Nanyang Business School

NTU 南洋 NBS

***Case Study***

***Indian Citrus River Company (B)***

# B6005 Financial Management

# (Group 2)

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## THE RISK OF FIRMS AND TYPES OF RISKS

Why do firms have to evaluate risks of individual projects? There are some important reasons for this, especially since each individual project also contributes to the value of a firm. The most important reasons are:

1. At any one point in time, an organization will be faced with many requests for (funds) various projects to be initiated.
2. Every project is fighting for limited funds that are available in an organization.
3. Most of the time, funds have to be raised in order to meet the money required for some of these viable projects.
4. There are costs attached to raising capital.
5. Hence it is imperative to measure the riskiness of individual projects so that funds are allocated to projects with the lowest amount of risk, relative to the amount of potential revenue gains.
6. This is to ensure that the projects with the highest possibility and/or amount of returns get the necessary capital that is to be raised.
7. Ideally the returns should be more than the cost of raising capital

In Capital Budgeting, there are three types of risks that are of importance, and these are:

1. Stand-alone Risk. This the project risk disregarding the fact that it is but one asset within the firm's portfolio of assets and that the firm is but one stock in a typical investor's portfolio of stocks. *Stand-alone risk is measured by the variability of the project's expected returns* .
2. Corporate (within-firm) Risk. This the project's risk contribution to the corporation, giving consideration to the fact that the project represents only one of the firm's portfolios of assets, hence that some of its risk effects will be diversified away. *Corporate risk is measured by the project's impact on uncertainty about the firm's future earnings.* Corporate risk is a function of the project standard deviation ($\sigma$) and its correlation with returns on the firm's other assets.

   Returns on an individual project may be highly uncertain, but if the project is small relative to the total firm, and if its returns are not highly correlated with the firm's other assets, the project may not be very risky in either the corporate or the beta sense.
3. Market or beta ($\beta$) Risk. This is the riskiness of the project as seen by a well-diversified stockholder who recognizes that the project is the only one of the firm's assets and

that the firm's stock is but one part of the investor's total portfolio. *Market risk is measured by the project's effect on the firm's beta coefficient.*

Theoretically, Market Risk is the most relevant because of its direct effect on the stock prices of a firm. Market risk depends on project's correlation with the stock market. It measures the project's final effect on the company's or investor's assets/stocks. Since the effects of Stand-alone Risk can be minimized by the other assets of the corporation, and Corporate Risk can be diversified away, Market Risk is deemed to be the relevant risk.
However, the Stand-alone Risk is the easiest to be measured. In order to determine the Stand-alone Risk of a project, its standard deviation ($\sigma$) of the expected future returns has to be calculated. The smaller the standard deviation $\sigma$ is, the lower the risk is. A low risk in general favours the project. Another measure of the Stand-alone risk is the Coefficient of Variation, named *cv*. It shows the risk per unit of return and is computed by dividing the standard deviation by the expected return.

Fortunately, in most cases, Stand-alone risk, Corporate Risk and Market Risk are highly correlated, and so the Stand-alone Risk can serve as a basis for the determination of the other risks. If the general economy does well (i.e., market risk is minimized), the firm then does well too (i.e., corporate risk is lowered), and so will the firm's projects (stand-alone risk).In the IRC case, the three risks are highly correlated. The unit sales are the only variable that cannot be clearly defined (200,000 to 625,000 units). Market conditions can impact the future sales and this could well have an overall effect on the firms value, given the initial capital investment is worth 570,000.

## SENSITIVITY ANALYSIS

Since the evaluation of a project's risk is so important, it is necessary to have structured methods for it so that objective risk evaluations can be done. One step in this direction is the *Sensitivity Analysis* which is a method that analyzes how the NPV changes if the input variables change. However, only one variable is changed at a time, and the results of the analysis are plotted in a graph. The resulting graph gives an idea about which input changes have a strong and which ones have a weak impact on the outcome, hence the NPV of the project. We base our Sensitivity Analysis on the Cash Flow Table shown on the next page, and starting from these values, we then vary the sales quantity, the salvage value of the equipment and the cost of capital in steps of 10% from -30% to +30%. Then, we examine the NPV resulting from

these changes.

***Net Investment Outlay:***

| | |
|---|---|
| Price | $500,000 |
| Freight | 20,000 |
| Installation | 50,000 |
| Change in NWC | 10,000 |
| | $580,000 |

