Out of Gas: An Empirical Analysis of the Fiscal regime for Exploration in India, 1999-2010

By
Anupama Sen
Senior Research Fellow, Oxford Institute for Energy Studies,
57 Woodstock Road, Oxford OX2 6FA, United Kingdom
Tel: 0044 1865 311 377 Fax: 0044 1865 310 527
Email: anupama.sen@oxfordenergy.org

Draft: 14 April 2014

Abstract:
This paper presents preliminary results from an analysis of the fiscal system for oil and gas exploration in India covering the period from the liberalisation of the upstream sector to the present. It begins by summarising literature on resource taxation and the trade-offs in fiscal design, followed by a description of the Indian regime. It then outlines the method, a meta-modelling approach which combines cash flow simulations from model field data into a regression model to identify the impact of fiscal terms under the regime on economic measures representing returns to both firms and the government. Preliminary results suggest that out of a set of seven parameters (representing the fiscal terms as independent variables), the share of profits to the government (particularly at the upper tranche of India’s ‘R Factor’ system), the oil price, and the discount rates used, account for the most influence on the system functionals (economic measures or dependent variables). The paper explores some implications of a proposed policy reform, changing the system from the R Factor model to a simplified revenue sharing model. Specifically, preliminary results imply that royalties and corporate income tax, both primary features of the proposed new model, are unlikely to influence broader government objectives in fiscal design unless elements of the R Factor model are incorporated into it via equivalent fiscal instruments.

1. Introduction

This paper presents an analysis of the fiscal system for oil and gas exploration in India from 1999-2010, covering the period from the liberalisation of the upstream sector to the present. The motivation for this paper is twofold. First, global perceptions of hydrocarbons within energy have altered significantly in the last decade, and rather than being formulated in isolation, optimal policy towards energy supply has to be considered along with broader goals relating to macroeconomic constraints and environmental impacts. The production of hydrocarbons is widely seen as underpinned by the fiscal regime governing exploration. It follows that the design of fiscal terms by governments can be utilised to achieve or to complement wider goals. There has also been a re-emergence of the relevance of fiscal design in developing countries with recently discovered reserves in Asia, particularly leading to the resurgence of gas, increasingly considered a major transition fuel which holds promise as a cleaner alternative to coal in developing countries (Helm, 2012).

---

1 This is a first draft of an Online Proceedings Paper for IAEE 2014, and therefore may be subject to corrections and further additions. A final version of results will be presented at IAEE 2014.
The second motivation relates specifically to the fundamental problem faced by energy-deficit developing countries such as India in designing their fiscal systems, namely, incentivising firms to invest in exploration and production whilst ensuring a fair and preferably early share of revenues to the government. India’s fiscal system for exploration has for the last decade and a half been based on Production Sharing Contracts, combined with a royalty. The system allows for the full recovery of costs and requires profits to be shared on the basis of a sliding scale pre tax investment multiple (similar to an R-factor). Despite nearly 15 years of operation, representing two full exploration cycles, only one ‘giant’ discovery of gas has been made under this fiscal regime, from which reserves and production have since 2010 been in decline. The regime has faced significant problems, with contracts going to arbitration and the National Auditor alleging the loss of large amounts of revenue to the exchequer. Given India’s growing demand for energy (predicted to triple to 1500 mtoe by 2030) balance of payments constraints and concerns over environment, equity and access, the design of a successful fiscal regime will underpin how India deals with its impending energy crisis.

This online proceedings paper contains the preliminary results of part of a larger research study of the Indian fiscal regime. This paper is organised as follows: section two summarises key literature on natural resource taxation and the issue of what to tax – based on the objectives of a host government, and how to tax - or the design of fiscal terms, and the argument that different systems can be designed to attain exactly the same goals. It also summarises trade offs between a set of desirable features in the design of fiscal terms: namely, efficiency (or the impact on resource allocation), neutrality (or the impact on investment decisions), equity (or the taxation of large versus marginal fields), risk sharing (between government and investors), stability (time consistency), and simplicity and clarity (in administration) (Nakhle, 2008). Section three describes the Indian fiscal regime. Section four describes the empirical method - a meta-modelling approach which combines cash flow simulations from model field data into a regression model to identify the impact of fiscal terms under the regime during 1999-2010 on variables representing returns to both firms and the government (Kaiser and Pulisipher, 2004). Section five discusses the empirical analysis and results and section six concludes.

2. Literature on the Taxation of Hydrocarbon Resources

Since the mid 20th century, a vast body of literature on the ‘optimal’ taxation of hydrocarbon resources (primarily oil, and later, gas) has emerged. Conventionally, the majority of this literature

---

2 Reforms to the system were announced in January 2014, changing it from a profit sharing regime to a revenue sharing regime, but these have yet to be officially adopted and implemented.

3 India’s current account deficit as a percentage of GDP reached a historically high level of 6.7% during the year 2012.

4 This paper is a first draft of an ongoing study. Results may be subject to corrections/additions at a later stage.
has focused on the extraction of ‘resource rents’, on the division of resource revenues between the governments who own or administer these resources and the firms (mostly private corporations) that extract them, and the contractual relations between the two. Since the turn of the millennium, environmental and climate objectives are increasingly being integrated into the energy planning frameworks of developed economies, which could in the future provide an arena for the confluence of policy on hydrocarbons extraction (via fiscal terms) with policy on mitigating the environmental impacts of climate change, thereby facilitating the transition to cleaner forms of energy. The literature on this is still, however, new and underdeveloped. For developing economies such as India - which faces severe energy shortages and where roughly half the population has yet to access any form of modern commercial energy, hydrocarbons policy is treated as separate from environmental issues, and indeed, it may even be argued that environmental issues are implicitly seen as secondary to the perceived challenge of mitigating the energy deficit. Despite this, there has been a concerted effort over the past decade and a half to drive domestic exploration (and production) in natural gas, widely seen as the ‘compromise’ solution – at least in the medium term, and relative to environmentally more harmful coal, of which India has abundant indigenous reserves. Despite these efforts, India’s energy import bill (particularly for oil) remains high and the success of efforts to promote gas via the fiscal regime for exploration has been limited. The following section provides an overview of issues in natural resource taxation related to conventional goals, but at the end it attempts to highlight areas relevant to the incorporation of environmental goals.

2.1 What to Tax

At a broader philosophical level, fiscal regimes have been characterised as one of two types: ‘liberal’ or ‘proprietal’ (Mommer, 1999). Liberal fiscal regimes are characterised by zero marginal fiscal take, where the state taxes only excess profits, careful not to obstruct the free flow of investment – it is argued that the aim of liberal fiscal regimes is to keep prices low for consumers, through the efficient management of the natural resource and the unhampered development of productivity (Mommer, 1999). Here, taxes are based on net income, necessitating information on prices, volumes, costs and investments. It has been argued that liberal regimes aim at oil being produced as soon as it is profitable for private firms to begin doing so (Mommer, 1999). At the other extreme, proprietal

---

5 For instance, in the UK, hydrocarbons policy and environmental /climate issues meet within the arena of electricity policy.

6 For instance, the consequences of using current market structures in electricity to reconcile security of supply targets with environmental goals is known (that is, they are unlikely to succeed), but new market mechanisms to deliver these goals have yet to be developed.

