Historical analysis

Comparative analysis

Pro forma analysis

Forming expectations about future prices, costs and productivity

Incorporation of risk
Timeline Required for Capital Budgeting...

Assume at the end of 2013 John Deere was expecting increased farm machinery and equipment sales over the next five years and wants to determine if plant expansion to meet this growing demand is economically feasible.
Timeline Required for Capital Budgeting...

Assume at the end of 2013 John Deere was expecting increased farm machinery and equipment sales over the next five years and wants to determine if plant expansion to meet this growing demand is economically feasible.

Capital budgeting models of this investment decision require projections of the annual revenue and cost values over the entire five year period.
## Annual Net Cash Flows

<table>
<thead>
<tr>
<th>Item:</th>
<th>Before expansion</th>
<th>After expansion</th>
<th>Net change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Revenue</td>
<td>$25,000</td>
<td>$30,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>2. Cash operating expenses</td>
<td>15,000</td>
<td>18,000</td>
<td>3,000</td>
</tr>
<tr>
<td>3. Depreciation</td>
<td>3,000</td>
<td>4,000</td>
<td>1,000</td>
</tr>
<tr>
<td>4. Tax deductible expenses</td>
<td>18,000</td>
<td>22,000</td>
<td>4,000</td>
</tr>
<tr>
<td>(2+3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Taxable income (1-4)</td>
<td>7,000</td>
<td>8,000</td>
<td>1,000</td>
</tr>
<tr>
<td>6. Taxes (5x25%)</td>
<td>1,750</td>
<td>2,000</td>
<td>250</td>
</tr>
<tr>
<td>7. Net income (1-4-6)</td>
<td>5,250</td>
<td>6,000</td>
<td>750</td>
</tr>
<tr>
<td>8. Net cash flow (7+3)</td>
<td><strong>8,250</strong></td>
<td><strong>10,000</strong></td>
<td><strong>1,750</strong></td>
</tr>
</tbody>
</table>

- **Startup firm**
- **Expanding firm**
Timeline Required for Capital Budgeting...

Assume at the end of 2013 John Deere was expecting increased farm machinery and equipment sales over the next five years and wants to determine if plant expansion to meet this growing demand is economically feasible.
What Must Deere Forecast

✓ Potential growth in sales
✓ Potential manufacturing and indirect costs
✓ Remember that sales projections must account for the derived demand for its product.
✓ For its farm equipment division, this means projecting factors affecting net farm income which would influence the demand for farm machinery.
Concept of Derived Demand for Farm Machinery

The demand for farm machinery is driven by the expected net economic benefit from use of the machine... by farmers. For example, economists at John Deere project future corn prices.
Alternative Forecasting Approaches
Corn Market Equilibrium

Demand consists of:
- Industrial use
- Feed use
- Exports
- Ending stocks

Supply consists of:
- Beginning stocks
- Production
- Imports

Price

Quantity

$P_e$

$Q_e$
Ad Hoc Modeling Approaches

- Naïve model – using last year’s prices, costs and yields.
- Simple linear trend to extrapolate historical prices, costs and yields.
- Moving Olympic average.
- Using assumptions made by others.
Ad Hoc Modeling Approaches

**Naïve model:**
\[ P_t = P_{t-1} \]

**Linear trend:**
\[ P_t = a_0 + a_1 \text{(Year)} \]

**Olympic average:**
\[ P_t = \text{Last 5 year annual prices, dropping high and low and calculating the average of the remaining three annual prices.} \]
Naïve approach:
The price in 2010 is given by the price in 2009. As you can see for a commodity like corn, this expectation does generally not work well.
Linear Trend Approach:
Passing a least squares trend line through these historical data points also does a poor job of forecasting the price movement in 2010 and 2011.
Olympic average approach:

Price of corn in 2005 = $2.00
Price of corn in 2006 = $3.04
Price of corn in 2007 = $4.20
Price of corn in 2008 = $4.06
Price of corn in 2009 = $3.55

1. Drop the high and the low and average the remaining three prices.
2. Drop $2.00 and $4.20
3. Average = ($3.04+$4.06+$3.55) / 3 = $3.55

Price of corn in 2010 = $5.19
Price of corn in 2011 = $6.20

Thus the Olympic average approach would also do a poor job of forecasting the price of corn in 2010.
Econometric Model Approach

