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A system dynamics model of capital structure policy for firm value maximization

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Abstract

The complexity surrounding the maximization of firm value agenda demands a comprehensive causal model that effectively embeds the intertwining relationships of the variables and the policies involved. System dynamics provides an appropriate methodology to model and simulate such complex relationships to facilitate decision making in a complex business environment. The objective of the study is to analyze the impact of capital structure policy, being a key managerial decision, on the firm value. For this purpose, the study develops a system dynamics-based corporate planning model for an oil firm, including the operational as well as financial processes. Various scenarios and capital structure policies have been designed and simulated to identify the policy that helps in increasing the firm value. The results demonstrate that increase in debt percentage in capital structure mix increase the firm value.

KEYWORDS

capital structure policy, financing, firm value, oil and gas production, simulation, system dynamics

1 | INTRODUCTION

The purpose of this paper is to investigate the potential impact of capital structure policy on the firm value to identify the optimal capital structure policy. Creating and maximizing firm value is the primary goal of a firm (Brealey, Myers, & Marcus, 2012). One of the tools to achieve this objective is framing the capital structure policy resourcefully (Lawal, 2014). Capital structure policy is one of the most debated topics in corporate finance literature due to its complexity and strategic importance in determining the firm value (Berk & DeMarzo, 2007; Brigham & Ehrhardt, 2002). Capital structure refers to the mix of financing sources of the firm to meet the financial requirements (Niu, 2008). Leverage irrelevance theory was put forward by Modigliani and Miller (Modigliani & Miller, 1958) that in the absence of taxes and transaction costs and perfect information among players, the value of the firm is indifferent to the choice of capital structure mix. Their later work (Modigliani & Miller, 1963) acknowledged the significance of taxes and transaction costs since real capital markets are not perfect. Tax assumption was later relaxed (Kraus & Litzenberger, 1973) proposing the trade-off theory (TOT) which recommends that firms decide their capital structure mix through the balance between the tax-shield benefits and bankruptcy costs associated with debt financing. Agency theory (Jensen & Meckling, 1976) advocates that agency costs arising due to conflict of interest between ownership and management influence the corporate financing choices. Pecking order theory (POT; Myers & Majluf, 1984) postulates the sequencing of the financing choices wherein firms prefer internal financing to external financing, equity being the last choice. Neither the theories nor the empirical research have arrived a consensus and there is an ongoing debate whether higher debt increases or decreases the firm value (Bilafif & Ibrahim, 2019; Li, Niskanen, & Niskanen, 2019). This study address the following research question: How the capital structure policy impacts the firm value per share? To address this question, this study develops a system dynamics model by taking a Norwegian oil firm as the case firm to identify the capital structure policy that enhances the firm value per share. The model incorporates the causalities surrounding the capital structure policy as postulated by the theories and test various capital structure policies under different scenarios to analyse their impact on the firm value.

The reason for using system dynamics for the analysis is that system dynamics facilitates the development of complex models and allows integration of nonlinearities and feedback loops existing in the real system (Richardson, 2011; Sterman, 2000). System dynamics is based on four guiding principles including the theory of information feedback systems, knowledge about the real system and decision-making processes, computer-based simulation models to represent mathematically the realistic systems, and iterative experimental modelling approach towards understanding the complex systems (Forrester, 1961). Capital structure policy involves variables intertwined with many other decision variables in feedback relationships that have long-term effects. The conflicting views grounded on internal characteristics of a firm and potential response of the market lead us to develop an integrated system dynamics model that allows us to experiment with different theoretical frameworks to understand dynamics of capital structure policy.

We employ the discounted cash flow valuation method (DCF) as a theoretical lens to perform the valuation. The DCF is based on the premise that value of a firm today is the present value of cash flow stream the firm is expected to generate in future (Ross, Westerfield, & Jordan, 2008). The DCF valuation is based upon two major elements: free cash flows (FCF) and weighted average cost of capital (WACC) (Gardner, McGowan, & Susan, 2012). Higher expected FCF would lead to higher valuation of the firm, ceteris paribus, and lower WACC would lead to higher valuation holding FCF constant. Thus, the role of financial management is to devise policies that increase the FCF to the firm and effectively reduce the WACC to increase the firm value (Gardner et al., 2012). Capital structure policy affects the firm value by having a potential significant impact on FCF as well as WACC (Brigham & Ehrhardt, 2002).

Our study embodies significance because our simulation model incorporates all the relevant operational and financial variables that embeds intertwining relationships in an effort to mimic the performance of all functional areas at an aggregate level that determine the firm performance. Separation of financial and operational decision variables leads to suboptimal decision making (Berman, Sanajian, & Abouee-Mehrizi, 2012) as they both contribute together to determine the firm performance and value. Thus, a comprehensive planning model that integrates operational as well as financial decisions and complies with the principles of accounting and corporate finance would lead to improved managerial decisions that would drive business productivity and success. This allows us to experiment with a variety of different scenarios and policies and does not constrain us to the empirical data that effectively limits the modelling choices.

Along with introduction in this section, we organize rest of the paper as follows. Section 2 represents the method. Section 3 characterizes the model structure. Section 4 validates the model. Section 5 develops the scenarios and presents the policy design whereas Section 6 provides the results and their discussion. Finally, Section 7 puts forward the conclusions drawn and policy implications. The study furnishes references at the end.

2 | METHOD

We used Vensim® software to develop the system dynamics model by using publicly available quantitative and qualitative data and other relevant information from different sources such as the firm's annual reports and its website, industry reports along with relevant academic literature. System dynamics is useful in developing the planning models for firms to understand the behavior, solving the problems, decision making, and analysis (Helo, 2000; Lyneis, 1980; Suryani, Chou, Hartono, & Chen, 2010). System dynamics is based on generating the behavior from the structure mimicking the real system, and as such, it is an appropriate tool to perform the firm valuation and policy analysis. The model is calibrated to match the real behavior in the past, and then it is simulated into the future to generate results. Forecasts generated from a calibrated model are more reliable than other approaches such as statistical models (Lyneis, 1980). The modelling process specifies assumptions and all-encompassing variables explicitly (Morecroft, 2015; Schoemaker, 1993) that facilitate understanding of the relationship between structure and behavior (Forrester, 1973) leading to comprehensive policies that ensure consistence and coherence.

3 | MODEL STRUCTURE

The system dynamics model developed for the purpose of this study uses Equinor, an international oil and gas firm based in Norway and listed in 2001, as the case firm. The model is simulated for a period of 50 years starting from year 2000. This allows sufficient time period not only for the model calibration using historical data but also to analyze expected behavior long into the future considering long-term nature of the investments in oil industry. The model comprises of three modules: financial, production, and valuation. Financial module includes integrated financial statements and financial decision variables. Production module comprises physical production processes of oil and gas, and renewable energy. Physical processes account for the delays and nonlinearities involved in investments into physical assets and construction process and ultimately production from these fixed assets (Halawa, Abdelalim, & Elrashed, 2013). The firm valuation module estimates the firm value based on DCF valuation method.