7 Indian energy consumers (not counting those who have no access to modern commercial energy) face deficits of 9-11% on average (representing the number of people who are disadvantaged from access to energy at any point in time) – the cumulative effect of this was visible in July/August 2012 when 20 Indian states representing roughly 600 million consumers faced 48 hours of blackouts.
fiscal regimes are characterised by a positive marginal rent, a reservation ground rent, and the taxation of excess profits (Mommer, 1999). The purpose of the proprietorial regime is the collection of higher ground rents as opposed to lower prices – analogous to the relationship between a landlord and a tenant (Mommer, 1999). Here, taxes are based on gross income, necessitating information only on prices and volumes. It can be argued that the proprietorial regime approximates to a concessions (royalty combined with taxes) regime and the liberal regime approximates to a contractual one – that is, production sharing combined with taxes on ‘rent’ – a significant concept in fiscal design.

The concept of ‘rent’ dates back to Hotelling (1931), and is underpinned by the idea that the scarcity of an exhaustible resource leads to the generation of economic rent when it is extracted – essentially amounting to the difference between the market price of a commodity and the opportunity cost of engaging in supplying the commodity (Baunsgaard, 2001). It is argued that ‘pure rent’ represents a surplus or a financial return not required to motivate economic behaviour, and could therefore in theory be taxed away without influencing production decisions - this underpins the theoretical argument that governments can aim at taxing a large share of the economic rent from resource extraction (Baunsgaard, 2001). Rent is affected by the ‘supply price of investment’ (the opportunity cost of supplying the resource), which is the return required by an investor to justify a decision to invest; this covers costs of capital and operation, as well as a risk premium (Baunsgaard, 2001). For a given return on total investment, the lower the supply price of investment, the higher the potential economic rent (Baunsgaard, 2001). Whilst the costs of capital and operation (particularly for offshore resources) are set to some extent on world markets, the risk premium is influenced by ‘political risk’ and ‘commercial risk’ (Baunsgaard, 2001). The risk premium can therefore be directly influenced by the design of policy, and of fiscal terms. Essentially, rent based taxes are therefore deemed to be revenue-neutral.

The choice of ‘what to tax’ is arguably one that is at least partially (if not entirely) political, and is also to a great extent based on the definition of ownership and property rights relating to resource wealth as enshrined within a country’s Constitution.

2.2 How to Tax

Instruments of resource taxation have typically been developed based on the reasoning in section 2.1 above. Royalties are based on the concept of resource ownership, as described earlier, and are

---

8 It has been pointed out that hydrocarbons are also subject to Ricardian rent, that is, differential rent accruing to fields with different resource characteristics (Nakhle, 2008). An additional classification of rent is ‘quasi rent’ or rent that is accrued in the short term due to innovation or changes in the market; quasi rents are competed away in the long term (Nakhle, 2008).

9 For instance, through the hiring rates for rigs.
typically applied as a fixed or sliding percentage per unit or *ad valorem* (that is, to the volume of production or to the gross value). Royalties, combined with taxes, form a key component of ‘concessions’ regimes which refer to fiscal regimes of the type operated in Norway and the United Kingdom. Royalties are typically front loaded\(^\text{10}\) and therefore are said to distort the firm’s optimal production path – however, they ensure an upfront source of revenue from the start of production. In contrast, *resource rent taxes* explicitly target the rent,\(^\text{11}\) and are classified under two systems: the first is an ‘R Factor’, which is based on the ratio of the firms’ cumulative receipts to cumulative costs – the tax becomes applicable when the ratio exceeds unity. The second is a ‘rate of return’ system which is a cash flow based tax linked to the real rate of return, which applies after a target rate of return has been achieved (Baunsgaard, 2001). The target rate of return should in principle equal the supply price of investment, but in practice it could be set as a mark-up on the return from a safe alternative investment; the annual cash flow is then increased by the target rate of return and continuously carried forward until the cash flow turns positive (Baunsgaard, 2001). Thereafter the rate of return is considered as realised and the resource rent tax applies. Resource rent taxes are therefore not front loaded\(^\text{12}\) but the risk is that firms may inflate (or ‘gold plate’) their capital costs to delay the onset of the tax, or that it could be difficult for governments to accurately set (or approve) the target rate of return due to information asymmetry between firms and the government.\(^\text{13}\)

An additional method of capturing rent is for governments to share the risk and therefore share in the ‘upside’ of projects. A common way to do this is though *equity participation* (technically a non-tax instrument), usually through a National Oil Company (NOC). Many developing-economy governments (such as India, in the past) have implemented equity participation through a ‘carried interest’ whereby the government (via its NOC) is ‘carried’ through the exploration and development phase by the private firm, and pays for its equity participation through the proceeds from production, should a commercial discovery occur (Baunsgaard, 2001). Equity participation also takes place through paid-up equity on concessional terms, through tax swapped for equity and through non-cash contributions (such as the provision of infrastructure facilities) swapped for equity (Baunsgaard, 2001). A *brown tax* represents a situation where the government shares in the upside and the downside. The tax is levied as a fixed proportion of the project’s net cash flow in each period; when the cash flow is positive firms have to pay the tax but when it is negative firms receive a rebate – this is equivalent to the payment of a proportional subsidy or tax credits or annual cash losses, and an equivalent tax on annual cash profits (Nakhle, 2008). The government essentially becomes an equity partner or equal participant in the venture (Nakhle, 2008). However, it has been argued that this

\(^\text{10}\) Also termed ‘regressive’ as taxation does not occur in proportion to an increase in production.

\(^\text{11}\) Garnaut and Clunies Ross (1975).

\(^\text{12}\) Also considered ‘progressive’ as taxation increases in proportion to an increase in production.

\(^\text{13}\) R Factor systems are typically undiscounted whereas rate-of-return systems take into account the time value of money (Daniel et al, 2010).
involves governments taking on a disproportionate amount of risk and could result in inefficient behaviour by firms as governments will essentially subsidise firms’ investments (Nakhle, 2008).

*Corporate income taxes* are generally levied on a firm’s profits from production, and may be levied at a higher rate than non-resource income in order to capture a greater share of the rent. *Progressive profits taxes* have a tax linked to higher product prices, production volumes, sales turnover, or the profit-to-sales ratio (Baunsgaard, 2001). In addition to income tax, firms may face withholding tax on dividends, often only when these are distributed to non residents, and perhaps on interest payments (Baunsgaard, 2001). Various deductions may be allowed from income tax to incentivise firms. However, hydrocarbons fields are typically ring fenced to protect present revenues, which could otherwise be postponed through continuous deductions (Baunsgaard, 2001).

*Production Sharing Agreements (PSAs)* are technically a non-tax instrument but in reality they approximate to a tax on production. The PSA is a long term agreement between a host government or NOC and a private investor, where the investor assumes all pre-production risk and recovers both costs and profit share out of production (Baunsgaard, 2001). When production starts, profit oil is derived from gross production by deducting allowable costs – the profit oil is then shared between the government and the contractor (Baunsgaard, 2001). The profit sharing mechanism is typically based on a sliding scale where, as production increases, a proportionately larger share of profits goes to the government, after the investor has recovered his costs.14 Other tax instruments include *import duties*, although these are typically waived in developing countries such as India as a fiscal incentive, and *Value Added Taxes (VAT)*, which are an instrument of taxation more generally. Non-tax instruments include *bonuses* (paid on signature, discovery and production)15 and *fixed fees*.