- Capturing future supply/demand impacts on prices and unit costs.
- Linkages to commodity policy.
- Linkages to domestic economy.
- Linkages to the global economy.
Forecasting Future Commodity Price Trends

\[ D = a - bP + cYD + eX \]

- Own price
- Disposable income
- Other factors

Price per unit

Quantity
S = n + mP – rC + sZ

Forecasting Future Commodity Price Trends

Own price
Input costs
Other factors

Price per unit

Quantity
Substitute the demand and supply equations into the equilibrium condition and solve for price.
Focusing on supply alone… no strong negative correlation
Considering both supply and demand, we see the negative correlation between stocks relative to use and price.
An Example

Let’s compare a simple linear trend with econometric model based on economic theory which captures the derived demand for farm machinery...
Historical Data on Industry Sales to Farmers

Farm Machinery and Equipment Sales

- Tractor sales
- Other sales

Farm financial crisis
Econometric Analysis Based on Investment Theory

\[ I_t = f(Year_t) \]

### OLS Regression Statistics for Sales, 3/26/2005 12:01:08 AM

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-test</td>
<td>0.036</td>
<td>0.964</td>
</tr>
<tr>
<td>MSE(^{1/2})</td>
<td>1.055</td>
<td>20.134</td>
</tr>
<tr>
<td>R(^2)</td>
<td>0.002</td>
<td>0.411</td>
</tr>
<tr>
<td>RBar(^2)</td>
<td>0.000</td>
<td>0.799</td>
</tr>
<tr>
<td>Akaike Information Criterion</td>
<td>1.004</td>
<td>5.498</td>
</tr>
<tr>
<td>Schwarz Information Criterion</td>
<td>1.053</td>
<td>1.004</td>
</tr>
</tbody>
</table>

### 95% Intercept Year

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta</td>
<td>25.585</td>
<td>-0.009</td>
</tr>
<tr>
<td>S.E.</td>
<td>91.197</td>
<td>0.046</td>
</tr>
<tr>
<td>t-test</td>
<td>0.281</td>
<td>-0.190</td>
</tr>
<tr>
<td>Prob(t)</td>
<td>0.782</td>
<td>0.851</td>
</tr>
<tr>
<td>Elasticity at Mean</td>
<td></td>
<td>-2.113</td>
</tr>
<tr>
<td>Variance Inflation Factor</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Partial Correlation</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Semipartial Correlation</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Slight downward trend
A linear time trend projection of future farm machinery and equipment sales therefore does a **poor job** of predicting future sales activity.
Econometric Analysis Based on Investment Theory

\[ I_t = f\left\{ \left[ E(P_t) \times E(Q_t) \right] / E(c_t) \right\} \]

Incorporates the economic concepts of MVP and MIC facing farmers.
An econometric model based on investment theory does a much better job of predicting future sales activity.
Conclusions

✓ Econometric models preferred over naïve models and linear time trend models.
✓ Much more accurate.
✓ Provide much more information (e.g., elasticities).
✓ Allow for sensitivity analysis with independent (exogenous) variables when evaluating potential variability about expected trends.
Stress Testing Your Forecast
Point Forecast Assumptions

Government Commodity Policy
Weather and Disease
Macro-Economic policy
Foreign Trade Policy
Global Market Events

One scenario examined

Baseline scenario

Assumes perfect knowledge of outcomes in all 5 areas!!!
Some Ideas Were Wrong…

✓ “Heavier than air flying machines are not possible”
  Lord Kelvin, President of the Royal Society, 1895

✓ “I think there is a world market for maybe 5 computers”
  Thomas Watson, Chairman of IBM, 1943.

✓ “Space flight is hokum”
  The Astronomer Royal, 1956.

✓ “Stocks have reached what looks like a permanently high plateau”
  Irving Fisher, Professor of Economics, Yale University, 1929.
Some Ideas Were Wrong…

✓ “We don’t like their sound, and guitar music is on the way out”
  Decca Recording Co. rejecting offering a contract to the Beatles, 1962.

✓ “640K of RAM ought to be enough for anybody”

✓ “We are prepared to use the tools that we have to address a short-term financial crisis, should one occur. I think the odds are that the market will stabilize.”
  Ben Bernanke, Chairman, Board of Governors of the Federal Reserve, August 2007.