A simplified causal loop diagram in Figure 1 highlights the major loops involving financial variables and valuation. Capital expenditure into the fixed assets define the level of operations and consequent profitability of the firm. Taking the financial management approach, the firm focuses on the quantity of investments and cash flows at the first place (Qureshi, 2007). Investment decisions depend upon the availability of the capital that depends on the financing capacity and policy of the firm.

Internal financing and external financing loops summarize the investment, production, and cash flow processes. For an oil firm, capital expenditure includes investments into exploration activities to discover oil and gas reserves and production activities to produce oil and gas from the proven reserves. Cash is calculated based on the sales and expenses of the firm. If the firm has more cash available internally, it needs less of external financing. The higher the external financing needs, the higher would be the level of debt and equity. Once the required capital needs are estimated, the firm raises external funds with a mix of debt and equity based on financing decision.

3.1 | Financial module

Financial module incorporates the financial activities of the firm following the accounting principles and rules. The module incorporates aggregated financial statements

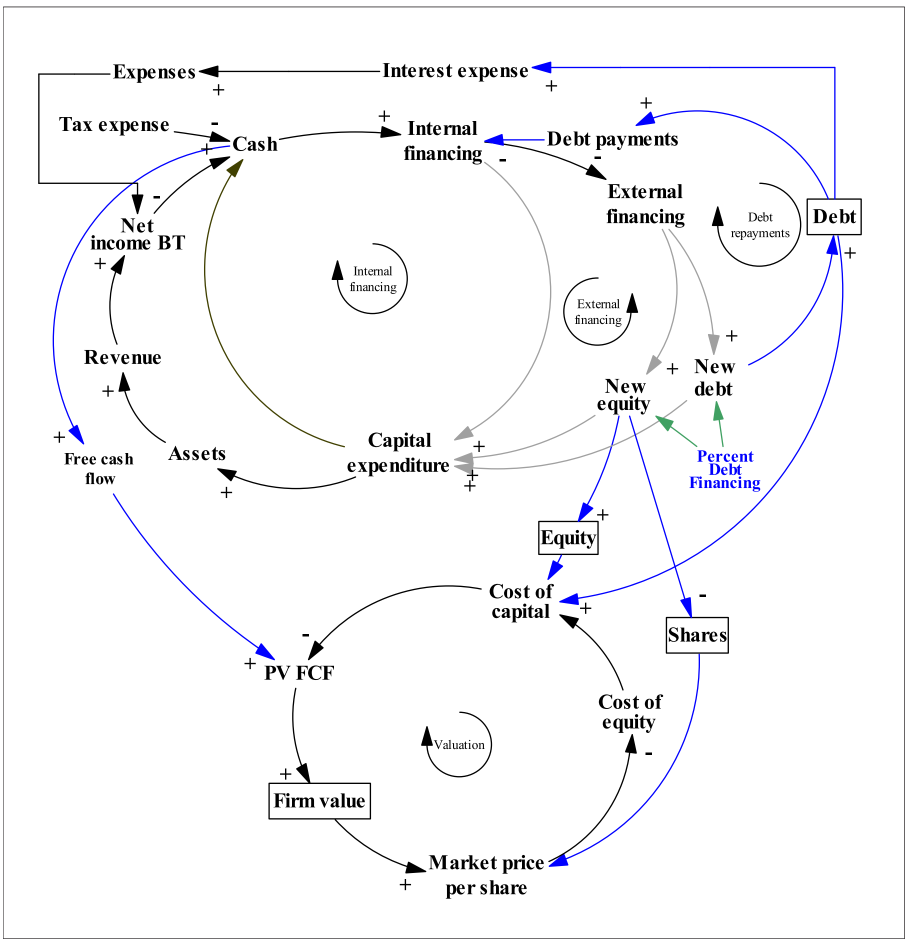

FIGURE 1 Overview of model structure [Colour figure can be viewed at wileyonlinelibrary.com]

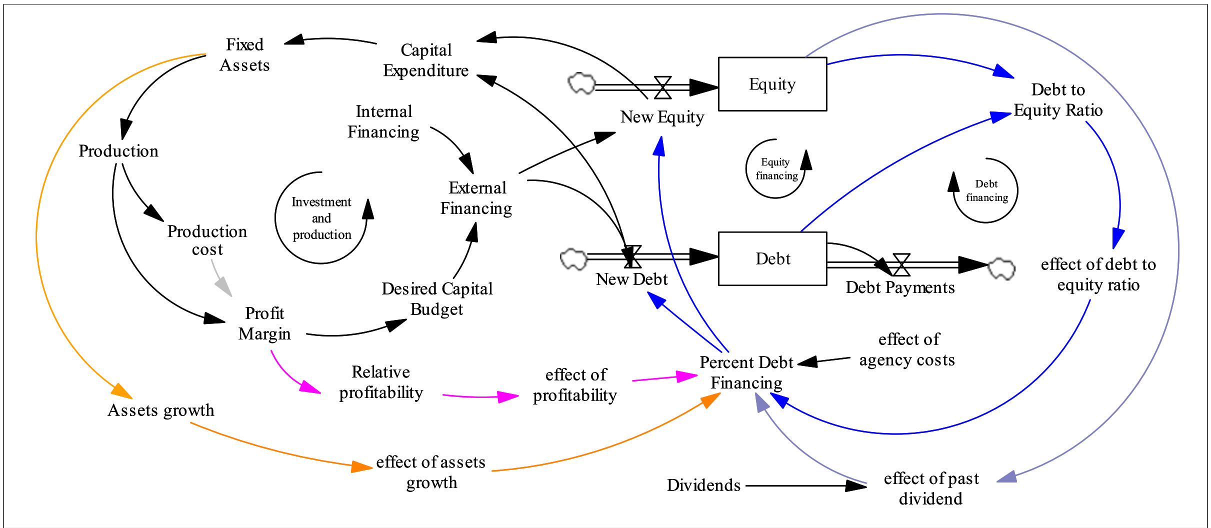

FIGURE 2 Simplified stock and flow diagram of major elements of capital structure [Colour figure can be viewed at wileyonlinelibrary.com]

including balance sheet, income statement, and cash flow statement (Yamaguchi, 2003). We demonstrate the focus of this article, capital structure policy in Figure 2 that represents the key variables, and their feedback relationships in a simplified diagram.

