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Firm‘s Perspective on Energy Transition: Energy Projects Portfolio Formation

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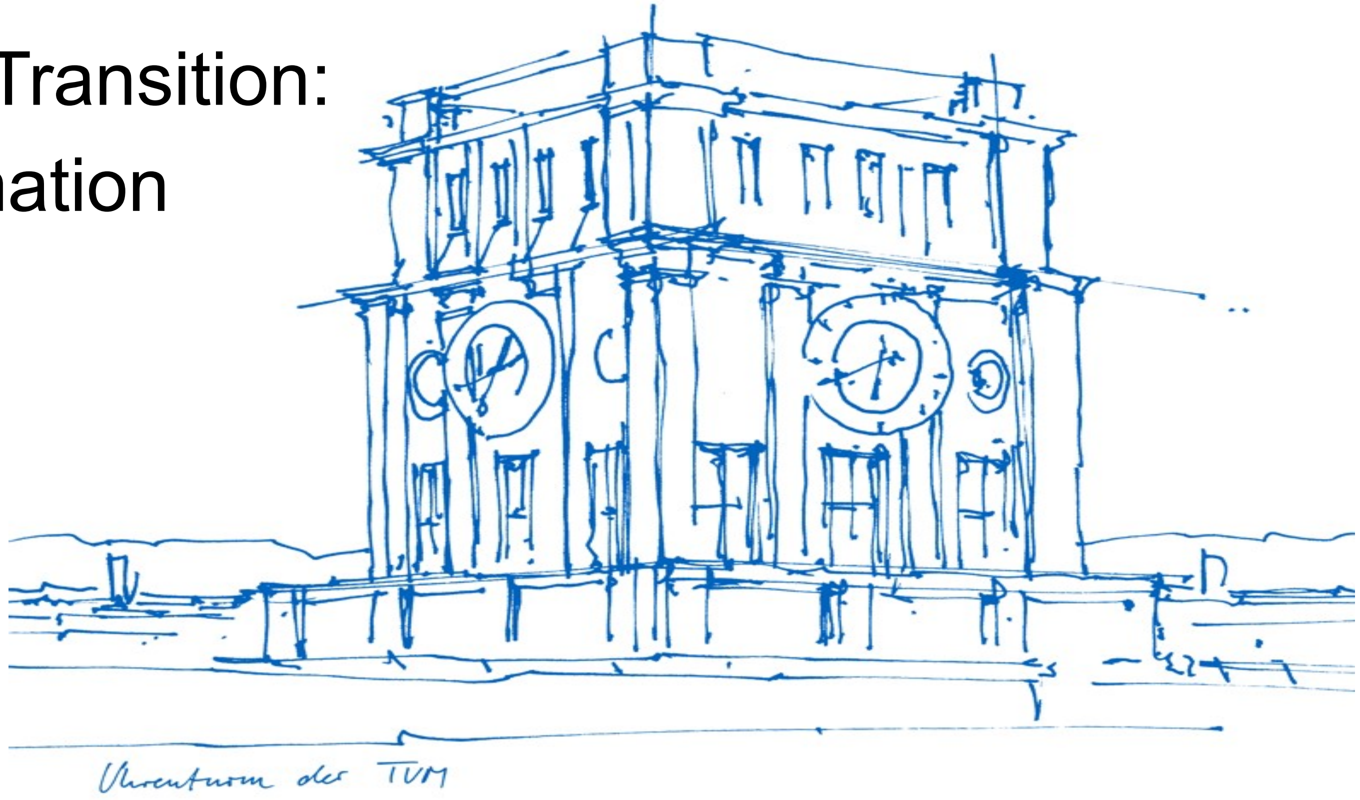


Pressure on oil and gas industry: Public

- Mass protests and petitions against oil and gas companies
  - Environmental opposition in Australia has led ban of hydraulic fracturing in Victoria state and moratoriums in New South Wales and Tasmania. Hydraulic fracturing is legal only on 2% of territory in Western Australia.
- Increasing interest for sustainable and social-responsible investments
  - From 2008 to 2018 in the USA sustainable and responsible investments have grown 10 times and now it accounted for 26% of total assets under professional management in 2018
- The World Wide Fund for Nature released online tool to help asset managers to align their portfolios with environmentally sustainable future

https://www.reuters.com/article/us-australia-gas/australias-northern-territory-lifts-fracking-ban-idUSKBN1HN360
US SIFReport on US Sustainable, Responsible and Impact Investing Trends 2018
https://www.bloomberg.com/news/articles/2020-01-30/as-investing-goes-green-environmental-warriors-are-here-to-help?cmpid=BBD013020_GREENDAILY&utm_medium=email&utm_source=newsletter&utm_term=200130&utm_campaign=greendaily

