Managing Oil Price Risk

with Derivatives

Stabilizing Oil Fiscal Revenues over the Short to Medium Term

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The World Bank Treasury

Agenda

- Definition of a Stabilization Policy
- Risk Management with Derivatives
- Implementation
- Case Study: European Airlines
Managing Oil Price Risk

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Managing Oil Price Risk

Definition of a Stabilization Policy

Oil price risk challenges fiscal policy

- Oil exporting countries may derive a large share of their fiscal revenues from oil sales

- Exposure to oil price challenges fiscal policy:
  - shelving of planned projects, higher savings and lower investments, wasteful use of oil 'windfall'
  - increased vulnerability of governments balance sheet

- Exporting countries have set up policies to insulate budgetary revenues from oil price shocks
Managing oil Price Risk
Definition of a Stabilization Policy

Stabilization Policy Objective

The objective of an oil price stabilization policy is to reduce the vulnerability to oil price shocks and to smooth the fluctuations in oil fiscal revenues over the short to medium term:

- at a minimum cost
- and subject to:
  - tolerance to downside risk
  - and concern with upside gains

Managing Oil Price Risk
Definition of a Stabilization Policy

Risk Management Techniques

There are essentially three ways to mitigate risk ¹:

- **Diversification:** multiply small & uncorrelated exposures
- **Hedging:** offset exposure to a market variable by creating a position with opposite sign
- **Insurance:** keep initial exposure, buy insurance and get compensated in case of adverse evolution of market variable

¹ Reference: Gray, Merton, Bodie (2002)
Managing Oil Price Risk

Definition of a Stabilization Policy

Approaches for a Stabilization Policy

- Issue oil Denominated Liabilities → Hedging
- Set up a Stabilization Fund → Self Insurance
- Transfer Risk to Markets using Derivatives → Hedging and/or Insurance

Stabilization Funds have been set up to immunize budgets

Oil revenues above a certain reference price are saved in the Fund. The Fund pays to the budget to ensure stable oil fiscal revenues based on the reference price.

Oil Price sensitive Fiscal Revenues

\[\text{Fluctuate} \rightarrow \text{Stabilization Fund} \rightarrow \text{Budget} \rightarrow \text{Stable}\]
Two categories of Funds with distinct objectives

Short to Medium Term Stabilization: “Stabilization Funds”
- Smooth fiscal oil revenues & insulate budget against oil price shocks and volatility.

Savings and Stabilization over the Very Long Run: “Funds for the Future”
- Transform depleting oil wealth into permanent & stable income through a diversified portfolio of financial assets.

Stabilization Funds have shortcomings

- The initial capitalization of and the reference price should be properly set to avoid either exhaustion or over-accumulation.
- The reference price is difficult to determine as oil prices do not exhibit a natural long term average. It could, however, be defined as a moving average.
- The accumulated savings may raise the question of their use. But the Fund may include a “Fund for the Future” tranche.
- Stabilization Funds require robust governance rules.
- Cost of carry if invested in short term liquid $ assets.
Transfer Risk to Markets using Oil Derivatives

Oil Derivatives enable hedging or insurance RM strategies. They do not require immobilization of capital. They can be combined with the Stabilization Fund approach.

Managing Oil Price Risk
Defining a Stabilization Policy

Derivatives can increase efficiency in Risk Management

- The use of derivatives in Risk Management has become much safer since the second half of the 90s
- There are now standard rules and methods for safely setting up a derivatives trading platform with the appropriate procedures and controls
- Derivatives such as swaps or forwards have become commoditized products that are increasingly used by central banks or government debt agencies
- Hedging or buying insurance from the market should improve on a savings policy. But the safe use of derivatives requires an appropriate platform
Managing Oil Price Risk

Definition of a Stabilization Policy

Formulation of a Risk Management Policy

- Objective
- Governance
- Approach
- Time Horizon
- Risk Tolerance
- Budget
- Instruments
- Implementation infrastructure

Managing Oil Price Risk

Agenda

- Definition of a Stabilization Policy
- Risk Management with Derivatives
- Implementation
- Lessons learned: Case Study of European Airlines
Basic Derivatives Instruments

**Forward**
A Forward sale contract with a commodities dealer bank is the agreement to deliver oil in the future at a predetermined price. Physically or cash settled.

**Futures**
A Futures is a Forward contract with an exchange (NYMEX, IPE)

**Swap**
A swap is a stream of [multiple] Forward contracts.

**Options**
Purchase of an Option (Put or Call) gives its owner the right but not the obligation to buy (Call) or sell (Put) oil in the future at a pre-determined price.

Generic Strategies with Derivatives

**Forward sales**

- **Hedging**
  Remove uncertainty. Fix future oil prices. Low cost (but implied costs of margin calls). Do not permit upside gains.

