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

US SIFReport on US Sustainable, Responsible and Impact Investing Trends 2018
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

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.power-technology.com/features/orsteds-wind-power-pivot-story-far/
Related research

- **Exhaustible resource theory**

- **Project Financing**

- **Stranded resource problem**
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:

<table>
<thead>
<tr>
<th>Project</th>
<th>Resource</th>
<th>Technology</th>
<th>Cost of capital</th>
<th>Productivity</th>
<th>Constrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Established</td>
<td>Old</td>
<td>Old</td>
<td>Highest</td>
<td>Highest</td>
<td>Yes</td>
</tr>
<tr>
<td>Transition</td>
<td>Old</td>
<td>New</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Alternative</td>
<td>New</td>
<td>New</td>
<td>Lowest</td>
<td>Lowest</td>
<td>No</td>
</tr>
</tbody>
</table>

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

- Consider a rational value \((V_i)\) maximizing firm:
  \[ V_i = \pi_t + A_t \rightarrow \text{max}, \]
  where \(k_t^n\) 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:
  \[ A_t^n = \gamma_t^n [ (\alpha^n Q_t^n - \alpha^n q_t^n k_t^n + \beta^n \cdot k_t^n Q_t^n - \beta^n q_t^n (k_t^n)^2) \hat{p}_{t+1} - \hat{r}_{t+1} k_{t+1} ], \]
  were technology improvements parameters: \(\alpha\) - industry wide; \(\beta\) - learning-by-doing.
Constraints

- **Budget is constrained:**

\[
\delta^e_i k^e_i + \delta^t_i k^t_i + \delta^a_i k^a_i = K_i \leq \pi_{t-1} \cdot F,
\]

where \( \delta^n_i = q^n_i / (q^e_i + q^t_i + q^a_i) \) is productivity normalisation; and \( F \) is external financing parameter.

- **Capacity is constraint:**

\[
\bar{K}_{t}^{lm} - k^e_i - \omega_t k^t_i \geq 0,
\]

where \( \omega_t \) represents resource use advantage of transitional projects.
The following optimizational problem were solved:

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

The following cases are possible:

<table>
<thead>
<tr>
<th>Case</th>
<th>( \lambda_t^m )</th>
<th>( \mu_t )</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( \neq 0 )</td>
<td>0</td>
<td>A company is not limited in finances</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>( \neq 0 )</td>
<td>Unlimited amount of projects that are related to established/transitional business</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>A company is not limited in both: finances and available projects that are related to the established/transitional business</td>
</tr>
<tr>
<td>4</td>
<td>( \neq 0 )</td>
<td>( \neq 0 )</td>
<td>A company is limited in both: finances and available projects that are related to the established/transitional business</td>
</tr>
</tbody>
</table>
Results

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

When productivities start to change across the projects, a firm would change the mix of projects in its portfolio ($q^e_t = q^t_t > q^a_t$).

When productivity changes even further, a firm would still invest in all of the available projects ($q^e_t > q^t_t > q^a_t$).
Results

Different discount factors influence on the mix of projects in a company’s portfolio ($\gamma^e_t = \gamma^t_t > \gamma^a_t$)

Further changes may cause the abandonment of projects in established group ($\gamma^e_t > \gamma^t_t > \gamma^a_t$)

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

Sofia A. Berdysheva, 2021
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)

<table>
<thead>
<tr>
<th>Company</th>
<th>Enhancing traditional oil and gas operations</th>
<th>Deploying CCUS</th>
<th>Supplying liquids and gases for energy transitions</th>
<th>Transitioning from fuel to “energy companies”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reducing methane emissions</td>
<td>Reducing CO₂ emissions</td>
<td>Sourcing renewable power</td>
<td>For centralised emissions</td>
</tr>
<tr>
<td>BP</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Chevron</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Eni</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>ExxonMobil</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Shell</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Total</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>CNPC</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Equinor</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Petrobras</td>
<td>●</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Repsol</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

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