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Investment Analysis of Agri-Food Ventures: What Risk Premia are Appropriate? The Silence of the Literature

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STAFF PAPER

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Abstract

Financial principles of project investment analysis deal with the cost and benefit flows over time. Invariably, the correct future cash flows and exact risks are unknown. The agricultural academic literature devotes substantial energy to discussing the estimation of the cash flows but it is relatively silent on applied estimation of risk. Empirical studies on agri-food ventures have made little or no attempt to estimate appropriate risk adjusted discount rates or other risk measures. Choice of discount rate has been arbitrary. Thus little guidance has been given to practitioners analysing agri-food investments as to the appropriate risk adjusted discounts rates. The Capital Market Line provides a relatively straightforward way to calculate risk premiums for project investments by non-diversified investors. These risk premiums can then be used in Net Present Value investment analysis.

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Introduction

Investment analysis evaluates the viability of any business investment. Since investment entails the allocation of limited funds to competing uses, the basic principles of investment analysis are similar between businesses. Financial principles of project investment analysis deal with the cost and benefit flows over time. Invariably, the correct future cash flows and exact risks are unknown. The agricultural academic literature devotes substantial energy to discussing the estimation of the cash flows but it is relatively silent on applied estimation of risk. Empirical studies on agri-food ventures have made little or no attempt to estimate appropriate risk adjusted discount rates or other risk measures. Choice of discount rate has been arbitrary and in many cases, the literature has used theoretically incorrect project analysis. Thus little guidance has been given to practitioners analysing agri-food investments as to the appropriate risk adjusted discounts rates.

This lack of leadership by the agricultural economics profession is unfortunate. Owners of businesses planning to expand are basing their investment decisions on faulty analysis if they try to follow much of agricultural economics literature. Outside investors are unable to fully evaluate the risk-return trade offs in new agri-food ventures. Consequently, capital may not be allocated as efficiently as possible. It is incumbent upon the applied agricultural economics profession to provide some practical leadership in investment analysis.

The objectives of this paper are (1) to reveal the literature's ad-hoc approach to choosing discount rates or risk measures in the analysis in the agri-food industry; (2) to suggest ways by which analysts of agri-food ventures can choose reasonable risk adjusted discount rates and (3) indicate future research directions. It will first describe principles and methods of investment analysis. The relevant literature on the theory and choice of discount rates is then discussed. However this paper is not designed to be an extensive literature review. The paper then proposes an existing model for improving the understanding of risk-adjusted discount rates.

One primary assumption underlies this paper. Individual investors in the agri-food sector are assumed to hold highly non-diversified portfolios. Furthermore the discussion focuses on the basic methods of investment analysis. While sophisticated Monte Carlo or simulations can be tacked onto the investment analysis, these techniques are irrelevant if the underlying fundamental analysis is incorrect. The promising area of contingent valuation (real option values) in investment analysis (Trigeorgis 1993; Pindyck 1991) is not discussed as this tool has only recently emerged in the agriculture literature (Purvis et al. 1995).

Principles of Investment Analysis

Any investment analysis requires information concerning initial capital outlay, income generated by the investment, operating costs, project life and an appropriate return on investment. The difference between the costs and revenues result in the net benefit or net cash flow for the year and is generally referred to as the net benefit stream. For a proper valuation of alternative ventures, it is necessary to reduce the cost and benefit streams to a single figure.

Various appraisal methodologies have been used to ascertain financial viability of an investment project. These include Net Present Value (NPV), Internal Rate of Return (IRR), Return on Investment (ROI) and Payback Method (PB). Each investment analysis method requires some form of

cash flow projection. Only NPV explicitly includes a measure for risk. This review already accepts that NPV is the theoretically superior investment analysis method. Each method of investment analysis is briefly described to start the discussion.

- **Payback Method (PB)**

The payback method is also known by other names such as payback period, pay-off period, capital recovery period and cash recovery factor. It is defined as the number of years required for the stream of cash flows generated by the investment to equal the original cost of the investment. A venture is accepted as worthwhile if the payback of an initial investment outlay is obtained within a predetermined time. This method is quick, simple to compute and it is readily understood by potential investors. The speed with which investment costs are recovered could become a major consideration where there are situations with severely limited investment funds. The speed of return, essentially an ad hoc risk adjustment, falls in line with avoiding or minimizing risk.