***Depreciation Schedule:***

| Year | MACRS Factor | Depr Expense | End-of-Year Book Value |
|---|---|---|---|
| 1 | 33% | $188,100 | $381,900 |
| 2 | 45% | $256,500 | $125,400 |
| 3 | 15% | $85,500 | $39,900 |
| 4 | 7% | $39,900 | $0 |
| | 100% | $570,000 | |

| **Cash Flows:** | **Year 0** | **Year 1** | **Year 2** | **Year 3** | **Year 4** |
|---|---|---|---|---|---|
| Unit price | | $2.10 | $2.21 | $2.32 | $2.43 |
| Unit sales | | $425,000.00 | $425,000.00 | $425,000.00 | $425,000.00 |
| Revenues | | $892,500.00 | $937,125.00 | $983,981.25 | $1,033,180.31 |
| Operating costs | | $650,250.00 | $663,255.00 | $676,520.10 | $690,050.50 |
| Depreciation | | $188,100.00 | $256,500.00 | $85,500.00 | $39,900.00 |
| Other project effects | | $20,000.00 | $20,000.00 | $20,000.00 | $20,000.00 |
| Before tax income | | $34,150.00 | -$2,630.00 | $201,961.15 | $283,229.81 |
| Taxes (40%) | | $13,660.00 | -$1,052.00 | $80,784.46 | $113,291.92 |
| Net income (loss) | | $20,490.00 | -$1,578.00 | $121,176.69 | $169,937.89 |
| Plus Depreciation | | $188,100.00 | $256,500.00 | $85,500.00 | $39,900.00 |
| Net op cash flow | | $208,590.00 | $254,922.00 | $206,676.69 | $209,837.89 |
| Salvage value | | | | | $100,000.00 |
| Salvage value tax (40%) | | | | | $40,000.00 |
| Recovery of NWC | | | | | $10,000.00 |
| Terminal CF | | | | | $70,000.00 |
| Project NCF | ($580,000) | $208,590.00 | $254,922.00 | $206,676.69 | $279,837.89 |

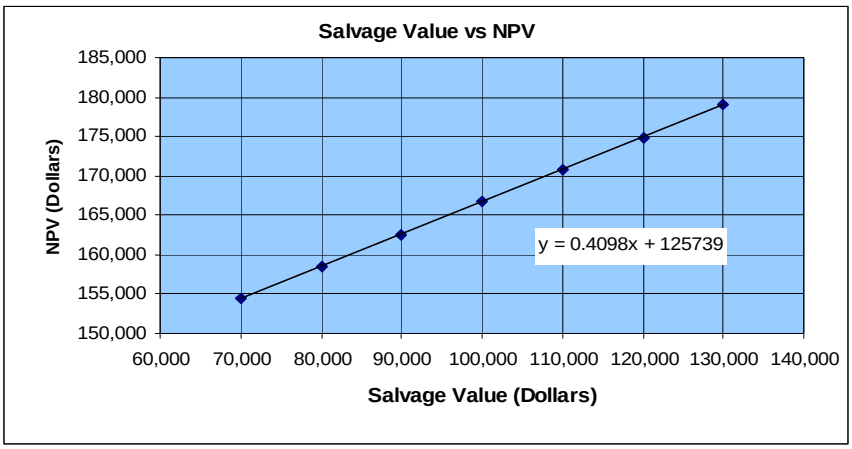
| Decision Measures: | |
|---|---|
| Cost of Capital k | 10% |
| NPV | $166,719 |
| IRR | 22% |
| MIRR | 17.17% |
| Payback | 2.6 years |

Sensitivity Analysis Results:

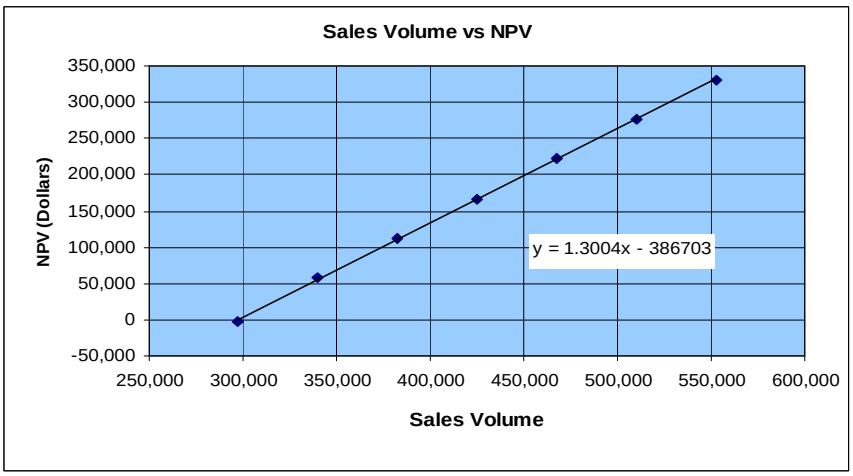
Orange Lite Juice Project

| Variable Change From Base Level | NPV after Indicated Change | | |
|---|---|---|---|
| | Quantity | Salvage Value | k (Cost of Capital) |
| -30 | -2572 | 154425 | 219799 |
| -20 | 57282 | 158523 | 201449 |
| -10 | 112003 | 162719 | 183766 |
| Base case | $166,719 | 166719 | 166719 |
| 10 | 221435 | 170817 | 150277 |
| 20 | 276150 | 174915 | 134414 |
| 30 | 330866 | 179013 | 119101 |