**Purchase of puts**

- **Insurance**
  An insurance strategy placing a floor on future oil prices. Purchase payments (premiums) for buying puts is the cost of insurance. Permit upside gains.
Managing Oil Price Risk
RM with Derivatives

Forward
- Initial exposure
- Net exposure
- Forward Oil Price
- Revenues

Put
- Initial exposure
- Net exposure
- Forward Oil Price
- Revenues

Fix future oil price
Hedging

Floor future oil price at a cost
Insurance

Buy Put + Sell Call
- Initial exposure
- Net exposure
- Forward Oil Price
- Revenues
- But upside gains are capped

Buy Sell Put
- Initial exposure
- Net exposure
- Forward Oil Price
- Revenues
- But protection is lessened
Oil Prices have increased markedly since 2003

Oil Prices exhibit high volatility
Implied volatility is the main driver of put prices

Managing Oil Price Risk
RM with Derivatives

Managing Oil Price Risk
Implementation
Capacity of Oil Derivatives Markets

The capacity of derivatives markets caps the maximum volume that can be hedged. The depth of markets has been increasing over the past three years.

As of October 2006, the following volumes of transactions, up to 5-year maturity, can be easily absorbed:

- 500 Million barrels / per year in forwards/futures
- 1 Billion barrels / per year in at-the-money puts

Some among the largest producers have fiscal revenues in excess of that capacity

Agenda

- Definition of a Stabilization Policy
- Derivatives: instruments, strategies and markets
- Implementation
- Lessons learned: Case Study of European Airlines
Good governance = clear separation of roles and accountabilities

**Hedging Board** sets policies, ensures accountability and reviews results. Should “own” the Hedging policy.

**Hedging Committee** selects and implements hedging strategies consistent with objectives and risk tolerance of the Board.

**Hedging execution teams (traders, analysts)**

**Control teams**, responsible for monitoring performance, review strategy based on commodity market changes.
Review and monitor Hedging strategy and roll-over

Establish guidelines for implementation

Determine forecasts and scenarios for oil prices. Select hedging strategy.

Operational Processes

Hedging policy, time horizon, risk tolerance

Execute hedging strategy

Managing Oil Price Risk

Implementation

Prob.-weighted scenarios

Hedging Strategy Selection Process

Annual Fiscal Oil Revenues net of hedging gains/losses

Present Value of oil revenues over the hedging time horizon

Select strategy with best gain profile subject to Risk Tolerance

Review scenarios

No hedge

Puts

.....
A first look at possible strategies (Forward = $58.68)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Strike</th>
<th>Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy at-the-money put</td>
<td>$58.68</td>
<td>$7.38</td>
<td>$7.38</td>
</tr>
<tr>
<td>Buy out-of-the-money put</td>
<td>$51.47</td>
<td>$5.00</td>
<td>$5.00</td>
</tr>
<tr>
<td>Sell call at 150% of forward</td>
<td>$88.02</td>
<td>-$1.30</td>
<td></td>
</tr>
<tr>
<td>and:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buy at-the-money put</td>
<td>$58.68</td>
<td>$7.38</td>
<td>$6.08</td>
</tr>
<tr>
<td>Buy out-of-the-money put</td>
<td>$51.47</td>
<td>$5.00</td>
<td>$3.70</td>
</tr>
</tbody>
</table>

Maturity for all options: 3 years

Managing Oil Price Risk
Implementation

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- Derivatives: instruments, strategies and markets
- Implementation
- Case Study: European Airlines
### Managing Oil Price Risk

#### Case Study

**Who hedges oil risk with derivatives?**

<table>
<thead>
<tr>
<th>Hedgers</th>
<th>Non- Hedgers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airline Companies: SouthWest, Lufthansa</td>
<td>Airline Companies. Some stopped hedging</td>
</tr>
<tr>
<td>US independent oil producers</td>
<td>Most oil exporters</td>
</tr>
<tr>
<td>Some oil importers (large users in public sector)</td>
<td>Most oil importers</td>
</tr>
<tr>
<td>Some oil exporters</td>
<td>Oil companies (strategic decision)</td>
</tr>
<tr>
<td>Utilities</td>
<td>Railways (can pass the oil bill on to their customers)</td>
</tr>
</tbody>
</table>

#### Lessons Learned

**Hedging of Jet fuel purchases among US airline companies**

- Significant economic impact of higher Jet fuel costs on US Airlines: second largest operating expense with about 1.6 million barrels consumed daily.

- Airlines found it difficult to raise air fares to reflect higher fuel costs. This lead many to file for bankruptcy. They now lack the cash or the creditworthiness to put on fuel hedges.

- Some US airlines have been hedging oil price volatility from an early stage, taking a risk management approach. They were able to plan budgets and earnings with greater accuracy.

