RESOURCE EXTRACTION CONTRACTS UNDER THREAT OF EXPROPRIATION

Arthur van Benthem
The Wharton School

Johannes Stroebel
Booth School of Business

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**Motivation**

- Resource contracts between governments and foreign firms = extensive collection of tax rules

- Exposure to oil price volatility for resource-rich countries
  - 72% of Algeria’s, 73% of Congo-Brazzaville’s and 77% of Equatorial Guinea’s tax revenues oil-related (2000 - 2007)
  - Gabon to cut its 2009 budget by 13% in response to falling oil prices

- Governments can benefit from IOCs since they provide:
  1. Technological/operational expertise and capital
  2. Price insurance through a tax framework that reduces exposure to price volatility
Motivation

- Tradeoff: insurance vs. expropriation:
  - Low resource price: government is happy ex-post
  - High resource price: government has incentive to expropriate

- Expropriations in the oil sector:
  - Prevalent in the 1970s
  - More recently: Ecuador, Algeria, Argentina, Russia, Bolivia, Venezuela
  - Enormous losses to foreign companies ($billion losses for IOCs such as ConocoPhillips and Shell)

- Expropriations = economic cost
Main Questions

1. Why do expropriations occur in practice?

2. What determines how much oil price insurance a country can obtain by contracting with a foreign company?
Key Findings

1. Expropriations can occur as part of an *optimal contract* with asymmetric information about expropriation costs.

2. The amount of insurance is:
   - Increasing in a country’s cost of expropriation
   - Decreasing in its hydrocarbon production expertise
Simplified Model - Assumptions

▶ Risk-averse host country, risk-neutral IOC

▶ Country has concave utility function \( u(R) \) over its oil revenue \( R \)

▶ Oil price: \( p \in (p_L, p_H) \) from i.i.d. Bernoulli, probabilities \( \pi_{p_L} = \pi_{p_H} = \frac{1}{2} \)

▶ Oil production normalized to 1, investment and production costs to 0.

▶ Contract specifies tax payments \( y(p_L) \) and \( y(p_H) \)

▶ IOC will make zero profit in expectation: \( E_p [p - y(p)] = 0 \)
Simplified Model - Assumptions

- Host country can expropriate the IOC at any time

- Fixed expropriation cost $\mu$:
  1. Domestic legal challenges
  2. International legal challenges
  3. Loss of reputation and FDI

- Following expropriation, the relative oil production efficiency loss is $\delta$ ("autarky")
**Simplified Model - Equations**

\[ V_{aut} = \sum_{t=0}^{\infty} \beta^t \left( \frac{1}{2} u \left( (1 - \delta) p_L \right) + \frac{1}{2} u \left( (1 - \delta) p_H \right) \right) \]

\[ = \frac{1}{1 - \beta} \left( \frac{1}{2} u \left( (1 - \delta) p_L \right) + \frac{1}{2} u \left( (1 - \delta) p_H \right) \right) \]

\[ \triangleright \quad V_e(p) = u(p) - \mu + \beta V_{aut} \]

\[ \triangleright \quad V_h(p) = u(y(p)) + \beta E_p[\max(V_e(p), V_h(p))] \]

\[ \triangleright \quad \text{Expropriate if } V_e(p) > V_h(p) \]
**Simplified Model - Predictions**

\[
\max_{y(p_L), y(p_H)} \frac{1}{1-\beta} \left( \frac{1}{2} u(y(p_L)) + \frac{1}{2} u(y(p_H)) \right)
\]

subject to

**PC:** \( y(p_L) + y(p_H) \leq p_L + p_H \)

**IC:** \( V_h(p) \geq V_e(p) \)

**Proposition 1.** No expropriation in equilibrium

- To explain expropriations, we need asymmetric information w.r.t. \( \mu \)