Policy on fiscal regimes has in fact evolved to represent hybrid versions of the philosophical ‘extremes’ described in section 2.1, and combinations of the instruments described above. It has in fact been argued that the fiscal terms can be so designed such as to bring about the same net economic impact. Since the fiscal terms can be replicated by different instruments it has further been argued that there is no intrinsic reason to prefer a tax/royalty regime to a production sharing regime or vice versa (Baunsgaard, 2001). The choice between the two will reflect administrative conditions or a particular structure that may be most suitable to local conditions (Baunsgaard, 2001).

14 A third contractual fiscal regime is the ‘Risk Service Contract’, largely prevalent in resource rich economies of the Middle East, where private firms are contracted to carry out the business of exploration and production but do not hold title to the hydrocarbons and do not generally have rights of sale.

15 Bonuses are typically aimed at Ricardian or differential rent (Mommer, 1999).
Table 2.1 Equivalencies between Different Fiscal Instruments

<table>
<thead>
<tr>
<th>Production Sharing</th>
<th>Royalties: Royalty rate = cost oil cap</th>
<th>Corporate Income Tax: Tax rate = government profit share</th>
<th>Resource Rent Tax</th>
<th>Brown Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid Equity</td>
<td>Tax rate = equity share</td>
<td>Tax rate = equity share</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carried Interest</td>
<td>Tax rate = equity share</td>
<td>Target real rate of return = interest rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concessional Equity</td>
<td>Tax rate = share of initial concessional investment</td>
<td>Tax rate = equity share</td>
<td>Target rate of return = interest rate</td>
<td></td>
</tr>
</tbody>
</table>

Source: Baunsgaard (2001); Garnaut and Clunies Ross (1983)

2.3 Trade-offs in Fiscal Design

Given the equivalencies that can be achieved through the applicability of different fiscal instruments, the selection of which instruments to use is contingent upon the objectives that governments wish to achieve through the fiscal regime, and in turn upon the trade-offs between different instruments.

In addition to the capture of resource rent, taxation is used for wider fiscal objectives – such as the financing of government expenditures (for which the energy sector can provide a substantial source of revenue), the meeting of distributional objectives, discouraging wasteful consumption / encouraging efficiency of energy use, and the pursuit of wider economic goals (Nakhle, 2008). The literature sets out some general criteria for the assessment of the effectiveness of fiscal systems design (Nakhle, 2008; Baunsgaard, 2001) - these include efficiency, neutrality, equity, risk sharing, stability, and simplicity. Efficiency refers to the impact of any tax on the allocation of resources in the economy; an inefficient fiscal design would result when as a consequence of a tax being imposed investments are not placed where the productivity of capital is highest (Nakhle, 2008). Neutrality is often defined as a criterion which leaves the pre-tax ranking of investments unchanged from the post-tax ranking – therefore a non-neutral tax would interfere with investment and operational decisions causing them to move away from the social optimum (Nakhle, 2008). Resource rent taxes, progressive profits taxes, paid equity, and carried interest score relatively better on efficiency and neutrality (Baunsgaard, 2001). Equity can be classified into horizontal equity – where firms in the same economic

---

16 This has been controversial in countries such as India, where the direct use of the pricing system for oil and gas to pursue distributional objectives has led to distortionary impacts and contributed to the current account deficit.

17 Such as macroeconomic management and the prevention of ‘Dutch Disease’.
circumstances or fields with the same characteristics should be taxed the same way – and vertical equity – where taxpayers with a greater ability to pay, should pay more taxes (Nakhle, 2008). A specific type of equity is *intergenerational equity* – achieved through a tax system that discourages the rapid depletion of resources at the expense of future generations (Nakhle, 2008). *Risk sharing* refers to the justifiable amount of risks that can be borne by firms (usually more) as opposed to governments (usually less) in a given resource project. *Stability* is achieved in a tax system which endures without substantial tinkering or political interference – although in practice this is not always the case unless policymakers are bound by constitutional legislation, as in Norway, for instance. Alternatively, contracts may contain fiscal stability clauses or equilibrium clauses to ensure that the fiscal terms stay the same or automatically adjust to exogenous changes to maintain the same outcomes. *Simplicity* relates to the administrative efficiency of the tax system (Nakhle, 2008).

There is a trade off between neutrality and simplicity, as the design of neutral taxes requires detailed information (often on a field basis) and the calculation of different levels of rent (Nakhle, 2008). An illustration of a simple tax is a royalty, which is easy to calculate and administer, but as argued earlier is not neutral. Similarly, neutrality trades off with revenue generation (Nakhle, 2008) and with efficiency – an arguably neutral tax is the Brown Tax – however, as described above, it may incentivise firms to act inefficiently as the government effectively ‘subsidises’ them. Equity trades off with simplicity and efficiency – the former is due to the fact that ‘equity’ or ‘fairness’ could mean different things to different taxpayers, and the latter is because an equitable tax is not always simple to administer – for instance, a progressive profits tax requires information to be gathered on costs and profits (typically on a field basis). Stability conflicts with fiscal risk (Nakhle, 2008), as fiscal systems are seldom left unchanged for long periods of time, given exogenous shocks, and the accountability of governments to their electorates on what may be perceived as policy inaction.

As environmental and climate policy becomes further integrated into mainstream fiscal policymaking, it is worth sketching out some of the issues and trade-offs as they relate to the design of fiscal systems for oil and gas exploration. The obvious goal of environmental policy is emissions reduction; further, it is the *total stock* of carbon that matters, subject to a time constraint. A successful policy solution either based on markets or on central planning, and upon which there is consensus by national governments, has yet to emerge. Arguably, an immediate way to pursue environmental policy objective is through hydrocarbons policy. A direct way would be to impose a carbon tax directly onto

---

18 Arguably, stability is not as relevant once resource potential has been proven – the UK fiscal regime has undergone repeated changes, yet firms have continued to invest. For a country with unsubstantiated resource potential, such as India for instance, stability is an important element of fiscal design.
19 The IEA and IPCC models for instance set out this constraint in terms of the timeframe within which emissions need to be contained in order to prevent catastrophic climate change.
20 National and supra-national governments (such as the EU) have attempted large scale programmes of emissions reduction, such as the EU Emissions Trading System, but these policy tools remain work in progress.
hydrocarbons extraction. The impact of this would however be to increase the supply price of investment, thereby reducing the amount of economic rent available for taxation under ‘liberal’ fiscal regimes and in general deterring investments. The trade-off here is therefore between security of supply and revenues from the production of hydrocarbons, and emissions reduction – therefore a government which pursues this option potentially needs to consider this trade-off in fiscal design. Environmental and climate policy can also be conceived as a time inconsistency problem – essentially, governments that value emissions reduction above the immediate production of hydrocarbons could design their fiscal systems to constrain the rapid depletion of hydrocarbon resources. However, in the case of developing economies such as India, this constitutes another trade-off – acute energy shortages and the lack of access to modern commercial energy by a large majority of the population have driven policymakers to adopt the aggressive pursuit of ‘energy security’ as a primary goal. A more conservative approach would be to use revenues from the taxation of hydrocarbons to invest in climate change mitigation and emissions reduction. However, resource revenues, especially when they form a substantial source of tax (or non tax) revenues, are typically hypothecated into the general government budget, making it difficult to subsequently link them directly to the pursuit of environmental goals. Nevertheless, it is clear that governments would typically need to rank the priority of their objectives in relation to the fiscal regime and accordingly design their systems.

