

Examining the Investment Model of the National Development Fund in the Upstream Oil and Gas Sector with Emphasis on Field Development Risks

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Highlights

- The I-HOPE model represents a fundamental strategic shift for the National Development Fund, transitioning it from a passive lender to an active, albeit non-controlling, investor in projects.
- The field development stage in upstream oil and gas constitutes a phase of substantial risk, characterized by critical subsurface uncertainties, capital-intensive surface facility construction, and exposure to volatile economic conditions. These risks are further amplified by the long-term project horizon and the magnitude of the required capital commitment.
- The present article critically reviews the National Development Fund's I-HOPE investment model and evaluates its “non-meddle” philosophy in light of the high-risk, capital-intensive, and inherently uncertain nature of oil and gas field development projects.
- The successful implementation of the I-HOPE model depends on the National Development Fund's transformation into a knowledge-based investor. Beyond the provision of capital, this transformation requires establishing robust and independent technical advisory bodies, deploying advanced digital monitoring tools, and creating a comprehensive macro-risk management unit. Most critically, institutional mechanisms must be designed to safeguard investment decisions and operational processes from governmental interference.

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Abstract

The present study examines the investment model of the National Development Fund (NDF) in the upstream oil and gas sector, with a particular focus on the risks associated with field development. Given the NDF's recent entry into direct investment activities, the challenges inherent in this domain are analyzed in detail. In addition, the NDF's investment policies and guidelines, project prioritization criteria, and the Non-Meddle Investment model (I-HOPE), as the Fund's principal strategy for risk mitigation and enhanced resource efficiency, are introduced and comprehensively evaluated. Finally, through a comparative assessment of the NDF's investment model and the specific challenges of field development, this study proposes solutions to strengthen the NDF's investment process in this sector. By critically evaluating the strengths and limitations of the I-HOPE model in addressing the inherent risks of field development, the study provides a structured framework for optimizing future investments. The proposed measures aim to enable the NDF to manage risks more effectively, enhance returns on allocated resources, and assume a more impactful role in the country's economic development.

Keywords: Non-meddle investment model, Risk, Uncertainty

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1. Introduction

The National Development Fund (NDF) of Iran possesses substantial financial capacity supported by the value of the assets under its management. Although the NDF's primary mission has historically been the provision of financing to projects, in recent years, and after obtaining the necessary approvals, it has entered the investment arena for several strategic reasons, including the enhancement of intergenerational wealth. These investments extend to upstream oil and gas projects, with the objective of transforming a portion of the proceeds generated from such projects into durable and productive wealth. The NDF seeks to undertake sustainable investments in projects that contribute meaningfully to national economic growth. However, the complex and high-risk nature of upstream oil and gas projects necessitates a rigorous evaluation of investment terms and conditions.

Upstream oil and gas projects are widely regarded as among the most capital-intensive and risk-laden investment domains. Contributing factors include substantial upfront capital requirements, technological complexity, geological uncertainties, volatility in global oil prices, and environmental considerations. During the field development phase, these risks manifest in multiple dimensions, including subsurface and surface risks, technological risks, security risks, financial and economic risks, partner-related risks, political risks, legal risks, and contractual risks.

It should also be recognized that the NDF's limited experience in managing large-scale oil and gas projects may introduce additional challenges. Insufficient technical and specialized expertise in risk assessment and project management, particularly in the upstream sector, may lead to suboptimal decision-making. Such shortcomings could result not only in inefficient allocation of financial resources but also in reputational harm to the NDF. Accordingly, it is essential for the NDF to strengthen its risk identification, evaluation, and management frameworks through collaboration with experienced industry specialists and consultants, while also drawing upon relevant international best practices.

This research seeks to examine the investment terms and conditions of the NDF in oil and gas field development projects from the perspective of field development-related risks. The ultimate objective is to analyze the findings of this assessment and propose recommendations to enhance the NDF's investment process in this sector. By doing so, the NDF can more effectively manage associated risks, secure appropriate returns on national financial resources, and pursue such investments with greater institutional confidence.

2. National development fund (NDF) of Iran

It was previously assumed that countries endowed with abundant natural resources, particularly oil-producing nations, could achieve high levels of development and sustained economic prosperity through substantial foreign exchange earnings from resource exports. However, the actual economic performance of many of these countries diverged markedly from such expectations. Over time, it became evident that a significant number of resource-rich economies faced persistent structural and macroeconomic challenges. In response, economists conducted extensive analyses of this phenomenon, which became known as the "resource curse," and proposed various institutional and policy-based remedies. Among the mechanisms advanced in recent decades has been the establishment of sovereign wealth funds. These funds have gained increasing prominence not only in oil-exporting countries but also in nations with substantial foreign exchange reserves. Accordingly, given the high vulnerability of

its economy to oil price shocks and the objective of reducing government dependence on oil revenues, Iran initiated the establishment of a sovereign wealth fund (Nabizadeh, 2019).