Percent debt financing is the key variable demonstrating the capital structure mix (equity financing and debt financing in Figure 2). The capital structure policy has multiple implications for a firm including its cost of capital that is a critical element in estimating the firm value. Based on the elements identified from relevant literature (Frank & Goyal, 2009; Qureshi, Sheikh, & Khan, 2015), we model percentage debt financing as a nonlinear function of debt to equity ratio, assets growth, profitability, agency costs, and past dividends.

$$\begin{aligned}\text{Percent debt financing} = {} & \text{debt financing ratio}\\ & * (\text{effect of profitability on debt})\\ & * (\text{effect of debt to equity ratio on debt financing})\\ & * (\text{effect of asset growth on debt})\\ & * (\text{effect of past dividend on debt})\\ & * (\text{effect of agency costs on debt financing}). \end{aligned} \tag{1}$$

Table 1 presents the variables along with their measurement and their relationships with debt financing predicted by the two competing theories.

Table 1 highlights conflicting postulations of the capital structure theories about five major variables. Based on empirical observations, the POT observes that as profitability of the firm increases, firms raise less debt as they prefer internal finances to debt. However, TOT postulates that as profitability increases, firms can benefit from debt as they can earn at a rate higher than they need to pay. According to POT, as firm is growing, it raises more debt

TABLE 1 Predicted impact of variables on debt financing percentage as per POT and TOT

Variable	Measurements	POT	TOT
Profitability	Net profit before taxes/Total assets	−	+
Growth	(Total assets$_t$ - Total assets$_{t-1}$) / Total assets$_{t-1}$	+	−
Past dividend	Dividend$_{t-1}$/Total equity$_{t-1}$	+	−

to support that growth. However, TOT postulates growing firms have lesser debt in their capital structure mix. POT predicts past dividends have positive influence on debt percentage whereas TOT assumes it has negative influence. Agency costs arise due to conflict of interest between the managers and the principles. According to agency theory agency, costs reduce when there is an increase in the level of debt as monitoring costs reduce and managers have lesser cashflows available at their discretion (Jensen & Meckling, 1976). Debt to equity ratio, a measure of firm's debt risk (Allen, Brealey, & Myers, 2006) in our model determines the risk premium the firm has to pay to debtholders over and above the risk-free interest rate. As the risk of the firm increases, the firm becomes conservative to new debt issuance. We model the firm's response to the risk as a nonlinear function, which has an effect on percent debt financing. Equity financing loop demonstrates that with increase in equity financing ratio the risk of the firm reduces and so does the return, negatively affecting the FCF and the firm value. We incorporate all these causalities of debt in our model that influence the percent debt financing of the firm.

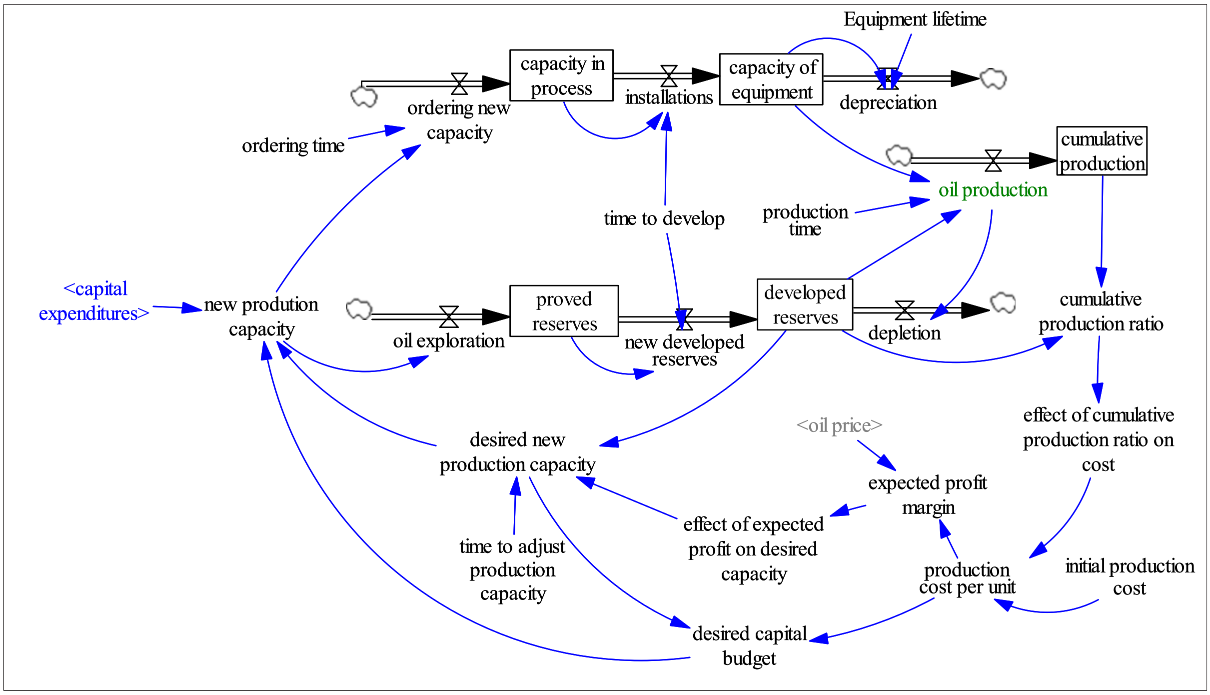

FIGURE 3 Simplified stock and flow diagram for oil and gas production processes [Colour figure can be viewed at wileyonlinelibrary.com]

The new debt and new equity determine the firm's level of debt and equity financing. Consequently, the capital structure policy determines WACC that is used to discount the FCF to determine the firm value. As such, from capital structure policy's perspective WACC is at the core of firm valuation that has long-term implications for the market price of the firm's shares.

3.2 | Production module

Production module includes the physical production processes for oil and gas and renewable energy. Oil and gas production process starts by investing to explore the oil and gas reserves beneath the seabed. Successful exploration efforts add to the proved reserves stock. Figure 3 illustrates the simplified stock and flow diagram of the production module. Time and investments are needed to develop these reserves in order to make extraction of oil possible from these reserves. Capacity to produce the oil and gas is a prerequisite for production and refers to the necessary equipment and materials required in the oil and gas extraction process. Quantity of oil and gas extracted is dependent on the quantity of developed reserves in the presence of capacity. Once there are proved reserves, they need to be developed in order to make extraction of oil and gas possible through building the capacity and all the required equipment. Given the physical capacity, extraction is possible from a reserve depending on the quantity of oil available. Production defines the depletion of the reserves, as the quantity of oil beneath the earth is finite and in place. The production processes involve many delays and nonlinearities. These delays are modelled to account for the long-term nature of the investments. Production quantity determines the production costs as they define the level of operations of the firm as well as the remaining reserves of the oil and gas. Thus, the production costs are modelled as a nonlinear function of cumulative production and developed reserves (Davidsen, Sterman, & Richardson, 1990).