3. India’s Fiscal Regime for Exploration and Production

In most countries in the world the ownership of natural resources is vested in sovereign states, with national governments acting as custodians. In India, the regulation and development of national resources lies constitutionally with the sovereign state. Up to the 1990s, India’s fiscal regime for oil and gas exploration was dominated by its National Oil Companies (NOCs), first through the granting of exclusive licenses to explore particular areas, and later through equity shares (carried interest) in joint ventures (based on a system of royalties combined with taxes) with private firms. By the early 1990s, the production of oil and gas was beginning to plateau and there was increasing pressure to reform the upstream regime due to a slowdown in the rate of reserve accumulation and the lack of

\[21\] Ringfencing provisions could, for instance, slow down the depletion of fields.
\[22\] In this case implying the pursuit of all potential energy supply options, often with a substantial negative impact on the trade deficit. For instance, the prices of domestically produced gas in India are controlled at a level of US$ 4.20 per MMBtu primarily to keep domestic prices low, yet LNG imports at US$17 per MMBtu are justified on the grounds of ensuring energy security.
\[23\] Draws from Sen and Chakravarty (2013).
\[24\] With some exceptions; for example, the US Constitution grants ownership rights to private landowners.
\[25\] In the Indian Constitution (Schedule 7) the regulation and development of oil and gas resources has been granted to the Government of India. In the Oilfields (Regulation and Development) Act, 1948, the regulation of onshore resources lies with the state governments, while that for offshore resources lies with the federal government. All royalty revenues from offshore resources flow to the federal government and all royalty revenues from onshore resources flow to the state governments. The division of other resource-related revenues is also set out according to the federal fiscal system.
capital to invest in offshore deep water exploration. It was also argued that the incentive structures were flawed in joint ventures – NOCs were often made liable for the payment of all royalties, leading to inefficiencies in joint operations.

In 1999, the federal government announced a new regime, the ‘New Exploration Licensing Policy’ (NELP) aimed at creating a level playing field for NOCs and private firms, and at boosting domestic exploration through private investments. The NELP was announced in a federal government resolution on 10 February 1999.\textsuperscript{26} The main statement of the resolution read:

In order to attract private investment in [the] oil sector, [the] Government of India had been offering exploration blocks to private companies from time to time. There have so far been nine rounds of exploration bidding and [the] Government of India has entered into contracts for exploration by private companies through Joint venture arrangements. The demand for petroleum is expected to rise rapidly and it is necessary to step up the level of investment in exploration to hasten the pace of reserve accretion, which can serve as a base for higher levels of domestic production.

The fiscal terms of the regime were enshrined within a Production Sharing Contract between the federal government and exploration firm.\textsuperscript{27} The regime was ‘progressive’, in that the system was not front-loaded from the investor’s point of view, and revenue (from the sharing of profits from production between the government and exploration company) was meant to flow to the government in proportion to the volume of cash flow, with profits beginning to be shared only after companies had recovered their capital costs of exploration. However, a royalty was included to provide an early source of government revenue. The basic components of the NELP regime were as follows:\textsuperscript{28}:

**Royalty**

Royalty rates for crude oil were set at 12.5% for onshore and 10% for offshore areas. Royalty for natural gas was set at 10%. To encourage deep-water exploration, royalty for these areas was charged at 5% for the first 7 years of deep-water production.

**Cost Recovery**

Companies were allowed to claim back 100% of capital and operating costs prior to sharing their profits from production with the federal government. Royalties were also cost recoverable. The annual limit on cost recovery was a biddable parameter in the auctions process. Tangible capital costs could be depreciated on a declining balance basis - accelerated depreciation was allowed at 60% for specific assets used in field operations. The generic rate was 15% and additional depreciation of 20% was

\textsuperscript{26} Available at [http://petroleum.nic.in/newgazette/goi1.pdf](http://petroleum.nic.in/newgazette/goi1.pdf)

\textsuperscript{27} Joint ventures and consortiums required each participating company to hold a minimum of 10% of the equity.

\textsuperscript{28} Based on tax guide for 2013.
allowed on the actual cost of new machinery or plant in the first year. Some items were not eligible for cost recovery, for instance, interest on financing, and marketing and transportation costs.

**Profit Sharing**

Profits from production were to be shared with the federal government on the basis of a ‘Pre Tax Investment Multiple’ (or PTIM - similar to an R factor scale in the literature on fiscal design). This PTIM was defined as the ratio of cumulative cash flow to cumulative capital expenditure. In the first six rounds of the NELP, companies were required to share a percentage of profits with the government at each of six tiers of this investment multiple: 1.5 and below, 1.5 to 2, 2 to 2.5, 2.5 to 3, 3 to 3.5 and 3.5 and above. Typically, a higher share of profits would be shared at higher tiers of the investment multiple, or as the company’s production (and therefore cash flow) grew in proportion to its capital expenditure. A spate of controversies over whether firms were incentivised to gold plate their capital expenditures in order to delay the sharing of profits with the government led to a change in the PTIM in the seventh NELP round, after which it was limited to just two trances, 1.5 and below and 3.5 and above, with the range in-between interpolated on a linear scale with a positive slope depending on the exact PTIM achieved in each preceding year using the formula:

\[
Z = a + [(b-a)*(X-1.5)/2],
\]

where,

- **Z** = Government share of profits (%)
- **a** = Government share (%) corresponding to the lowest PTIM or <= 1.500
- **b** = Government share (%) corresponding to the highest PTIM or >= 3.500
- **X** = PTIM of the contractor (firm or consortium) at the end of the preceding year

**Income Tax**

Indian firms paid income tax at 30% and foreign firms at 40%. Additionally, a surcharge at different rates for domestic and foreign companies was mandatory if the income of the company was in excess of Rs 10 million. An education levy of 3% was also applicable. The effective corporate tax rates were:

- for Indian firms with a net income up to and including Rs 10 million – 30.9%, otherwise 32.45%;
- for foreign firms with a net income up to and including Rs 10 million – 41.2%, otherwise 42.02%.

**Other Taxes**

A Minimum Alternate Tax (MAT) was also applicable on the firm if the tax payable on income was less than 18.5% of its book profit. The MAT was levied at an effective rate of 19.06%. For the purposes of analysis book profit can be calculated as gross revenue (cost recovery plus profit share) less royalty, operating costs, intangible capital costs and the depreciation of tangible capital costs. The MAT could be offset against income tax for a period of 10 years.
More generally, firms were not required to pay signature, discovery, or production bonuses. A seven year tax holiday was granted from the start of production, but this was withdrawn in 2011. Fiscal stability was guaranteed during the contract period and contracts were subject to the Conciliation and Arbitration Act (1996). Companies, including the NOCs, were to be paid international prices for crude oil.\(^{29}\) Firms were also given the contractual ‘freedom to market’ their production within the domestic (Indian) market, although this provision has been controversial in practice and gas is still subject to rationing policies.\(^{30}\) There was no ‘ring-fencing’ of blocks, so the expenditure from one block could be offset against that of another block. Figure 3.1 below provides a schematic of the Indian fiscal regime.

**Figure 3.1: Schematic of India’s NELP Production Sharing Regime, 1990-2010**

---

Figure 3.1 above provides a schematic of the Indian fiscal regime.

Source: Dharmadji et al (2002)

Despite being classified as a reasonably ‘progressive’ fiscal regime for exploration, the response from private investors has been disappointing. Roughly 250 production sharing contracts have been signed, US$16 billion of investments committed, and reserves of 700 million metric tonnes of oil and oil-equivalent gas accumulated through nine rounds of leasing exploration acreage under the NELP – however, actual exploration activity has been reducing, and only three discoveries have been brought

\(^{29}\) There was a separate price discovery mechanism for gas. Sen (2012) provides an analysis of gas pricing in India.

