Understanding New Resource Projects

Kenneth W Clements, Jiawei Si, Thomas Simpson

Business School
The University of Western Australia
THE MINING BOOM IS OVER

THE WEEKEND AUSTRALIAN, SEPTEMBER 7-8, 2013
Value of Resource Projects

Projects that are:
- Possible
- Under Consideration
- Committed
- Under Construction

Current Projects (LHS)

Change (RHS)

Growth slowing
Resource Projects and Media Attention

Number of articles


Growth rate (percent p.a.)

Growth (RHS)
Issues to be Examined

1. Inflation of project costs

2. Merits of alternative data sources

3. Economic determinants of success of projects
Pluto LNG Project

- Carnarvon Basin, off the north west coast of WA
- Discovered in 2005
- Woodside (90% & operator)
- A$14.9 billion
- Offshore gas field platform piping LNG to an onshore facility
- Forecast production of 4.3 million tonnes per year
Pluto LNG Project

Cost escalation and delays caused by:

- Lower productivity, industrial action, construction errors
- Bad weather and increased contingencies

Dec 2003
Exploration permit granted

Aug 2005
Project announced
Following gas field discovery in April

2H 2007
Approved
Construction starts
Cost = $12b

Mar 2012
Completed
Start-up achieved.
Production next month


$1.4b $12b $13b $14b $14.9b
Site preparation budget
Crocker Well Uranium Mine

- Curnamona province in north-east SA at the border with Broken Hill, NSW
- Joint venture:
  - PepinNini Minerals 40%
  - Sinosteel Corp. 60%
- A$160m open-cut uranium mine
- Estimate 11.6m pounds of Indicated and Inferred U$_3$O$_8$ at 150ppm
Crocker Well Uranium Mine

- **Nov 2004**: Exploration permit granted
- **Mar 2006**: Project announced
- **Jul 2007**: BFS preparation
- **Sep 2008**: BFS commissioned
- **Dec 2009**: Project on hold

**Uranium prices peak**
- **$160/lb** in 2008
- **$160m** in 2008

**Notes:**
- BFS – Bankable Feasibility Study
- All values in AUD

- **Mar 2006**: Project announced
- **Jul 2007**: BFS preparation
- **Dec 2009**: Project on hold

- **Mar 2006**: Exploration permit granted
- **Sep 2008**: BFS commissioned

**Project on hold**
- Poor uranium prices & strong AUD

- **Nov 2004**: Exploration permit granted
- **Mar 2006**: Project announced
- **Jul 2007**: BFS preparation
- **Sep 2008**: BFS commissioned

**Notes:**
- BFS – Bankable Feasibility Study
- All values in AUD

- **Nov 2004**: Exploration permit granted
- **Mar 2006**: Project announced
- **Jul 2007**: BFS preparation
- **Sep 2008**: BFS commissioned

**Project on hold**
- Poor uranium prices & strong AUD

- **Nov 2004**: Exploration permit granted
- **Mar 2006**: Project announced
- **Jul 2007**: BFS preparation
- **Sep 2008**: BFS commissioned

**Notes:**
- BFS – Bankable Feasibility Study
- All values in AUD
Actual vs. Predicted

From earlier…

<table>
<thead>
<tr>
<th>Project</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_B</td>
<td>V_D</td>
</tr>
<tr>
<td>Pluto</td>
<td>12,000</td>
</tr>
<tr>
<td>Crocker</td>
<td>160</td>
</tr>
</tbody>
</table>
Actual vs. Predicted: Cost

Mean inflation = 8.3%
RMSE = 24.2%

Inflation = actual – predicted
- Unexpected
- Why mostly > 0?
Actual vs. Predicted: Project Length

- Mostly above 45° line
- Mean delay = 2.6 quarters (31%)
Investment Monitor

- Deloitte Access Economics
- Quarterly publication
- All investment projects in Australia
- Costs $1,210 for an annual subscription of four issues or $616 for a single issue
# The Investment Monitor Data

(226 resource projects, 2001-2012)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth value ($m)</td>
<td>278</td>
</tr>
<tr>
<td>Death value ($m)</td>
<td>391</td>
</tr>
<tr>
<td>Age (quarters)</td>
<td>12.3</td>
</tr>
<tr>
<td>Lifetime cost change (%)</td>
<td>13.1</td>
</tr>
<tr>
<td>Annual cost change (% p.a.)</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Share of the 226 projects with no lifetime cost change = 65%

Average annual CPI growth, Mar 2001 – Sep 2012 = 2.8% p.a.
Repeat Sales Regression

- Hedonic pricing model:
  \[ \log P_i^t = \gamma^t + \sum_{k=1}^{K} \phi_k x_{ik} + \tilde{\epsilon}_i^t, \quad \log P_i^{t'} = \gamma^{t'} + \sum_{k=1}^{K} \phi_k x_{ik} + \tilde{\epsilon}_i^{t'} \]

- Difference out characteristics:
  \[ \log \left( \frac{P_i^{t'}}{P_i^t} \right) = \gamma^{t'} - \gamma^t + \tilde{\epsilon}_i \]