Production costs and expected oil and gas prices that determine profit expectation play a significant role for deciding desired capacity for future that determines the capital expenditure. Firm needs to invest at least equal to its depletion and depreciation to maintain the steady state. However, to increase the capacity, they need to invest more than the steady state amount of investment. The capacities and reserves development involve major delays consisting of many years. The model incorporates the delays through parameters, nonlinear functions, and stocks mechanism to mimic the real system structure.

Following the recent global trends, Equinor is also moving towards carbon free energy solutions.[1] new energy solutions (NES) in the model includes offshore wind energy, solar energy and some other renewable

[1]https://www.equinor.com/en/what-we-do/new-energy-solutions.html

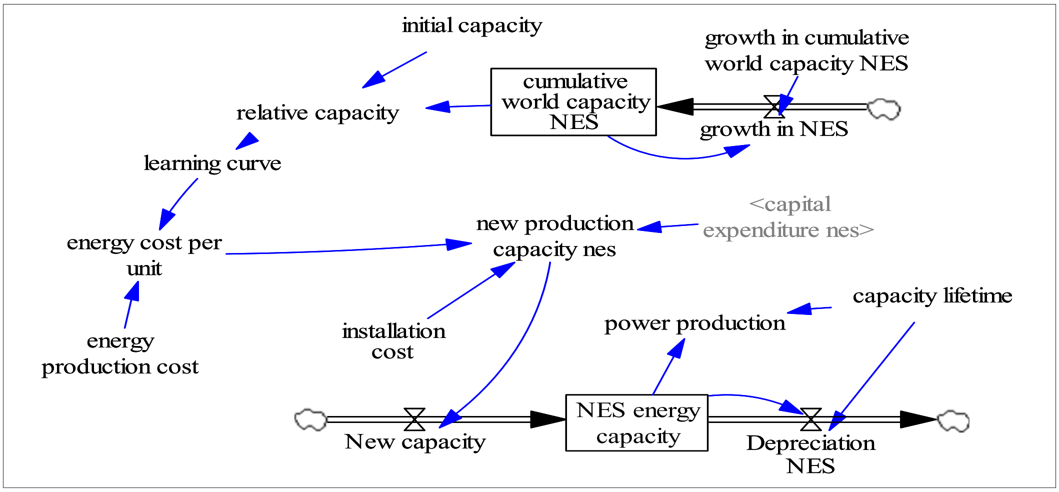

FIGURE 4 Simplified stock and flow diagram for renewable energy production processes [Colour figure can be viewed at wileyonlinelibrary.com]

energy sources included in the firm's portfolio. To simplify, we merge all these resources in one stock in our model. Figure 4 demonstrates the simplified structure for the NES.

NES are at developing phase and are expected to become cost effective in future. The costs have been calculated incorporating the learning curve (Goldemberg, Coelho, Nastari, & Lucon, 2004; McDonald & Schrattenholzer, 2001) which incorporates nonlinear effect of learning on costs. Resultantly, the model assumes that the NES becomes efficient and improved learning process decreases the production costs overtime. Energy capacity yields power production that integrates the production module to the financial module.

3.3 | Valuation module

The valuation module integrates the variables from the financial module for the DCF valuation that relies on the estimation of the FCF and the WACC to estimate the firm value (Damodaran, 2010). The following equation provides formulation of FCF (Benninga, 2008), and we use weighted average cost of debt and equity as WACC (Brealey, 2012).

$$\begin{aligned}\text{Free cash flow} = {} & \text{net income after taxes}\\ & + \text{depreciation expense}\\ & + \text{after tax interest on debt}\\ & + \text{increase in current liabilities}\\ & - \text{capital expenditures}\\ & - \text{increase in current assets.}\end{aligned} \tag{2}$$

Terminal value estimates the value of the firm under the assumption of going concern that is the firm would continue the business to infinite future (Palepu, Healy, & Peek, 2013). The terminal value represents the future expectations estimated through the firm's return on equity. The present value of FCF accumulates into the stock of firm value. Every year new value adds through inflows and old value outflows. The model calculates the market price per share by dividing the firm value with the number of shares outstanding. The estimated market price per share feedbacks to the cost of equity next time around. Figure 5 presents the simplified version of the operationalization of the DCF.

4 | MODEL VALIDATION

The validity of results from a model depends on the validity of the structure and the model. The validity of the model is exhibited if the internal structure of the model conforms to the theoretical and empirical knowledge about the real system and depicts adequately the behavior that is relevant to the issue (Sterman, 2000). This ensures the structural validity of the model that the model is generating the right behavior for the right reasons. Given the model structure discussed above, we carried out direct structure tests that review validity of the model structure by direct comparison with knowledge about real system (Barlas, 1996; Senge & Forrester, 1980). Every equation of the model uses knowledge and theory about the real system to depict the organic relationships. To ensure that the model is dimensionally consistent, we applied dimensional consistency tests. Based on the tests' results, we can report that our model is structurally valid and

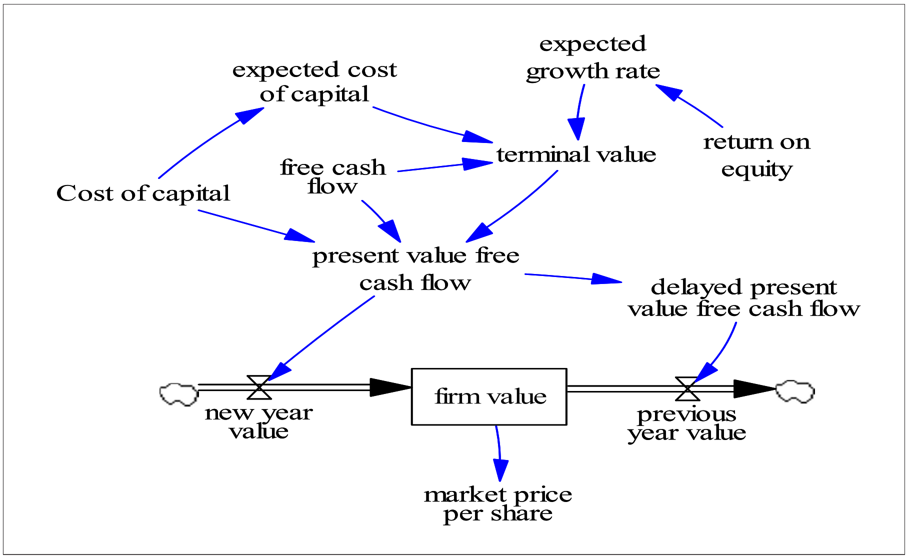

FIGURE 5 Simplified stock and flow diagram for valuation module [Colour figure can be viewed at wileyonlinelibrary.com]

dimensionally consistent. Extreme conditions tests assess the model behavior by assigning the selected parameters extreme values and comparing the simulated model behavior to the observed and/or expected behavior of the real system under similar extreme conditions. The results of extreme conditions test applied to certain parameters suggest that the model behavior is realistic under extreme conditions.