\(^{30}\) Jain (2011) provides a detailed analysis of the government’s ‘Gas Utilisation Policy’.
into production thus far. Investment commitments have quite often not been fulfilled, as shown in the figure below.

**Figure 3.2 Percentage of investment commitments not fulfilled**

![Figure 3.2](image)

Source: Sen and Chakravarty (2013)
Note: Data not available for 7th, 8th and 9th rounds.

Further, very few of the international majors have shown an interest in India’s bidding rounds for exploration. Table 3.1 compares the response to India’s upstream regime with Brazil’s, which was launched around the same time (in the 1990s).

| Table 3.1 Participation of International Majors in Bidding Rounds, India vs Brazil |
|---------------------------------|-----------------|-----------------|
|                                 | India (NELP) Auctions | Brazil Bidding Rounds |
| **Anadarko**                    | √                |                 |
| **BG**                          | √                | √               |
| **BHP Billiton**                | √                | √               |
| **BP**                          | √                | √               |
| **Chevron**                     |                  |                 |
| **ConocoPhillips**              |                  |                 |
| **ExxonMobil**                  |                  |                 |
| **ENI**                         | √                |                 |
| **Gazprom**                     | √                |                 |
| **Petrobras**                   |                  |                 |
| **Royal Dutch Shell**           |                  |                 |
| **Statoil**                     |                  |                 |
| **TOTAL**                       |                  | √               |

Source: Sen and Chakravarty (2013)

---

31 A controversial issue in domestic gas has been the dramatic drop in production since 2011 from India’s largest offshore gas block in the eastern offshore ‘KG’ basin, from which production began in 2009. There is controversy over whether the drop was due to unforeseen technical issues (as alleged by the contractor) or unfavourable fiscal terms and pricing (as alleged by the government). Reserves from the block have since downgraded from 11 tcf to between 3-5tcf.
The market for exploration acreage has also been very concentrated, with the data indicating that most acreage is split held by just two large firms (one NOC and one private), but with very little progress on exploration and production. The level of market concentration is indicated in the figure below.

**Figure 3.3: Herfindahl Index of Market Concentration**

![Graph showing Herfindahl Index over time]

Source: Sen and Chakravarty (2013)

Typically, a market with an Index of less than 1000 is less concentrated and can be described as being ‘competitive’ (Iledare et al., 2004). A market is moderately concentrated if the Index lies between 1000 and 1800, and highly concentrated when the Index is greater than 1800 (Iledare et al., 2004). While the poor performance of the regime has been partially attributed to the system of auctions (Sen and Chakravarty, 2013), fiscal design is likely to have played a role as well. Nevertheless, an analysis of the fiscal system for exploration can provide useful insights into the effectiveness of individual fiscal terms in relation to their impact on investor behaviour, as well as economic outcomes for the government. Further, it could go towards designing fiscal systems that incorporated a wider set of government objectives, which go beyond economic outcomes and incorporate environmental and social issues.

Following largely unsatisfactory performance under the NELP system of production sharing contracts, a major reform was recommended to the fiscal regime for oil and gas exploration in 2013. At the time of writing, this was yet to be officially implemented, however, it would involve replacing the provision for profit sharing based on the R Factor (investment multiple, or ratio of cumulative

---

32 See Sen and Chakravarty (2013) for an analysis of market concentration.
costs to cumulative income) with a simplified revenue-sharing model, where revenues (as opposed to profits) from production would be shared with the government from day one of production based on a biddable matrix of production slabs and oil prices. Under these recommendations, cost recovery would be eliminated, but royalties and taxes would be retained. The implications of the revenue-sharing system can arguably be gauged through exploring the dynamics of the current system; we return to this in Section 5.

4. Method of Analysis

A typical approach to the analysis of fiscal systems focuses on the behaviour of four key economic indicators or system functionals – the Present Value of net cash flows (to the firm or the government), the Internal Rate of Return (IRR), and the discounted government and contractor takes (which indicate the shares of cash flow from the project received by the government and the contractor, respectively).\textsuperscript{33} The typical approach then depicts the functional under consideration as a function of one or more variables under a ‘high’, ‘medium’ and ‘low’ case scenario\textsuperscript{34} - this method is generally piecemeal, with the results anchored to the initial conditions employed (Kaiser and Pulsipher, 2004).

The restrictions associated with geometric and tabular representations of multidimensional data are however, significant. For instance, on a planar graph, at the most four variables can be examined simultaneously (Kaiser and Pulsipher, 2004). Meta-modelling, a relatively recent approach in fiscal system analysis, allows us to understand the interactions between variables and their relative influence using a constructive modelling approach (Kaiser and Pulsipher, 2004). A cash flow model of the system is constructed and parameters of the system are defined and bound through specified design intervals, which are based on reasonable historical assumptions combined with the given parameters in the fiscal system\textsuperscript{35}. The parameters of the system are sampled from the design space and evaluated in the cash flow model (Kaiser and Pulsipher, 2004). The results of the model and system parameters are then analysed and a linear model is constructed from the generated data (Kaiser and Pulsipher, 2004).

The method of analysis follows an approach developed in Kaiser and Pulsipher (2004) and Hong and Kaiser (2010). Using data from a representative field and the fiscal terms under the Indian regime, the

\textsuperscript{33} These are arguably not the only criteria for the assessment of fiscal systems. Fiscal design often involves more nuanced interpretations of different variables based on marginal rather than total outcomes (Johnston, 1994); however, this serves as an initial step to more detailed analyses.

\textsuperscript{34} With regards to production and prices.

\textsuperscript{35} For instance, commodity prices may be selected from a triangular or lognormal distribution, fiscal terms pertaining to royalty rates may be set on the basis of the model contract, and discount rates may be assumed to be within a certain range based on existing conventions.
first step is to simulate a cash flow analysis, where the after tax net cash flow associated with field \( f \) in year \( t \) takes the form:

\[
NCF_t = GR_t - ROY_t - CAPEX_t - OPEX_t - PO/G_t - TAX_t - OTHER_t
\]

Where:

- \( NCF_t \) = After tax net cash flow in year \( t \)
- \( GR_t \) = Gross revenues in year \( t \)
- \( ROY_t \) = Total royalties paid in year \( t \)
- \( CAPEX_t \) = Total capital expenditures in year \( t \)
- \( OPEX_t \) = Total operating expenditures in year \( t \)
- \( PO/G_t \) = Government profit oil in year \( t \)
- \( TAX_t \) = Total taxes paid in year \( t \)
- \( OTHER_t \) = Other costs paid in year \( t \)

The after tax net cash flow vector associated with field \( f \) is then denoted as:

\[
NCF(f) = (NCF_1, NCF_2, \ldots, NCF_K)
\]

The next step involves the computation of four typical indicators representing economic outcomes from the application of the fiscal regime: the present value, the internal rate of return (IRR), and the discounted government and contractor takes. For field \( f \) and the fiscal regime \( F \), the present value and internal rate of return of the cash flow vector \( NCF(f) \) is:

\[
P V(f, F) = \sum_{i=1}^{K} \frac{NCF_i}{(1 + D)^{t-i}}
\]

\[
IRR(f, F) = \{ D | PV(f, F) = 0 \}
\]

Similarly, government take and contractor take are:

\[
\tau^g = \frac{GT_i}{TP_i} \quad \text{and} \quad \tau^c = \frac{CT_i}{TP_i}
\]

where \( GT \) = government take, \( CT \) = contractor take and \( TP \) = total profit in year \( t \).

