COMPARATIVE STUDY ON FIXED-PRICE CONTRACT VERSUS INCENTIVE-BASED CONTRACT IN INDONESIA'S OIL AND GAS INDUSTRY

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ABSTRACT

The commonly used fixed-price contract in the oil and gas industry is experiencing lots of problems because of high expenditures and low productivity. This paper conducts a comparative study of the uncommon incentive-based contract and the common fixed-price contract. The contracts are modelled with 20 parameters composed of fixed-price contract parameters and additionally time correction parameters and production rate parameters for the incentive-based contract.

A Monte Carlo Simulation is conducted to expand the limited production data into 1000 cases with several baseline parameters. The preference for the two contracts will be illustrated with analytical equations and graphical illustrations.

The study's findings show that the operator and service provider prefer the incentive-based contract to the fixed-price contract, as the latter contract brings greater profit to both parties. Hence, the main practical challenges of high expenditures, such as monitoring, coordination, moral hazard, and adverse selection, can be minimized by applying this solution.

INTRODUCTION

The oil and gas industry in Indonesia is currently experiencing cost increases and reduced productivity. It is stated that the cost of oil services and rig hire are the most presiding expenditures in the drilling projects, yet with low drilling efficiency (Osmundsen, Sørenes, & Toft, 2008). Because of this low drilling efficiency, it is hardly unexpected that various types of alternative contracts have emerged. Contracts that bind actual performance to incentives are already allowed based on Tender Implementation Instruction (PTK No EDR-0167/SKKMH0000/2017/S7), yet with minimum applications. Heretofore, it is unclear whether these few applications impact recent cost rises and productivity declines.

The main challenges faced in the commonly used fixed-price contract are high monitoring and coordination costs, moral hazards, and adverse selection. Moral hazards allow the agent to pursue its own goal, as the principal has no way of knowing if the agent has exerted maximum effort since its actions are impossible to see. Resembling moral hazards, adverse selection is a pre-contractual situation with skewed information where the principal cannot be certain whether or not the agents' behaviours are in the principal's best interest. Because of these uncertainties, a fixed price contract that has a proper installment each day for one unit of work is considered a contract with inadequate power in the sense of giving feeble incentives.

An incentive scheme is then proposed to eliminate these opportunistic behaviours. The model is built upon Sund's model (Sund, 2012), accounting for features relating to profit, gross income, and operating expenditure. Additional corrections are also established, namely completion time and production rate, to adjust the model to the current situation of the oil and gas industry in Indonesia.

Ultimately, a comparative study between common fixed-price contracts and uncommon incentive-based contracts is performed to come to a conclusion on which contract brings greater profit to both operator and service provider based on Indonesia's current situation. The authors' analysis also assesses how this better scheme will comply with the budgeting scheme of the operators/ K3S and SKK Migas.

METHODS

This study is conducted by using lifting data from several wells in Indonesia (mostly onshore wells) to

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account for their monetary gains. Since the actual data is limited, a Monte Carlo Simulation is performed to expand the data by generating 1000 different cases with different outcomes using random parameters (Table 1). These parameters are kept within a range based on the data from the wells.

Afterward, a fixed-price model and an incentive-based model are established by adapting the preceding model (Sund, 2012). These models rely on several other parameters and baselines for the fixed-price model (Table 2), the incentive-based model (Table 3), and both models (Table 4). The next section will explain the model development of the two contracts. The result of these two models will be compared based on the operator's payment, operator's profit, and service provider's profit to determine which the most preferable contract is from the perspectives of the operator and service provider.

MODEL DEVELOPMENT

To determine the most optimal contract based on the operator's and service provider's point of view, two different contracts are developed. The first one is the fixed price contract, which is commonly used in Indonesia's oil and gas industry. However, Eisenhardt (1985) states that this type of contract is arguable as a fixed price contract may provide an incentive for the agent not to operate efficiently because the compensation is fixed regardless of earnings. Because of this dilemma, the second type of contract, an incentive-based contract, emerges to prevent this efficiency problem.

Hence, this study will encompass a comparative analysis of these two methods. To do so, models quantifying gross income, OPEX, and profit for both parties are established. In the end, the models will show whether the incentive-based is worthy enough to be applied in Indonesia's current situation and how the incentives scheme will comply with the budgeting scheme of the K3S.

Gross Income for Operator and Service Provider

Operator's gross income

Gross income (G) for the operator is determined by multiplying the estimated production (Q) in barrels with the oil price (P) in US$/barrel. The gross income determination is the same for fixed-price contracts and incentive-based contracts.

$$G = PQ \text{ ……………} (1)$$

Service provider's gross income

Gross income for the service provider is calculated for the fixed-price contract and the incentive-based contract. The service provider's gross income for the fixed contract is modelled as follows:

$$g_F = \begin{cases} (f+d)T\,, T \leq T_N \\ (f+d)T + A(T - T_N)\,, T \geq T_N \end{cases} \text{ ……………} (2)$$

As seen, should the service provider finish the project before the estimated time ($T_N = 100$), there will be no additional income as the duration of the contract is fixed for T_N. Should the service provider finish the project after T_N, the contract will no longer apply and should be replaced with a new one. Of all the reasons a fixed contract often becomes a problem, these two are the most common.

Sund (2012) states that the service provider can earn a new contract negotiation. The value of A can be positive or negative, depending on the negotiation. The value of A will become positive (additional income) if the service provider can hand over proof that the contract duration was unrealistically too short. However, the value of A can also become negative (punishment/ fine) if the operator can prove that the service provider had too much non-productive time.