Figure 6 characterizes the reference mode for market price per share (the variable of interest) and the total debt as compared to the historical data. The results suggest that the model is replicating the behavior substantially and thus could be simulated into the future for policy and scenario analysis.

Behavior reproduction tests have been performed to further assess the model's ability to reproduce the behavior. Table 2 presents the R^2 (coefficient of determination), mean square error (MSE), root mean square percentage error (RMSPE), and Theil's inequality statistics (Theil, 1966) by decomposing MSE into bias (U^M), unequal variation (U^S), and unequal covariation (U^c) for total debt and market price per share. The R^2, RMSPE, and MSE indicates that the model structure is capable to mimic the underlying behavior pattern. Moreover, the decomposition of RMSPE wherein larger U^c in both cases indicates that the model is capturing the mean and the underlying trends of the data reasonably well and the error is only due to difference from point to point estimation (Sterman, 2000). Advocating utility of such models, researchers observe that forecasts from calibrated model are more reliable than from other approaches (Suryani et al., 2010).

5 | SCENARIOS AND POLICY DESIGN

The study designs capital structure policies and scenarios to test the impact of capital structure policies on the firm

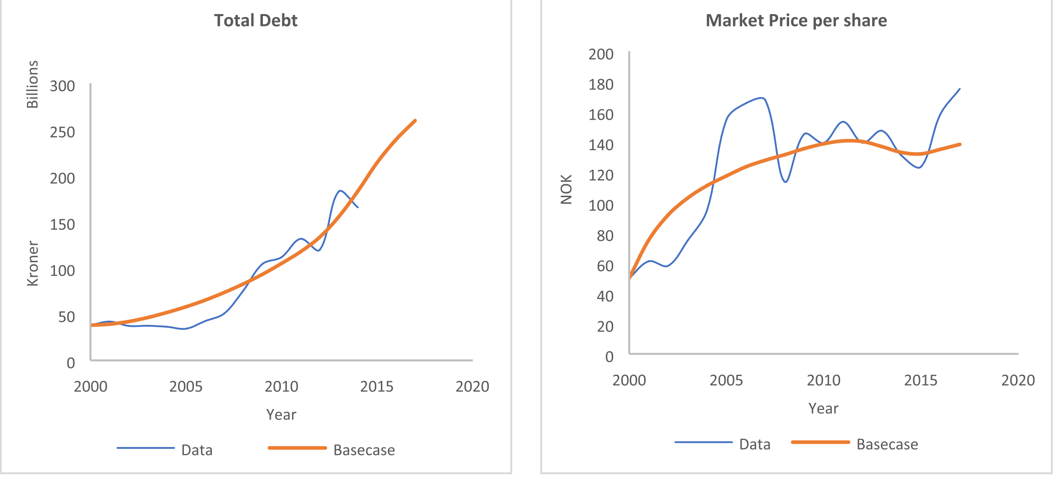

FIGURE 6 Reference mode and total debt, simulation and historical data [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Model fits to historical data (error analysis)

Variable	RMSPE	MSE (units)	U^m	U^S	U^C	R^2
Total debt	0.30	2.35E+20	0.07	0.38	0.55	0.92
Market price per share	0.23	5.56E+02	0.01	0.39	0.6	0.72

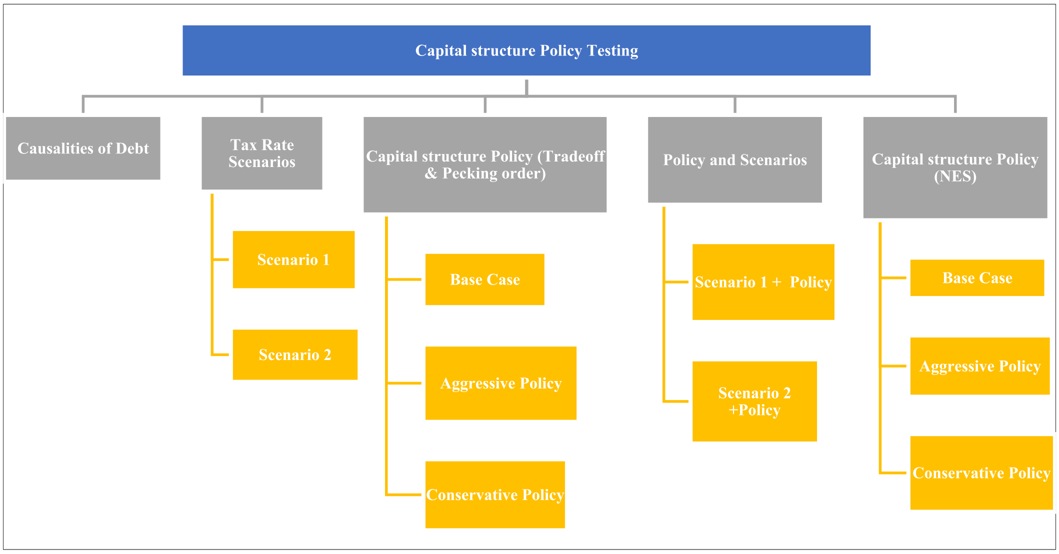

FIGURE 7 Capital structure policy analysis [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 3 Capital structure policy and scenarios

Capital structure policy	Policy variable	Policies
Aggressive policy	Debt fraction	75% debt
Base case	Debt fraction	55% debt
Conservative policy	Debt fraction	35% debt
Tax rate scenarios		Scenarios
Base case		68%
Scenario 1		Base case +5%
Scenario 2		Base case −5%

value. Considering the key role of tax deductibility of debt interest payments in financing choices (Graham, 1996; Fama & French, 1988), we designed tax rate scenarios to capture the uncertain alternative situations that might affect the outcomes of capital structure policy and the firm value. A profitable firm could benefit from increasing the level of debt to a point where marginal tax benefits start to decline; however, the evidence suggests that large and profitable firms use debt conservatively (Graham, 2000). For our case firm, taxes are important primarily because oil firms operating in Norway are subject to heavy petroleum and income taxation. We have designed capital structure policies by increasing and decreasing the percent debt financing with reference to the base case. We test these policies in isolation and then in combination with the tax rate scenarios to test their impact in different situations.

Considering the market push for the renewable energy and potential depletion of oil and gas reserves, the oil and gas firms are trying to diversify their investment portfolios. Our case firm is utilizing its offshore expertise in offshore wind energy and other sources of renewable energy such as solar energy. As such, we model NES explicitly to test if these new investments would change the results of capital structure policies' impact on the firm value. We have modelled the investments in NES based on the firm's goal to invest 100 billion kroner by 2030 so that 15%–20% of the firm's investments would be in NES by the end of 2030.[2] Therefore, it is interesting to investigate the impact of NES investments on the firm value and to identify which debt policy would be optimal in that case. We have made relevant assumptions based on the available predictions about this industry (InnoEnergy, 2017).Table 3 outlines the designed capital structure policies and tax rate scenarios.