The present value of government take \( PV(\tau^g) \) and contractor take \( PV(\tau^c) \) are calculated by applying discount rates \( D^g \) and \( D^c \) for the government and contractor respectively, and both are computed on a cumulative discounted basis.

### 4.1 Meta Modelling\(^{36}\)

We are interested in determining how the system functionals \( PV(f, F) \), \( IRR(f, F) \), \( \tau^g(f, F) \) and \( \tau^c(f, F) \) are influenced by the fiscal terms of the Indian regime \( F(\psi) \).

\(^{36}\) Based on Kaiser and Pulsipher (2004).
We specify the variable set $\psi$ and determine the interval $l_i \leq \psi \leq u_i$, $i=1\ldots n$, for each parameter of interest, where the values of $l_i$ and $u_i$ are user defined and account for a reasonable range of historic uncertainty associated with each parameter. The design space is denoted as $\Omega$, where $\Omega = \{ \psi = (\psi_1\ldots \psi_n) \mid l_i \leq \psi \leq u_i, i=1\ldots n \}$.

We sample the components parameters $\psi^* = (\psi_1^*\ldots \psi_n^*)$ uniformly over the design space and compute the economic indicators $\{\varphi (f, F(\psi^*))\}$. Based on the datasets $\{ \psi^* \}$ and $\{\varphi (f, F(\psi^*))\}$ we estimate for each indicator the functional relation:

$$\varphi(f, F(\psi)) = \alpha_0 + \sum_{i=1}^{n} \alpha_i(\varphi)\psi_i$$

where the coefficients $\alpha_i(\varphi)$ are determined through regression modelling.

5. Results and Discussion

The empirical analysis is conducted by applying the fiscal terms of the Indian upstream exploration regime for offshore oil and gas as described in Section 3. A model or representative field projection with estimated production volumes, tangible and intangible capital expenditure, and operating expenditure, is used. The field life is 15 years and cumulative production amounts to 40 MMBLs.

### Table 5.1: Model Field Projection

<table>
<thead>
<tr>
<th>Year</th>
<th>Prodn (MMBL)</th>
<th>Oil Price ($/bbl)</th>
<th>Intangible Capex ($M)</th>
<th>Tangible Capex ($M)</th>
<th>Opex ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>0</td>
<td>90</td>
<td>0</td>
<td>10000</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>0</td>
<td>90</td>
<td>0</td>
<td>8000</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>0</td>
<td>90</td>
<td>0</td>
<td>15000</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>4500</td>
<td>90</td>
<td>15000</td>
<td>10000</td>
<td>11500</td>
</tr>
<tr>
<td>1998</td>
<td>7000</td>
<td>90</td>
<td>2000</td>
<td>0</td>
<td>14000</td>
</tr>
<tr>
<td>1999</td>
<td>5600</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>12600</td>
</tr>
<tr>
<td>2000</td>
<td>4760</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>11760</td>
</tr>
<tr>
<td>2001</td>
<td>4046</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>11046</td>
</tr>
<tr>
<td>2002</td>
<td>3439</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>10439</td>
</tr>
<tr>
<td>2003</td>
<td>2923</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>9923</td>
</tr>
<tr>
<td>2004</td>
<td>2485</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>9485</td>
</tr>
<tr>
<td>2005</td>
<td>2087</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>9087</td>
</tr>
<tr>
<td>2006</td>
<td>1732</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>8732</td>
</tr>
</tbody>
</table>

These results are preliminary and subject to correction. Final results will be presented at IAEE 2014.

This model field is used to generate preliminary results. Final results will include a projection from a real representative Indian field.
The parameters of interest are the oil price $P_{Oil}$, the discount rates applied to calculate NPVs for government and contractor share of revenues, $D_g$ and $D_c$, the royalty rate $R$, the effective rate of corporate income tax $T_i$, the share of profits of the government at the upper tranche of the Investment Multiple (3.5 and above), $IM_{higher}$, and the share of profits of the government at the lower tranche of the Investment Multiple (1.5 and below), $IM_{lower}$. The functionals or economic measures of interest are the net present value of government revenues $NPV_{GOV}$, the net present value for the contractor $NPV_{CON}$, the internal rate of return for the contractor $IRR$, the government take $\tau^g$ and the contractor take $\tau^c$. A preliminary (static) cash flow projection is carried out for the model field.

**Table 5.2: Static Cash Flow Projection**

<table>
<thead>
<tr>
<th>Economic Measures</th>
<th>Model Field Projection</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR</td>
<td>83%</td>
</tr>
<tr>
<td>$NPV_{GOV}$</td>
<td>96857125</td>
</tr>
<tr>
<td>$NPV_{CON}$</td>
<td>933043.1</td>
</tr>
<tr>
<td>$\tau^g$*</td>
<td>74.47%</td>
</tr>
<tr>
<td>$\tau^c$*</td>
<td>14.89%</td>
</tr>
</tbody>
</table>

*Undiscounted

As described in Section 4, the set of parameters $P_{Oil}$, $D_g$, $D_c$, $R$, $T_i$, $IM_{higher}$ and $IM_{lower}$ constitute independent variables, and the set of functionals or economic measures $NPV_{GOV}$, $NPV_{CON}$, $IRR$, $\tau^g$ and $\tau^c$ each constitute dependent variables, and the objective of this analysis is to explore relationships between the two. Using Oracle Crystal Ball, the set of independent variables are classified as ‘assumption variables’ and a design space is constructed for each independent variable based on reasonable assumptions and historical data.

**Table 5.3: Independent / Assumption Variables - Design Space**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Design Space</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{Oil}$ ($/bbl)$</td>
<td>Oil price</td>
<td>$T^*(60,90,110)$</td>
</tr>
<tr>
<td>$D_g$ (%)</td>
<td>Gov Discount Rate</td>
<td>$U^*(0.05,0.12)$</td>
</tr>
<tr>
<td>$D_c$ (%)</td>
<td>Contractor Discount Rate</td>
<td>$U(0.10,0.20)$</td>
</tr>
<tr>
<td>$R$ (%)</td>
<td>Royalty Rate</td>
<td>$U(0.10,0.20)$</td>
</tr>
<tr>
<td>$T_i$ (%)</td>
<td>Effective Corporate Tax Rate</td>
<td>$U(0.30,0.43)$</td>
</tr>
<tr>
<td>$IM_{higher}$ (%)</td>
<td>Profit share at IM &lt;=3.5</td>
<td>$U(0.50,0.99)$</td>
</tr>
<tr>
<td>$IM_{lower}$ (%)</td>
<td>Profit share at IM &gt;=1.5</td>
<td>$U(0.10,0.49)$</td>
</tr>
</tbody>
</table>

* Triangular distribution; ** Uniform distribution

---

39 Government take and contractor take are undiscounted in these preliminary results. However, they provide some indication of the dynamics of R factor systems as the literature shows that the distinguishing factor between R factor systems (such as India) and Rate of Return systems is that the former are undiscounted.
The design space for $P_{ov}$ is based on a triangular distribution, with $60$/bbl, $90$/bbl and $110$/bbl as the minimum, likeliest and maximum values. $D_c$ is based on a uniform distribution with a range of 10-20%. $D_g$ which is typically lower than $D_c$ is based on a uniform distribution ranging between 5-10%. The royalty rate is set to range between 10-20% in a uniform distribution, and the effective corporate income tax rate is set between 30-43%, also in a uniform distribution. The share of profits to the government is also based on a uniform distribution. Table 5.4 contains summary statistics for preliminary results. The appendices contain scatter plots, sensitivity analyses, and tornado and spider charts depicting preliminary results.