According to information published on the official website of the National Development Fund of Iran, the concept of establishing the Fund emerged following the unsuccessful experience of the Foreign Currency Reserve Account. This account was created under the Third Development Plan in 2000, and its operational framework was approved in the Fourth Development Plan in 2004. In the Fifth Development Plan, a new approach to managing oil and gas revenues led to the formal proposal to establish the National Development Fund. The NDF was established in 2010 and commenced operations in 2011. It is mandated to transform a portion of the revenues derived from the export of oil, gas, gas condensates, and petroleum products into sustainable wealth and productive investments, while safeguarding the share of future generations from these exhaustible resources. According to Nabizadeh (2019: 2–4), the primary objective underlying the creation of a sovereign wealth fund was to enable long-term economic governance without reliance on foreign currency revenues obtained from oil exports.

2.1. Investment

As stated in the Non-Meddle Investment* document, “until 2022, the NDF had only carried out one of its mandates, namely the provision of financing, and had not implemented its other mandates, including domestic investment, as stipulated in Clause 2 of the duties of the Board of Executive Directors.”

In light of this observation, as well as the criticisms directed at the NDF’s performance and its statutory mission, the Fund’s leadership in recent years has sought to shift its operational focus from financing toward direct investment and to strengthen its role as an intergenerational fund. These efforts culminated in the issuance of the “Directive for Domestic Investment of the National Development Fund” by the Plan and Budget Organization. According to this directive, the investment of the NDF’s resources is intended to promote sustainable economic growth and balanced national development, while converting the Fund’s assets into durable holdings with higher added value for future generations.

Pursuant to the issued authorizations, the NDF has prepared a document entitled the “Domestic Investment Policy Statement,” which outlines its investment framework. This document addresses the Fund’s mission, philosophy, objectives, and governance structure; the asset management entity; permitted investment instruments; asset allocation policies; valuation models and exit strategies; as well as mechanisms for oversight, reporting, and performance evaluation.

According to this policy framework, a maximum of 80% of the total asset value may be allocated to the oil, gas, and petrochemical sectors, with up to 70% directed toward upstream activities and up to 50% toward downstream industries. Within the upstream and downstream oil sectors, priority is assigned to investments in incomplete or producing projects. In the upstream gas sector, priority is given to projects that have not yet commenced operations. Furthermore, given the scale of required capital investment in upstream oil and gas activities and the need to secure associated resources from the government, the Fund’s participation in upstream projects is generally expected to be controlling, defined as ownership exceeding 50%. In contrast, investments in downstream industries are generally structured as non-controlling interests.

2.2. Non-meddle investment model

According to the Non-Meddle Investment document, the NDF states that, “in alignment with its new

* I-HOPE

governance framework and drawing upon lessons learned from domestic and international investment practices, as well as the unsuccessful experiences of corporate ownership by banks and pension funds in the country, it has undertaken the design and implementation of various non-meddle investment models under the title I-HOPE. These models are structured in accordance with project requirements, applicable laws, and existing national capacities. The objective of the Fund's new financing model is, on the one hand, to avoid, to the greatest extent possible, long-term involvement in corporate ownership, and on the other hand, to participate effectively in national investment activities, while refraining from granting non-repayable facilities or loans with uncertain collectability, as occurred in the past."

Based on this framework, the NDF will design and propose an appropriate participation structure for each project following comprehensive evaluation and rigorous analysis. Such structures are intended to mitigate investment-related risks, facilitate enterprise development with minimal long-term operational involvement, and ultimately contribute to the growth of the Fund's assets and national economic development.

The selection of a specific participation model from among numerous alternatives is influenced by multiple factors, including the nature of the project's business, the existence of domestic execution and operational experience, the level of technological maturity and expertise, the competence and credibility of the project's management team and shareholders, market conditions for products and feedstocks, access to raw materials and distribution networks, the reliability of energy and water supply, social and environmental considerations, the financing structure, industry-specific risks, and other relevant variables.

Non-meddle investment models, in practice, represent structured combinations of diverse financial instruments, including various types of debt financing, non-controlling equity participation, investment funds, different classes of securities, and option-based instruments such as call and put options. As illustrated in Figure 1, the Fund's investment model comprises five distinct yet interrelated stages, beginning from the left.



Figure 1

The five distinct yet interrelated stages of Fund's investment model

At the stage of determining the participation or financing structure (Investment), a non-meddle investment or financing model is selected in accordance with the project's risk profile. The structure of the Fund's participation is defined and operationalized through appropriate contractual instruments and the provision of necessary guarantees. All financing mechanisms, including the extension of facilities, direct cash contributions, issuance of bonds, and other funding arrangements, are determined at this stage.

During the project execution phase, which encompasses permitting and construction activities (Handling), the Fund typically maintains limited involvement in day-to-day execution and management. Instead, it relies on a range of structured and data-driven oversight mechanisms to monitor the proper allocation of funds in alignment with project objectives and to enhance overall performance.