The two main problems faced in the fixed contract can be counteracted using an incentive-based contract. The preceding model of Sund (2012) states that there should be time correction if the project is finished before or after T_N. In this study, we propose a more advanced model which accounts for time correction and production rate correction. The service provider's gross income for the incentive-based contract is modelled as follows:

$$g_i = (f+d)T + \Delta g_T + \Delta g_Q \text{ ……………} (3)$$

where time correction (Δg_T) and production rate correction (Δg_Q) are defined as follows:

$$\Delta g_T = \begin{cases} +w(T_N - T)^b, & T \leq T_N \\ -C((T_N - T)^c, & T \geq T_N \end{cases} \text{ ……………} (4)$$

$$\Delta g_Q = \begin{cases} +w_Q(Q-Q_N)T\left|\dfrac{Q-Q_N}{Q_N}\right|^{b_Q}, & Q \geq Q_N \\ -C_Q(Q-Q_N)T\left|\dfrac{Q-Q_N}{Q_N}\right|^{c_Q}, & Q \leq Q_N \end{cases} \quad \dots\dots (5)$$

Simply put, if the project is finished before T_N, the service provider will receive a bonus where w is the time reward function and b is the scale of the time reward. $b \geq 1$ means convex reward and $0 \leq \mathrm{b} \leq 1$ means concave reward. On the other hand, if the project is finished after T_N, the service provider will receive a punishment where C is the time punishment function and c is the scale of the time punishment. The convex and concave principle also applies similarly in the scale of time punishment (c) as in the scale of time reward (b).

Next, if the production rate is $\geq Q_N$, the service provider will receive a bonus where w_Q is the production rate reward function and b_Q is the scale of the rate reward. On the other hand, if the production rate is $\leq Q_N$, the service provider will receive a punishment where C_Q is the production rate punishment function and c_Q is the scale of the rate punishment. The same convex and concave principle in time correction also applies in production rate correction for b_Q and c_Q. The terms $w_Q(Q-Q_N)T$ and $C_Q(Q-Q_N)T$ in the production rate correction physically reflect the monetary value from a portion of oil gain or loss deviating from the production baseline due to the technology application that will correct the gross income of the service provider.

In this study, the value of those correction parameters can be seen in Table 3. However, the severity level of a project may also affect them. For example, if the project is to be conducted in a harsh environment with a low success rate, the time reward and production reward should be increased under this situation. However, should the project be conducted in a mild environment with high average gain, the time punishment and production punishment should be increased to ensure a quick and productive operation. By using this method, the operator will not have to worry about monitoring costs, moral hazard costs, and adverse selection cost anymore as the contract is more flexible with an income under the productivity of the service provider's operation.

OPEX for Operator and Service Provider

Operator's operating expenditure

Operating expenditure (OPEX) for the operator is different in the fixed-price contract and incentive-based contract. The OPEX with the fixed-price contract is defined as follows:

$$O_F = g_F + (M+L)T \quad \dots\dots\dots\dots\dots (6)$$

The OPEX results from the service provider's gross income with additional costs composed of monitoring, coordination, moral hazard, adverse selection, and other costs per day $(M+L)T$.

The OPEX with the incentive-based contract is simply defined as follows:

$$O_i = g_i \quad \dots\dots\dots\dots\dots (7)$$

The OPEX is only obtained from the gross income, as the operator does not have to worry about additional costs in an incentive scheme.

Service provider's operating expenditure

With the use of a fixed-price contract, the service provider's OPEX results from the fixed income, other income, other costs, moral hazard, and adverse selection. The model is defined as follows:

$$o_F = [(f+d+v)(1-SP_m)+z+h]T \quad \dots\dots\dots (8)$$

Unlike the preceding model (Sund, 2012), d is the service provider's other income coming from mobilization cost. Hence, the fixed income (rental cost) and other income (mobilization cost) are first paid by the operator, in which the payment is later used for operational and other purposes by the service provider. v is the service provider's other cost (Manpower cost) which must be paid by the service provider for its employees' salary. $(f+d+v)$ are then multiplied with $(1-SP_m)$ to account for margin that is usually hidden in the price of services to improve the profit's estimate.

With the use of an incentive-based contract, the service provider's OPEX results from the fixed income, other income, and other costs. The model is defined as follows:

$$o_i = [(f+d+v)(1-SP_m)]T \quad \dots\dots\dots\dots\dots (9)$$

This OPEX model is rather similar compared with the fixed-price model. Moral hazards and adverse selection are excluded as they are not necessary to be paid in the incentive model.

Profits for Operator and Service Provider

Operator's profit

The operator's profit with the use of a fixed-price contract is defined as follows:

$\Pi_F = G - O_F$ … … … … … (10)

The profit can be obtained by deducting the operator's OPEX from the operator's gross income.

The operator's profit with the use of an incentive-based contract also works the same way, where the profit can be obtained by deducting the operator's OPEX from the operator's gross income, as follows:

$\Pi_i = G - O_i$ … … … … … (11)

Service provider's profit

The service provider's profit with the use of a fixed-price contract is defined as follows:

$\pi_F = g_F - o_F$ … … … … … (12)

The profit can be obtained by deducting the service provider's OPEX from the service provider's gross income.

The service provider's profit with the use of an incentive-base contract is defined as follows:

$\pi_i = g_i - o_i$ … … … … … (13)

This service provider's profit with an incentive contract works the same as the fixed contract.

