A Margin Risk Approach to Risk Analysis and Risk Management in Agriculture

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Two (Related) Types of Ag Risk

- Operations and Financing
  - price, cost, and yield
  - debt (including interest expense)

- Debt Financing Links Them
  - operational debt for cultural costs
  - debt incurred to cover thin or negative margins

- Address Margin Risk Perspective
  - revenue is volatile; function of price and yield
  - costs are less volatile
  - margin risk results
Managing Margin Risk

• Operational and Financial Risks Intersect in Margins
  – low prices, high costs, low yield
  – margins indicative of risks in other areas
  – manage margins and address broader risk issues

• Important Strategic Function
  – success or failure can depend on margin management strategy
The Case
The Case

- Iceberg Lettuce Grower and Shipper
  - leases 1500 acres in Salinas Valley
  - two harvests a year
  - 850 cases per acre average
  - borrows 50% of cultural costs
  - rule of thumb: hedge 80% of production
The Problem

- Farm Credit Wants Operator to Manage Margins
  - default risk too high
  - operational (not credit) issue
  - condition of credit
  - manages risk to revenue using forwards
    - no management of risk to costs
  - hedge ratio insufficient
For Purposes of This Simulation

• Margin
  – revenues less all costs
    • costs include debt service (P & I)
  – similar to debt service coverage
  – margin is what’s left over

• Margin Risk
  – chance that annual debt service (P&I) will not be covered, triggering a default event
Revenues Driven by Spot and Yield

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Spot Price</th>
<th>Yield (40 lbs per carton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>$8.10</td>
<td>850</td>
</tr>
<tr>
<td>2005</td>
<td>$7.93</td>
<td>804</td>
</tr>
<tr>
<td>2006</td>
<td>$10.75</td>
<td>725</td>
</tr>
<tr>
<td>2007</td>
<td>$12.38</td>
<td>830</td>
</tr>
<tr>
<td>2008</td>
<td>$11.93</td>
<td>824</td>
</tr>
<tr>
<td>2009</td>
<td>$9.08</td>
<td>928</td>
</tr>
<tr>
<td>2010</td>
<td>$12.88</td>
<td>983</td>
</tr>
<tr>
<td>Mean</td>
<td>$10.44</td>
<td>849</td>
</tr>
</tbody>
</table>

Correlation Matrix

<table>
<thead>
<tr>
<th>Yield (40 lbs per carton)</th>
<th>Average Spot Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.2082</td>
</tr>
<tr>
<td>Average Spot Price</td>
<td>0.2082</td>
</tr>
</tbody>
</table>

Forward Contract Prices Vary with Spot Price Between $11.50 and $12.50 on Sliding Scale ($0.25 Increments)
Total Revenue, 50% Leverage, $12.50 Contract
Regression Coefficients

+Yield / Stochastic (Empirical Distribution)

Coefficient Value: 0.94

+Price / Stochastic (Empirical Distribution)

Coefficient Value: 0.33
## Harvest Costs Variable (Driven by Yield); Cultural Costs Fixed

Production Costs (per Acre, Single Harvest)