Pressure on oil and gas industry: Governments

- Increasing greenhouse gases emissions costs or encouraging its reduction
  - Canada (2016) Greenhouse Gas Industrial Reporting and Control Act (British Columbia)
  - UK (2014) Climate Change Agreement
  - Launch of EU ETS trading scheme in 2005
- Forbid on oil and gas exploration in some areas
  - France (2017) Bans hydraulic fracturing on its territory
- Constrains on resource use
  - Canada, France, and the United Kingdom committed to phase out all coal plants by 2030

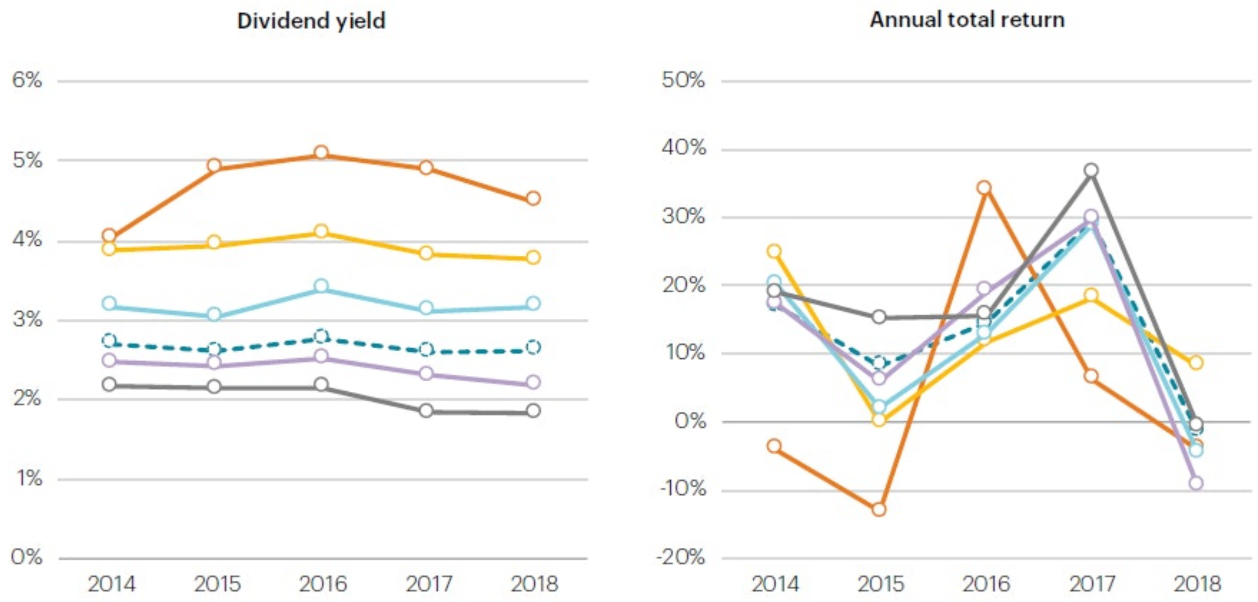
Lou, “Canada Speeds up Plan to Phase out Coal Power, Targets 2030”; Williams, “France Follows UK in Naming Coal Phase-out Date”; BBC News, “UK’s Coal Plants to Be Phased out within 10 Years.”