Table 5.4: Summary Statistics for Economic Measures

<table>
<thead>
<tr>
<th></th>
<th>IRR</th>
<th>NPV$_{CON}$</th>
<th>NPV$_{GOV}$</th>
<th>$\tau^c$</th>
<th>$\tau^g$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td>0.830</td>
<td>933043.098</td>
<td>16857125.476</td>
<td>14.894</td>
<td>74.470</td>
</tr>
<tr>
<td>Mean</td>
<td>0.889</td>
<td>1348561.222</td>
<td>22886893.563</td>
<td>19.426</td>
<td>67.956</td>
</tr>
<tr>
<td>Median</td>
<td>0.902</td>
<td>1121675.213</td>
<td>20244456.892</td>
<td>18.756</td>
<td>68.913</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.224</td>
<td>903539.119</td>
<td>9665928.038</td>
<td>7.568</td>
<td>11.346</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.285</td>
<td>1.277</td>
<td>0.867</td>
<td>0.242</td>
<td>-0.214</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.952</td>
<td>5.183</td>
<td>2.961</td>
<td>1.937</td>
<td>1.714</td>
</tr>
<tr>
<td>Coeff. of Variation</td>
<td>0.252</td>
<td>0.670</td>
<td>0.422</td>
<td>0.390</td>
<td>0.167</td>
</tr>
<tr>
<td>MSE</td>
<td>0.007</td>
<td>28572.416</td>
<td>305663.483</td>
<td>0.239</td>
<td>0.359</td>
</tr>
<tr>
<td>Trials</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
</tr>
</tbody>
</table>

The relationships between economic measures and the set of parameters or independent variables follow broad expectations, and the results highlight parameters which are particularly influential in the context of the Indian fiscal regime - we focus here on correlation (causation will be explored in a later version of this paper). $\text{IRR}$ predictably has a positive relationship with the oil price and negative relationships with royalties, tax rates and share of profits to the government. Specifically, the share of profits to the government at the higher tranche of the $R$ factor has a strong negative correlation with $\text{IRR}$. $\text{NPV}_{GOV}$ expectedly has positive correlations with the share of profits at both tranches of the $R$ factor (indicating higher shares equate with a higher $\text{NPV}_{GOV}$), oil prices, royalties and taxes. $\text{NPV}_{CON}$ predictably has positive correlations with oil prices and negative correlations with government share of profits, royalties and taxes. Again, $\text{NPV}_{CON}$ has particularly strong negative correlation with $\text{IM}_{\text{higher}}$. Government take $\tau^g$ expectedly has positive correlations with government profit shares and oil price, and negative correlation with contractor discount rates. However, it also shows negative but negligible correlations with royalties, taxes and the government discount rate, which is a counterintuitive result.

---

40. The cash flow is formulated to take into account the application of the Minimum Alternate Tax rate at 19.06% based on the book profit.
41. Although preliminary results may show favourable economics for the specific model field under consideration for both the contractor and the government, the relationships between the parameters and the economic measures are of greater interest in relation to fiscal design and the various objectives of governments.
42. Preliminary results are subject to correction in the final version. Regression results will be included in the final version.
Contractor take $\tau^c$ shows negative correlations with government profit shares, royalties, and taxes, but interestingly also shows negligible but small negative correlations with oil price and contractor discount rates.

The sensitivity analysis, tornado and spider charts in the appendices show which independent variables out of the set of parameters account for the most variation in the economic measures represented by the system functionals in table 5.4. For the economic measure $\text{IRR}$, the government share of profits at the upper tranche of the R Factor arguably contributes the most, followed by the oil price, contractor discount rate, government share of profits at the lower tranche of the R factor, royalties, and taxes. For $\text{NPV}_{\text{GOV}}$, the government discount rate, followed by oil price and the government share of profits at the upper tranche of the R Factor, contribute the most to variation. For the measure $\text{NPV}_{\text{CON}}$, variation is explained most by government share of profits at the upper tranche of the R Factor, followed by the contractor discount rate, oil price, taxes and royalties. For government take and contractor take ($\tau^g$ and $\tau^c$), the government share of profits at the upper tranche of the R Factor arguably contributes the most to variation.

The general conclusion from preliminary analyses\(^{43}\) is that out of the set of parameters or independent variables, the share of profits to the government (particularly at the upper tranche of the R Factor), the oil price and the discount rates arguably account for the most influence on the system functionals or dependent variables. The explanatory contribution of royalties and taxes is arguably much less. Profit sharing constitutes a distinct feature of the current regime under the NELP. However, the proposed policy reform to the fiscal regime for exploration and production in India constitutes a move from the system of profit sharing administered through the Production Sharing Contract, to one of revenue sharing. The justification provided for the adoption of a revenue sharing system is its administrative simplicity. Under the system of profit sharing, firms are required to share their profits from the production of hydrocarbons with the government on an agreed ratio only after they have recovered their costs of capital for exploration – this involves the monitoring and estimation of firms’ capital costs by the Ministry of Petroleum and Natural Gas through its designated upstream regulator, the Directorate General of Hydrocarbons (DGH). Given its limited technical and administrative capability in relation to the number of Production Sharing Contracts that it was required to monitor (over 200), policymakers have sought to simplify the role of the DGH in administering these contracts through the proposed reform. Revenue sharing, in contrast to profit sharing, requires no monitoring of capital costs – instead, firms are simply required to share a percentage of their revenues from production, which is predetermined on the basis of a range of production slabs and oil prices. The argument is that this will simplify the role of the government in monitoring capital costs, prevent firms from allegedly

\(^{43}\) Specific conclusions will be discussed in a final version/presentation, along with more detailed analyses.
gold plating their capital expenditures in order to delay sharing profits from production with the government, and prevent contracts going into arbitration or legislative procedures.

Three observations can be made based on these preliminary results.\(^{44}\) First, the proposed reform and move to revenue-sharing arguably represents a preference for *simplicity* in fiscal design, presumably due to the administrative problems described above. However, referring to the discussion in Section 2, simplicity trade-offs with neutrality (influencing investment decisions away from the social optimum), and with equity (both current and intergenerational). A consequence of this may be that contractor discount rates are higher, thereby increasing the supply price of investment, and impacting future investment decisions, future production, and future revenue streams.

This follows into the second major observation which is that the move from a profit sharing (R Factor) regime to a revenue-sharing regime arguably represents the move from a relatively liberal to a relatively proprietorial regime, where royalties/ fixed payments combined with taxes are a primary feature. Whilst, as section 2 argued, proprietorial regimes place constraints on the rapid depletion of reserves, which may be conducive to environmental objectives in fiscal design, the preliminary results show that royalties and taxes explain very little of the variation in the system functionals. This holds implications for their potential role in influencing specific government objectives in fiscal design, and strengthens the argument for incorporating the R factor parameters into the system via equivalent fiscal design (for instance, as suggested in table 2.1)\(^{45}\). The elimination of the R factor also holds implications for riskier offshore investments in India (as it places greater risk with the investor), given that most resource potential is perceived to be in offshore areas, specifically in gas.