There are major problems associated with this methodology. PB ignores cash flows occurring after the payback period. It also fails to allow for the timing of cash flows by treating cash flows in all years as equally important and assumes that all cash flows are equally certain. PB favours projects having higher cash flows in early years but cash flows in many projects are slow to start for a number of reasons. Finally, the speed of capital recovery and the risk adjustment must be determined in some ad hoc fashion.

- **Return on Capital/Investment Method (ROI)**

ROI, also known as accounting rate of return, is the ratio of the accounting profit to the project capital outlay, expressed as a percentage. In this framework, a project is accepted if the ratio exceeds some target rate of return. Partial budgets, used extensively by extension farm management agents, fall under this ROI method.

ROI provides a straightforward "accept or reject" decision depending on the predetermined target. It also takes account of the profit flows over the whole project life. In spite of these advantages, the rate of return method has several shortcomings. It fails to recognize the time value of money and concentrates on a project's financial flows in accounting terms rather than cash flows. There exist many methods, with little general agreement on how profit should be defined. Since a proposed investment is measured in percentage terms, the rate of return method is unable to take into account the financial size of a project when alternatives are compared. Although ROI allows for profit flows over the life of a project, it ignores the possibility of differing project lives. Finally the target rate of return is an ad hoc risk adjustment.

- **Internal Rate of Return (IRR)**

The internal rate of return represents the return (in present value terms) earned on an investment over its economic life. It is defined as that interest rate which, when applied to the cash flows generated by an investment, will equate the present value of the cash inflows to the present value of the cash outflows. In other words, it is the discount rate which will cause the NPV of an investment to be zero. The IRR method often results in the same conclusion as the NPV method. However, in certain situations the use of IRR may lead to different conclusions from those indicated by NPV. For example, where projects are mutually exclusive (acceptance of one project excludes the acceptance of another), application of the IRR rules can lead to conflicting recommendations. Another problem with the IRR method is that it expresses the result as a percentage rather than in monetary terms. Comparison of percentage returns can be misleading especially where capital is a constraint. The IRR assumes that all funds can be re-invested at the same rate which is often not possible. A further

problem with IRR is encountered when unconventional cash flows occur (e.g. negative cash flows coming in later years). If the sign of the net cash flows changes in successive periods, it is possible for the calculations to produce multiple IRRs. While multiple rates of return are theoretically possible, only one rate of return is significant in an "accept" or "reject" decision. The final problem still remains determination of an acceptable rate of return given the investment risk.

- **Net Present Value Method (NPV)**

The NPV method consists of discounting all future cash flows to the present value by means of some appropriate discount rate. The discount rate specifically includes a risk premium appropriate for the project. The quantitative data required to carry out this method are: the initial cost of the project (C_0), the discount rate (r), the life of the project (T), and the expected cash flow in each period ($C_1....C_T$). The computation is carried out as follows:

(i) Calculate the present value of each year's net cash flow by multiplying the projected cash flow by the appropriate discount factor.

(ii) Add the computations to arrive at the single figure of net cash flows in present value terms.

Algebraically, this is expressed as:

$$NPV = C_0 + \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} \qquad (1)$$

where *r* is the risk adjusted discount rate.

A venture is deemed worth undertaking if the NPV is zero or positive, implying that the net present value of the cash inflows is equal to or greater than the net present value of all cash outflows. The problems associated with the use of NPV are related to the estimation of the cash flow and the determination of the relevant risk adjusted discount rate. Determining the appropriate risk adjusted discount rate is important in cash flow analysis (Butler and Schachter 1989), because it adjusts the project analysis for risk.

It is well accepted in the finance literature that of the four methods described above, NPV is the preferred method for analysing investments. However, no matter how accurately cash flows are estimated, NPV becomes a mere exercise in algebra if insufficient attention is paid to the choice of risk adjusted discount rate. Unless relevant risk adjusted discount rates are used, NPV is not inherently superior to any of the three other investment analysis methods discussed earlier. The agricultural economics profession needs to focus attention on practical, relatively simple ways to include risk in the investment decisions. NPV provides a vehicle for explicitly including risk measures and the challenge is to measure this risk. The literature reviewed in the next section has largely ignored this challenge.