My point in that long term expectations are often wrong. When making long term investment decisions, you should consider what can go wrong…
Stress Testing Your Forecast

Multiple scenario examined

Examine demand and supply-side risk and potential price variability
Stress Testing Your Forecast

- Government Commodity Policy
- Weather and Disease
- Macro-Economic policy
- Foreign Trade Policy
- Global Market Events

Multiple scenario examined

Examine demand and supply-side risk and potential price variability

Multiple scenarios

Graph with PE and QE axes.
Stress Testing Your Forecast

- Government Commodity Policy
- Weather and Disease
- Macroeconomic policy
- Foreign Trade Policy
- Global Market Events

Multiple scenarios

Examine demand and supply-side risk and potential price variability
Concept of Required Rate of Return
Adjusting Discount Rate

✓ We said to date that the discount rate is the firm’s opportunity rate of return.
✓ Realistically we must allow for business risk by including a risk premium.
✓ Realistically we must also allow for financial risk by adding an additional risk premium if the firm is highly leveraged.
Present Value with Unequal Discount Rates

All the equations involving calculation of the present value of a future stream thus far has assumed identical discount rates (i.e., \( R_1 = R_2 = \ldots = R_N \)). The use of the present value interest factor tables distributed in class rests on this assumption. That means that equations (31) and (32) are not applicable if this assumption does not hold. Let’s relax this assumption by restating equation (32) as follows:

\[
(35) \quad PV = \text{NCF}_1 \left[ \frac{1}{(1+R_1)} \right] + \text{NCF}_2 \left[ \frac{1}{(1+R_1)(1+R_2)} \right] + \ldots + \text{NCF}_N \left[ \frac{1}{(1+R_1)(1+R_2)\ldots(1+R_N)} \right]
\]

Hint: if \( R_1 = R_2 \) then \((1+R_1)(1+R_2) = (1+R)^2\). This allows you to use the PIF and EPIF tables.

But if \( R_1 \neq R_2 \) then \((1+R_1)(1+R_2) \neq (1+R)^2\), and you **cannot** use the PIF and EPIF tables.
Business Risk

✓ Risk associated with **price** of the product or products you are producing.

✓ Risk associated with the **unit costs** for the inputs used in producing the product(s).

✓ Risk associated with **yields** (productivity) in production.

✓ All three represent random variables affected by forces external to the firm!
Business Risk

✓ Risk associated with \textit{price} of the product or products you are producing.

✓ Risk associated with the \textit{unit costs} for the inputs used in producing the product(s).

✓ Risk associated with \textit{yields} (productivity) in production.

\[ \text{NCF}_i = P_i \times \text{yields}_i \times \text{acres} - C_i \times \text{unit inputs} \]
Increasing Risk Over Time

Product price distribution

<table>
<thead>
<tr>
<th>Year 1</th>
<th>E(P)</th>
<th>Year 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2.95</td>
<td>$3.05</td>
<td>$3.15</td>
</tr>
</tbody>
</table>

- Pessimistic price
- Expected price
- Optimistic price
Increasing Risk Over Time

Product price distribution

Probability

Year 10  
$2.05  
Pessimistic price

Year 1  
$2.95  
Expected price

E(P)  
$3.05

Year 1  
$3.15

Year 10  
$4.05  
Optimistic price

20%  
60%  
20%

Increasing Risk Over Time
Probability Distributions Over Time

- Short run
- Intermediate run
- Long run
- Structural change
The required rate of return is often referred to as a “hurdle” rate, or the rate of return required by the investor or firm to compensate for the risk associated with a specific investment.

In the case of IRR capital budgeting model we would compare the IRR to the required rate of return when assessing the economic feasibility of an investment.

Requiring a risky investment to *clear a hurdle* above a risk free rate of return
Different investors or firms may exhibit different attitudes toward accepting the degree of potential business risk associated with a particular investment.
A risk neutral investor or firm would use the risk free rate of return (e.g., yield on a government bond) as the required rate of return when evaluating an IRR or computing an NPV.
A lowly risk averse investor or firm would use a higher required rate of return (here $0.10 per dollar of expected net cash flow) to compensate for taking this risk. A risk premium of $\text{RRR}_L - \text{R}_{\text{FREE}}$ is added.
The risk neutral investor would use a RRR of 5% as a hurdle. The lowly risk averse investor would use a RRR of 7% as a hurdle, which includes a 2% business risk risk premium.
A highly risk averse investor or firm would use an even higher required rate of return to compensate for taking this same level of risk. A risk premium of $\text{RRR}_H - \text{R}_{\text{FREE}}$ is added.
The highly risk averse investor would use a RRR of 10% as a hurdle, which includes a 5% business risk premium, or a 3% additional return required over and above that required by the lowly risk investor.
Financial Risk

✓ Risk associated with low used borrowing capacity (remember we captures this in the implicit cost of capital).

