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

Fresh Market Harvest Cost ($/Carton)
- Cut/Pack/Haul: $5.85
- Average Yield/Acre (Cartons): 850
- Total Harvest Cost (cooling, palletize, and sell) per acre: $4,972.50
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

\[
\sigma_{\text{Revenue}} = 894 \quad \sigma_{\text{Cost}} = 492
\]
No Hedge, 50% Leverage

Sim Results

σ_{Revenue} = $1464
σ_{Cost} = $498
Hedge at $12.50: Net Income, Total Costs, Total Revenue...
Net Income with 50% Leverage

Cum Probability vs. Net Income

- $5,000 to $5,000

All Hedge, $12.50 Contract

0% to 100%
Net Income with 50% Leverage

Cumulative Probability

Net Income

-5,000 -3,000 -1,000 0 1,000 3,000 5,000

-5,000 -3,000 -1,000 0 1,000 3,000 5,000

Cum Probability

Net Income

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

-5,000 -3,000 -1,000 0 1,000 3,000 5,000

-5,000 -3,000 -1,000 0 1,000 3,000 5,000

All Hedge, $12.50 Contract

All Hedge, $10.50 Contract
The Hedge
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)
$6,000 $7,000 $8,000 $9,000 $10,000 $11,000 $12,000 $13,000
1 10 19 28 37 46 55 64 73 82 91 100 109 118 127 136 145 154 163 172 181 190 199 208 217 226 235 244 253 262 271 280 289 298 307 316 325 334 343 352 361 370 379 388 397 406 415 424 433 442 451 460 469 478 487 496

SimResults

100% Hedge, 50% Leverage, $11.25 Contract

Total Revenue
Total Costs
Cum Probability

Net Income with 50% Leverage

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

Net Income

All Hedge, $12.50 Contract
All Hedge, $11.25 Contract
No Hedge
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
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
For additional information on the Agribusiness program at Cal Poly, please contact:

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