FIRM'S PERSPECTIVE ON ENERGY TRANSITION: ENERGY PROJECTS PORTFOLIO FORMATION

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Overview

Over the past few decades, the growing climate change concerns have led to a transformation in the global energy mix: many countries work towards increasing the share of renewable energy while decreasing the use of emission-heavy fossil fuels. This transition has been supported by a variety of public policies and market mechanisms, along with the shift in public preferences for "responsible" investments. The increasing number of public and private investment institutions (Berkeley Haas [1], Oxford [2], Guardian Media Group [3], etc.) has announced divestment from fossil fuel companies. The emerging discrimination in capital allocation, together with the poor financial performance of the major oil and gas companies compared to the average S&P 500 returns over the last decade [4], have raised a question of oil and gas sector development. The change in investor preferences and public attitude, accompanied by the regulatory incentives, forces oil and gas companies to expand their portfolio by including non-fossil energy projects and, thus, results in the *energy transition*.

Many oil and gas industry champions, such as Exxon Mobil, Chevron, Royal Dutch Shell, BP, and Total, have already started allocating a portion of their capital to renewable and low carbon technology projects [5, 6]. Yet, new technologies are costly and often estimated to have low or even negative return on investments raising a question on whether such decisions are justified. The majority of companies are dependent on both: internal and external capital. So, to make transition strategies feasible and sustainable, firms have to ensure they continue making profits and growing assets useful for raising external capital.

The goal of our work is to investigate the trade-offs faced by fossil energy companies investing in the alternative low-carbon technologies, transitional, and established fossil energy projects. Especially, we are interested in (1) understanding how investor preferences and technological uncertainty may affect the allocation of capital and (2) investigating the interplay between costs and availability of capital for diverse projects (fossil fuels vs. renewables).

Methods

We adopt the view of Miao [7] and Brown et al. [8] and assume that firm's value is determined by its assets-at-hand, or profit, and growth assets. A rational firm is expected to maximize its value by investing in a mix of established, transitional, and alternative projects. Established projects can be associated with exhaustible fossil energy resources. Transitional projects exploit the same resource as the established projects, but technological advances allow for reduced environmental impact. Finally, alternative projects utilize new technologies to develop different kind of resources, e.g., renewable energy or hydrogen. Investments may affect either firm's profit, or its growth asset value, or both. For instance, investments in alternative projects may offer low returns today, but thanks to learning-by-doing could increase the growth asset value and the ability to generate profit in the future. Yet, the total effect on the firm's value is non-trivial and depends, among other things, on the budget constraint, resource constraints, and the discount rates (or time horizon).

Results

We solving the firm's value maximization problem under capital and resource constraints to find how the transition strategy depends on the technology parameters, cost of capital, and uncertainty about the ability to develop the established projects in the future. The results enable us to suggest that:

- The increased costs of capital and constraints in capital availability would create incentives to invest in higher return fossil energy projects;
- The lower costs of capital available for investing in new technologies, would make companies prone to invest in more risky projects or projects with higher uncertainty with respect to their growth value
- The investing in new low-carbon technologies will depend on the firm's reliance on the external capital and profitability distribution of the existing fossil projects.

Hence, we are able to explain the observed differences in investments by various firms with the differences in firms' characteristics, including their ability to raise external capital, beliefs regarding the future of the traditional resource, and perceived uncertainties with regard to the new technologies.

Conclusions

We see a variety of implications of our model and also contribute to the literature on energy transition [9], financing of energy transition, and a firm investment strategy [8] and industry dynamics [7, 10]. International Energy Agency [11] and a variety of international energy councils called energy transition financing as a fundamental future development challenge. Our analysis helps identify the incentives for companies to invest in technologies supporting energy transition, offering the much-needed formal approach to analysis of energy companies behavior which was mentioned in the article by Pickl [6]. The presented model also allows to see the trade-offs associated with capital and foresee the changes in industrial supply under various market conditions and public preferences.

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