- Southwest has been very successful and consistent with its hedging strategy overtime.

*Based on congressional hearings February 2006*
Managing Oil Price Risk

Case Study

Fuel Hedging Activity of Major U.S. Airlines

<table>
<thead>
<tr>
<th>Airline</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwest</td>
<td>70% @ $36 per barrel</td>
<td>56% @ $37 per barrel</td>
<td>35% @ $37 per barrel</td>
<td>30% @ $39 per barrel</td>
</tr>
<tr>
<td>Alaska</td>
<td>45% @ $40 per barrel</td>
<td>20% @ $45 per barrel</td>
<td>7% @ $48 per barrel</td>
<td>0%</td>
</tr>
<tr>
<td>AirTran</td>
<td>25% @ $56 per barrel</td>
<td>16% @ $59 per barrel</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>JetBlue</td>
<td>16% @ $68 per barrel</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>American</td>
<td>18% @ $60 per barrel</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>US Airways</td>
<td>13% @ $67 per barrel</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Frontier</td>
<td>4% @ $62 per barrel</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Continental/Delta/Northwest</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

% of Total Annual Fuel Requirement Hedged and Hedge Level (Source: Air Transport Association)

Managing Oil Price Risk

Case Study: European Airlines

Formulation of the Risk Management Policy

Objective: Minimize variability in jet fuel purchase costs
Time Horizon: Two years
Size: 8 million tons of crude/jet fuel p.a.
Risk Tolerance: Tighter “cap” on oil price, but reducing the costs by selling out-of-money puts
Instruments: Options (buying calls and selling puts)
Governance: Hedging committee reporting to the Board
Implementation: 6 staff in Trading, Analytics, Risk Management, M/O & B/O functions, Systems
Infrastructure: Software bought & customized (~ $1 Mio)
Budget: Net price of calls = 5% Jet Fuel purchase costs
Managing Oil Price Risk
Case Study: European Airlines

Generic Risk Management Strategy based on collars

Program: ~ 8 Mio tons purchase of Kerosene per year
Annual Cost: ~ $ 4 Bio
Budget: ~ 4% of purchase ~ $ 160 Mio ~ $3 / bbl
Upside Protection: ~ $ 2 / bbl above forward price
Downside Opportunity Risk: ~ - $ 10 $ / bbl

Basis Risk Management

The Airline Company is mainly exposed to Kerosene price risk.

However, Kerosene futures are much less liquid than Crude oil. An extra liquidity premium has to be paid. Estimated to be around $7 per ton (~ $ 56 Mio).

Kerosene is fairly well correlated with Crude although the two prices may deviate.

The Airline decided to hedge mainly on Crude oil derivatives
Airline Risk Management Strategy is more geared towards reducing uncertainty

Trade off in Hedging Strategy

Insurance against Price increase (buy call)

Acceptance of Opportunity loss (sell put)

Cost of Insurance Premium
Managing Oil Price Risk
Case Study: European Airlines

Hedging strategy is implemented over time in 18 layers
Target hedge ratio is 90%

Implementation of Risk Management Policy

Mandatory/Automatic Trading

- Computer-generated automatic trading program (works as a benchmark)
- Given budget and insurance parameter solves for the last value (strike of sold put)
- Price averaging approach

Active Management

- Can deviate from the mandatory hedging program to take advantage of market conditions
- Provides flexibility to the hedging program
- Within the pre-determined parameters such as stop-loss limits and tolerance range of the hedge ratio
Simulation model

7-year horizon. Annual data. Simulates future random oil prices. Enables to run scenarios for oil price evolutions and volatilities

The model uses market data: yield curve, oil forward rates, oil options volatilities

The present value of future oil sales net of hedging costs is computed for each 7-year oil price path

The model computes performance indicators. For each strategy, for each simulation, the mean and the 5% and 95% fractiles are computed.
Managing Oil Price Risk
Annex

Simulation model

The Simulation Model Uses Market Data

Enter Today’s Price
Enter Annual Oil Production Volume

<table>
<thead>
<tr>
<th>Expected Annual Oil Price</th>
<th>Change</th>
<th>Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>2 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>3 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>4 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>5 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>6 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>7 year</td>
<td>-10%</td>
<td>25%</td>
</tr>
<tr>
<td>Cap 2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MARKET DATA - YIELD CURVE & FORWARD PRICES

Discount Factors

<table>
<thead>
<tr>
<th>Discount Factors</th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
<th>5 year</th>
<th>6 year</th>
<th>7 year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.76%</td>
<td>4.86%</td>
<td>4.97%</td>
<td>5.12%</td>
<td>5.25%</td>
<td>5.41%</td>
<td>5.57%</td>
</tr>
</tbody>
</table>