Literature Review

Empirical investment analyses for agri-business ventures and procedures for estimating risk premia are examined in this section. Although NPV is widely used by researchers, PB, ROI and IRR have also been used in studies. Researchers who have used the NPV approach include Braden et. al. (1983), Kiker and Lieblich (1986), and Singh and Rizvi (1994), among others. Flores et. al. (1993) and Hanson (1985) use NPV and IRR while Gebremedhin and Gebrelul (1992) use the NPV and the PB methods. Almost without exception, attention has focused on the technology and the estimation of the cash flows, while the issue of the discount rate or risk measure has been ignored.

Braden et. al. (1983) assess the viability of an ethanol-livestock project using nominal interest rates of 9.2% and 13.4% which they indicate compare favourably to an 11% market loan rate. In a

similar analysis for a large-scale ethanol project, Hanson (1985) uses a discount rate equal to the interest rate on borrowed capital. Kieker and Leiblich (1986) do not give the basis for choosing the discount rate but combine a 6 % real discount rate with an overall inflation rate of 3.4 % to derive a nominal discount rate equivalent to 9.64%. Countryman and Miller (1989) indicate that researchers could use the interest rate on a certificate of deposit as the discount rate because that is the individual's investment alternative. Brewer et al. (1990) obtain IRRs ranging from virtually zero to 22% on a potato storage investment. Schater and Smith (1990) choose three discount rates in their study on pecan orchard investments. Gebremedhin and Gebrelul (1992) use six different discount rates ranging from zero to twelve per cent in their study on meat goat enterprises. In a study on processing milk fat with supercritical carbon dioxide, Singh and Rizvi (1994) use PB and ROI analysis.

Almost all of the studies cited above use arbitrary discount factors, emphasize production technology or use inappropriate investment analysis methods. The methods used to choose discount rates or adjust for risk in the above studies are theoretically incorrect. Market loan rates, interest rates on certificates of deposit and other rates are more or less risk free. There are more risks associated with an investment venture than borrowing money or investing in bank deposits. Furthermore, certificates of deposits or similar financial instruments are not the only investment alternatives available. Individuals have a whole host of readily available market investment alternatives that vary from riskless to high risk.

Determination of the risk premium, especially as it relates to the agri-food industry, is ignored in these studies. For many agri-food ventures, it is likely that these ad hoc estimates of the discount rate or other risk adjustments grossly underestimate the risk adjusted discount rate. Discount rates in the above studies provide no relevant or practical guidance to the finance practitioner. Applied agricultural finance practioners cannot be faulted for choosing alternatives to NPV for investment analysis.

Other economists address the problem of determining a discount rate by using the Capital Asset Pricing Model (CAPM) (Sharpe 1964) or the Single Index Model (SIM) (see for example Turvey and Driver 1987, Collins and Barry 1986, 1988; and Moss, et al. 1991). These models also have drawbacks for the non-diversified investor.

CAPM assumes investors hold widely diversified portfolios. Thus, all unique risk specific to the project is diversified away. The investor only needs to be compensated for the covariance risk (systematic risk) between the individual investment project and the total market. Since CAPM is explained in most finance texts (e.g. Copeland and Weston 1988), the details behind the model are not provided here. The final model is expressed as:

$$E(r_i) = r_o + \beta_i[E(r_m) - r_o] \qquad (2)$$

where r_i is the rate of return on the individual asset, r_o is the risk free rate of return, β_i is the measure of the systematic risk of asset i, and r_m is the return on the market portfolio. $E(r_i)$ is the risk adjusted discount rate used in equation (1) for NPV. β_i, often called the Beta risk, measures the covariance between the project risk and the total market risk. The market measure, r_m, is often proxied by using major stock market indices. Given estimates of the expected return on the market, the systematic risk and the risk free rate, risk adjusted discount rates, $E(r_i)$, are estimated. This CAPM discount rate provides no compensation for risk unique to the investment and this issue is discussed by Collins and Barry (1988). Thus CAPM, while useful for investors who hold widely diversified portfolios, does not provide adequate risk measures for agri-food projects or proprietary firms where investors cannot diversify their wealth.