- Dummy variable regression:
  \[ \log \left( \frac{P_i^{t'}}{P_i^t} \right) = \sum_{s=1}^{T} \gamma^s D_i^s + \tilde{\epsilon}_i, \quad i = 1, \ldots, n \]
  \[ D_i^{t'} = 1, \quad D_i^t = -1, \quad 0 \text{ otherwise} \]
Repeat Sales Regression

• Again:

\[ \log \left( \frac{p_{i}^{t'}}{p_{i}^{t}} \right) = \sum_{s=1}^{T} \gamma^s D_i^s + \tilde{\varepsilon}_i, \quad i = 1, \ldots, n \]

• Application to resource projects – weight by value shares:

\[ \sqrt{w_i} \left[ \log \left( \frac{v_{Di}}{v_{Bi}} \right) \right] = \sum_{s=1}^{T} \gamma^s \sqrt{w_i} D_i^s + \varepsilon_i, \quad i = 1, \ldots, n \]
Repeat Sales Regression

Level of index (LHS)

Average change = 12% p.a.

Change (RHS)

Index Percent p.a.

Average large
○ > 4.8%
○ volatile
Three Sources of Data

Prospect

Investment Monitor

BREE
The Structure of the Data

226 projects

11 years

Unbalanced

72 matched projects for 6 years in 3 sources
Matched Projects from Three Sources

- 354 matched triplets
- 72 unique projects
- March 2006 – September 2012
- 13 six-month periods
- Western Australia only
Three-way Comparison
($ million)

Investment Monitor

45° line

<table>
<thead>
<tr>
<th>Source</th>
<th>PR</th>
<th>IM</th>
<th>BREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect</td>
<td>0</td>
<td>7.28</td>
<td>9.09</td>
</tr>
<tr>
<td>IM</td>
<td>-7.28</td>
<td>0</td>
<td>1.81</td>
</tr>
<tr>
<td>BREE</td>
<td>-9.09</td>
<td>-1.81</td>
<td>0</td>
</tr>
</tbody>
</table>

PR is 9% “cheaper” than BREE

- BREE most expensive
- PR cheapest
Cost Biases

• Hedonic pricing model:

\[ \log v_{it}^s = \text{time effects} + \text{source effects} + \text{project effects} + \varepsilon_{it}^s \]

Value of project i in source s for period t

• Estimated source effects (horizontal lines = SEs):

BREE

IM

Prospect

IM neither over nor understates cost
Source Biases by Capex

Source bias (percent)

Capex quantile

IM always bracketed by BREE and Prospect

IM

Prospect

Small, cheap

Large, expensive
A VAR Model

• For project $i$, consider a VAR for the 3 sources:

$$g_{it}^s = \alpha_i^s + \sum_{r=1}^{3} \beta_{i}^{sr} g_{i,t-1}^r + \varepsilon_{it}^s, \quad s = 1, 2, 3 \text{ sources},$$

where $g_{it}^s = \log \left( v_{it}^s / v_{i,t-1}^s \right)$ is the revision of the cost of $i$ from $t-1$ to $t$

• This model for $i = 1, \ldots, n$ contains $n$ sets of coefficients $\alpha_i^s$ and $\beta_i^{sr}$

• Suppose that these coefficients are the same across projects
Information Flows

• VAR model:

\[ g_{it}^s = \alpha^s + \sum_{r=1}^{3} \beta_{sr}^r g_{i,t-1}^r + \varepsilon_{it}^s, \]

for source s (s = 1, 2, 3) where \( g_{it}^s = \log \left( \frac{v_{it}^s}{v_{i,t-1}^s} \right) \)

• Coefficient matrix \( \hat{\beta}_{sr} \times 100 \)

<table>
<thead>
<tr>
<th>s</th>
<th>r</th>
<th>PR</th>
<th>IM</th>
<th>BREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect</td>
<td></td>
<td>-4.3</td>
<td>1.7</td>
<td>11.5</td>
</tr>
<tr>
<td>IM</td>
<td></td>
<td>8.9</td>
<td>-7.2</td>
<td>10.1</td>
</tr>
<tr>
<td>BREE</td>
<td></td>
<td>5.6</td>
<td>21.0</td>
<td>-19.0</td>
</tr>
</tbody>
</table>

21% of past IM revisions pass through into current BREE revisions

Directional flow if positive
**Information Trade Balances**

1. **Coefficient matrix** $\hat{\beta}_{sr}$

<table>
<thead>
<tr>
<th></th>
<th>PR</th>
<th>IM</th>
<th>BREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect</td>
<td>-4.3</td>
<td>1.7</td>
<td>11.5</td>
</tr>
<tr>
<td>IM</td>
<td>8.9</td>
<td>-7.2</td>
<td>10.1</td>
</tr>
<tr>
<td>BREE</td>
<td>5.6</td>
<td>21.0</td>
<td>-19.0</td>
</tr>
</tbody>
</table>