✓ Risk associated with increasing explicit cost of debt capital relative to ROA. We discussed this when analyzing the economic growth model:
Financial Risk

✓ Risk associated with low used borrowing capacity (will cover this when covering the implicit cost of capital).

✓ Risk associated with increasing explicit cost of debt capital relative to ROA. We discussed this when analyzing the economic growth model:

\[
ROE = [(\text{ROA} - i)L + \text{ROA}](1 - t_x)(1 - w)
\]

Said in MB 663 that financial risk appears here
A Refresher

\[ ROE = [(ROA - i)L + ROA](1 - t_Y)(1 - w) \]

Rate of return on assets
Cost of debt capital
Leverage ratio or debt/equity
Income tax rate
Rate of withdrawals from firm
## Economic growth model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Initial expectation</th>
<th>1% higher interest rate</th>
<th>75% maximum leverage limit</th>
<th>Higher income tax rate</th>
<th>Reduce ROA to 2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROA</td>
<td>10.00%</td>
<td>10.00%</td>
<td>10.00%</td>
<td>10.00%</td>
<td><strong>2.00%</strong></td>
</tr>
<tr>
<td>Interest rate</td>
<td>7.00%</td>
<td>8.00%</td>
<td>8.00%</td>
<td>8.00%</td>
<td>8.00%</td>
</tr>
<tr>
<td>Debt</td>
<td>$50,000.00</td>
<td>$50,000.00</td>
<td><strong>$43,000.00</strong></td>
<td>$43,000.00</td>
<td>$43,000.00</td>
</tr>
<tr>
<td>Assets</td>
<td>$100,000.00</td>
<td>$100,000.00</td>
<td>$100,000.00</td>
<td>$100,000.00</td>
<td>$100,000.00</td>
</tr>
<tr>
<td>Income tax rate</td>
<td>25.00%</td>
<td>25.00%</td>
<td>25.00%</td>
<td>35.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Withdrawal rate</td>
<td>40.00%</td>
<td>40.00%</td>
<td>40.00%</td>
<td>40.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Equity</td>
<td>$50,000.00</td>
<td>$50,000.00</td>
<td>$57,000.00</td>
<td>$57,000.00</td>
<td>$57,000.00</td>
</tr>
<tr>
<td>Leverage ratio</td>
<td>1.00</td>
<td>1.00</td>
<td><strong>0.75</strong></td>
<td>0.75</td>
<td>0.75</td>
</tr>
</tbody>
</table>

### Solving for ROE:

<table>
<thead>
<tr>
<th>ROE</th>
<th>5.85%</th>
<th>5.40%</th>
<th>5.18%</th>
<th>4.49%</th>
<th>-2.53%</th>
</tr>
</thead>
</table>

### Difference from base

| Difference from base | -0.45% | -0.67% | -1.36% | -8.38% |
Assuming the case of the highly risk averse investor, an additional financial risk premium to account for exposure to financial risk given use of leverage is included. Let’s assume it is 2% (shift in intercept reflecting sensitivity to financial risk time the firm’s leverage ratio).
Let’s look at the specifics underlying the triangular probability distribution.
Consider the following events associated with a normal triangular probability distribution for an investment in a particular year:

\[ P_{i,1} = \text{probability of pessimistic scenario in } i^{\text{th}} \text{ year} \]
\[ P_{i,2} = \text{probability of expected scenario in } i^{\text{th}} \text{ year} \]
\[ P_{i,3} = \text{probability of optimistic scenario in } i^{\text{th}} \text{ year} \]
Consider the following events associated with a normal triangular probability distribution for an investment in a particular year:

