Balancing Rent Extraction and Project Execution: The Case of Auctions for Oil Leases in Marginal Fields in Mexico

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This research models government revenues and project completion under different scoring rules in auctions for oil leases in Mexico.

- Every oil lease has a minimum royalty and work program. Bidders make offers on top of this.
- A formula converts bids into a score. The highest score wins the auction.
- In 2014 (Round 1.3), the government used the following scoring formula:

$$\underbrace{S_{ij}}_{\text{Score bidder } i \text{ for block } j} = 0.9 \times 3.5 \times \underbrace{\phi_{ij}}_{\text{Additional royalty}} + 0.1 \times 50 \times \underbrace{(e_{ij})^{1/2}}_{\text{Additional investment}}$$

- By August 2019, 2 of 11 oil projects from Round 1.3 had moved to a development stage. The government argued that it had something to do with the high royalties bid at this auction

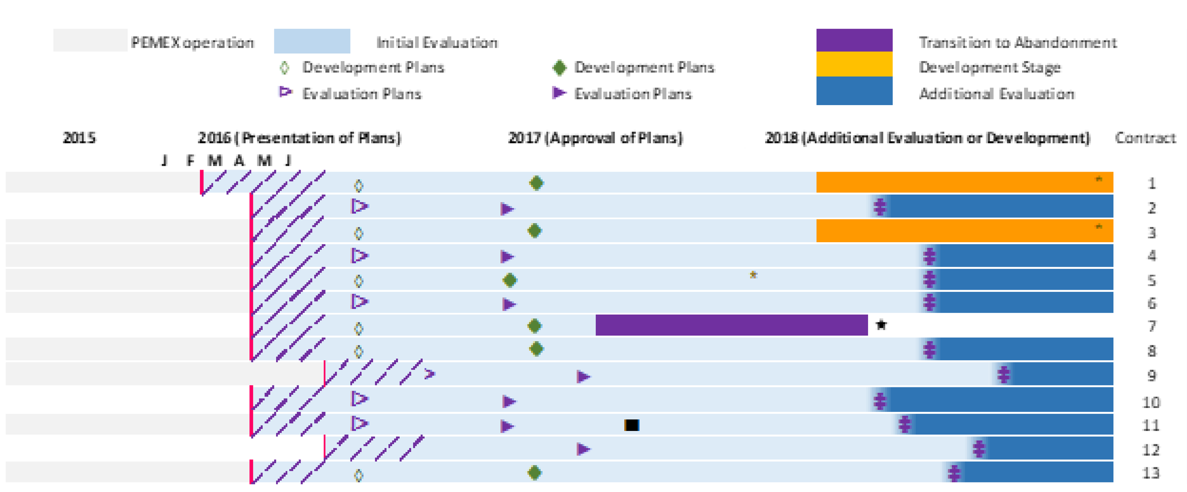


Figure 1:Timeline projects. Round 1.3

- In 2015 (Round 2.2 and 2.3), the government changed the formula and set a ceiling for the additional royalty:

$$S_{ij} = \phi_{ij} + \left(7.55 \times \frac{\phi_{ij}}{100} + 1.33\right) \times \underbrace{IF(e_{ij})}_{\text{Investment factor}}$$

- The government wanted to stimulate participation from local firms and avoid large (and potentially inefficient) investment obligations, which motivated the high weight on royalties.
- Auctions on contingent payments (such as royalties) can lead to aggressive bidding, since the project can be treated as a financial option (Kong, Perrigne, Vuong, 2019; Tufano, 1996)

Data

- Small onshore fields in Mexico, previously operated by PEMEX, open to small Mexican firms.

	Round		
	1.3	2.2	2.3
# Bidders	10.07	1.9	5.7
# Bids	220	15	52
$\phi_{ij}(\%)$	32.42	26.94	34.50
e_{ij} (units)	2,162	9,400	14,993

- Change in scoring rule, had less royalty and higher investment.
- Reduced form estimation for ζ_{ij}, which can be either ϕ_{ij} or e_{ij}

$$\zeta_{ij} = \beta_1 jointbid_{ij} + \sum_{k=2}^{8} \beta_k 1[Size_{ij} = k] + \beta_9 scrule + \beta_{10} oilproduction_j$$

where *jointbid* is a dummy for a joint bid, *size* is based on number for employees, and the historical oil production around a 6 km radius from the block.

- Change in scoring rule has an impact on royalties.