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>$144.00</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>$359.00</td>
</tr>
<tr>
<td>Weed Control/Thinning Labor</td>
<td>$146.00</td>
</tr>
<tr>
<td>Pest Management (includes PCA costs)</td>
<td>$582.00</td>
</tr>
<tr>
<td>Water</td>
<td>$280.00</td>
</tr>
<tr>
<td>Irrigation Labor</td>
<td>$241.70</td>
</tr>
<tr>
<td>Tractor Labor</td>
<td>$148.35</td>
</tr>
<tr>
<td>Fuel</td>
<td>$172.93</td>
</tr>
<tr>
<td>Tractor and Machinery Cost</td>
<td>$255.58</td>
</tr>
<tr>
<td>Supervision and General Labor</td>
<td>$105.00</td>
</tr>
<tr>
<td>Compost</td>
<td>$50.00</td>
</tr>
<tr>
<td>Total Cultural Costs</td>
<td>$2,484.56</td>
</tr>
<tr>
<td>Fresh Market Harvest Cost ($/Carton)</td>
<td></td>
</tr>
<tr>
<td>Cut/Pack/Haul</td>
<td>$5.85</td>
</tr>
<tr>
<td>Average Yeld/Acre (Cartons)</td>
<td>850</td>
</tr>
<tr>
<td>Total Harvest Cost (cooling, palletize, and sell) per acre</td>
<td>$4,972.50</td>
</tr>
<tr>
<td>Total Production Costs</td>
<td>$7,457.06</td>
</tr>
<tr>
<td>Cash Overhead per acre</td>
<td>$130.00</td>
</tr>
<tr>
<td>Land Rent per Acre</td>
<td>$1,100.00</td>
</tr>
<tr>
<td>Interest on Operating Capital (based on 6.275% per year on half of cultural cost)</td>
<td>$38.98</td>
</tr>
<tr>
<td>Total Overhead Cash Cost</td>
<td>$1,268.98</td>
</tr>
<tr>
<td>Depreciation and Interest on Investments</td>
<td>$50.00</td>
</tr>
<tr>
<td>Total per Acre Cost</td>
<td>$8,776.04</td>
</tr>
<tr>
<td>Total Cost less Harvest Cost</td>
<td>$3,803.54</td>
</tr>
</tbody>
</table>
The @Risk Simulation
Technical Specifications

- **@Risk Functions**
  - RiskNormal
    - yield driving harvest costs
  - RiskGeneral
    - spot price and contract price
    - yield driving revenues
    - 500 simulations
- **@Risk for Excel 6.0.0 (Industrial Edition)**
- **MS Excel 2010, Windows 7**
- **Oracle VM VirtualBox Manager 4.1.23**
- **iMac (3.1 GHz Intel Core i5)**
100% Hedge, 50% Leverage, $12.50 Contract

σ_{Revenue} = $894  \quad \sigma_{Cost} = $492
No Hedge, 50% Leverage

\[ \sigma_{\text{Revenue}} = $1464 \quad \sigma_{\text{Cost}} = $498 \]
No Hedge: Net Income, Total Costs, Total Revenue...

<table>
<thead>
<tr>
<th>Total Revenue / Net Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: $-3,406.12</td>
</tr>
<tr>
<td>Maximum: $4,378.06</td>
</tr>
<tr>
<td>Mean: $226.46</td>
</tr>
<tr>
<td>Std Dev: $1,586.64</td>
</tr>
<tr>
<td>Values: 500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Cost / Net Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: $7,117.07</td>
</tr>
<tr>
<td>Maximum: $10,517.25</td>
</tr>
<tr>
<td>Mean: $8,771.25</td>
</tr>
<tr>
<td>Std Dev: $494.67</td>
</tr>
<tr>
<td>Values: 500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum: $6,001.18</td>
</tr>
<tr>
<td>Maximum: $12,490.99</td>
</tr>
<tr>
<td>Mean: $8,997.71</td>
</tr>
<tr>
<td>Std Dev: $1,473.90</td>
</tr>
<tr>
<td>Values: 500</td>
</tr>
</tbody>
</table>
Hedge at $12.50: Net Income, Total Costs, Total Revenue...

<table>
<thead>
<tr>
<th>Values x 10^...</th>
<th>-2...</th>
<th>0...</th>
<th>0.0...</th>
<th>90.0...</th>
<th>3125...</th>
<th>5...</th>
<th>100...</th>
</tr>
</thead>
</table>

**Total Revenue / Net Revenue**
- Minimum: -$1,217.38
- Maximum: $4,248.05
- Mean: $1,489.18
- Std Dev: $1,009.18
- Values: 500