MONTE CARLO SETUP

To determine the preferable contract for both parties, a model is used to calculate the given data (SKK Migas, 2021). The data is the combination of baseline parameters (Table 2, Table 3, and Table 4) with the randomized parameters (Table 1) using Monte Carlo Analysis. To gain some insights on how sensitive these baseline parameters are in affecting operator's and service provider's profits, a sensitivity analysis is conducted in three groups namely parameters affecting the fixed-price contract (M, L, h, z, A), time correction parameters affecting the incentive-based contract (w, C, b, c), and production rate correction parameters affecting the incentive-based contract (w_Q, C_Q, b_Q, c_Q).

RESULTS AND ANALYSIS

Fixed-Price Contract vs Incentive-Based Contract

The simulation result of these two contracts (Figure 1) shows that both operator and service provider prefer the incentive-based contract more than the fixed-price contract. From the payment view, it can be seen that the operator's OPEX with a fixed contract is more skewed to the right, showing that the average payment that must be paid in a fixed contract is greater than the payment with an incentive contract. Out of 1000 cases, the average operator's OPEX is $553,341 for a fixed contract and $528,163 for an incentive contract. This is because, in an incentive contract, the operator's OPEX results purely from the service provider's gross income (g_i) without having to pay additional costs. However, in the fixed contract, the operator's OPEX results not only from g_F but also from additional costs, namely monitoring cost, coordination cost, moral hazard cost, and adverse selection cost, which are accounted for daily.

The simulation result also looks promising from the profit view. Both fixed contract and incentive contract produce higher operator's profit than service provider's profit. This is because the service company margin is maintained from 10% to 50% when a Monte Carlo Simulation is conducted. The charts also show the result when we compare the profit apple to apple. It is proven that the operator's profit obtained with an incentive-based contract is slightly higher than with a fixed-price contract. Out of 1000 cases, the average operator's profit with a fixed contract is $136,743, while the average operator's profit with an incentive contract is 18.5% higher ($161,921).

The same results also apply to the service provider's profit. Unlike the operator's profit, the difference between profit gained with a fixed contract and an incentive contract is quite large. This analysis can be seen in the chart where the service provider's profit with incentive contract is a lot more skewed to the right showing a higher profit difference. The average service provider's profit with a fixed contract is $83,219, while the profit obtained with an incentive contract is 45% higher ($120,518).

If the project is completed before the estimated completion time $(T \leq T_N)$, the service provider will always prefer the incentive-based contract as it gives them an incentive/ bonus which according to the simulation result is quite substantial. However, Sund (2012) argues that under some circumstances, the operator does not always prefer the incentive-based contract. The reason behind it is because sometimes the incentive is too costly for the operator, especially if the project is conducted in a severe environment (high bonus function) with little monetary gain. In these circumstances, the operator prefers the fixed-price contract over the incentive-based contract as it is more profitable to pay the additional costs of monitoring and coordination cost rather than to pay the incentive for the service provider.

If the project is completed after the estimated completion time ($T \geq T_N$), the preferable contract will depend on the punishment function inflicted. Should the punishment be too lenient, the operator will prefer the fixed-price contract as the operator earning from the punishment function will be too small. In this case, the renegotiation parameter in the fixed contract may sound more interesting as it will give the operator more earnings than by complying with the lenient punishment function in the incentive contract. On the contrary, should the punishment be too harsh, the service provider might prefer the fixed-price contract instead, as the renegotiation parameter in the fixed contract might sound more interesting than the harsh punishment in the incentive contract.

However, following Indonesia's current situation, neither the operator nor the service provider would prefer the fixed-price contract to the incentive-based contract, which can be seen from the simulation result of the SKK Migas data. This is because of the high burden of monitoring cost, moral hazard cost, adverse selection cost, and other additional costs affecting both operator and service provider under the fixed-price contract.

Sensitivity Analysis

The aim is to get insights into how the parameters in a fixed-price contract and how the time correction parameters along with production rate correction parameters in incentive-based contract affect the payment and NCF. The sensitivity analysis performed is based on a single dependant parameter, meaning that other parameters are kept constant and the same as the original data, while one parameter is changed. The values seen in the spider chart are only the average value of the payment and profit, as it is impossible to visualize multiple changes because of the number of parameters in 1000 cases.

The sensitivity result for the parameters in a fixed-price contract (Figure 2) shows that both operator's OPEX and the operator's profit are sensitive to changes in $M \, and \, L$. This analysis supports the previous statement (Osmundsen, Sørenes, & Toft, 2008) that the main challenges for the fixed-price contract are high monitoring and coordination cost. This monitoring and coordination cost affect the operator's OPEX and thus affects the operator's profit. For example, if there is no monitoring cost applied, the operator's profit will rise 19% to $161,730 from the original case. As the impact of coordination cost acts the same way as monitoring cost, we can assume that $M + L$ operate together in generating the operator's profit.

The service provider's profit is also sensitive to $h \, and \, z$. They do not affect the payment, as the operator's OPEX is not related to either parameter. Since the sensitivity analysis shows the same pattern between the service provider's cost of moral hazard and adverse selection, we can also presume $h + z$ operate together in generating the service provider's profit. The renegotiation parameter also only works in the fixed price contract as it affects the operator's OPEX which also affects the operator's profit. However, the changes are only moderate-to-little proving that the renegotiation parameter is not sensitive enough to greatly alter the operator's profit in Indonesia.