Similarly, during the production and operational phase (Operation), the Fund generally avoids direct managerial intervention. It continues to employ systematic and effective monitoring tools to ensure that

financial flows and operational activities remain consistent with predefined objectives and performance benchmarks.

The Pay-off stage defines the mechanism through which project returns are allocated among the participating parties. The Fund's returns are not confined to interest income from financing facilities; they may also include participation in value creation during the construction and operational phases. Such returns may take the form of a percentage of product sales revenue or an equity stake in the established enterprise.

Finally, the Exit Scenario specifies the mechanism and timing of the Fund's withdrawal from the project. Under this framework, the Fund exits after a predetermined period or upon fulfillment of specified conditions. This stage is critical to ensuring that the Fund's enterprise-creation strategy does not result in prolonged or indefinite corporate ownership.

2.3. Participation in oil and gas field development projects

According to the Non-Meddle Investment document, NDF's investment model for developing oil and gas fields can take several forms, including within the framework of Iran Petroleum Contract (IPC) agreements. In this model, the Fund participates by financing a substantial portion of the project's exposure through a non-meddle partnership with qualified Exploration and Production (E&P) companies. NDF maintains minimal involvement in project management during the preparation and operational stages, relying primarily on its effective and intelligent oversight tools to monitor expenditures in alignment with the project's objectives while safeguarding the Fund's interests. The Fund's returns, following First Target Production (FTP), are derived from two sources: first, the benefit of providing financing, represented by the interest rate, and second, a share of the Fee per Barrel. Additionally, the Fund has the option to sell its share of the proceeds to its partner.

According to the National Development Fund's report, by January 2024, a total of 296 projects with an estimated value of \$300 billion had been submitted to the Fund. Of these, 159 projects were in the oil, gas, and petrochemical sectors, with requested funding totaling \$207 billion, representing approximately 70 percent of the total requested resources.

In the upstream oil and gas industry, the National Development Fund has participated in the development of the Azadegan oil field; the Homa, Varavi, and Tabnak gas fields, along with the Tabnak separation center; and the gas storage project in the Shourijeh field. The total required investment for these projects amounts to \$13.1 billion.

3. Oil and gas field development

The oil and gas industries are generally divided into three main sectors: upstream, midstream, and downstream. The upstream sector encompasses the exploration and production of oil and gas, whereas the downstream sector focuses on refining and distributing the products. The midstream sector serves as a link between these two, being responsible for the transportation and storage of oil and gas (Razavi and Motavalli, 2023; Patidar et al., 2024). In some classifications, however, the midstream sector is considered part of the downstream sector (Kord Zanganeh and Asadzadeh, 2022).

According to most existing classifications (Mojarad, Atashbari, and Tantau, 2018; Balossino, 2020; Craige and Quagliaroli, 2020), field development in the upstream sector, also referred to as Exploration and Production, represents the stage between exploration and production. Within this framework, the exploration phase involves identifying potential crude oil and natural gas reserves, either onshore or offshore, followed by drilling exploration and appraisal wells. Commercial production begins after the

field development stage is completed, which includes drilling a number of development wells and connecting them to surface production facilities and transportation infrastructure.

From another perspective, the activities involved in field development can be described as consisting of five main stages: Exploration, Evaluation, Development, Production, and Abandonment. In the Exploration stage, geological surveys and methods such as seismic studies are employed to identify hydrocarbon accumulations, and exploration wells are drilled to confirm the presence of hydrocarbons. The Evaluation stage involves detailed investigation of areas with potentially significant resources, determination of a drilling program, drilling appraisal wells to collect additional reservoir data, and conducting simulations to understand reservoir characteristics. The Development stage, regarded as the most critical phase, includes detailed design (specifying well types, production facilities, and other infrastructure), infrastructure construction up to first oil and gas production, and execution of the development plan. In the Production stage, hydrocarbons are extracted through wells and facilities and transported for processing and distribution. Finally, the Abandonment stage occurs when further extraction is no longer economically justified; operations cease, facilities are dismantled, wells are plugged, and the site is remediated (Kolahdooz, 2018; Rui et al., 2018).

In general, during the field development stage, key parameters are determined, including the volume of recoverable hydrocarbons, the production profile, the type of field development plan (specifying the number, locations, and types of wells), the drilling schedule for each well, the program for production support pressure (using natural reservoir pressure or water/gas injection to compensate for pressure decline), the types of required processing facilities, and numerous other technical and operational factors (Kolahdooz, 2018; Abtahi Ferooshani and Nikbakhti, 2014).

3.1. Risk and uncertainty in oil and gas field development

The upstream oil and gas sector is inherently characterized by complexity, uncertainty, and instability, which are further amplified by the long-term nature of its projects, typically spanning 10 to 15 years, thereby increasing associated risks over time (Kolahdooz, 2018). A pivotal challenge arises during the field development phase, where initially limited information creates significant uncertainty in accurately modeling reservoir characteristics, making effective management of this uncertainty a primary concern (Balossino, 2020). These risks are broadly categorized into quantifiable technical risks, such as reserve volume and reservoir quality, and non-technical risks, which include measurable economic factors, such as costs and oil prices, as well as less quantifiable political and stakeholder-related risks (Kolahdooz, 2018).