The SIM is a model mathematically similar to CAPM where the market portfolio return is replaced with returns on a specified index, hence the name Single Index Model. It is expressed as:

$$E(r_i) = r_o + b_i(E(r_f) - r_o) \qquad (3)$$

where b_i measures the covariance risk between the individual asset and the selected index, and r_f is the index returns. For example, Moss et al. (1991) use a SIM to study the production of citrus varieties where the index is composed of returns to different citrus fruit varieties. Turvey and Driver (1987) construct their index from a portfolio of different crop mixes in Ontario while Collins and Barry (1986) construct their index from returns for twelve California crops. Certainly, the index is less diversified than CAPM and the estimated risk premium now measures how the new project's risk varies with the select group of assets in an index.

The SIM can be criticized on several fronts. Some risk unique to the investment project is still not measured and consequently the risk premium may be understated for the non-diversified investor. Moreover, the choice of the index is arbitrary. Whereas theory suggests the use of a total market risk measure in CAPM, no such theory guides the choice or the construction of the index for the SIM[1]. Finally, the SIM completely ignores the investment alternatives available to the investor. The investor can make alternative investments in the market with a similar risk profile as that of the investment project. Collins and Barry (1988) attempt to overcome these problems by adjusting the discount rate with a measure of the individual's risk aversion. However, the authors admit that there is still the difficult problem of quantitatively estimating an individual's risk aversion coefficient. Given that an individual's preferences are difficult to measure and given that moral hazard issues exist, finance practioners are unlikely to be able to quantitatively estimate an individual's risk aversion coefficient.

Problems with the ad hoc nature of risk adjustments for investment analysis are outlined above. Empirical studies provide little hard evidence about how investors' decisions take into account estimation of risk adjusted discount rates (Butler and Schachter 1989) and the empirical studies cited here do not remove the professions ignorance regarding usable valid risk measures. CAPM or SIM provide measures that are not suitable for non-diversified investors. Methods for estimating risk adjusted discount rates for non-diversified investments are proposed in the next section. It is based on an interim step in the derivation of CAPM.

Choosing A Risk Adjusted Discount Rate

Quantifying risk is essential to project analysis. Risk is often measured in terms of the spread or dispersion for a distribution. If the distribution is very spread out, the returns are very uncertain. In other words, the more variable the expected future returns, the riskier the investment. The variability of a distribution is usually measured by the standard deviation (i.e. the square root of variance). Standard deviation is a measure of the total investment risk and it is an appropriate applied risk measure for non-diversified investors. However the standard deviation must be converted into a risk premium to be usable in NPV calculations.

Standard deviations are the risk measures used in the Capital Market Line (CML) (see Copeland and Weston 1988). The CML uses standard deviations to estimate discount rates. Essentially

[1]Indeed the SIM model simply becomes a Arbitrage Pricing Theory Model (Ross 1976) with only a single index. The studies referenced above do not determine how many factors there actually are in the model and put an arbitrarily determined factor into the model. Several of the references cited used these single index models to determine crop choices and not to do long term investment analysis.

the CML combines assumptions regarding individuals and the market to derive the most efficient portfolios; combinations of a risk free asset and a risky portfolio. These portfolios have the highest return for a given level of risk where risk is measured by the standard deviation of returns[2].

The CML assumes the investor can invest in some linear combination of the risk free asset (often assumed to be T-Bills) and the efficient market portfolio. The market portfolio is often proxied by using a portfolio of stocks such as those on the New York Stock Exchange. Derivation of the CML is found in most finance texts and is not presented here. An investor's expected return using the CML is expressed as:

$$E(r_p) = r_f + \sigma_p E[\frac{r_m - r_f}{\sigma_m}] \qquad (4)$$

where $E(r_p)$ is the expected return on the investment, r_f is the risk free rate, r_m is the uncertain return on the market portfolio, σ_p is the standard deviation of the investment, and σ_m is the market portfolio standard deviation. The market portfolio risk premium is $r_m - r_f = RP_m$. Equation (4) indicates that the expected return on any efficient portfolio on the CML is equal to the riskless rate plus a risk premium which is equal to $(r_m - r_f)/\sigma_m$ multiplied by the investment standard deviation, σ_p. $E(r_p)$ is a risk adjusted discount rate.