The tree diagram in Figure 7 depicts the framework that we used for the purpose of capital structure policy testing under different scenarios. First, we test the causalities of debt by simulating the model through the predictions of each theory as depicted in Table 1 and examine the impact on the market price per share. Second, we simulate the model under three tax rate scenarios as

[2]https://www.equinor.com/en/magazine/transitioning-to-broad-energy-company.html

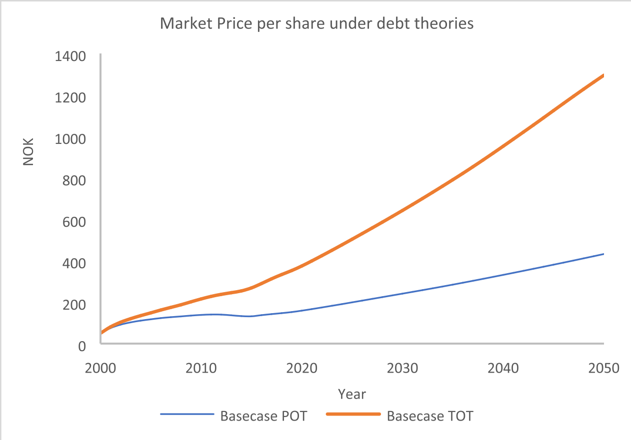

FIGURE 8 Causalities of debt (POT, TOT [Colour figure can be viewed at wileyonlinelibrary.com]

described in Table 3 to examine the impact on the market price per share. Third, we simulate the model under three capital structure policies as represented in Table 3. Fourth, we couple the policies with the tax scenarios to examine their impact. Finally, we add the NES explicitly to the model and test which capital structure policy would be beneficial in this case.

6 | RESULTS AND THEIR DISCUSSION

The results section provides the simulation outcomes from the model. Figure 6 demonstrates the reference mode for the market price per share, a representation of the firm value. Market price per share reflects the value that investors believe the firm is worth for per unit of ownership in the firm and is expected to incorporate all the publicly available information (Palepu et al., 2013). Therefore, we present the market price share behavior under all assumed capital structure policies and scenarios.

6.1 | Testing the theories (causalities of debt)

First, we examined the capital structure theories through their predicted causalities that we incorporated in the model. The simulation results demonstrate that POT's predicted effects portray the market price per share realistically (Figure 8). It is interesting to note that the data also indicate that the firm prefers internal finances to external finances[3] potentially following the POT. The simulation results indicate that POT outperforms TOT in this case to explain the capital structure of the firm.

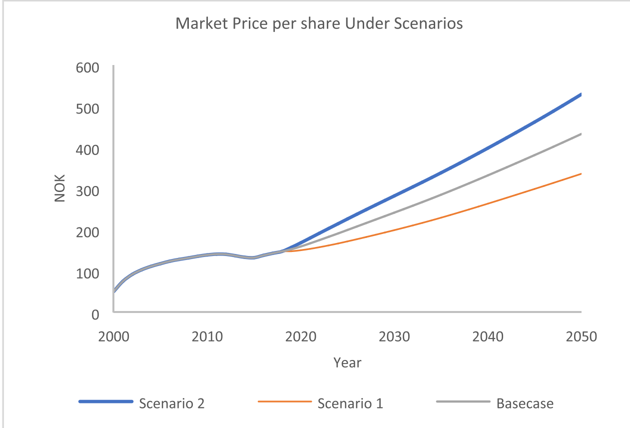

FIGURE 9 Market price per share under tax rate scenarios [Colour figure can be viewed at wileyonlinelibrary.com]

6.2 | Taxes

A key variable of interest in consideration of capital structure policy is the tax rate, which plays a significant role in determining the net income after taxes of the firm. Tax rate plays a major role in debt to equity tradeoff, as one of the key benefits is tax advantage of debt that interest expenses are tax deductible. The tax rate scenarios reveal (Figure 9) that increase in tax rate significantly decreases the firm value and vice versa. This emphasizes the importance of taxes for an oil firm. An increase in tax rate reduces the net income available for shareholders and reinvestment. Lesser amount of FCF is available that results in decrease in the firm value.

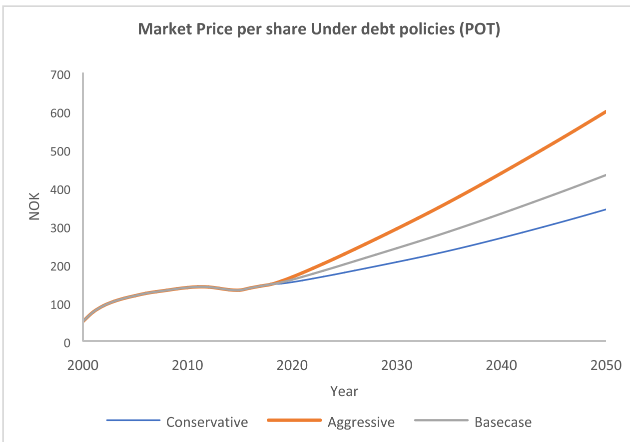

FIGURE 10 Market price per share under debt policies (POT) [Colour figure can be viewed at wileyonlinelibrary.com]

[3]https://www.equinor.com/en/investors/our-dividend/annual-reports-archive.html

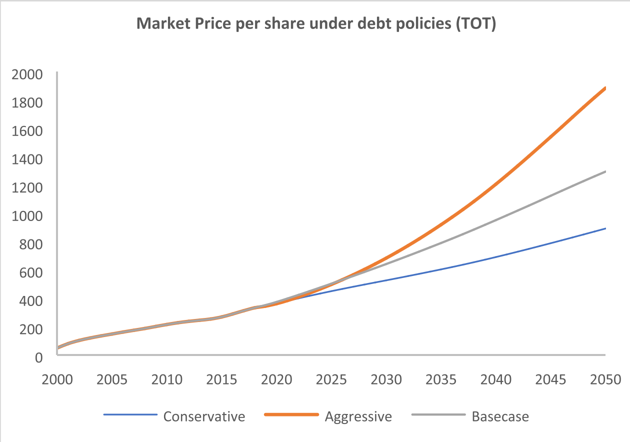

FIGURE 11 Market price per share under debt policies (TOT) [Colour figure can be viewed at wileyonlinelibrary.com]