ζ_{ij}	ϕ_{ij}	e_{ij}
Scoring rule (β_9)	-0.163***	-0.462
	(0.0476)	(3.546)
Number of obs	154	154

Standard errors in parenthesis
$^*p < 0.10$ $^{**}p < 0.05$ $^{***}p < 0.01$

- **Expectations on production are higher than actual production.**

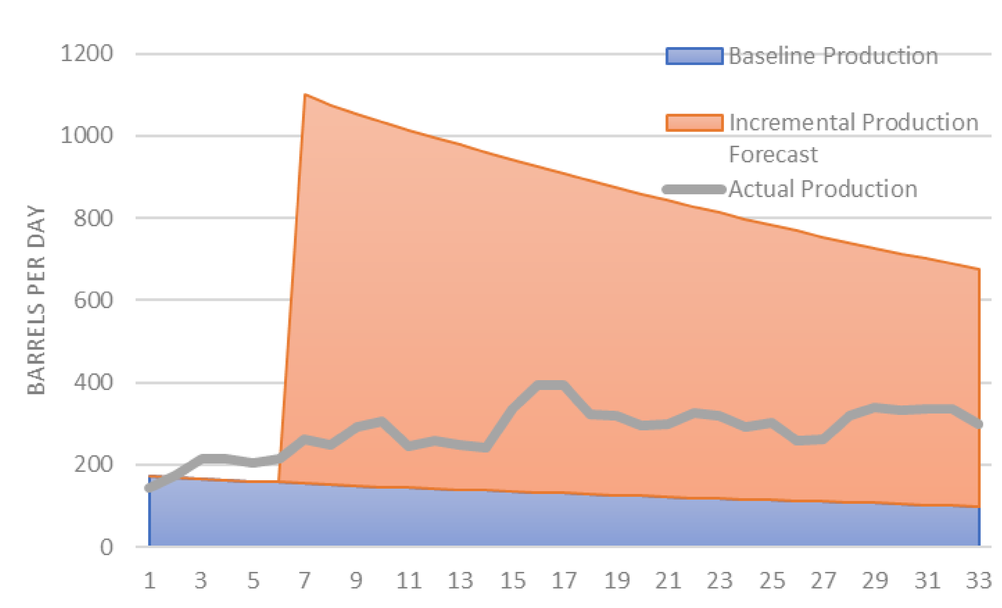


Figure 2:Production. Forecast and Realized. Round 1.3 Block 1

Model and Structural Estimation

- Auction stage: companies learn the operating c_{ij} and investment cost γ_{ij}.
- In the evaluation stage, companies receive a shock ϵ_{ij} (which is not known at the auction stage), that reflects infrastructure and geology conditions, for example, and decide whether to move to a development stage.
- Model estimates the distribution of c_{ij}, γ_{ij} and ϵ_{ij}

PEMEX — Evaluation (true ϵ_{ij})
0 — T_P — T_E — T_D
Auction — Development stage

Bidder i problem is to maximize expected profits from winning block j.

$$\max_{\phi_{ij}, e_{ij}} E_\epsilon \left\{ \underbrace{G(\phi_{ij}, e_{ij})}_{\text{Winning probability}} \left(\underbrace{\epsilon}_{\text{Unrealized shock}} - \underbrace{I(\gamma_{ij}, e_{ij})}_{\text{Evaluation stage footnotesizeinvestment}} + \underbrace{\pi_{ij}^{DEV}(\phi_{ij}, a(\phi_{ij}), c_{ij}, .)}_{\text{Development stage profits}} \right) \middle| \epsilon \geq \underline{\epsilon} \right\}$$

where the expectation $E(\epsilon)$ is conditional on ϵ being greater than some value $\underline{\epsilon}$ so that firms will bid. **In this model, the realization ϵ_{ij} of the shock is what allows a firm to win the auction but fail to complete the project** .