The sensitivity result of the incentive-based contract due to time correction parameters can be seen in Figure 3. The profit changes are moderate-to-little for w and C and substantial for b and c as the scales of time reward and punishment are in exponential form. To allow the incentive-based contract to fully work, proper adjustments must be established. If the b exponent is too high, the service provider will benefit whilst the operator will suffer to pay the incentive should the project be completed before the estimated time. However, if the c exponent is too high, the operator will benefit whilst the service provider will suffer to pay the punishment should the project be completed after the estimated time. Needless to say, the incentive-based contract gives a better flexibility than the fixed-price contract.

The sensitivity result of the incentive-based contract from production rate correction is quite high. As explained earlier, b_Q and c_Q adopted the same principle applied in b and c. Therefore, the scales of rate reward and the scales of rate punishment follow the exponent form and thus deliver moderate-to-high changes to both parties. The interesting thing is that though w and C do not deliver high changes to the

NCF, the w_Q and C_Q do. This is because rate reward function and rate punishment function are adopted from the oil price (BOPD). The idea behind it is if the daily rate emerges above the estimated rate, the service provider will receive some percentage of those extra oil per day which is corrected with the scaling parameter as stated in the Δg_i model earlier. To fully maximize the incentive-based contract, the rate reward function and rate punishment function must be properly adjusted. This is because of the result that service company gross income is very sensitive to the operator's profit (Figure 4). It can be seen in the spider chart that if the rate reward function is too big, the operator will suffer a great money loss to pay this incentive. On the contrary, if the rate punishment function is too big, the service provider will suffer a loss should the daily production rate not achieve the estimated rate.

CONCLUSIONS

As many problems arise with the use of a fixed-price contract, the uncommon incentive-based contract is proposed. Unlike the preceding model (Sund, 2012), the proposed incentive-based contract model has been developed to internalize the project's completion time and post-treatment production performance as the value determinant. This incentive scheme turns out to be good not only for the service provider but also for the operator. With this compensation, the operator does not need to pay monitoring cost, coordination cost, and other expensive costs. The simulation result from the original data shows that the operator and service provider prefer the incentive scheme to the fixed scheme, as the latter contract gives them more profits.

However, when a sensitivity analysis is conducted, a proper adjustment must be made to ensure the incentive-based contract is fully operational. If the time bonus function and rate bonus function are too great, the operator might suffer great losses to pay for the incentives for the service provider. Vice versa, if the time punishment function and rate punishment function are too great, the service provider will suffer great losses to pay for the fine should the project be completed above the estimated completion at a lower rate than the expected rate.

In conclusion, we believe that the uncommon incentive-based contract is worth trying. The contracts in Indonesia's oil and gas industry should not be treated as simple as determining the project specification and the project duration. Instead, the contracts should encourage the project developing positively. We believe that the use of an incentive-based contract will increase the motivation for both parties to do their job as best as possible, producing lower completion time and higher profit. The proposed model can easily be extended with more data to have broader relevance. In the future, a study can also be conducted to achieve maximum profit for operator and service provider by emphasizing the value of these sensitive parameters to the model. The model can be employed to assess the most feasible incentive-based scheme to be implemented by SKK Migas in Indonesia's oil and gas industry.

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NOMENCLATURE

P	Oil price (US$/ barrel)
Q	Production (barrels)
G	Operator's gross income (US$)
g_F	Service provider's gross income in fixed-price model (US$)
g_i	Service provider's gross income in incentive-based model (US$)
Δg_T	Time correction parameters in incentive-based model (US$)
Δg_Q	Production rate correction parameters in incentive-based model (US$)
O_F	Operator's OPEX in fixed-price model (US$)
O_i	Operator's OPEX in incentive-based model (US$)
o_F	Service provider's OPEX in fixed-price model (US$)
o_i	Service provider's OPEX in incentive-based model (US$)
Π_F	Operator's profit in fixed-price model (US$)
Π_i	Operator's profit in incentive-based model (US$)
π_F	Service provider's profit in fixed-price model (US$)
π_i	Service provider's profit in incentive-based model (US$)

Other parameters along with their values can be seen in Table 1, Table 2, Table 3, and Table 4.

REFERENCES

Eisenhardt, K. M. (1985). Control: organizational and economic approaches. *Management Science, Vol. 31, No.2*, p.134-139.

Osmundsen, P., Sørenes, T., & Toft, A. (2008). Drilling contracts and incentives. *Energy Policy, Vol. 36, No.8*, p.3138-3144

SKK Migas. (2021, December 10-11). *Focus Group Discussion (FGD) Kajian Komprehensif terhadap Strategic Alliance and Partnership with Advanced Technology Provider.* Online: SKK Migas.

Sund, K. A. (2012). Fixed price contract versus incentive-based contract. *Int. J. Global Energy Issues, Vol. 35, No. 5*.