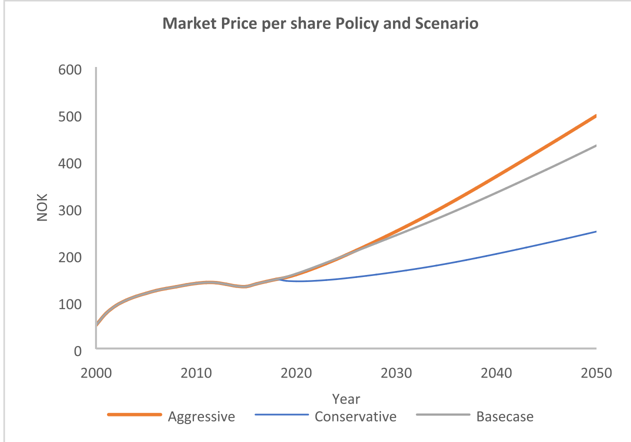

FIGURE 12 Market price per share under scenario 1 and debt policies [Colour figure can be viewed at wileyonlinelibrary.com]

6.3 | Capital structure policy

Capital structure policy has been analyzed by modeling explicitly the financing through two competing capital structure theories. The debt policy has been modeled in such a way that the desired capital budget is financed through debt first, then internal financing is the preference and external equity is the last choice. The results (Figure 10) demonstrate the market price per share behavior under the assumptions of POT. The debt policies discussed in Table 3 have been simulated to find the optimal policy for debt and equity mix. Simulation results demonstrate that as percentage of debt increase in the capital mix, the value is increased and vice versa. Aggressive capital structure policy maximizes the value whereas conservative capital structure policy performs substantially poor as compared to the base case.

The TOT has been investigated assuming debt as a first choice to finance the capital budget requirements. The results (Figure 11) demonstrate that aggressive capital structure policy increases the share price. However, an increase in the firm value is higher than that under POT. The reason is that under TOT debt is the most preferred source of financing, and thus, it is obtained in the first place making the total debt and percentage of debt in new financing higher. The tax advantage of debt leads to increase in FCF (see Equation 2) and decrease in WACC and consequently increasing the firm value. However, under the aggressive policy, the tradeoff becomes so risky that the debt payments are so huge that some of the payments would be outstanding even after using all internal profits to pay back the debt. Consequently, the firm would have to raise new equity to pay off the debt, which is a risky situation. Therefore, although the simulations results suggest higher firm value with high level of debt due to tax advantages of debt, there are limits to that. Even under the base case policy, internal profits are very low after making

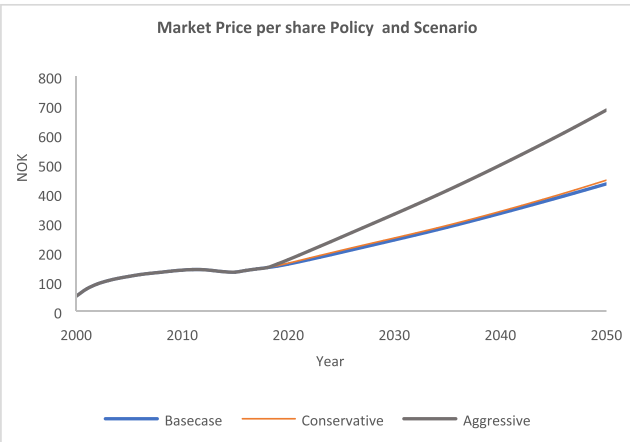

FIGURE 13 Market price per share under scenario 2 and debt policies [Colour figure can be viewed at wileyonlinelibrary.com]

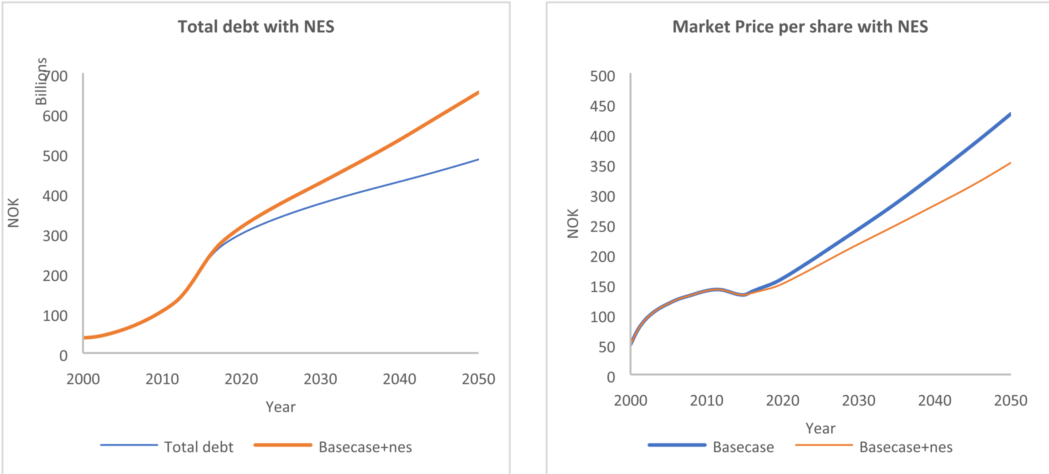

FIGURE 14 Reference mode and total debt with incorporated NES [Colour figure can be viewed at wileyonlinelibrary.com]

the debt payments. A firm does not want to reach a level of debt where they need to raise the money to pay back the debt.

The simulated outcomes (Figures 12 and 13) indicate multiple aspects of the firm's financial operations. Percent debt financing for new external financing for the firm varies over time between 35%–55%. One aspect could be the firm is having less debt in the capital structure mix than optimal. The firm is able to earn at a rate higher than its borrowing rate, which results in higher firm value as debt percentage increases (Ward & Price, 2006). Figure 1 demonstrates the simplified causal structure highlighting the benefits and costs of debt financing. Two major inputs from financial module to the valuation module are FCF and WACC, which are the two major elements of DCF valuation method (Janiszewski, 2011). The FCF are calculated from cash generated from internal operations of the firm accounted for all the expenses and investment needs. Debt financing influences cash through interest expense and debt payments. Interest expenses and debt payments increase as the level of debt increases. However, interest payments are tax deductible. Tax benefits of debt add to the firm value by having positive impact on the firm value. An increase in interest expenses reduces the taxes to the government and increases the cash available for shareholders (Brealey, Myers, Marcus, Wang, & Zhu, 2007). Alternatively, when debt payments increase, lesser internal finances are available for the firm and consequently the firm needs to generate cash through external financing. As the level of debt rises, the WACC is reduced as the cost of debt is lesser than the cost of equity. The FCF of the firm is discounted at a lower discount rate causing the firm value to increase. The results are supported by the agency cost theory as debt increases, agency costs reduce due to less cashflows available at manager's discretion and reducing the conflict between owners and managers and reducing the monitoring costs (Berger and Patti, 2006).