**Proposition 2.** \( \frac{dy(p_H)}{d\mu} < 0 \) and \( \frac{dy(p_H)}{d\delta} < 0 \)

- Higher cost of expropriation: more insurance
- Limited production expertise: more insurance
MODEL INTUITION

\[ \text{Government revenue} \]

\[ \text{Oil price } p \]

\[ 45^\circ \text{ line / autarky} \]

\[ p_L \]

\[ p_H \]
MODEL INTUITION

45° line / autarky
IC, low $\mu$

Government revenue

Oil price $p$

$p_L$

$p_H$
MODEL INTUITION

45° line / autarky

IC, low $\mu$

IC, high $\mu$

$p_L$  $p_H$

Oil price $p$

Government revenue

$p_H$, $p_L$, high $\mu$, low $\mu$
Data

- Real-world oil contracts are extremely complex

- WoodMackenzie tax simulator for hydrocarbon projects: 2,466 contracts for 1,167 fields in 38 non-OPEC countries (Africa, Central Asia, Far East Asia, Europe)

- Calculates slope (insurance) of each contract

\[
\gamma_i(p) = \left( \frac{TGR_i(p + \Delta p) - TGR_i(p)}{\Delta p} \right) / RR_i
\]

- “Additional government revenue per barrel when the oil price increases by 1$”

- In practice \( \gamma_i(p) \approx \gamma_i \) for most \( p \): contracts are linear in the oil price
Data

- Cost of expropriation $\mu$:
  - Constraint on Executive Index (Polity IV)
  - Real FDI per capita (United Nations)
  - Bilateral Investment Treaties (United Nations)

- Production expertise $\delta$:
  - Cumulative oil production (WoodMackenzie)
## Empirical Results - Statistical Significance

**Table**: Contract Structure Regressions - Dependent Variable: $\gamma(60)$

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional Quality</td>
<td>-0.0222***</td>
<td>-0.0254***</td>
<td>-0.0275***</td>
</tr>
<tr>
<td></td>
<td>(0.0051)</td>
<td>(0.0053)</td>
<td>(0.0055)</td>
</tr>
<tr>
<td>Per Capita FDI Inflow</td>
<td>-0.0255**</td>
<td>-0.0266**</td>
<td>-0.0189*</td>
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<tr>
<td></td>
<td>(0.0105)</td>
<td>(0.0106)</td>
<td>(0.0098)</td>
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<tr>
<td>Cumulative Hydrocarbon</td>
<td>2.379***</td>
<td>2.205***</td>
<td>2.211***</td>
</tr>
<tr>
<td>Production</td>
<td>(0.827)</td>
<td>(0.826)</td>
<td>(0.826)</td>
</tr>
<tr>
<td>Number of BITs</td>
<td>-0.00204***</td>
<td>-0.00178***</td>
<td>-0.00145***</td>
</tr>
<tr>
<td></td>
<td>(0.000409)</td>
<td>(0.000406)</td>
<td>(0.000431)</td>
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<tr>
<td>BIT with the United States</td>
<td>-0.0561**</td>
<td>-0.0460*</td>
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</tr>
<tr>
<td></td>
<td>(0.0242)</td>
<td>(0.0247)</td>
<td></td>
</tr>
<tr>
<td>Energy Charter Treaty</td>
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<td></td>
<td>-0.0507***</td>
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<tr>
<td>Treaty Member</td>
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<td>(0.0194)</td>
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<tr>
<td>R-squared</td>
<td>0.168</td>
<td>0.173</td>
<td>0.177</td>
</tr>
<tr>
<td>N</td>
<td>2035</td>
<td>2035</td>
<td>2035</td>
</tr>
</tbody>
</table>

**Note**: Standard errors clustered at the country-year level in parentheses. Only IOCs are included. Table shows coefficients proxying for $\mu$ and $\delta$. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 
Empirical Results - Economic Significance

Interpretation of parameters:

▶ ↑ Constraint on Executive Index by 1 st.d. ⇒ ▼ γ by 0.05

▶ ↑ Per capita FDI by 1 st.d. ⇒ ▼ γ by 0.02

▶ ↑ Cumulative hydrocarbon production by 1 st.d. ⇒ ▲ γ by 0.03

▶ ↑ Number of BITs by 1 st.d. ⇒ ▼ γ by 0.04

▶ ↑ BIT with U.S., Energy Charter Treaty membership ⇒ ▼ γ by 0.05
Other Empirical Results