Consequently, decision-making in field development is intrinsically linked to navigating geological, economic, and technological uncertainties, requiring precise data on extraction rates, investments, operational costs, and related parameters for effective risk analysis (Schiozer, Ligerio, and Santos, 2004). A fundamental reason for the failure of many investing companies is a lack of familiarity with this risk taxonomy and the impact of specific uncertainties, such as production profiles, produced oil quality, and operational costs, which are unique to each field. This underscores the critical need for a thorough understanding of these factors prior to project commencement (Abtahi Ferooshani and Nikbakhti, 2014).

3.2. Subsurface complexities and surface facilities risks

Oil and gas field development projects possess a unique characteristic that distinguishes them from projects in other industries: the extraction of hydrocarbons from reservoirs located hundreds or even thousands of meters beneath the earth's surface. The location and volume of these reserves must be

estimated through geological and engineering analyses, as well as drilling tests, which inherently involve uncertainties. Consequently, subsurface characteristics constitute the primary factors that must be examined to assess the performance of oil and gas projects. These characteristics determine the volume of recoverable hydrocarbons, the complexity of their extraction, the selection of appropriate technology and development scenarios, the engineering design of wells and production facilities, the required investment, and the interpretation of acquired data, among other critical aspects (Kolahdooz, 2018; Abtahi Froushani and Nikbakhti, 2014; Rui et al., 2018).

During the field development stage and following the commencement of production, oil produced from the wells is transported through pipelines to processing units. After the separation of water and gas, the hydrocarbons are sent to refineries or export terminals. Along this pathway, numerous risks may arise, including delays in completing facilities, environmental contamination from gas and fluid leaks or infiltration of pollutants into near-surface layers, human errors in the design, construction, or operation of facilities, and non-compliance with government regulations concerning health, safety, and the environment (HSE) (Abtahi Froushani and Nikbakhti, 2014).

3.3. Environmental requirement

Complying with environmental requirements is a critical consideration in the execution of oil projects. In Iran, key environmental concerns include the prohibition of gas flaring, protection of underground aquifers, and prevention of pollution in coastal and international waters for offshore projects. To uphold the principle of sustainable development, an Environmental Impact Assessment must be conducted prior to the commencement of any oil project, ensuring adherence to relevant environmental laws, regulations, and standards (Shiravi and Taghizadeh, 2020). Mavridis (2018) notes that major hazards associated with development and production activities include well blowouts, pipeline ruptures resulting in large hydrocarbon spills, waste disposal challenges, and decommissioning issues for end-of-life production facilities. He further highlights that some global oil operations have experienced severe accidents, causing human casualties, environmental pollution, financial losses, and reputational damage to companies. Askari, Sadeghi Shahdani, and Seifloo (2016) emphasize that risks in this sector also arise from catastrophic natural disasters and harsh climatic conditions, as well as project-specific accidents, including fires, explosions, equipment failures, vessel collisions, and oil and gas spills at sea.

3.4. Financial and economic risks

The upstream oil and gas industry involves a series of increasingly costly investments, which in turn generate highly uncertain revenue streams that in some cases never recoup the capital expenditures (McKie et al., 2008: 329). Project execution cost is a critical factor influencing field development, and deviations between actual and forecasted costs during project execution can create significant challenges for investors (Kolahdooz, 2018; Hendalianpour et al., 2022). Investors recognize that risks arising from cost overruns in major projects can lead to bankruptcy or financial distress, particularly given that the average capital cost for large oil and gas projects exceeds two billion dollars (Rui et al., 2018). These long-term investments are also exposed to numerous volatile economic variables beyond the investor's control, which can severely impact project profitability. Key among these variables are unpredictable global oil and gas prices, instability in host country economic indicators, changes in supply and demand, fluctuations in raw material costs, alterations in taxes and royalty rights, interest rate volatility, exchange rate fluctuations affecting international loan repayments and oil revenues, the global value of the US dollar, insufficient equity, the risk of uneconomic production, and inflation, all of which complicate long-term price forecasting (Kolahdooz, 2018; Abtahi Froushani and Nikbakhti, 2014; Askari, Sadeghi Shahdani, and Seifloo, 2016).

3.5. Technological risks

Technological factors play a significant role in field development, as technology can enhance productivity and influence the timing, quality, transportation, and processing of production (Hendalianpour et al., 2022). However, many upstream oil and gas projects experience cost overruns and delays due to difficulties in identifying suitable technologies and forecasting associated uncertainties. The complexity of field development and the degree of technological challenges are directly related to reservoir complexity; thus, less complex reservoirs generally present fewer development and technological challenges, whereas more complex reservoirs require advanced solutions (Rui et al., 2018). This issue is particularly critical for developing countries, which often lack the capacity to implement advanced technologies for exploration and extraction operations and are therefore compelled to contract with technology-owning nations to access expertise and mitigate financial and technical project risks (Aghaei Hajiabadi, 2016).