TABLE 1

RANDOM PARAMETERS APPLIED ON THE MONTE CARLO SIMULATION

Parameters	Min	Most Likely	Max	Distribution
Production gain (US$)	140,184	613,008	1,316,304	Triangle
Manpower (US$/month)	15,000	20,000	25,000	Triangle
Mobilization cost (US$)	10,000	15,000	20,000	Triangle
Rental cost (US$/day)	4,000	5,000	6,000	Triangle
Service provider margin	10%	30%	50%	Triangle
Completion time (days)	90	100	110	Triangle

TABLE 2

PARAMETERS AND BASELINE APPLIED ON FIXED-PRICE MODEL

Baseline	Parameters
250 US$	M operator's cost of monitoring, coordination, moral hazard, and adverse selection
125 US$	L operator's other cost including planning and administration
120 US$	h service provider's cost of moral hazard
130 US$	z service provider's cost of adverse selection
725 US$	A renegotiation parameter

TABLE 3

PARAMETERS AND BASELINE APPLIED ON INCENTIVE-BASED MODEL

Baseline	Parameters
173 US$	w time reward function
150 US$	C time punishment function
1.55	b scales the reward when $T \leq T_N$
1.5	c scales the punishment when $T \geq T_N$
20 US$	w_Q production rate reward function
20 US$	C_Q production rate punishment function
1.55	b_Q scales the reward when $Q \geq Q_N$
1.5	c_Q scales the reward when $Q \leq Q_N$

TABLE 4

PARAMETERS AND BASELINE APPLIED ON BOTH MODEL

Baseline	Parameters
Randomized rental value/day	f service provider's fixed income in US$
Randomized mobilization cost	d service provider's other income in US$
Randomized manpower/ month	v service provider's other cost in US$
Randomized service provider's margin	SP_m service provider's margin in %
80 US$	P oil price per barrel
100 days	T_N estimated time to complete the project
76.626 BOPD	Q_N average production rate of all wells

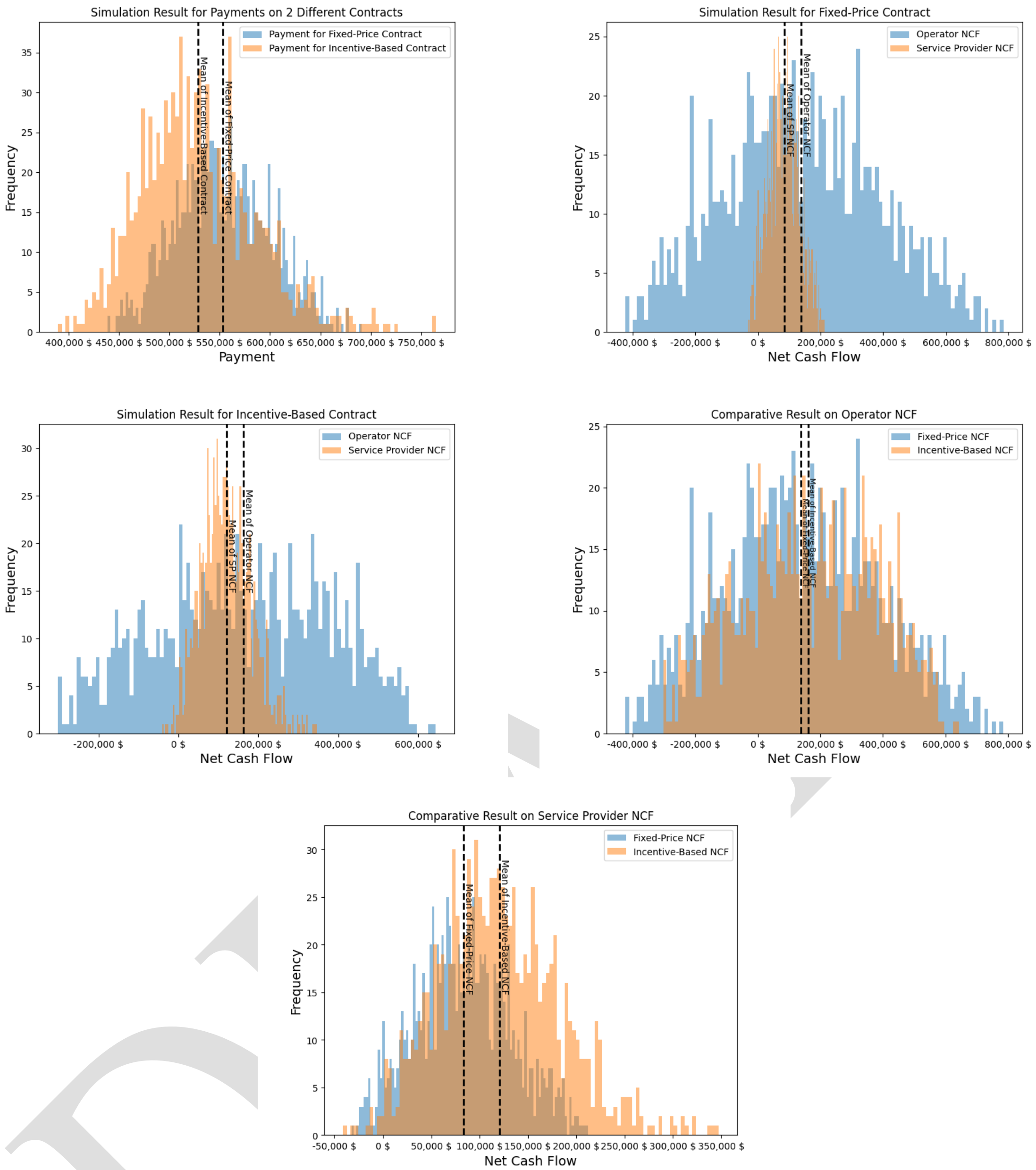

Figure 1 - Comparative result between fixed-price contract and incentive-based contract. Two quantifying parameters to compare both contracts are operator's OPEX/ payment and profits/ net cash flow. The dotted line shows the mean of calculation results of 1000 cases derived from Monte Carlo Analysis. Out of 1000 cases, incentive-based contract shows a lower payment with higher profit for both operator and service provider.

