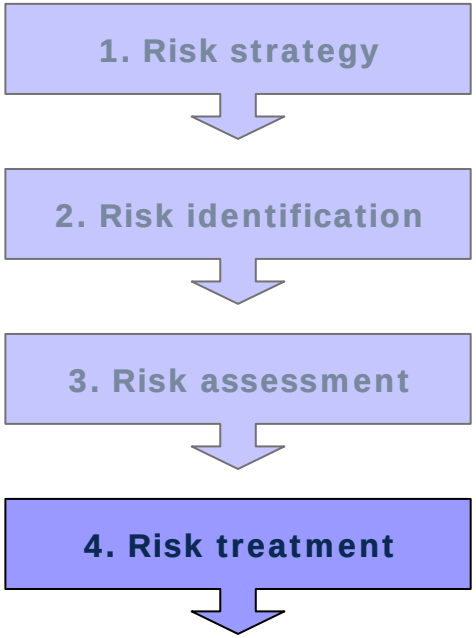
Buisness A	Probability	Impact	Climate Risk Exposure Index
Physical	50	20	10
Macroeconomic	40	40	16
Regulatory	60	60	36
Competition	60	40	24
Production	50	50	25
Reputation	90	10	9

Risk Assessment

1. Risk strategy
2. Risk identification
3. **Risk assessment**



Risk Treatment



- The major elements of risk treatment are avoidance, mitigation, transfer or acceptance of risk.
- The aim of risk treatment is to reduce the impacts and avoid risks with high occurrence probabilities in order to minimize the expectation value.
- To avoid or mitigate climate change risk, companies can **invest in emissions reduction technologies**.

Risk Treatment

Qualitative Real Options Analysis [-100]	CREX	Option A Hard Coal	Option B Hydro	Option C Solar
Physical Climate Risk	23	13	33	28
Macroeconomic	45	75	35	35
Regulatory	67	107	57	57
Competition	37	22	42	40
Production	35	35	40	45
Reputation	12	42	-18	-18
Sum	219	294	189	187
		CREX after Option A	CREX after	CREX after

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Conclusion

Real options thinking is a valuable heuristic tool for the…

- **…application of climate change risk management.**
- **… assessment of a company's exposure to climate change risk.**
- **… identification and evaluation of investment opportunities to mitigate climate change risks**
- **… identification of business climate change opportunities**

Thank you for your attention!

For more questions: www.tu-dresden.de/wwbwlbu/en

www.co2navigator.org

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Technische Universität Dresden is validated according to EMAS regulations since January 2003, successful revalidation in December 2006.

Information: http://www.tu-dresden.de/umwelt/english.htm

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