In this context, technology transfer in petroleum contracts often arises from domestic legal requirements. Many contracts stipulate obligations such as managing exploration and development operations, hiring and training local personnel, transferring data to the host country, utilizing local services and goods, and providing operational equipment (Hajiabadi, 2016). Furthermore, the absence of adequate infrastructure, whether due to challenging geographical conditions, limited equipment and labor supply, or project complexity, can cause delays and constrain project execution (Rui et al., 2018).

Specifically, in Iran's upstream sector, Manzoor and Ranjbar (2017, p. 189) established a prioritization of technologies based on resistance economy principles, ranking them as follows: Enhanced Oil Recovery (EOR) technologies, productivity improvement technologies, reservoir modeling and simulation technologies, drilling technologies, reservoir development technologies, production network optimization technologies, reservoir monitoring technologies, well completion technologies, geophysical technologies, geological technologies, geochemical technologies, well workover technologies, and surface facility technologies. For field development, drilling, well completion, well workover, and surface facility technologies are identified as key priorities. Ultimately, technological learning can yield substantial cost savings, emphasizing the importance of technology transfer and development in the upstream sector as a mechanism for achieving optimal policies in hydrocarbon resource exploitation (Rui et al., 2018, citing Hueberger, 2017; Manzoor and Ranjbar, 2017).

3.6. Political and legal factors

Kolahdooz (2018) identifies country-specific political, policy, and regulatory risks as significant challenges for exploration and production companies. Askari, Sadeghi Shahdani, and Seifloo (2016) classify a range of factors under the political and legal risks of upstream oil and gas projects, including the risk of expropriation and nationalization, the risk of civil unrest and insurrection, the risk of terrorism, the risk of unilateral changes to contract terms by the government, the risk of corruption (such as bribery and collusion), the risk of amendments to foreign investment laws, the risk of international developments, the risk of political instability in the host country, the risk of inability to convert local currency into hard currency, credit risk, the risk of changes in laws and regulations, and the risk of sanctions or specific prohibitions. Abtahi Foroushani and Nikbakhti (2014) further emphasize that, following an investment decision, any subsequent changes in laws and regulations can impose substantial risks on investors.

3.7. Security issues

All oil and gas projects face security challenges. Security risks arising from illegal activities include fraud, arson, kidnapping, sabotage, theft, and related threats. This dimension of security encompasses both asset protection and personal safety. To mitigate these challenges, oil and gas companies are often required to employ local contractors or security personnel to safeguard their assets and staff, which increases project costs and timelines. Primary drivers of such conflicts include environmental degradation, insufficient infrastructure, low levels of human development, limited economic opportunities, and fragmentation among various social groups (Rui et al., 2018). Additionally, Kolahdooz (2018) highlights the growing risk of cyber incidents and potential breaches of information security.

3.8. Partner risk

The cooperation framework in the upstream oil and gas industry is typically organized through partnerships or joint ventures, which serve to mitigate risk and enhance project development capacity. Joint venture partners may include government organizations, international oil companies, national oil companies, and financial institutions. The advantages of such partnerships include securing necessary capital, reducing risk, leveraging technology, utilizing available resources, optimizing the supply chain, and strengthening market position. However, disadvantages include complex partnership structures, limited interaction, challenges in aligning votes, objectives, and strategies, lack of trust among partners, integration difficulties, project management complexity, conflicts over technical priorities, and a high incidence of disputes among partners (Abtahi Foroushani and Nikbakhti, 2014; Rui et al., 2018).

4. Discussion: I-HOPE and field development risks

Given the five-stage structure of the NDF's investment model (I-HOPE), it can be interpreted that at each stage, the Fund seeks to facilitate the review and revision of decisions through the use of diverse financial and monitoring tools. This phased and iterative structure enables the Fund to dynamically manage and control risks arising from initial uncertainties, rather than making definitive and irreversible decisions at the outset of a project. As operations progress and technical and economic dimensions become clearer, the model allows the Fund to maintain the flexibility necessary to adapt to changes in geological conditions, technology, market dynamics, regulations, and other relevant factors.

However, despite the model's emphasis on minimal intervention in executive management, questions remain. In projects with very high risks, is remote intelligent supervision alone sufficient? Could this approach result in "strategic neglect," whereby the Fund, due to its lack of direct involvement, fails to develop a deep understanding of emerging project crises? In practice, this model faces the risk that the Fund may be compelled either to intervene—contradicting its core philosophy—or be perceived as a passive investor in the event of project failures.

Furthermore, the effectiveness of the I-HOPE model is highly dependent on the transparent, accurate, and timely flow of information from the project executor. In Iran's economic context, which faces persistent challenges in corporate governance and information transparency, it is unclear how the Fund can ensure that the technical and financial data it receives are genuine and free from manipulation. The risk of information asymmetry is particularly acute, as the project executor possesses full knowledge of technical details, while the Fund must make decisions based solely on reported information.