- Results robust to alternative proxies for $\mu$

- Timing of real-world expropriations is consistent with our model predictions
Conclusions

- Contract model (with asymmetric information) consistent with data:
  - Suggestive evidence that the threat of expropriation affects contract structure

- Expropriations may be unavoidable, even under the optimal contract (not shown today)

- Ability to commit to contracts is valuable

**Policy recommendation:** Increase the recourse of investors through bilateral investment treaties
Backup Slides
Empirical Results - Alternative Proxy for $\mu$

**Table:** Contract Structure Regressions - Dependent Variable: $\gamma(60)$

<table>
<thead>
<tr>
<th></th>
<th>Constraint on Executive</th>
<th>Invest. Prof. Score</th>
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<tbody>
<tr>
<td></td>
<td>(1) OLS</td>
<td>(2) WLS</td>
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<tr>
<td>Institutional Quality</td>
<td>-0.0204***</td>
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<td>(0.0055)</td>
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<tr>
<td>Per Capita FDI Inflow</td>
<td>-0.0300***</td>
<td>-0.0301***</td>
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<tr>
<td></td>
<td>(0.0083)</td>
<td>(0.0083)</td>
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<tr>
<td>Cumulative Hydrocarbon Production</td>
<td>2.149**</td>
<td>2.165***</td>
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<tr>
<td></td>
<td>(1.030)</td>
<td>(1.030)</td>
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<tr>
<td>R-squared</td>
<td>0.061</td>
<td>0.063</td>
</tr>
<tr>
<td>N</td>
<td>2035</td>
<td>2035</td>
</tr>
</tbody>
</table>

**Note:** Columns (1) - (2) use the “Constraint on the Executive” as the proxy for $\mu$, columns (3) and (4) use the “Investment Profile Score.” Standard errors clustered at the country-year level in parentheses. WLS weighting by remaining barrels of oil equivalent. Only IOCs are included. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. 

[Go Back to Other Empirical Results]
**Empirical Results - Probability of Expropriation**

**Table:** Probit Regressions - Dependent Variable: Probability of Expropriation

<table>
<thead>
<tr>
<th></th>
<th>Constraint on Executive</th>
<th>Invest. Prof. Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
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<tr>
<td>Real Oil Price</td>
<td>0.0002</td>
<td>0.0004***</td>
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<tr>
<td></td>
<td>(0.0002)</td>
<td>(0.0001)</td>
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<tr>
<td>Institutional Quality</td>
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<td>-0.0020</td>
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<tr>
<td></td>
<td>(0.0015)</td>
<td>(0.0014)</td>
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<td>Per Capita FDI Inflow</td>
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<tr>
<td></td>
<td>(0.0077)</td>
<td>(0.0090)</td>
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<tr>
<td>Cumulative Hydrocarbon Production</td>
<td>0.0020**</td>
<td>0.0031***</td>
</tr>
<tr>
<td></td>
<td>(0.0009)</td>
<td>(0.0010)</td>
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<tr>
<td>GDP &amp; Production Controls</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>2625</td>
<td>2625</td>
</tr>
</tbody>
</table>

Columns (1) - (2) use the “Constraint on the Executive” as the proxy for \( \mu \), columns (3) and (4) use the “Investment Profile Score.” Regressions include observations with positive hydrocarbon production only. Standard errors in parentheses. * \( p < 0.10 \), ** \( p < 0.05 \), *** \( p < 0.01 \).
Empirical Results - Probability of Expropriation

Interpretation of parameters:

- ↑ Oil price by 1 st.d.  $\implies$ ↑ annual probability of expropriation by 0.63 percentage points

- ↑ Cumulative hydrocarbon production by 1 st.d.  $\implies$ ↑ annual probability of expropriation by 0.57 percentage points