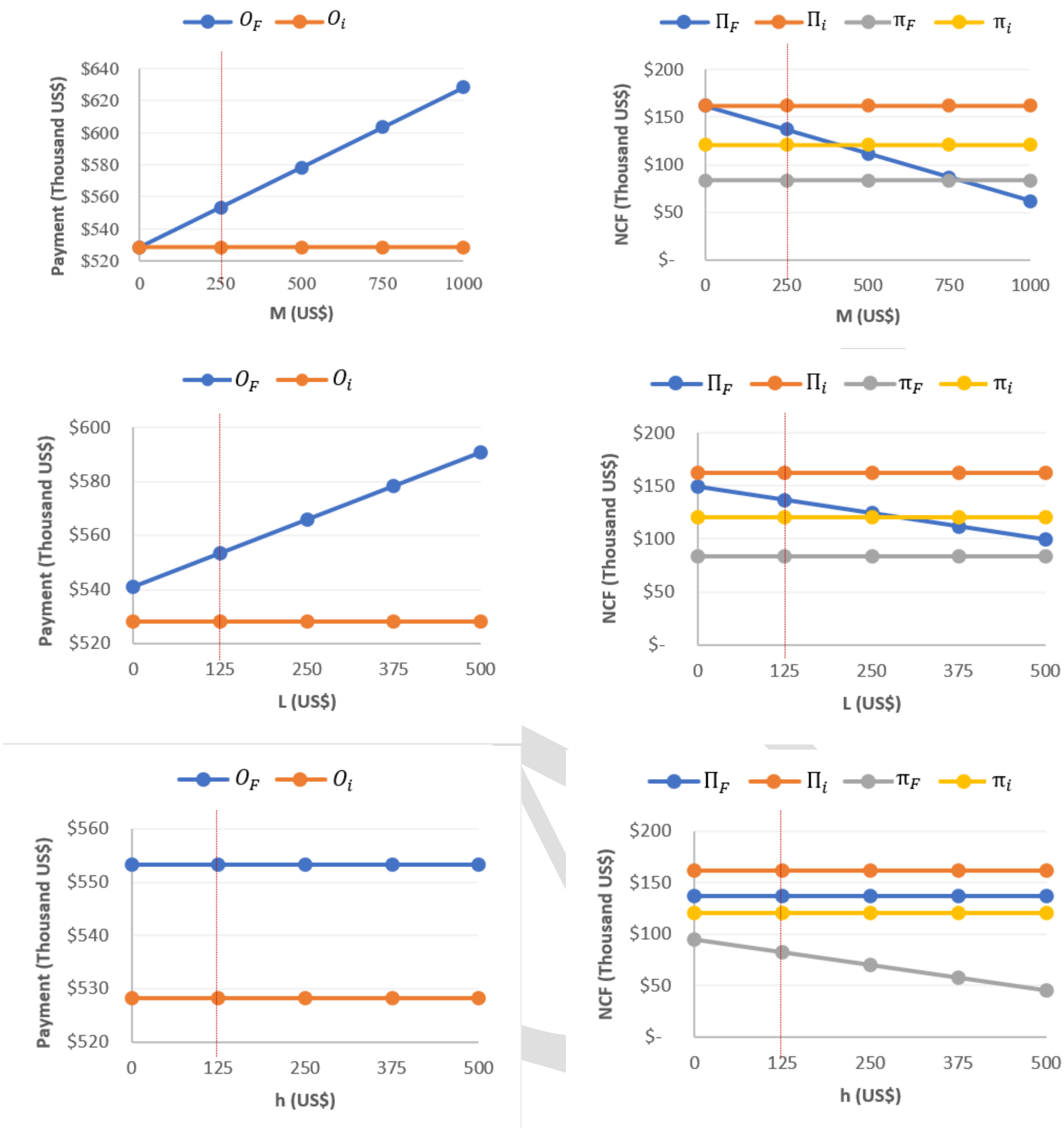

Figure 2 - How the parameters in fixed-price model affect the payment and net cash flow. The parameters are operator's cost of monitoring and coordination (M), operator's other costs (L), moral hazard (h), adverse selection (z), and renegotiation parameter (A). The result shows that the most sensitive parameters are monitoring cost and coordination cost, proofing the hypothesis (Osmundsen, Sørenes, & Toft, 2008) stating that monitoring cost and coordination cost are the most expensive expenditures in oil and gas activities, especially in drilling activities.