Non-diversified investors considering an investment in some risky agri-food project always have the choice of investing in some other portfolio. The relevant comparison to the agri-food project is a readily available market investment with a similar risk profile. Once the risk profile of the agri-food investment is determined, it can be compared to the risk profile from the market portfolio. The agri-food investment risk premium becomes the same as the risk premium from the comparable market portfolio.

An example might clarify the use of the CML. The nominal historical risk premium and standard deviation of returns on the New York Stock Exchange are about 7.1% and 14.6%, respectively for the years 1946-1990 (Siegel 1992)[3]. If the risk free T-Bill rate is 4.9% and the risky investment has a standard deviation of 37.5% then the risk adjusted discount rate from the CML (equation 4) is about 23% as illustrated in Figure 1 along with other information. That is, a market portfolio with the same risk profile as the proposed non-diversified investment has an expected return of 23%. Siegel (1992) or Patterson (chap. 5 1995) provide estimates of broad market returns and risk premiums for estimating the CML.

Alternatively, prior research may show that the expected return from projects with similar risk profiles to the proposed investment is 22%. If the risk free rate during these studies was, say 6%, then the risk premium is 16%. This risk premium can be added to the current risk free rate to derive the discount rate needed. Using the CML implies the proposed project has a standard deviation of returns of 45%.

The CML then justifies two ways to derive a discount rate for non-diversified investment projects: (1) Measure the historical standard deviation of returns from investments that are very similar to the proposed project and use the CML or (2) use a method in common practice, measure the

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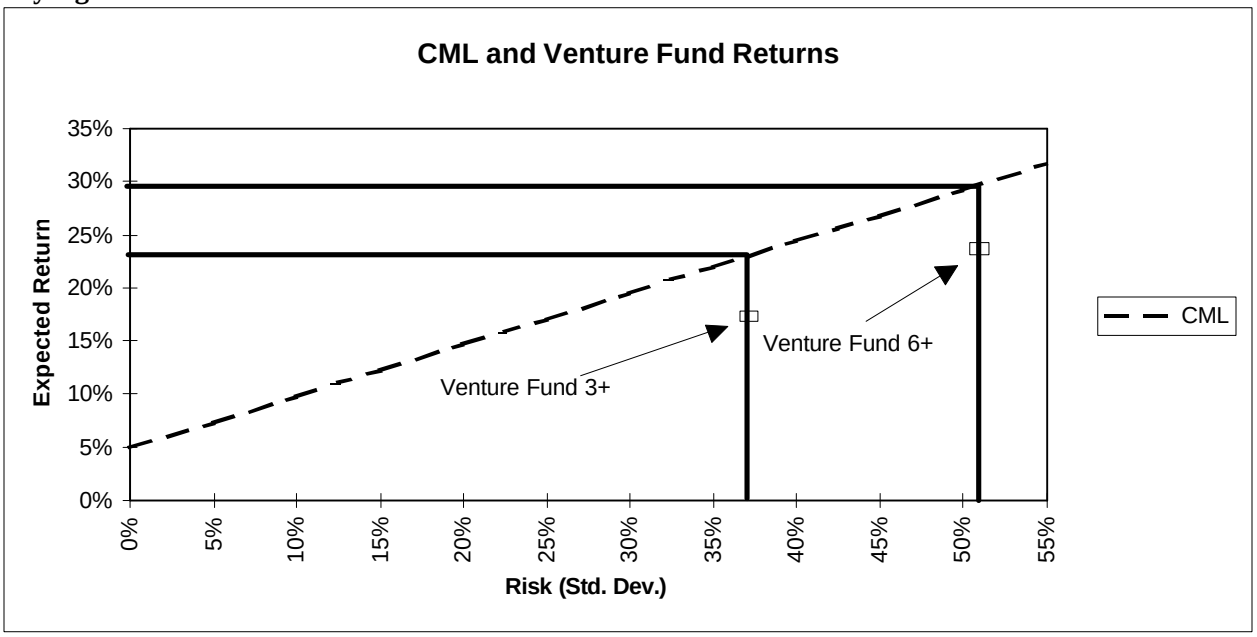
[2]Details on deriving the efficient frontier portfolio can be found in most finance texts (Copeland and Weston (1988) or Turvey and Driver (1987), Collins and Barry (1986)).

[3]Real Rates would be preferable to use in the CML however nominal rates are presented here to conform with other nominal data from the Venture Capital literature discussed later.