Forward Prices

<table>
<thead>
<tr>
<th>Forward Prices</th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
<th>5 year</th>
<th>6 year</th>
<th>7 year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>66.20</td>
<td>65.07</td>
<td>63.36</td>
<td>61.92</td>
<td>60.78</td>
<td>60.06</td>
<td>59.65</td>
</tr>
</tbody>
</table>

The Simulation Model Uses Market Data

HEDGING STRATEGIES AGAINST OIL PRICE DECLINE

PV OF OIL REVENUES

HEDGING STRATEGIES

No Hedge
Forward
ATM Put
In USD

5% Lowest
Mean Net of Cost of Hedge
Total Hedging Cost

95% Highest

Present Value of Oil Revenues for 6 Strategies

30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
-50,000
-60,000
-70,000
-80,000

30,000
20,000
10,000
0
-10,000
-20,000
-30,000
-40,000
-50,000
-60,000
-70,000
-80,000
## Simulation model

### HEDGING STRATEGIES AGAINST OIL PRICE DECLINE

#### STRATEGY 1: NO HEDGE

<table>
<thead>
<tr>
<th></th>
<th>1 Year</th>
<th>2 Year</th>
<th>3 Year</th>
<th>4 Year</th>
<th>5 Year</th>
<th>6 Year</th>
<th>7 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% Highest</td>
<td>8,713</td>
<td>10,441</td>
<td>12,178</td>
<td>13,862</td>
<td>15,718</td>
<td>18,063</td>
<td>19,406</td>
</tr>
<tr>
<td>5% Lowest</td>
<td>4,502</td>
<td>4,071</td>
<td>3,838</td>
<td>3,727</td>
<td>3,644</td>
<td>3,570</td>
<td>3,492</td>
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<tr>
<td>Mean</td>
<td>6,397</td>
<td>6,842</td>
<td>7,236</td>
<td>7,847</td>
<td>8,392</td>
<td>8,983</td>
<td>9,575</td>
</tr>
</tbody>
</table>

**HEDGING COST**

- Total: 0
- Per BBL: 0

#### STRATEGY 2: FORWARD SALES

<table>
<thead>
<tr>
<th></th>
<th>1 Year</th>
<th>2 Year</th>
<th>3 Year</th>
<th>4 Year</th>
<th>5 Year</th>
<th>6 Year</th>
<th>7 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% Highest</td>
<td>6,129</td>
<td>5,937</td>
<td>5,746</td>
<td>5,591</td>
<td>5,491</td>
<td>5,427</td>
<td>5,415</td>
</tr>
<tr>
<td>5% Lowest</td>
<td>6,129</td>
<td>5,937</td>
<td>5,746</td>
<td>5,591</td>
<td>5,491</td>
<td>5,427</td>
<td>5,415</td>
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<tr>
<td>Mean</td>
<td>6,129</td>
<td>5,937</td>
<td>5,746</td>
<td>5,591</td>
<td>5,491</td>
<td>5,427</td>
<td>5,415</td>
</tr>
</tbody>
</table>

**HEDGING COST**

- Total: 0
- Per BBL: 0

#### STRATEGY 3: ATM PUTS

<table>
<thead>
<tr>
<th></th>
<th>1 Year</th>
<th>2 Year</th>
<th>3 Year</th>
<th>4 Year</th>
<th>5 Year</th>
<th>6 Year</th>
<th>7 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>95% Highest</td>
<td>7,930</td>
<td>9,535</td>
<td>11,229</td>
<td>12,901</td>
<td>14,764</td>
<td>17,103</td>
<td>18,445</td>
</tr>
<tr>
<td>5% Lowest</td>
<td>5,347</td>
<td>5,031</td>
<td>4,798</td>
<td>4,629</td>
<td>4,537</td>
<td>4,468</td>
<td>4,454</td>
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<tr>
<td>Mean Net of Cost of Hedge</td>
<td>5,995</td>
<td>6,295</td>
<td>6,705</td>
<td>7,180</td>
<td>9,628</td>
<td>10,208</td>
<td>8,875</td>
</tr>
</tbody>
</table>

**PUT STRIKES = FORWARD PRICES**

**HEDGING COST**

- Total: 6,474
- Per BBL: 64.74

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### PRESENT VALUE OF OIL REVENUES

**HISTOGRAMS FOR 4 GENERIC STRATEGIES**

7-YEAR SIMULATION
ANNUAL OIL REVENUES FOR DIFFERENT HEDGING STRATEGIES

- **NO HEDGE**
- **ATM PUTS**
- **5% OTM PUTS**
- **10% OTM PUTS**

<table>
<thead>
<tr>
<th>Years</th>
<th>USD</th>
<th>95% Highest</th>
<th>5% Lowest</th>
<th>Mean</th>
<th>Net of Cost of Hedge</th>
</tr>
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<tbody>
<tr>
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03/23/2008