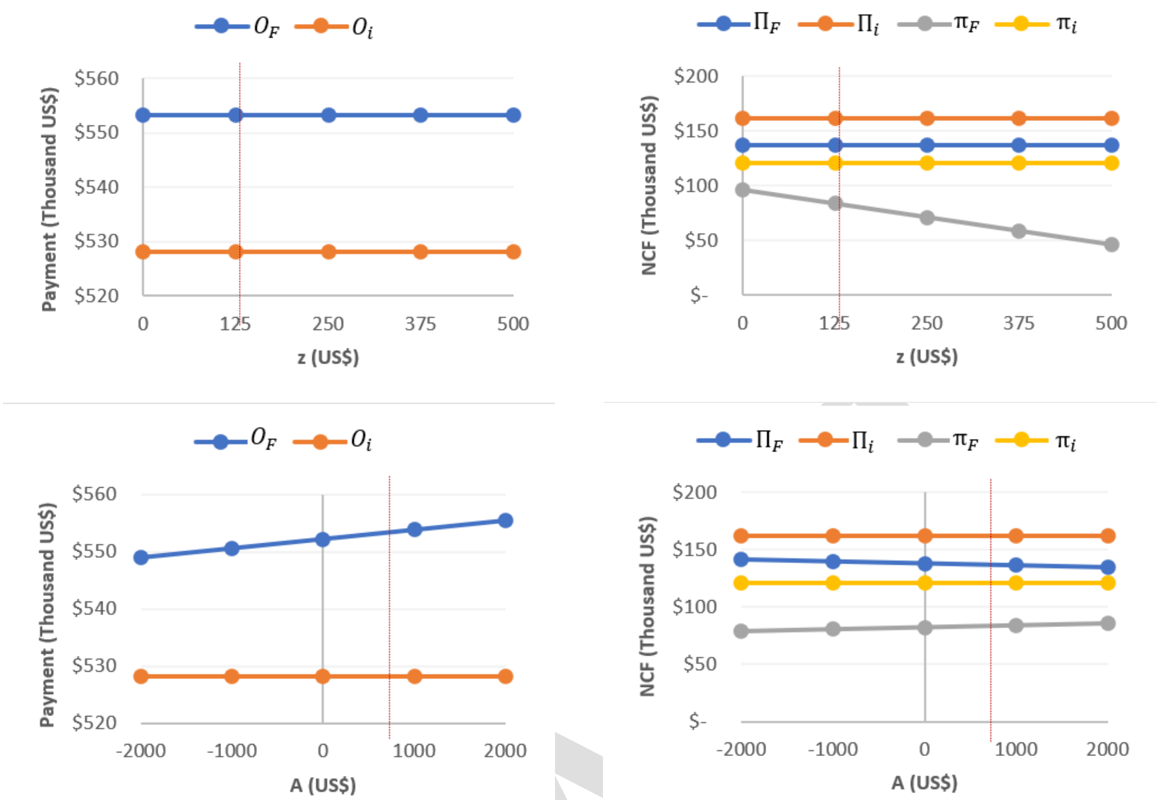

Figure 2 (continued) - How the parameters in fixed-price model affect the payment and net cash flow. The parameters are operator's cost of monitoring and coordination (M), operator's other costs (L), moral hazard (h), adverse selection (z), and renegotiation parameter (A). The result shows that the most sensitive parameters are monitoring cost and coordination cost, proofing the hypothesis (Osmundsen, Sørenes, & Toft, 2008) stating that monitoring cost and coordination cost are the most expensive expenditures in oil and gas activities, especially in drilling activities.