Pressure on oil and gas industry: Investors

- Increase in capital cost for projects which are related to fossil fuels
- Issue of Green Bonds
- Divestment from oil and gas sector which can be explained by:

1. S&P 500 returns are higher than return on oil and gas companies, but dividend yield are higher
2. The total returns on stocks of large oil and gas companies which are listed on European and US stocks in 2017-2018 were below than global average total return on oil and gas sector
3. Reputational issues

Equity performance of majors and global listed companies by selected sector



IEA , 2019

Reaction by oil and gas industry

- Under this pressure and in a view of other developments, oil and gas industry has started investing in „low-carbon“ projects changing its portfolio
  - Shell invests into H2 Mobility project in Germany
  - Exxon is going to use wind and solar energy for crude oil extraction
  - Equinor (Formerly Statoil) invests into floating wind farm in Scotland
- Some may switch completely
  - Ørsted (Denmark) has shifted away from oil and gas extraction to power generation: the share of fossil fuels in their generation is 14% with 86% being renewable
- However, the share of investments into low carbon technologies (R&D and R&D&D) is still low, <5% of total energy sector investments (IEA, 2020)

https://h2.live/en/h2mobility
https://www.bloomberg.com/news/articles/2018-11-28/oil-giant-exxon-turns-to-wind-solar-for-home-state-operations
https://www.equinor.com/en/news/hywindscotland.html
https://www.power-technology.com/features/orsteds-wind-power-pivot-story-far/

Related research

- **Exhaustible resource theory**
  - Harold Hotelling. The economics of exhaustible resources. Journal of Polit- ical Economy, 39(2):137–175, April 1931.
  - Kenneth J Arrow and Sheldon Chang. Optimal pricing, use, and exploration of uncertain natural resource stocks. Journal of Environmental Economics and Management, 9(1):1–10, March 1982.
  - Anthony J. Venables. Depletion and development: Natural resource supply with endogenous field opening. Journal of the Association of Environmental and Resource Economists, 1(3):313–336, September 2014.
  - Shantayanan Devarajan and Anthony C. Fisher. Hotelling's "economics of exhaustible resources": Fifty years later. Journal of Economic Literature, 19(1):65–73, 1981.
- **Project Financing**
  - Jianjun Miao. Optimal capital structure and industry dynamics. The Journal of Finance, 60(6):2621–2659, November 2005.
  - James R. Brown, Steven M. Fazzari, and Bruce C. Petersen. Financing innovation and growth: Cash flow, external equity, and the 1990s r&d boom. The Journal of Finance, 64(1):151–185, January 2009.
- **Stranded resource problem**
  - Partha Dasgupta and Joseph Stiglitz. Resource depletion under technological uncertainty. Econometrica, pages 85–104, 1981.
  - R. Davison. Optimal depletion of an exhaustible resource with research and development towards an alternative technology. The Review of Economic Studies, 45(2):355, June 1978.

Framework

- A rational risk-neutral firm maximizes its **value**, which consists of:
  I. Net profit or assets-at-hand
  II. Value of growth assets (liquidation or future profits) that are determined by:
      A. Future prices
      B. Regulation changes
      C. Technologies changes
- A firm chooses from a set of available projects, characterised by:
  - Varying productivity and profitability
  - Production potential decreasing with investments (exhaustibility)
  - The same output price, e.g. electricity price, price of 100 km ride, etc.

Model and Main Assumptions

- We distinguish projects with respect to technology:

Project	Resource	Technology	Cost of capital	Productivity	Constrained
Established	Old	Old	Highest	Highest	Yes
Transition	Old	New	Medium	Medium	
Alternative	New	New	Lowest	Lowest	No

- Number of established and transitional projects is **limited** by resource availability

Model set-up

- **Consider a rational value (V_t) maximizing firm:**

$$V_t = \pi_t + A_t \xrightarrow[\{k_t^n\}_{n \in L_m, L_a}]{} max,$$

k_t^n is the investments in a project n in period t

- **Total profit is given by:**

$$\pi_t = \sum_{n \in \{e,t,a\}} q_t^n k_t^n p_t - r_t^n k_t^n,$$

where q_t^n - productivity or output per unit of capital invested

- **Growth assets:**

$$A_t^n = \gamma_t^n [(\alpha^n \bar{Q}_t^n - \alpha^n q_t^n k_t^n + \beta^n \cdot k_t^n \bar{Q}_t^n - \beta^n q_t^n (k_t^n)^2) \hat{p}_{t+1} - \hat{r}_{t+1}^n k_{t+1}^n],$$

were technology improvements parameters: α - industry wide; β - learning-by-doing

Constraints

- **Budget is constrained:**

$$\delta_t^e k_t^e + \delta_t^t k_t^t + \delta_t^a k_t^a = K_t \leq \pi_{t-1} \cdot F,$$

where $\delta_t^n = q_t^n / (q_t^e + q_t^t + q_t^a)$ is productivity normalisation; and F is external financing parameter