**TotCost / Net Revenue**
- Minimum: $6,962.08
- Maximum: $10,498.52
- Mean: $8,770.94
- Std Dev: $495.77
- Values: 500

**Total Revenue**
- Minimum: $8,352.96
- Maximum: $12,266.23
- Mean: $10,280.12
- Std Dev: $901.54
- Values: 500
Net Income with 50% Leverage

Cum Probability

Net Income

-5,000  -3,000  -1,000  1,000  3,000  5,000

0%  10%  20%  30%  40%  50%  60%  70%  80%  90%  100%

All Hedge, $12.50 Contract
Net Income with 50% Leverage

Cum Probability

Net Income

- $5,000
- $3,000
- $1,000
$1,000
$3,000
$5,000

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

- $5,000
- $3,000
- $1,000
$1,000
$3,000
$5,000

All Hedge, $12.50 Contract
All Hedge, $10.50 Contract
The Hedge

Oh merde!
The Hedge

• Analysis Says 100% Hedge is Sensible
• In Practice, 80% Hedge Ratio
  – acting as though contract price is $11.25
  – locking in a reduction in net income
• Why Take the Risk?
  – retail market and supply chain dynamics
  – strategy not focussed on minimizing margin risk
  – trading upside for chance at extra $150 per acre
  – self-insured; moral hazard; “What the hell?” attitude
80% Hedge Ratio (@ $11.25 Contract Equivalent)

Cum Probability

Net Income

-5,000 -4,000 -3,000 -2,000 -1,000 0 1,000 2,000 3,000 4,000 5,000 6,000

Green line: All Hedge, $11.25 Contract
Red line: No Hedge
100% Hedge, 50% Leverage, $11.25 Contract
Net Income with 50% Leverage

- All Hedge, $12.50 Contract
- All Hedge, $11.25 Contract
- No Hedge
P&L For Resulting Hedge

Cum Probability

Net Income

0% - $5,000
10% - $3,000
20% - $1,000
30% - $1,000
40% - $3,000
50% - $5,000
The Forecast
The Forecast

- @Risk Functions
  - RiskNormal (as before)
  - RiskGeneral (as before)
  - RiskTriang (0, 0.0074721, 0.0074721)
    - cultural costs grow at maximum annual rate of 1.5%
  - 500 simulations
Forecast Net Income: 2012a to 2017b

Cum Probability

- All Hedge 2012a
- No Hedge 2012a
- All Hedge 2017b
- No Hedge 2017b
Net Income Forecast: Harvests 2012a to 2017b

- Mean
- +/- 1 Std. Dev.
- 5% - 95%
Reconsider Understanding of Risk

• Look Beyond Revenue Side
  – prices, yields, revenue require management

• What About Costs?
  – land, fertilizer, energy, water, seed, weather, pests, disease, regulations, technology, food safety, foreign currency
  – major sources of risk
  – all require management
Reconsider Our Treatment of Risk

- Mistake to Focus Mainly on Prices
  - ignores effect of financing and capital costs
- Must Focus on Revenues and Costs -- Margins
- Margin Risk Management is Key Strategic Competence
Hope is Not an Option

• Risk Management is a Strategic Function
  – part of competitive advantage
    • or lack thereof
  – major component of management responsibility
    • just like operations, harvest, distribution, sales
    • operations and finance intersect in margins
    • integral part of strategic activities
  – needs daily attention, high level of expertise, and good information
  – contributes to success or failure of company
Strategic Implications for Industry

- More Broadly:
  - prepare to adapt and change
  - in other words, research, develop, innovate

- There Will be Failure; Risk Taking Required
  - small scale failure (no catastrophes)
  - fail quickly, learn, move on
  - risk management more important than ever

- Innovation Creates Value
  - share benefits with customers
  - share risks with customers, too
Data Sources

- University of California Cooperative Extension (2009)
- USDA Agricultural Marketing Service Market News
- Monterey County (CA), Office of the Agricultural Commissioner
- Proprietary Sources
Contact Information

For additional information on the Agribusiness program at Cal Poly, please contact:

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