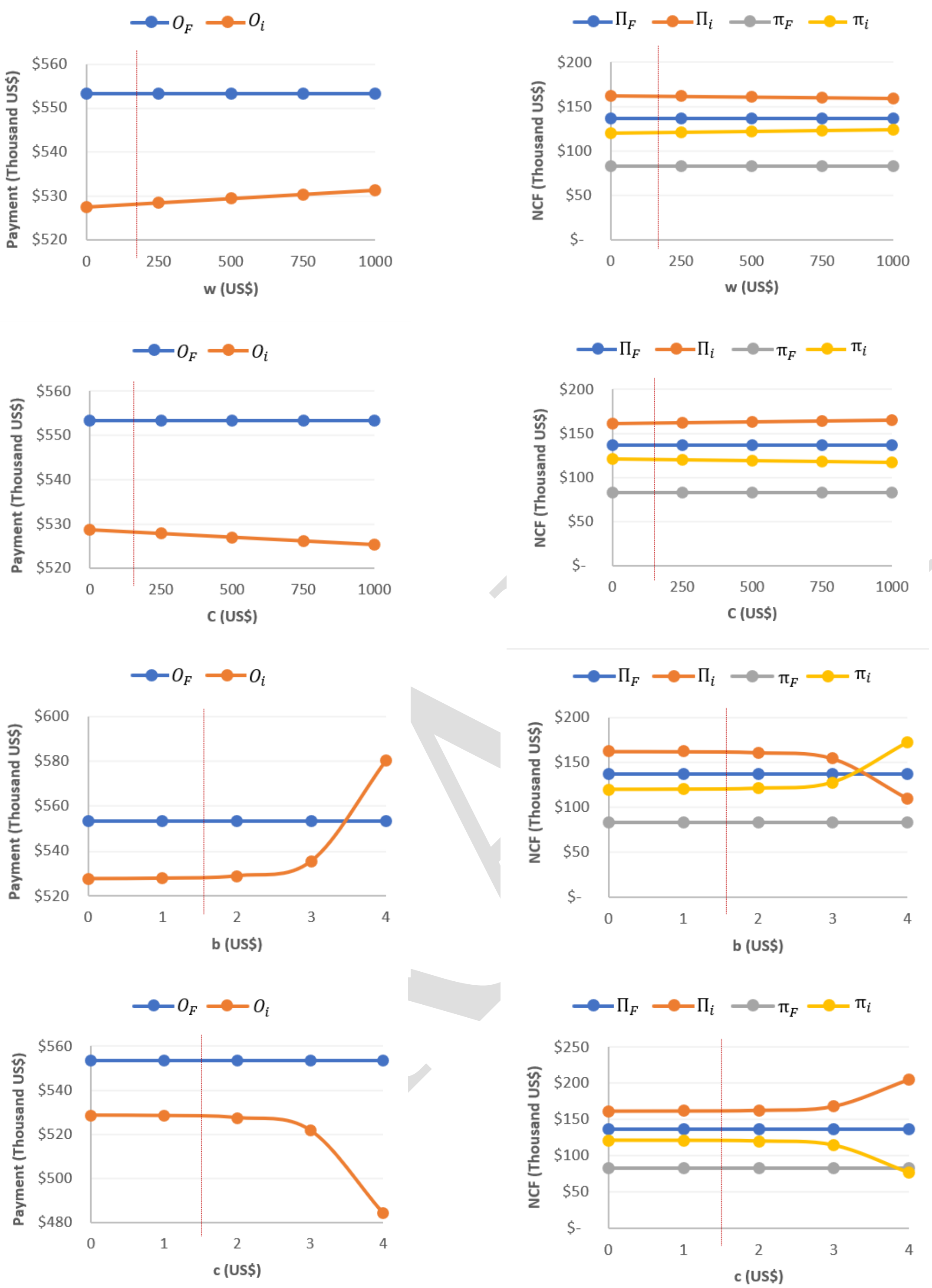

Figure 3 - How the time correction parameters affect the payment and net cash flow. The parameters are time reward function (w), time punishment function (C), scales of time reward (b), and scales of time punishment (c). The changes for w and C are little-to-moderate, while the changes for b and c are high as the equation is in the exponential form.

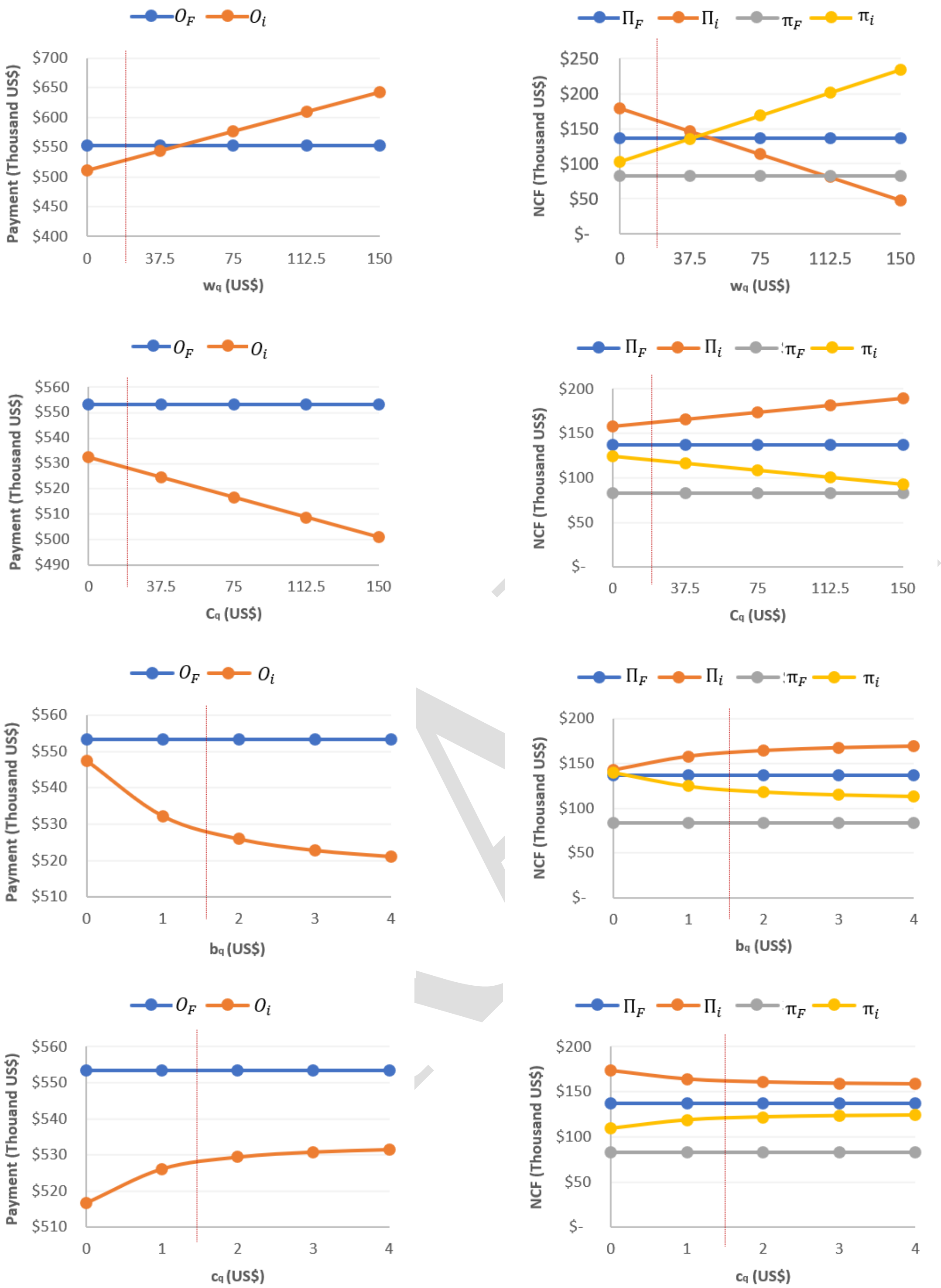

Figure 4 - How the production rate correction parameters affect the payment and net cash flow. The parameters are rate reward function (w_Q), rate punishment function (C_Q), scales of rate reward (b_Q), and scales of rate punishment (c_Q). The changes for b_Q and c_Q are moderate-to-high as the equation is in the exponential form. While the changes for w_Q and C_Q are high as the rate reward function and rate punishment function are adopted from the oil price (BOPD).