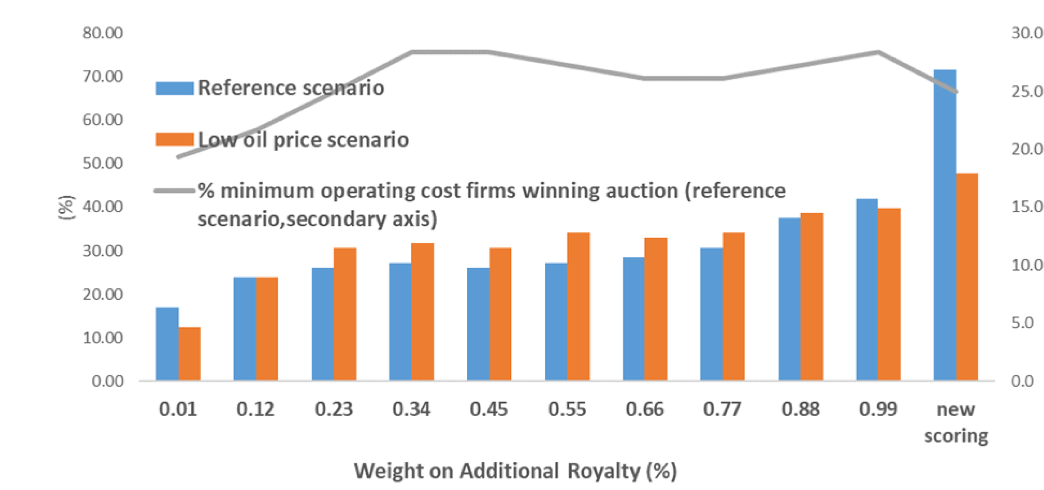
- I use bid information, and firm and block characteristics to estimate $G(\phi_{ij}, e_{ij})$. Ex-post profit maximization conditions allows identifying c_{ij}.
- First order conditions from the bidder problem allow identifying the distribution of ϵ and γ_{ij}.
- c_{ij}, γ_{ij}: bivariate stationary Gaussian process, with common component model and spatially dependent.
- ϵ_{ij} is univariate Gaussian, also with spatial dependence.
- ML estimation for Gaussian random fields allows to estimate parameters reflecting the spatial dependence of the costs and the shock.

Results

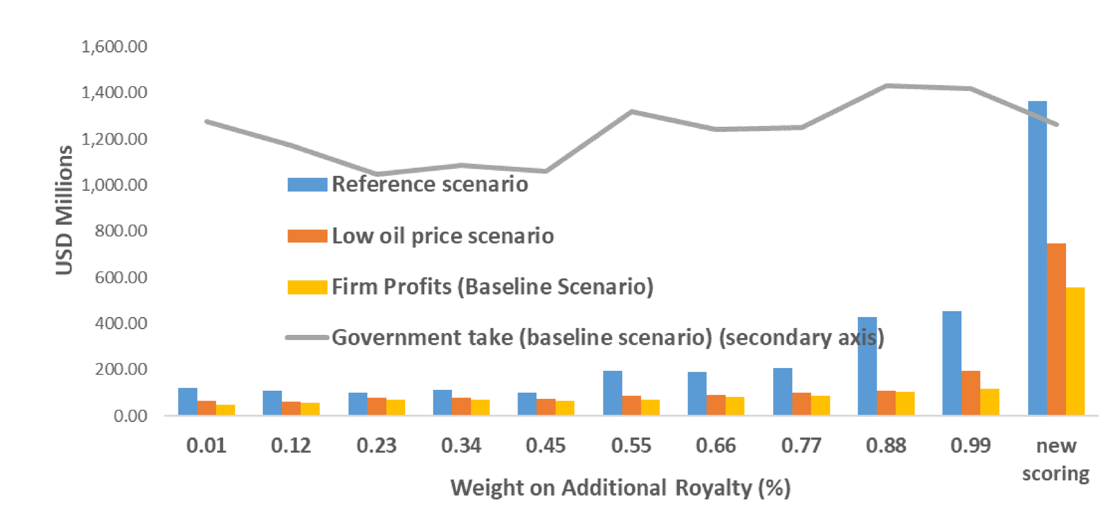
- Mean c_{ij}: USD 15.5 per barrel
- Mean γ_{ij}: USD 2,431 per working unit (around USD 8.5 million per exploratory well).
- Mean ϵ_{ij}: **USD 10.92 million** (between 5% and 21% of ex-post profits). Std. deviation USD 48.2 million

Under the new rules (ceiling on the additional royalty and the new scoring rule, the percentage of execution increases to 70%

- Firms with lowest operating cost only win between 20% and 30% of the blocks.



Simulated government revenues and firm profits under the new rules are more than twice those under the old scoring rule.



Findings suggest limitations to the use of royalties or contingent payments as bid dimensions, but also understand better how expectations are formed for bidders. Other energy projects with uncertainty, where bids could be aggressive (low electricity prices, for example), also potentially face shocks that delay project execution.