It is also important to note that although the Fund has prioritized incomplete or producing projects, even these require substantial capital and entail long payback periods. Are the Fund's available resources and managerial capacity sufficient to participate simultaneously in multiple large-scale projects?

Excessive concentration on a few major projects creates concentration risk, and the failure of even a single project could inflict a severe setback on the entire portfolio of the Fund's assets.

Finally, the NDF does not operate in isolation. Decisions by the government, the Ministry of Petroleum, the Plan and Budget Organization, the Parliament, and broader geopolitical developments, such as sanctions, directly influence the outcomes of projects in which the Fund has invested. How can the I-HOPE model insulate itself from shifts in government macro-policies or from the prioritization of short-term budgetary interests over the Fund's long-term objectives?

Finally, it should be noted that the Exit stage represents the focal point of the I-HOPE model, designed to avoid long-term asset retention. However, a critical question remains: who will be the buyer of the Fund's shares or assets in large upstream projects, or in mature or declining oil fields? International companies may be reluctant to acquire these assets due to Iran's political risks and legal complexities. Domestic companies are likely to lack the financial capacity for such acquisitions, and Iran's capital market does not have the capacity to absorb assets of this scale. Consequently, there is a risk that the Fund may be unable to exit projects in a timely manner while achieving the expected returns. In such a scenario, the Non-Meddle model could inadvertently transform into long-term asset holding. Furthermore, it is unclear what provisions the I-HOPE model includes for emergency exits. Could the Fund be forced to sell its assets at significantly reduced prices, thereby compromising intergenerational interests?

In addition to these overarching concerns, several specific risks facing the Fund in upstream oil and gas field development should be highlighted. One of the most significant risks is subsurface complexity. Geological and reservoir characteristics, reserve volume and quality, extraction difficulties, selection of appropriate technology, development scenarios, well engineering design, and required investment volumes all involve substantial uncertainties at the project outset (Kolahdooz, 2018; Abtahi Froushani and Nikbakhti, 2014; Rui et al., 2018), which become apparent during the production phase. Initial exploration and development data are not always accurate; if actual reservoir performance is significantly lower than forecasts, the Fund's revenue stream can be substantially reduced. A key question is whether the I-HOPE model includes mechanisms for contract review and adjustment in response to such information shocks, or whether the Fund is obliged to continue under uneconomical contracts until their conclusion.

Surface facility risks represent another major challenge. Human errors in the design, construction, or operation of facilities, as well as non-compliance with government regulations on health, safety, and the environment, pose significant hazards (Abtahi Froushani and Nikbakhti, 2014). While the Fund's model emphasizes intelligent monitoring and reporting tools to mitigate these risks, it remains uncertain whether the Non-Meddle approach alone can effectively manage the complexities of surface facilities. The accuracy and reliability of data reported by contractors are always uncertain and may be influenced by economic or schedule pressures, creating a supervisory gap that could lead to serious incidents. Additional challenges include the continuous maintenance and operation of facilities, which often require specialized expertise that may be overlooked under a non-intervention approach. Coordination among different project sectors, such as drilling, production, and transportation, also presents significant challenges that can adversely affect operational integrity.

Environmental requirements constitute the third major category of risk, which has gained increasing importance in recent years. Environmental laws and regulations, government and societal sensitivity to the impacts of oil and gas projects, and the mandatory requirement for environmental impact assessments all play a decisive role in the investment process (Hendalianpour et al., 2022; Shiravi and Taghizadeh, 2020). The Fund's model seeks to manage this risk by incorporating environmental clauses

into partnership contracts and mandating compliance with established standards. However, it remains uncertain how the Fund's Non-Meddle supervision can ensure strict adherence to safety and environmental protocols by the project operator. In the event of catastrophic incidents, harsh climatic conditions, or weak enforcement of regulations, the Fund, despite its non-intervention stance, bears full legal and reputational responsibility as a primary investor. Consequently, the project, the initial capital, the assets, and the Fund's credibility would all be exposed to significant threats.

In the realm of financial and economic risks, in addition to fluctuations in oil and gas prices, changes in operational costs and broader macroeconomic developments are emphasized as critical factors (Kolahdooz, 2018; Hendalianpour et al., 2022). Calculating economic indicators for upstream projects involves substantial uncertainty due to price and cost volatility, complicating decisions on project entry. Reservoir models and production profiles are typically developed based on limited data from exploration wells. Once large-scale production begins, actual reservoir behavior may diverge significantly from initial forecasts. The Fund's financial contracts and revenue model (in the Pay-off stage) are structured based on these initial projections. If actual production falls short of expectations, it remains unclear whether the I-HOPE model includes a mechanism for contract adjustment, or whether the Fund is forced to accept minimal returns from an underperforming project over many years. The absence of such a mechanism exposes the Fund to significant information asymmetry risk.