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\[ P_{i,2} = \text{probability of expected scenario in } i^{\text{th}} \text{ year} \]
\[ P_{i,3} = \text{probability of optimistic scenario in } i^{\text{th}} \text{ year} \]

\[ \text{NCF}_{i,1} = \text{pessimistic net cash flow in } i^{\text{th}} \text{ year} \]
\[ \text{NCF}_{i,2} = \text{expected net cash flow in } i^{\text{th}} \text{ year} \]
\[ \text{NCF}_{i,3} = \text{optimistic net cash flow in } i^{\text{th}} \text{ year} \]
Triangular Normal Distribution

This distribution has the following characteristics:

**Expected value or mean:**
\[ E(NCF_i) = P_{i,1}(NCF_{i,1}) + P_{i,2}(NCF_{i,2}) + P_{i,3}(NCF_{i,3}) \]

or:

\[ E(NCF_i) = P_{i,2}(NCF_{i,2}) \]
Triangular Normal Distribution

This distribution has the following characteristics:

**Expected value or mean:**
\[ E(NCF_i) = P_{i,1}(NCF_{i,1}) + P_{i,2}(NCF_{i,2}) + P_{i,3}(NCF_{i,3}) \]

or:
\[ E(NCF_i) = P_{i,2}(NCF_{i,2}) \]

**Standard deviation:**
\[ SDV(NCF_i) = \sqrt{2[(P_{i,1}(NCF_{i,1}) - E(NCF_{i,1}))^2]} \]
Triangular Normal Distribution

This distribution has the following characteristics:

**Expected value or mean:**
\[ E(NCF_i) = P_{i,1}(NCF_{i,1}) + P_{i,2}(NCF_{i,2}) + P_{i,3}(NCF_{i,3}) \]

or:
\[ E(NCF_i) = P_{i,2}(NCF_{i,2}) \]

**Standard deviation:**
\[ SDV(NCF_i) = \sqrt{2[(P_{i,1}(NCF_{i,1}) - E(NCF_{i,1}))^2]} \]

**Coefficient of variation:**
\[ CV(NCF_i) = SDV(NCF_i) / E(NCF_i) \]

Our measure of business risk
\[ RRR_i = Rfree_i + b_i(CV(NCF_i)) + c_i(L_i) \]

where:
- \( RRR_i \) required rate of return in the \( i^{th} \) year
- \( Rfree_i \) risk free rate of return in the \( i^{th} \) year
- \( b_i \) slope of risk return preference curve in the \( i^{th} \) year
- \( CV(NCF_i) \) coefficient of variation in the \( i^{th} \) year
- \( c_i \) shift coefficient for leverage in the \( i^{th} \) year
- \( L_i \) leverage position in the \( i^{th} \) year
$$RRR_i = R_{free,i} + b_i(CV(NCF_i)) + c_i(L_i)$$

- Business risk premium
- Financial risk premium
Aversion to Business Risk

Highly risk averse

Business risk premium

Coefficient of variation

$\text{RRR}_i = \text{Rfree}_i + b_i(\text{CV(NCF}_i))$
Adding in Financial Risk

\[ RRR_i = Rfree_i + b_i(CV(NCF_i)) + c_i(L_i) \]
Let’s assume I ask you what rate of return you would require before you would invest in a project with a risk of 10 cents per dollar.
Let’s assume I ask you what rate of return you would require before you would invest in a project with a risk of 10 cents per dollar.
You respond after considering this level of risk exposure and your leverage position that you would require a 20% rate of return.
The slope of this curve would be 1.5, and can be determined as follows: 
\[ 0.20 = 0.05 + \text{slope}(0.10) \]
\[ \text{slope} = \frac{0.15}{0.10} = 1.5 \]
This suggests this risk return preference curve and a total risk premium of 15% if the risk free rate is 5%.
Suppose the coefficient of variation is $.05 rather than $.10. The slope of the curve does not change in the current year, so the risk premium would fall from 15% to 7.5%.
Some Conclusions

✓ A *highly risk averse* investor will require an investment clear a higher “hurdle” than that required by a *lowly risk averse* investor.

✓ A risk neutral investor requires *no additional hurdle or additional return* when making a risky investment.

✓ Under the internal rate of return capital budgeting model which we will review next, we would want to see if the \( IRR > RRR \).

✓ Under the net present value capital budgeting model which we will also review, we use the annual \( RRR_i \) to discount the net cash flows and terminal value back to the present to determine if the \( NPV > 0 \).