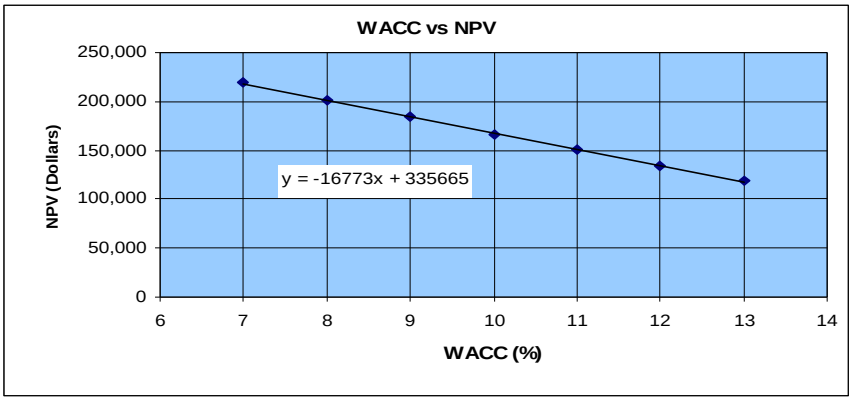
| NPV ($) | Salvage Value ($) |
|---|---|
| 154,425 | 70,000 |
| 158,523 | 80,000 |
| 162,621 | 90,000 |
| 166,719 | 100,000 |
| 170,817 | 110,000 |
| 174,915 | 120,000 |
| 179,013 | 130,000 |



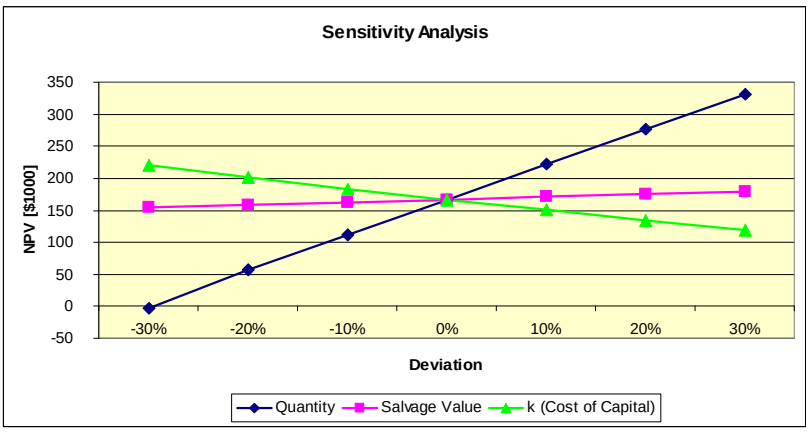

| NPV ($) | Sales Volume |
|---|---|
| -2,572 | 297,500 |
| 57,287 | 340,000 |
| 112,003 | 382,500 |
| 166,719 | 425,000 |
| 221,435 | 467,500 |
| 276,150 | 510,000 |
| 330,886 | 552,500 |



| NPV ($) | WACC (%) |
|---|---|
| 219.799 | 7 |
| 201.449 | 8 |
| 183.766 | 9 |
| 166.719 | 10 |
| 150.277 | 11 |
| 134.414 | 12 |
| 119.101 | 13 |




| Percent Change (%) | Sales Volume | Salvage Value ($) | WACC (%) |
|---|---|---|---|
| -30 | 297,500 | 70,000 | 7 |
| -20 | 340,000 | 80,000 | 8 |
| -10 | 382,500 | 90,000 | 9 |
| Base Value | 425,000 | 100,000 | 10 |
| 10 | 467,500 | 110,000 | 11 |
| 20 | 510,000 | 120,000 | 12 |
| 30 | 552,500 | 130,000 | 13 |




Sensitivity Analysis has some major advantages when evaluating the risk of a project:

1. It provides managers with a <u>qualitative figure</u> and aids them in the decision making process when allocating funds to competing projects. A very important point is that Sensitivity Analysis shows us which input variables have the biggest impact on our NPV outcome. It shows us the "dangerous" variables.
2. It tells us when the breakeven is reached.
3. It is easy to be used.

Nevertheless, Sensitivity Analysis is also limited in many aspects:

1. It does not take into account the probability of occurrence for different scenarios for the input variables and thus cannot inform us about the risk of our project..
2. Since the sensitivity analysis measures Stand-alone Risk, the <u>effects of</u> <u>diversification</u> (among the firm's other projects and investors' personal investment portfolios) are <u>ignored</u>.

   We need to look at the <u>correlation</u> of the project with the firm's other assets and with the stock market. Even when the analysis is completed, <u>no clear cut rule</u> emerges as we only have an expected NPV and a distribution about this expected value.
3. <u>Sensitivity Analysis does not provide a criterion which</u> indicates whether a project's

profitability, as measured by its expected NPV, is sufficient to compensate for the risk as measured by $\sigma$.

## SCENARIO ANALYSIS

Scenario Analysis is a risk management technique to assess the risk of a project which overcomes some of the weaknesses of Sensitivity Analysis. It brings in the probabilities of changes in the key variables and allows us to look at the range as well as sensitivity for many variables. Therefore, Scenario Analysis has some important benefits:

1. It takes into account the probability of the input variables
2. Scenario Analysis is easy to apply.
3. It provides useful insights into the riskiness of a project.