Technology risks are also critical in upstream oil and gas projects. Intelligent monitoring relies on accurate and transparent data. In environments where contractors may manipulate data to conceal problems, or where design errors, the use of substandard materials, or inappropriate technology selection are not promptly reported, the Fund's monitoring system may suffer from perceptual errors, failing to detect impending disasters until it is too late. Failures in implementing new technology can result in multi-year delays and substantial cost overruns, while the Fund remains a passive observer. Moreover, technological advancements and the need to upgrade facilities over the project lifespan represent additional challenges not adequately addressed in the current model. Given the rapid pace of technological change in the oil and gas industry, facilities require continuous updates, creating operational difficulties under a non-intervention framework. These requirements not only increase contractual complexity but also elevate execution and cost risks, reinforcing the necessity for the Fund to exercise precision in selecting partnership structures and contractual instruments.

Political, legal, and contractual factors constitute another fundamental category of risk that can significantly influence project execution and investment returns (Farkhani, Ghorbani Lachvani, and Asarian, 2022). The core challenge in this domain lies in the cross-sectoral nature of political and legal risks, which largely exist beyond the Fund's control and are shaped by macro-political and international dynamics. Changes in laws, government policies, international sanctions, and contractual disputes can entangle the Fund's resources in prolonged legal and operational challenges. The Fund seeks to conduct its investments in a Non-Meddle manner, ensuring that potential legal or executive interventions do not disrupt project implementation. However, important questions remain: can this approach practically maintain the necessary balance between essential oversight and non-intervention? Can the Fund's model genuinely shield it from political and legal volatilities in the country? Can exit planning provide reliable protection against sudden shifts in national macro-policies? Is a non-interventionist approach adequate for addressing risks that inherently require intervention and advocacy at high governmental levels? How can the Fund preserve its investment during critical situations that demand intervention without violating the core philosophy of its model?

Security risks, although not explicitly addressed in the Fund's policy documents, remain a major concern, particularly in high-risk or historically unstable regions where security incidents could severely affect project progress and investment returns. The high cost of providing security in such

areas can also undermine the economic viability of projects. Moreover, reliance on private security contractors introduces additional legal and reputational risks. Key questions for the Fund's model include: how can asset protection and personnel safety be ensured in insecure regions without direct involvement in security management? Can local partners provide sufficient guarantees for safeguarding large-scale projects? How can the balance between security requirements and the principle of non-intervention be maintained? What contingency measures exist for emergency situations requiring immediate security responses? How can the Fund verify the effectiveness and compliance of security arrangements without direct oversight?

Partner risk is another critical determinant of the success or failure of the Fund's model, especially in field development projects. If the selected partner lacks the necessary capabilities or encounters financial, technical, or legal difficulties during project execution, both the project and the Fund's interests are jeopardized. Large, qualified companies typically prefer to retain operational control and may favor working with passive investors rather than a powerful partner like the NDF, which may exercise substantial oversight behind the scenes. Conversely, smaller companies that could be more flexible often lack the financial and technical capacity to execute large-scale upstream projects. The Fund is thus confronted with a trade-off between a strong partner, which entails potential loss of control, and a weaker partner, which allows relative retention of control. Each option carries its own distinct set of risks.

5. Conclusions

Complexities, uncertainties, and instabilities have always characterized the oil and gas industry, particularly in the upstream sector, which encompasses exploration, development, and production stages. The long-term nature of contracts in this sector, the need for massive investment, the unpredictability of reservoir and market behavior, the existence of diverse risks—both potential and actual—the strategic and security significance of oil and gas resources internationally, the involvement of numerous stakeholders including the private sector, the state, and multinational companies, as well as public ownership of resources in some countries, all contribute to a clear distinction between upstream contracts and other public contracts, including those in the downstream sector. Additionally, developments in economic, political, technical, financial, legal, environmental, technological, and social dimensions—each of which can affect contract execution—are to be expected (Farkhani, Ghorbani Lachvani, and Asarian, 2022). As Kolahdooz (2018: 88) notes, “An oil and gas development project lasts on average 10 to 15 years. It is evident that the longer the duration of a project's implementation, the greater the associated uncertainties and risks will be.”

The NDF's Non-Meddle Investment model (I-HOPE) represents a structured effort to manage these challenges and fulfill the Fund's mandate of converting oil and gas revenues into productive, intergenerational wealth. Based on its five stages—Investment, Handling, Operation, Pay-off, and Exit—the model provides the flexibility required to navigate the high-risk environment inherent in upstream projects.

Based on the analysis presented in the preceding sections, the following strategies are proposed to enhance the NDF's investment process in upstream projects, particularly during the field development stage:

Subsurface Complexities and Surface Risks: To manage subsurface uncertainties, the Fund must require comprehensive risk analyses, detailed geological studies, and advanced reservoir modeling as essential components of the Master Development Plan (MDP). A dynamic approach is necessary, ensuring that reservoir simulation models and development plans are updated continuously with new

data and reservoir tests, and revised as needed (Abtahi Froushani and Nikbakhti, 2014). For surface facilities, a hybrid monitoring system is recommended, combining intelligent digital tools with periodic, unannounced field inspections conducted by independent experts to identify technical defects and operational risks.