- **Capacity is constraint:**

$$\bar{K}_t^{l_m} - k_t^e - \omega_t k_t^t \geq 0,$$

where ω_t represents resource use advantage of transitional projects

Optimization

- The following optimizational problem were solved:

$$L_t = \sum_{n \in \{e,t,a\}} (\pi_t^n + A_t^n) + \mu_t(\pi_{t-1} \cdot F - K_t) + \lambda_t^m(\bar{K}_t^m - k_t^e - \omega k_t^t) + \mu_t(\pi_{t-1} \cdot F - K_t)$$

- The following cases are possible:

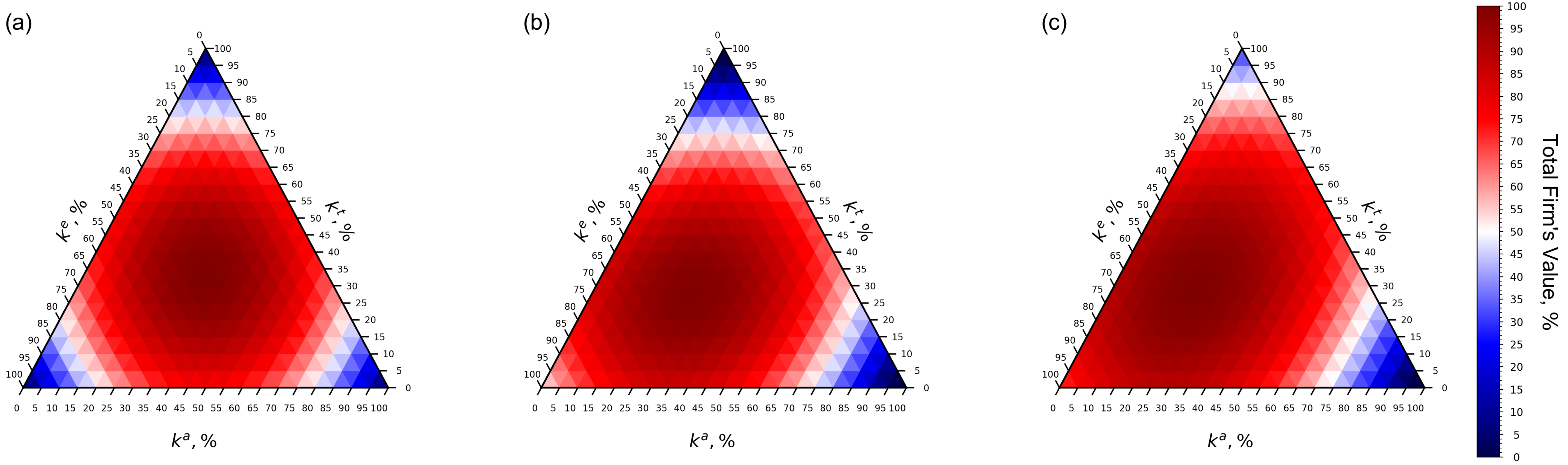
Case	λ_t^m	μ_t	Interpretation
1	$\neq 0$	0	A company is not limited in finances
2	0	$\neq 0$	Unlimited amount of projects that are related to established/ transitional business
3	0	0	A company is not limited in both: finances and available projects that are related to the established/transitional business
4	$\neq 0$	$\neq 0$	A company is limited in both: finances and available projects that are related to the established/transitional business

Results

When characteristics of all projects are the same, a firm is indifferent between available projects

When productivies start to change across the projects, a firm would change the mix of projects in its portfolio ($q_t^e = q_t^t > q_t^a$)

When productivity changes even further, a firm would still invest in all of the available projects ($q_t^e > q_t^t > q_t^a$)