However, Scenario Analysis also has its drawbacks, and the weaknesses are:

1. Scenario Analysis results in only a few discrete outcomes (NPV) rather than a complete spectrum of possible NPV and their probability. Usually, only the standard case, the worst case and the best case are computed. In reality, however, there are infinite numbers of possible NPV outcomes.
2. Probability of each scenario is ‘guestimated’ which means that many of the underlying input probabilities are guessed rather than based on fundamental research.
3. Scenario Analysis Measures only the Stand-alone Risk, which may not be the most relevant risk in capital budgeting. Hence, it ignores the effects of diversification

On the following page, a Scenario Analysis for the IRC case is given.

| Scenario | Probability | NPV | Squared Deviation Times Probability |
|---|---|---|---|
| Best Case | 25% | ($122,952) | 20,977,249,643 |
| Base Case | 50% | $166,719 | 0 |
| Worst Case | 25% | $456,388 | 20,977,104,808 |
| | | | 41954354450 |
| Expected NPV = sum, prob times NPV | | $166,719 | |
| Standard Deviation = Sq Root of column I sum | | $204,828 | |
| Coefficient of Variation = Std Dev / Expected NPV | | 1.23 | |

| Scenario | Probability | IRR | | MIRR | |
|---|---|---|---|---|---|
| Best Case | 25% | 0.0% | 0.011449 | 3.6% | 0.00403225 |
| Base Case | 50% | 22.2% | 3.2E-05 | 17.2% | 4.05E-05 |
| Worst Case | 25% | 41.2% | 0.009801 | 27.2% | 0.00297025 |
| Expected NPV = sum, prob times NPV | | 21.4% | | 16.3% | |
| Standard Deviation = Sq Root of column I sum | | 14.6% | | 8.4% | |
| Coefficient of Variation = Std Dev / Expected NPV | | 0.7 | | 0.5 | |

## MONTE CARLO SIMULATION

Monte Carlo Simulation is a technique that originated from analysis work from the mathematics of casino gambling and it is named after the famous *Casino de Monte Carlo* in Monaco. Monte Carlo Simulation enhances the Scenario Analysis by taking into account not only the worst, standard and best case of the input variables, but the whole range of possible values and their respective probability for the different input variables. Typically, the Monte Carlo Simulation is executed on a computer either with EXCEL® and special plug-ins or with separate mighty simulation tools. In doing so, the Monte Carlo Analysis provides us with a comprehensive set of decision variables such as the expected NPV, $\sigma_{NPV}$, and $cv_{NPV}$. Monte Carlo Simulation therefore is the most complete method of assessing Stand-alone Risk of all three presented methods.

The drawbacks of Monte Carlo Simulation are that it is not easy to determine correlations and probability distributions in practice. However, for an accurate output of the Monte Carlo Simulation, it is absolutely mandatory that the input variables are determined correctly. False or incorrect input variables will invariably lead to false outputs; this must always be kept in mind. A wrong sense of security can arise from the fact that the Monte Carlo Simulation offers a broad range of decision variables as outputs. Finally, Monte Carlo Simulation only computes the Stand-alone Risk and not the more important Market Risk of a project.

How is Monte Carlo Simulation done in practice? There are a number of steps that are executed consecutively:

1. Choose a random value for each uncertain variable
2. Determine the Net Present Value (NPV)
3. Repeat steps 1 and 2 many times (>1000)Plot the probability distribution of the output variable (mostly the NPV) with its expected value and standard deviationWhen

compared to Scenario Analysis, Monte Carlo simulation is better than Scenario Analysis in the way that it provides a detailed analysis of the expected NPV, $\sigma_{NPV}$ and takes into account correlations and dependencies of the input variables. On the other hand Scenario Analysis is better than Monte Carlo simulation in terms that it provides a rough and quick estimation of the worst case, average case, and the best case. However, both of them have their limitations because they only compute the Stand-alone Risk and thus provide less relevant decision rule.

## THE ORANGE LITE JUICE PROJECT AND ITS RISK

In the IRC case, the type of risk being measured is Stand-alone Risk. As far as Stand-alone Risk is utilized as a measure of risk, it should classify the Lite Orange Juice Project as a high risk project because the project's coefficient of variation of NPV is 1.2 as computed by the Scenario Analysis. The average range of the coefficient of variation at IRC, however, is 0.50 to 1.00. Therefore, our conclusion is that although this project has a positive expected NPV, it is considered a risky project as indicated by the coefficient of variation.