A third and final observation relates to the broader reasoning for moving to a revenue sharing from a profit sharing model, which can intuitively be explored further in terms of the debate in regulatory literature over rate of return (RoR) regulation versus price cap regulation, famously applied to the regulation of utilities (Helm, 2010). RoR regulation involves the monitoring and estimation of capital costs of utilities by governments, whereas price cap regulation involves the setting of periodical (for instance five yearly) ‘caps’ on price increases, with utilities permitted the freedom to carry out their operations within these price caps (Helm, 2010). Price cap regulation therefore leaves the estimation of capital costs to the utilities and assumes that utilities will be incentivised to maintain their capital costs within the price cap such that their returns to capital are optimised (Helm, 2010). RoR regulation therefore arguably equates with a profit sharing system, whereas price cap regulation equates with revenue sharing. Under revenue sharing, the ‘caps’ that are set would equate to the slabs of production volumes and the ranges of oil prices. However, the literature indicates that ‘price cap’ (or equivalent)

\(^{44}\) These will be explored further in a later version of this paper.
\(^{45}\) One way could be through sliding scale royalties.
systems almost always tend towards RoR, due to concerns over the impact on domestic pricing and the inevitability of government intervention \textit{ex post} (Helm, 2010; Tapia, 2012). It therefore follows that a revenue-sharing (price cap) model could potentially result in the same outcomes as the profit sharing (RoR) system.

6. Conclusion

This proceedings paper has sought, through a preliminary analysis of results, to explain some of the trade-offs in fiscal design as they relate to India’s fiscal regime for oil and gas exploration during the period from the liberalisation of the upstream fiscal regime (1999) to the most recent bidding round for exploration acreage (2010). The results show that the fiscal parameters relating to the R Factor scale of profit sharing contribute significantly to explaining variations in the variables representing the economic outcomes of fiscal design – $\text{IRR, } \text{NPV}_{\text{GOV}}, \text{NPV}_{\text{CON}}, \tau^g$ and $\tau^c$ – along with the oil price and discount rates used. The paper has also discussed some implications of a proposed policy reform, changing the system from the R Factor model to a simplified revenue sharing model. Specifically, preliminary results imply that royalties and taxation, both primary features of the proposed new model, are unlikely to influence broader government objectives in fiscal design unless elements of the R Factor model are incorporated into it via equivalent fiscal instruments. This paper also argued that a comparison between the existing system and the proposed reform can be explored further through the analogy of RoR versus price cap systems. A final version of this paper\textsuperscript{46} will explore these equivalencies further, along with a ranking of government objectives and associated trade-offs.

\footnote{46 To be presented at IAEE 2014.}
References


APPENDICES - Scatter Charts: IRR and Fiscal Terms

Oil Price

Royalty

Discount Rate (Contractor)

Discount Rate (Government)

Profit Share (Higher Investment Multiple)

Profit Share (Lower Investment Multiple)
Effective Tax Rate

NPV (Gov) and Fiscal Terms

Discount Rate (Contractor)

Discount Rate (Government)

Profit Share (Higher Investment Multiple)

Profit Share (Lower Investment Multiple)
NPV (Contractor) and Fiscal Terms

Discount Rate (Contractor)   Discount Rate (Government)

Profit Share (Higher Investment Multiple)   Profit Share (Lower Investment Multiple)

Oil Price   Royalty
Effective Tax Rate

\( \tau^g \) (Government Take) and Fiscal Terms

Discount Rate (Contractor) vs. Discount Rate (Government)

Profit Share (Higher Investment Multiple) vs. Profit Share (Lower Investment Multiple)
Oil Price

Royalty

Effective Tax Rate

*Undiscounted
$\tau^c$ (Contractor Take)* and Fiscal Terms

- Discount Rate (Contractor)
- Discount Rate (Government)
- Profit Share (Higher Investment Multiple)
- Profit Share (Lower Investment Multiple)
- Oil Price
- Royalty
*Undiscounted*
Sensitivity Analysis for Economic Indicators

Internal Rate of Return

NPV (Government)
NPV (Contractor)

Contractor Take (Undiscounted)
Government Take (Undiscounted)

![Graph showing sensitivity to various factors with IMhigher at 97.6% and other factors at lower percentages.](image-url)
Further Analysis: IRR

<table>
<thead>
<tr>
<th></th>
<th>IMhigher</th>
<th>Poil</th>
<th>IMlower</th>
<th>Ti</th>
<th>Dc</th>
<th>R</th>
<th>Dg</th>
</tr>
</thead>
<tbody>
<tr>
<td>40% IRR</td>
<td>0.94</td>
<td>73.42</td>
<td>0.45</td>
<td>41.70%</td>
<td>0.19</td>
<td>19%</td>
<td>0.09</td>
</tr>
<tr>
<td>60% IRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80% IRR</td>
<td>0.55</td>
<td>106.58</td>
<td>0.14</td>
<td>31.30%</td>
<td>0.11</td>
<td>11%</td>
<td>0.09</td>
</tr>
<tr>
<td>100% IRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120% IRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Upside**
- **Downside**

**Graph:**
- **IMhigher**
- **Poil**
- **IMlower**
- **Ti**
- **Dc**
- **R**
- **Dg**

**IRR Values:**
- 10.00%
- 30.00%
- 50.00%
- 70.00%
- 90.00%
Further Analysis: NPV (Government)

NPVGov

<table>
<thead>
<tr>
<th></th>
<th>Upside</th>
<th>Downside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dg</td>
<td>0.11</td>
<td>0.06</td>
</tr>
<tr>
<td>Poil</td>
<td>73.42</td>
<td>106.58</td>
</tr>
<tr>
<td>IMhigher</td>
<td>0.55</td>
<td>0.94</td>
</tr>
<tr>
<td>Ti</td>
<td>31.30%</td>
<td>41.70%</td>
</tr>
<tr>
<td>R</td>
<td>11%</td>
<td>19%</td>
</tr>
<tr>
<td>IMlower</td>
<td>0.14</td>
<td>0.45</td>
</tr>
<tr>
<td>Dc</td>
<td>0.15</td>
<td></td>
</tr>
</tbody>
</table>

NPVGov

<table>
<thead>
<tr>
<th></th>
<th>10.00%</th>
<th>30.00%</th>
<th>50.00%</th>
<th>70.00%</th>
<th>90.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMhigher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ti</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMlower</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dc</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Further Analysis: NPV (Contractor)

NPV Contractor

<table>
<thead>
<tr>
<th>IMhigher</th>
<th>Dc</th>
<th>Poil</th>
<th>Ti</th>
<th>R</th>
<th>IMlower</th>
<th>Dg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.94</td>
<td>0.19</td>
<td>73.42</td>
<td>41.70</td>
<td>19%</td>
<td>0.45</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>31.30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.11</td>
<td></td>
<td>106.58</td>
<td></td>
<td></td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IM higher: 0.00, 500,000.00, 1,000,000.00, 1,500,000.00, 2,000,000.00, 2,500,000.00
Dc: 0.00, 10.00, 30.00, 50.00, 70.00, 90.00
Poil: 0.00, 30.00, 50.00, 70.00, 90.00
Ti: 0.00, 30.00, 50.00, 70.00, 90.00
R: 0.00, 30.00, 50.00, 70.00, 90.00
IM lower: 0.00, 500,000.00, 1,000,000.00, 1,500,000.00, 2,000,000.00, 2,500,000.00
Dg: 0.00, 10.00, 30.00, 50.00, 70.00, 90.00