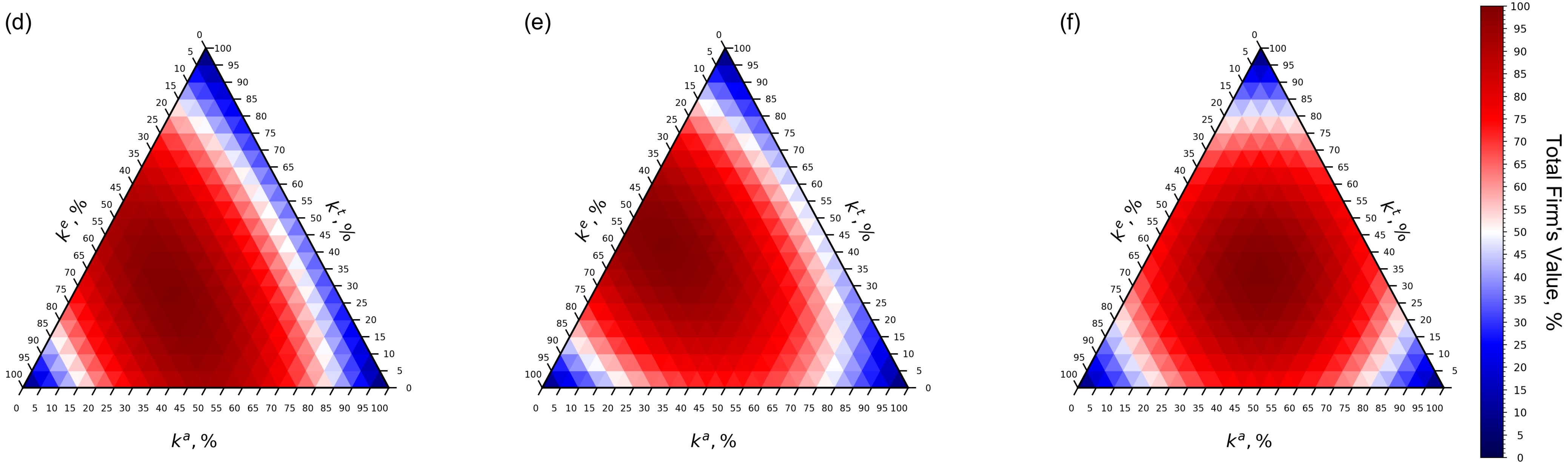


Results

Different discount factors influence on the mix of projects in a company's portfolio ($\gamma_t^e = \gamma_t^t > \gamma_t^a$)

Further changes may cause the abandonment of projects in established group ($\gamma_t^e > \gamma_t^t > \gamma_t^a$)

Variations in discount factors may be compensated by different productivities, leading to equal investments in every type of projects



Summary conclusions

1. Firms varies with respect to:
   - Expectations on future changes in regulation
   - Expectations on the future cost of capital
   - Current level of technology
   - The speed of learning
2. A firm’s expectations on the future **together** with its current level of technology rules a firm’s transition
3. Firms should develop its transitional strategy based on their expectations

Questions?

Types of investments

Investment and strategic responses to energy transitions by selected companies (illustrative, based on 2015-19 activity)

Company	Enhancing traditional oil and gas operations			Deploying CCUS		Supplying liquids and gases for energy transitions		Transitioning from fuel to “energy companies”			
	Reducing methane emissions	Reducing CO_2 emissions	Sourcing renewable power	For centralised emissions	For EOR	Low-carbon gases	Advanced biofuels	Solar PV and wind generation	Other power generation	Electricity distribution/retail	Electrified services / efficiency
BP	●	●	◐	◐	◐	●	◐	●	◐	◐	●
Chevron	●	◐	●	●	◐	◐	◐	◐	○	○	◐
Eni	●	◐	●	◐	◐	◐	●	●	●	●	◐
ExxonMobil	●	◐	●	●	◐	◐	◐	○	○	○	○
Shell	●	●	●	●	◐	●	◐	●	●	●	●
Total	●	●	●	◐	◐	●	●	●	●	●	●
CNPC	◐	○	◐	◐	●	◐	◐	●	○	○	○
Equinor	●	●	●	●	◐	◐	◐	●	○	◐	◐
Petrobras	◐	◐	●	●	●	●	◐	◐	●	◐	○
Repsol	●	●	◐	◐	◐	◐	◐	●	●	●	◐

IEA (2020), "The Oil and Gas Industry in Energy Transitions", IEA, Paris https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions

Model’s parameters

- Exogenous
  - Price scenarios
  - Interest rates
  - Taxes rates
  - Initial value for profit
  - Total amount of available projects
  - Productivity per project
  - Industries innovations
  - Firm’s pace of improvement
- Endogenous
  - Investments into each project type at each time step
  - Firm’s value at each step