The Corporate Risk of a project is the risk that the project adds to the portfolio of current projects at a firm.
It can be calculated as:

$$s_{\text{Corporate}} = s_{Firm_after_adding_new_project} - s_{Firm_before_adding_new_project}$$

Corporate Risk therefore reflects the effects of a project on the firm's risk, and it is measured by the project's effect on the variability of the firm's earnings. An example shall illustrate this:
Let us assume a firm which has old projects and one new project. The key numbers of the old projects are:

$\sigma_{old} = 10$, $B_{old} = 200$

where $\sigma_{old}$ reflects the standard deviation of the old projects and $B_{old}$ reflects the budget of the old projects. Our new project comes with the figures:

$\sigma_{new} = 100$, $B_{new} = 100$

where $\sigma_{new}$ reflects the standard deviation of the new project in consideration and $B_{new}$ reflects the budget of the new projects. We further assume the cross-correlation of our old projects with the new project to be $\varrho$=0.8. Since

$$B_{total} = B_{old} + B_{new}$$

$$s_{Firm_after_adding_new_project} = \sqrt{w_{old}^2 s_{old}^2 + w_{new}^2 s_{new}^2 + 2 w_{old} w_{new} s_{old} s_{new} r_{oldnew}}$$

$$s_{Corporate} = s_{Firm_after_adding_new_project} - s_{old}$$

$$w_{old} = \frac{B_{old}}{B_{old} + B_{new}} \qquad w_{new} = \frac{B_{new}}{B_{old} + B_{new}}$$

we can compute the following results:

$B_{total} = 300$

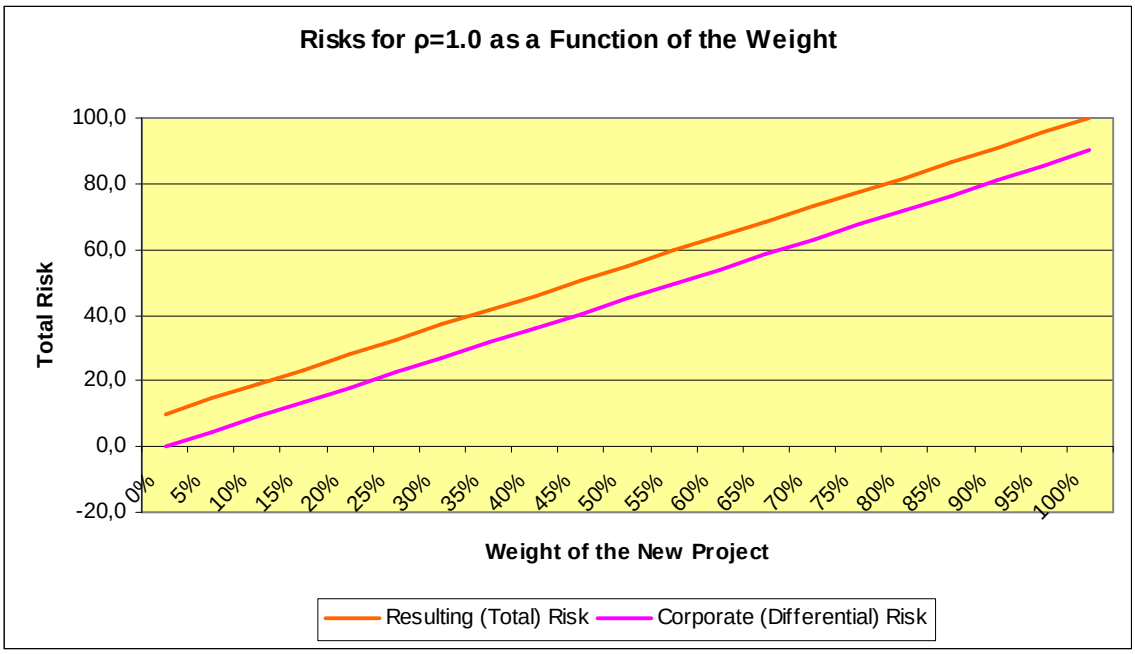
$\sigma_{Firm_after_adding_new_project} = 38.87$