Environmental Requirements: The Fund must mandate a thorough Environmental Impact Assessment prior to the commencement of any project. Additionally, it should implement a continuous environmental monitoring system to address potential liabilities. Contractual clauses must clearly assign responsibility and require adherence to international environmental standards.

Financial and Economic Risks: Brown (2000) suggests that mitigating risks arising from market uncertainties can be achieved by moving away from large, long-term investment projects and developing oil and gas assets through smaller, faster initiatives. This approach enables phased decision-making based on more certain short-term conditions, allowing investors to continue, modify, or halt projects as needed, thereby maintaining flexibility in uncertain market environments. In this context, the NDF has emphasized the importance of selecting partnership instruments suited to the specific risks of the industry and diversifying financial tools to better manage economic exposure. At the Investment stage, choosing appropriate profit-sharing mechanisms and ensuring timely exits from projects are key strategies for reducing financial risks associated with underperforming or high-risk investments. Moreover, developing robust models that incorporate macroeconomic parameters, such as inflation and exchange rates, into profitability analyses is essential. The Fund could also prioritize projects with favorable economic indicators—preferably derived from actual conditions in developing fields—that align with its technical, operational, and financial capacities. Establishing contingency reserves is another prudent measure to address price and cost volatility.

Technology Risks: To enhance project evaluation, contract formulation, and supervision of project execution, the Fund should leverage the expertise of specialized professionals across technical and operational domains from the initial project review through at least the first three stages of the Non-Middle investment model (Investment, Handling, and Operation). Employing modern technologies—such as digital field monitoring, IoT sensors to track operational progress, satellite imagery for site oversight, and artificial intelligence for early detection of cost and schedule deviations—can mitigate these challenges. Establishing a dedicated technology assessment committee to evaluate and monitor the performance of selected technologies throughout the project lifecycle is also recommended.

Political and Legal Factors: The Fund's model seeks to mitigate dependence on long-term political stability through its Exit stage planning, which involves strategizing the sale of shares or transfer of ownership. Additionally, drafting flexible and transparent contracts can partially reduce legal and contractual risks. Critically, the Fund must design mechanisms to ensure that government interference does not compromise its operational processes.

Security Issues: Some security risks can be managed by selecting reliable partners, establishing monitoring mechanisms, and implementing insurance structures during the partnership formation phase. For projects located in high-risk regions, the Fund should require partners to develop and fund credible, comprehensive security management plans in collaboration with reputable security contractors. The Fund should also establish independent verification systems to assess the effectiveness of these arrangements and implement early warning systems for emerging threats, all without direct involvement in day-to-day security management.

Partner Risk: Selecting partners with proven technical, financial, and legal competencies, a track record of success in similar projects, and legal credibility is a fundamental prerequisite for the success of the Fund's model. The Fund must develop a comprehensive partner qualification index and

implement a rigorous due diligence process to create effective and optimal cooperation models with potential partners. The partnership structure defined during the Investment stage should include clear performance metrics and a pre-defined mechanism for exiting the partnership if the partner fails to fulfill its obligations.

In addition to partner selection, it is important to recognize that several organizational factors enable effective management of profound and volatile uncertainties, including work culture, available capital, and institutional capabilities (Brown, 2000). Strategies such as improved forecasting, diversification, resilience, agility, and flexibility are also critical for confronting uncertainties. Equally, the training and empowerment of human resources are essential: well-trained personnel can prevent human errors, enhance knowledge and technological capabilities, reduce cost overruns, and improve project productivity (Hendalianpour et al., 2022; Rui et al., 2018, citing Eti et al., 2006). Given the novelty of the Fund's active investment mandate, employing specialized and highly trained personnel is crucial to establishing the foundation for success and effectiveness in upstream oil and gas projects. Moreover, creating a dedicated unit focused exclusively on continuously monitoring diverse risks—including political, economic, and geopolitical factors—and assessing their impact on the Fund's investment portfolio could provide significant strategic value.

Ultimately, the success of the National Development Fund in this complex environment depends on its transformation into an intelligent, agile, and knowledge-based investor—an institution that, beyond financial resources, possesses the wisdom, insight, and analytical capacity necessary to navigate the risks inherent in the upstream oil and gas industry. This new approach requires strengthening the risk assessment and management process, enhancing technical and managerial expertise, committing to continuous learning, ensuring transparency of information and processes, leveraging international experience, and adhering to developmental and intergenerational policies. By doing so, the Fund can safeguard the interests of future generations, generate optimal returns from the country's resources, and play a more effective role in the sustainable development of the oil and gas industry.

Nomenclature

E&P	Exploration and production
EOR	Enhanced oil recovery
FTP	First target production
HSE	Health, safety, and environment
I-HOPE	Non-meddle investment model (name of the NDF's investment framework)
IoT	Internet of things
IPC	Iran petroleum contract
MDP	Master development plan
NDF	National development fund

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