Figure 1: **CML Predicted Returns Versus Actual Returns on Two Venture Fund [1] Groups Segregated By Age of the Funds**



1. The source of venture capital data from 1978 to 1987 is Chiampou and Kallett (1989). The CML is derived from Siegel (1992) for the period 1946-1990.

historical returns and risk free rate from projects with similar risk profiles. This provides an estimate as to the relevant risk adjusted discount rate for non-diversified capital investments.

The CML provides many benefits to the applied practitioner for estimating risk adjusted discount rates for NPV analysis. It does not require the calculation of an index or an efficient portfolio. The market already provides this information. It allows comparisons between the proposed investment project and alternative market investments with similar risk profiles. This expands the "opportunity cost" arguments beyond the erroneous assumption that certificates of deposit or borrowing rates are the only investment alternatives. Theory suggests using the market portfolio and the risk free rate to form the CML. This removes the ad hoc choice of indices for SIM. Standard deviations and mean returns are relatively simple measures to estimate and use. This by-passes the estimation problems required to determine individual risk aversion coefficients. Practioners can also look at other industries or investment projects with known risk premiums or standard deviations of returns that are similar to the proposed project. This provides another way to derive risk premia consistent with the CML.

There are drawbacks to using the CML. CML is a single period model and many investments are multi-period. Analysis extending CML risk measures to multi-period projects in practical ways is possible but needs further research. CML only applies to non-diversified investments and uses mean and variance estimates only. Where diversified investors are involved, CAPM is a suitable alternative. The debate by academics regarding the appropriateness of the mean and the variance for measuring risk is ongoing. However while academics debate (eg. see Antle 1983; Hanson and Ladd 1991; Levy 1974; Borch 1974; Bierwag 1974, or Tsiang 1972 for a small sample of the debate), agricultural finance practioners wait and the CML provides a viable way to approximate risk premia. The main

challenge is finding standard deviations or historical returns for investments with similar risk profiles. This is an area for future research. Work is required to estimate and compile this information where it will be available to agricultural finance practioners. As an interim step, information from the venture capital literature provides insights on appropriate discount rates for new or start-up agri-business ventures.

Studies on venture capital funds provide information on returns and standard deviations. Chiampou and Kallett (1989) examine a venture capital sample and provide a risk/return profile for two types of venture funds. Established venture capital groups offer average annual returns of 24.4% and the entire sample averaged 17.5%. The associated standard deviations of returns were 51.2% and 37.6%, respectively. These venture fund results are tied in with the CML in Figure 1 which uses the data from Siegel (1992) to estimate the CML. Both types of funds exhibit returns below what the CML shows to be consistent with non-diversified portfolios. The diversification within the venture funds and the averaging across different funds may account for the reported returns below the expected returns. The CML provides an upper bound on expected returns. Unfortunately the specific type of investments by these venture capital funds are not discussed in detail in the article.

Other venture capital studies provide further incites on the range of risk premia for start up ventures. Gaston (1989) reports that, among US informal investors, the median annual rate of return expected is 22%. In the UK, Mason and Harrison (1994) indicate that variations in the perceptions of informal investors of risks at different stages of development of the venture reflect their minimum rate of return expectations. Expected returns range from 45% for pre-start-ups, 32% for start ups, 29% for early stage, 25% for young firms, to 21% for established firms. As a bench-mark, informal investors in the UK expect a minimum annual rate of return of 15% for investments in blue chip companies. Note that these venture capital rates are substantially above the risk free rate used in many of the studies cited earlier. These studies provide introductory information that assists in determining discount rates for projects in the early development stage.

Conclusion

With increasing use of capital intensive technology in the agri-food industry, it is necessary that applied agricultural economists increase their research in the area of investment analysis. Previous work emphasised the analysis of the production technology and cash flows without adequately assessing and accounting for risk. No matter how accurately cash flows are estimated, the use of Net Present Value, the preferred investment technique, becomes a mere algebraic exercise if insufficient attention is given to the choice of a risk adjusted discount rate.

The Capital Market Line (CML) provides one viable alternative for determining risk-adjusted discount rates for non-diversified agri-food investments. The CML uses historic standard deviations on similar investments and readily available market information to estimate risk. Further research is needed to derive relevant risk premia for agri-food firms using the CML.

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