$\sigma_{Corporate} = 28.87$

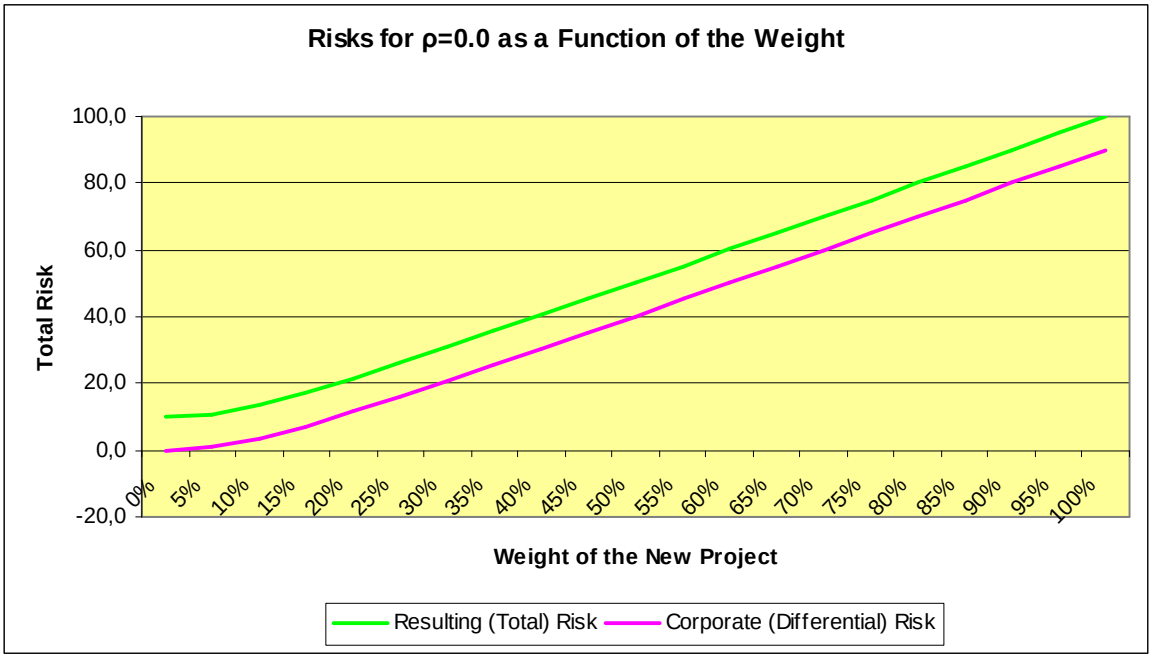
This means that in our example, the additional project adds a significant risk to the ongoing projects at the firm.

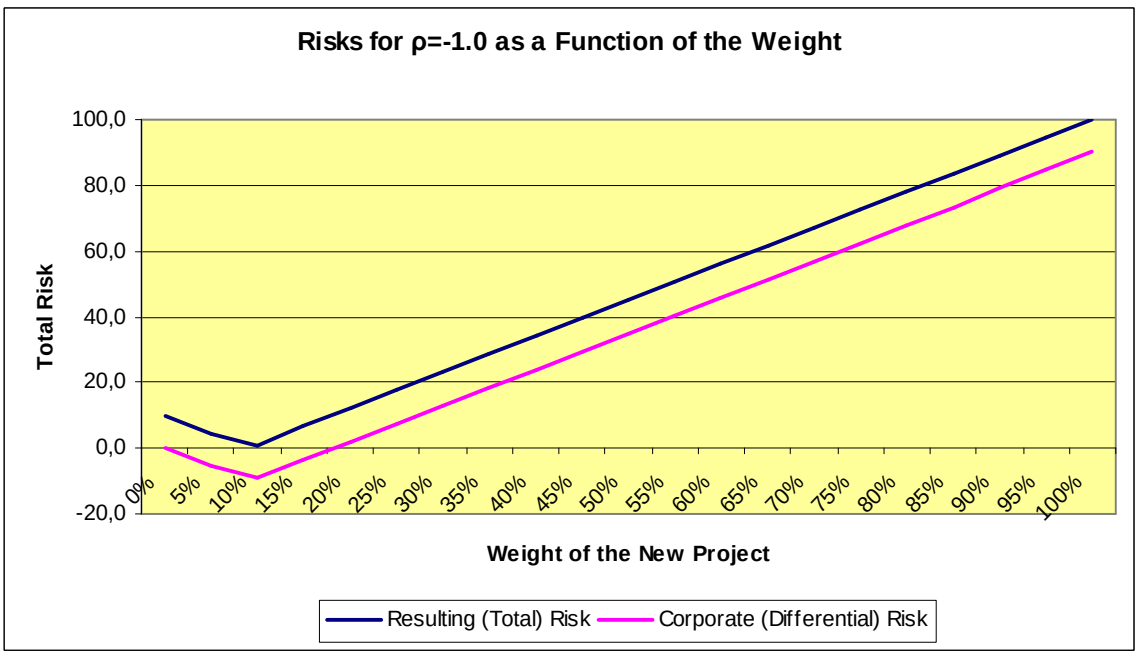
How does a new project in general influence the ongoing projects at a firm? In order to answer this, we shall look at some computations that we have done on this field:

The following graphs show us how the resulting total risk of the firm and the Corporate Risk of the firm develop if we change the weight of the new project. Keep in mind, that the weight of the new project is calculated as its investment value divided by the total investment value in




the firm. Thus, the assumptions of a weight of 50%...100% are only of theoretical use since most projects will not exceed the value of all ongoing projects. The three graphs differ in the correlation coefficient between the ongoing old projects and the new projects whose influence has to be assessed.




As we can observe, there are tremendous differences in the resulting total risk and in the Corporate Risk when we deal with different correlation coefficients. If $\varrho$=1.0, the resulting risk of a combination of the old and the new project is just a linear function. However, the smaller $\varrho$ gets, the more we can observe a change in the beginning of the curve. For a negative $\varrho$ we even can see a negative Corporate Risk for a certain weight. This clearly highlights that a negative correlation can even diminish the total risk of a firm if none of the projects outweighs the other projects. Our simulation shows that you can even achieve a risk of 0% if $\varrho$=-1.0 for a certain weight. However, in practical life, $\varrho$ typically lies in the range of $\varrho$ = 0.7,

and therefore, there is no decrease in risks. For $\varrho \approx 0$, we can identify a diversification effect that is our total risk does not increase significantly when we add the new project. Nevertheless, it will then be necessary to compute the resulting risk and we cannot just assume that the risk stays the same.