2. **Transpose** $\hat{\beta}_{rs}$

<table>
<thead>
<tr>
<th></th>
<th>PR</th>
<th>IM</th>
<th>BREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect</td>
<td>-4.3</td>
<td>8.9</td>
<td>5.6</td>
</tr>
<tr>
<td>IM</td>
<td>1.7</td>
<td>-7.2</td>
<td>21.0</td>
</tr>
<tr>
<td>BREE</td>
<td>11.5</td>
<td>10.1</td>
<td>-19.0</td>
</tr>
</tbody>
</table>

3. **Net information flows** $\left[\hat{\beta}_{sr} - \hat{\beta}_{rs}\right]$

<table>
<thead>
<tr>
<th></th>
<th>PR</th>
<th>IM</th>
<th>BREE</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect</td>
<td>0.0</td>
<td>-7.1</td>
<td>6.0</td>
<td>-1.1</td>
</tr>
<tr>
<td>IM</td>
<td>7.1</td>
<td>0.0</td>
<td>-10.9</td>
<td>-3.8</td>
</tr>
<tr>
<td>BREE</td>
<td>-6.0</td>
<td>10.9</td>
<td>-0.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Sum</td>
<td>1.1</td>
<td>3.8</td>
<td>-4.9</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Positive means column source informs row source more than vice versa.

- **Prospect and IM net informers**
- **BREE net receiver**
- Multi-lateral trade is balanced
Update Frequency by Source

(354 triplets less 72 unique projects = 282 possible updates)

- **BREE** Total: 150
  - 84
  - 19
  - 11

- **IM** Total: 76
  - 28
  - 3
  - 26

- **Prospect** Total: 52
  - 19
  - 11

- No cost inflation: 92

Total: 150 + 76 + 52 = 282
Are updates independent?

H₀: Independence of Source
Critical value = 3.84

- All three sources depend on one another
- Small \( \chi^2 \) suggests IM updates more independently
- Consistent with IM being a net informer

<table>
<thead>
<tr>
<th>Does Prospect update?</th>
<th>Do IM and/or BREE update?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes ( N_{11} ) \quad No ( N_{12} )</td>
</tr>
<tr>
<td>No</td>
<td>\quad Yes ( N_{21} ) \quad No ( N_{22} )</td>
</tr>
</tbody>
</table>
Speed of Adjustment

- VECM:

\[
\Delta \log v^s_{i,t} = \alpha^s \left( \mu + \sum_{r=1}^{3} \beta^r \log v^r_{i,t-1} \right) + \lambda^s + \sum_{r=1}^{3} \gamma^{sr} \Delta \log v^r_{i,t-1} + \varepsilon^s_{it}
\]

<table>
<thead>
<tr>
<th>Source</th>
<th>Adjustment speed ( \alpha^s )</th>
<th>Cointegrating vector ( \beta^r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospect</td>
<td>-0.074 (0.031)</td>
<td>1.000</td>
</tr>
<tr>
<td>IM</td>
<td>-0.138 (0.027)</td>
<td>1.144 (0.210)</td>
</tr>
<tr>
<td>BREE</td>
<td>0.138 (0.035)</td>
<td>-2.223 (0.213)</td>
</tr>
</tbody>
</table>
## Summary Evaluation

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Prospect</th>
<th>IM</th>
<th>BREE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bias</td>
<td>-5%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Net information flow</td>
<td>Neutral</td>
<td>Informer</td>
<td>Receiver</td>
</tr>
<tr>
<td>Number of revisions</td>
<td>Modest</td>
<td>Moderate</td>
<td>Many</td>
</tr>
<tr>
<td>Independence</td>
<td>Less</td>
<td>More</td>
<td>Less</td>
</tr>
<tr>
<td>Speed of revisions</td>
<td>Slow</td>
<td>Fast</td>
<td>Fast</td>
</tr>
<tr>
<td>Cost</td>
<td>Free</td>
<td>$1,200 p.a.</td>
<td>Free</td>
</tr>
</tbody>
</table>

“You get what you pay for”
Probability of Success

- Probit model:
  \[ E(Y \mid x) = F(\beta'x) \]
  - \( Y = 1 \) if success, 0 if failure
  - \( \beta \) is a vector of coefficients
  - \( x \) is a vector of explanatory variables
  - \( F(.) \) is the cumulative normal distribution

- Continuous variables:
  \[ \text{Marginal Effect} = \frac{\partial E(Y \mid x)}{\partial x_i} = f(\beta'x)\beta_i \]
  - \( f(.) \) is the standard normal density function

- Discrete variables:
  \[ \text{Marginal Effect} = \text{Prob}(Y = 1 \mid x, d = 1) - \text{Prob}(Y = 1 \mid x, d = 0) \]
Marginal Effects

(Probit model, 226 resource projects from IM, 2001-2012)

Marginal effect

-15.8%
-2.0%
0
10
20
30

Committed
29.7%

Starting State
(Base = Possible)

Industry
(Base = Elec.)

Value
($100m)

Commodity prices
(1% increase)

Age
(1 qtr inc)

Mining
9.6%

Consideration
18.2%

Number of “End of mining boom” media articles

Post-2009 dummy