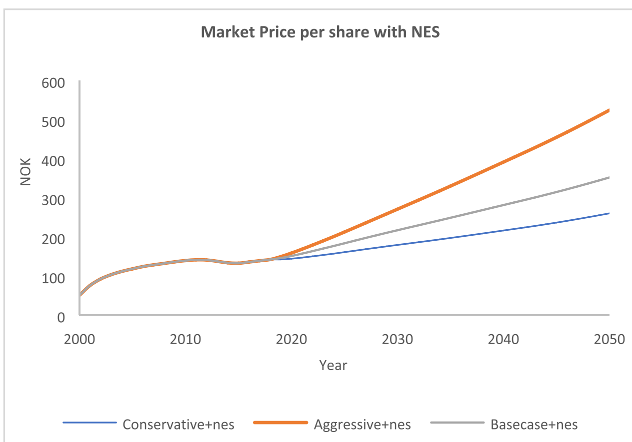

FIGURE 15 Reference mode and total debt, simulation and historical data [Colour figure can be viewed at wileyonlinelibrary.com]

6.4 | Policy and scenarios

We present the simulation results of the interaction of capital structure policies and tax rate scenarios in Figure 12. An increase in taxes has significant impact on the firm value. Aggressive policy underperforms base case policy in the early years of simulation period. This explains as the tax rate increases, the tax benefit of increased debt financing is compromised for the increased costs. However, around year 2025, aggressive policy yields the same market price per share as base case policy. After that, aggressive policy outperforms the base case policy and conservative policy. Capital structure policies under assumed tax rate scenarios reveal that market price per share is positively influenced by decreases in tax expenses (Figure 13). Aggressive policy proves out to be robust policy under all assumed tax rate scenarios. Even though the results emphasize the importance of tax rate and external environmental changes in the policy design, nevertheless, the results demonstrate that the firm should have relatively more debt in its capital structure to maximize the firm value per share whatever is its tax rate.

6.5 | New energy solutions

The above debt policy analysis was carried out before introducing the NES into the model. Figure 14 represents the market price per share and total debt after introducing the NES to the model. The value reduces as investment made in this diversification reduces the FCF over time.

As renewable energy production is not yet cost-effective, the FCF from NES are lesser than those generated through normal business operations causing the market price per share to decrease. To finance these higher investments, the firm needs more capital and consequently the total debt increases. In this case, we performed the debt policy analysis to identify better debt policy given additional investments into NES (Figure 15). The results indicate that higher debt increases the firm value in this case as well. This refers to the fact that firm can profit from debt benefits by increasing the debt ratio in financing NES even though NES yield FCF lesser than normal business operations. Aggressive debt policy proves out to be the best policy among assumed policies in all cases and scenarios.

The results are supported by the agency theory, which claims that by increasing the debt in the capital structure mix the value is enhanced (Jensen & Meckling, 1976). The firm can benefit from increased debt percentage for financing the capital requirements. However, tax scenarios also reveal that changes in some of the key financial variables could lead to different inferences. This means the benefits of increasing debt in capital structure mix need to be sizeable enough to increase the firm value to compensate the potential costs and risks associated with increased debt. Although debt is a cheaper source of finance as compared to equity, a firm cannot increase the debt ratio to the limits due to multiple reasons including the risk considerations. Especially for the case firm, debt repayments become a challenge as debt ratio is increased. That explains one reason as why the base case has lower level of debt. If external environment turns out to be the worst or the product market expectations do not turn out optimistic as expected, high ratio of debt could lead the firm into financial distress (Cao & Chen, 2012). Especially for Equinor, oil and gas prices are fluctuating in the short term and a very high ratio of debt could be risky for the firm if the price expectations do not meet up. The firm's policy is to keep the financial flexibility and thus prefer internal finances for investments. High funds from operations as compared to the debt ratio facilitate better rating by the rating agencies leading to lower WACC. Another vital perspective is limited natural resources. The firm's operational capacity is limited by the availability of natural resources. Oil and gas reserves are in place in a certain quantity in the Norwegian Continental Shelf and internationally. The firm's investment opportunity set is limited by the natural resources' availability that limits its financing choices as well. Therefore, the firm prefers to utilize its internal capital first to meet the capital requirements. However, our case firm would be better off by taking advantage of debt tax benefits if it wishes to diversify its business by expanding its investment opportunity set. Another reason could be strong net cash flows to the firm that effectively reduces the need to raise debt. All these factors explain some of the reasons for firm's conservative debt ratio. However, the simulation results suggest that increasing the debt ratio would add to the firm value as the firm is expected to earn at a rate higher than its WACC.

7 | CONCLUSION

The objective of this study is the capital structure policy analysis to maximize the firm value. For this purpose, the study develops a system dynamics-based simulation model of corporate planning activities for an oil firm integrating operational and financial variables. The model comprises of financial, production, and valuation modules. First two modules integrate production and financial activities of the firm to estimate the major financial variables, which feed into the valuation module that performs the firm valuation using DCF method. Extensive policy analysis has been performed to explore the influence of firm's capital structure policy on the firm value to identify the optimal policy. While doing so, the study reviewed and tested major capital structure theories. Various scenarios involving changes in taxes have been designed to investigate how changes in certain key financial variables would influence the firm value. The results for debt policy demonstrate that as percentage of debt increases in the capital structure mix, the firm value per share increases and vice versa. This is because of cost reduction as debt is cheap source of financing due to tax advantages of debt and equity is an expensive choice. The results for scenarios suggest that the lower rate of taxes is beneficial for the firm value. However, tax rate scenarios reveal that changes in key financial variables should be considered while devising the policy as they play a major role. The firm is operating in the oil and gas market where prices of oil and gas are fluctuating in the short term that making it highly risky to form expectations about future prices of oil and gas. Consequently, making a decision to finance such investment with a very high debt ratio would increase the firm's debt repayment requirements potentially consuming all its FCF and resultantly increasing its liquidity risk. Currently, the firm is very conservative in its debt policy; however, the results suggest that the firm can benefit from increased debt ratio in the capital structure mix to improve its firm value per share. The simulation results of capital structure theories suggest that POT outperforms TOT in enhancing the firm value in this case.

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APPENDIX

Behavior sensitivity test involves identifying the parameters to which the model is sensitive and determining if the sensitivity of the model to the parameter is realistic (Barlas, 1996). We report the results of the sensitivity tests parameters "time to develop", "average age of fixed assets", and "debt retirement time" in Figure 6. Time to develop is the time it takes for proved reserves to become developed making production possible. If time to develop is less (more), reserves would be developed quicker (slower) and production would be more (less). The results confirm the behavior pattern. The second parameter is average age of fixed assets which defines how quickly (slowly) fixed assets are depreciated. If fixed assets are depreciated quickly (slowly), there are less (more) available next time around. Debt retirement time has been investigated with different time periods and the total debt behavior is realistic. When time is less, accumulated debt is lesser and vice versa.