Therefore, if we knew that the cash flows from the new project were totally uncorrelated with IRC's other cash flows, we would know that further risk adjustments to the firm would be necessary since it would not be sure how this project would affect the company's other projects, as they are independent. On the other hand, if the cash flows from this project were expected to be negatively correlated, the firm's total risk would probably be reduced by the new project, assuming that the new project was added in a healthy weight and not exceed the old ongoing projects. The risk should then be conservatively assessed because the cash flows from the project would be expected to move counter to IRC's existing cash flows.

It was already mentioned in the previous chapters that the cash flow of IRC will typically be well correlated with the market's cash flow, which itself can be expressed by the S&P 500. Since we expect our Stand-alone Risk to be correlated closely to the Corporate Risk, and the Corporate Risk to be well correlated to the Market Risk at the same time, the project's Stand-alone Risk is also correlated to the Market Risk.

Stand-alone Risk can easily be measured for the capital budgeting analysis. But it is still difficult to determine Market Beta. However, if we could obtain Market Beta, we would be able to measure Market Risk more precisely.

## THE PROJECT'S DIFFERENTIAL RISK-ADJUSTED NPV

As we saw, new projects can have a significantly different risk from ongoing projects, and investors will not be willing to invest money under the same conditions in new projects that are riskier than existing projects. Therefore, in order to assess a project's NPV, we have to take into account that our cost of capital may vary according to the risk of the project and this has a great influence on our expected NPV. At IRC, the current practice is that the financial controller usually adds or subtracts 3% to the cost of capital in order to adjust for differential project risk. In our case, the *Lite Orange Juice Project* represents a high risk project, and therefore, an ad-hoc risk premium of 3% will be added to the cost of capital which was about 10% for the old projects. This then results in:

Higher Risk: k=10%+3%=13% $\Rightarrow$ $NPV_{high}$=\$119,101

Standard Risk k=10% $\Rightarrow$ $NPV_{std}$=\$166,719

As we can verify, the *Lite Orange Juice Project* still has a positive NPV when the increased cost of capital is taken into account, and so we can state that the project should be accepted.

Now let's assume that the coefficient of variation was cv = 0.15, and then, the project would be a low risk project, and our cost of capital would be 3% lower for this project than for IRC's average projects. This would then result in:

Low Risk k=10%-3%=7% $\Rightarrow$ $NPV_{low}$=\$219,799

This risk adjustment is called the *Ad-Hoc Method.* The better method to determine NPV is the CAPM (= Capital Asset Pricing Model) method which will be highlighted in the subsequent sections.

## RISK ADJUSTED NPV ON BASIS OF THE CAPM

Research has shown that a Market Beta of $\beta = 2.0$ is a reasonable assumption for the *Lite Orange Juice Project*, and so, the NPV can be computed on basis of the CAPM:

$k_{rf} = 8\%$; $RP_m = 6\%$; $\beta = 2.0$

$k_s = k_{rf} + (RP_m)\ \beta = 8 + 6 \times 2.0$

$k_s = 20\%$

$WACC = w_d \times k_d\ (1\text{-}T) + w_{ce} \times k_p$

$= 0.5 \times 10\% \times (1\text{-}40\%) + 0.5 \times 20\%$

$= 13\%$

## ESTIMATION OF THE PROJECT'S BETA

There are essentially two methods that can be used to estimate the beta of a new project, and they are briefly highlighted here.

### THE PURE PLAY METHOD

The *Pure Play Method* is used in order to find several single-product companies in the same line of business as the one who intends to introduce the new product, and the average of the betas of these companies is used to determine the cost of capital for the own project. The Pure Play approach can only be used for major assets such as whole divisions, and even then it is frequently difficult to implement because it is often impossible to find pure play proxy firms. However, it is possible to obtain beta when a firm considers a major investment outside its primary field. The following steps are necessary in order to apply the Pure Play Method:

1. Determine the beta of pure play firms.
2. Adjust for leverage by calculating the unlevered beta.
3. Re-leverage the asset beta to reflect the capital structure that will be used to finance the project.
4. Calculate the project's cost of equity and WACC.

### THE ACCOUNTING BETA METHOD

Sometimes, it may be impossible to find single-product, publicly traded firms suitable for the Pure Play approach, and then we can use the *Accounting Beta Method*. Betas normally are found by regressing the returns of a particular company's stock against returns of the stock market index. However, we could run a regression of the company's accounting return on assets against the average return on assets for a large sample of companies. Accounting betas for a totally new project can be calculated only after the project has been accepted, placed in operation, and begun to generate output and accounting results. However, to the extent management thinks a given project is similar to other projects the firm has undertaken in the past, the similar project's accounting beta can be used as a proxy for that of the project in question.

The *Accounting Beta Method* is more feasible in the context of our case study since it is hard to find other companies in a similar line of business that can be used as a benchmark to estimate beta and since the IRC has a similar project which is being currently undertaken.

## FOCUSING ON A PROJECT'S MARKET RISK

The Market Risk or beta risk is theoretically the most relevant measure of risk, and this is due to the following reasons:

1. The Market Risk should be the only concern for well-diversified stockholders, and we can assume that our stockholders are well diversified especially when the investors are professionals like fund managers rather than individuals.
2. The Market Risk directly affects the stock price, which is the only concern of the management.

However, there are a number of concerns with this strategy, and the most important are:

1. The Market Risk for a project is the most difficult risk to estimate.
2. The CAPM may not operate exactly as theory predicts.
3. Not all investors are well diversified.
4. Some substantial costs such as bankruptcy costs depend on a firm's corporate risk, not on its beta risk.**ADDITIONAL EXAMPLE**

You are advising a telephone company that is planning to invest in the field of multimedia projects. The beta for the telephone company is 0.75 and it has a debt/equity (D/E) ratio of 1. Its after-tax cost of borrowing money is 4.25%. The multimedia business is considered much riskier than the telephone business i.e. the average beta and average debt/equity ratio for comparable (multimedia) firms are 1.3 and 50%, respectively. Let's assume that the tax rate is 40%, the risk-free Treasury bond rate is 7%, and the market risk premium is 5.5%.

Then, we can compute the unlevered beta to:

$\beta_u = \beta / [1+ (1-T) (D/E)] = 1.3/ [1+ (1-O.4) (0.50)] = 1$

$\beta = \beta_U[1 + (1 – T)(D/E)] = 1 \times [1 + (1 – 40\%) 100\%] = 1.6$ $k_s = k_{RF} + (k_M - k_{RF}) \beta = k_{RF} + RP_M \beta = 7\% + 5.5\% \times 1.6 = 15.8\%$

WACC $= w_d(k_d)(1-T) + w_{ce}(k_s) = (D/A)(k_d)(1-T) + (E/A)(k_s)$

$= ((D/E)/(D/E +1))(k_d)(1-T) + (1-(D/E)/(D/E +1))(k_s)$

$= (100\% / (100\%+1)) \times 4.25\% + (1 – 100\%/(100\%+1)) \times 15.8\%$

$= 10.025\%$

Now, let's assume that a multimedia division is created which takes these projects, based on a debt/equity ratio of 40%. In that case, the beta and cost of capital for the projects would turn out to be:

$\beta = \beta_U [1 + (1 – T)(D/E)] = 1 \times [1 + (1 – 40\%) 40\%] = 1.24$

$k_s = k_{RF} + (k_M - k_{RF})\,\beta = k_{RF} + RP_M\,\beta = 7\% + 5.5\% \times 1.24 = 13.82\%$ WACC $= w_d(k_d)(1\text{-}T) + w_{ce}(k_s) = (D/A)(k_d)(1\text{-}T) + (E/A)(k_s)$

$= ((D/E)/(D/E+1))(k_d)(1\text{-}T) + (1\text{-}(D/E)/(D/E+1))(k_s)$

$= (40\% / (40\%+1)) \times 4.25\% + (1 - 40\%/(40\%+1)) \times 13.82\%$

$= 11.086\%$

## WASTE DISPOSAL SYSTEMS EVALUATION

As mentioned in the questions to the IRC Case Study, an evaluation of a two different waste disposal systems shall be done, considering different scenarios of risks. The table below gives the cash flow associated with the two projects under consideration:

Expected Net Costs

| Year | Plan W | Plan C |
|---|---|---|
| 0 | ($2,000) | ($4,000) |
| 1 | ($2,000) | ($1,200) |
| 2 | ($2,000) | ($1,200) |
| 3 | ($2,000) | ($1,200) |

Now, we first assume that both projects are of comparable, average risk. Since this is a cost minimization project involving negative cash flows, we will accept the plan with the higher NPV.

NPV of Plan W = ($2,000) + ($1,818) + ($1,653) + ($1,503) = ($6,974)
NPV of Plan C = ($4,000) + ($1,091) + ($992) + ($902) = ($6,985)

As the NPV for Plan W is higher than the NPV for Plan C, Plan W should be chosen.

Now we assume that the labour intensive Plan W is judged to be riskier than an average project, because future labour costs are very difficult to forecast. Plan C is still of average risk because most of its costs can be firmly established. In that case, we have to calculate the risk-adjusted NPV for plan W because plan W is riskier now, and so we have to expect a lower cost of capital for plan W. The new cost of capital then is (according to subjective judgment of John Gerber):

WACC= 10%-3%=7%, so the $NPV_W$= (7,249)

NPV for Plan W = ($6,974)NPV for Plan C = ($6,985)

Finally, we will think about the IRR of both projects. Is it possible to calculate an IRR of the projects? Obviously, in both projects, we only have cash outflows and no single cash inflow, and therefore, no IRR can be calculated. The projects are not revenue generating projects.