

# Gain and Risk in Sustainable-Style Investments

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## Abstract

The paper examines the gain and risk from investing in businesses that promote sustainable products, such as plantations, forests, aquaculture and agribusiness generally. And, by inference, indicates what such businesses need to offer in order to appear attractive to investors. An analysis of business failures leads to a finite probability that the investor will lose money. Failure here can be generalised to mean failure of the sustainable product, and not just the business. The attractiveness of the investment is further diminished because of the uncertainty in the downstream return on investment and time of the return. Based on probabilistic arguments, the paper presents a robust methodology on which to make investment decisions. The methodology is not only practical but will be useful to people interested in sustainable-style investments, and businesses promoting sustainable-style investment. The methodology is significant in that it quantifies what heretofore was largely undertaken qualitatively.

## Keywords

Gain; risk; sustainability; business failure

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## 1. Introduction

Plantations, forests, aquaculture and similar agribusinesses are commonly promoted as a result of society's push for more sustainable practices. With taxation concessions, investment in such businesses (and products) is popular and is perceived as being socially responsible, but it is not without risks (CPA Australia, 2007). This paper addresses such risk, and gives a methodology for looking at investment gain. The methodology is not only practical but will be useful to people interested in sustainable-style investments, and businesses promoting sustainable-style investment. The methodology is significant in that it quantifies what heretofore was largely undertaken qualitatively.

The typical cash flow for an investor involves an initial outlay  $\alpha_0$ , with a return  $\zeta_n$  at year  $n$ ; alternatively the initial outlay  $\alpha_0$  may be spread over  $n$  years as an annual amount  $\psi_i$ ,  $i = 1, 2, \dots, n$ . Uncertainties in this investment scenario are in terms of when the return will be obtained, the magnitude of the return and the survivability of the business (or product) to the point where the return is obtained. That is,  $n$ ,  $\zeta_n$  and the time to business failure are random variables. Gain to the investor and any decision on investment should acknowledge such uncertainty. Businesses promoting such sustainability style investments should be aware of this decision making.

CPA Australia (2007) makes a distinction between forestry investment and non forestry investment, based on current taxation rulings. The formulation

given in this paper covers both investment types. "A forestry managed investment scheme (MIS) typically involves an investment used to predominantly finance the initial cost of planting trees with only a relatively low amount applied for ongoing maintenance. In practice, the duration of such schemes is also typically longer than most non-forestry schemes as it usually takes a longer time to reach maturity. Generally it is only at the point of harvest that there is any material quantifiable return on the project. By contrast a non-forestry scheme will usually require greater ongoing maintenance costs as well as the initial plantation costs. In return, such schemes will also generally provide some income before the crops are fully ready for harvest."

Investment returns are uncertain, and depend on the economic conditions, extreme natural events, weather patterns, competing products, pests, diseases, consumer behaviour and so on prevailing at the time of harvest. Likely returns as advertised in investment prospectuses may not be achieved, or may be bettered. "Predicting returns for growing new products can be very uncertain, both as to the crop return and the potential market for the product." (CPA Australia, 2007)

The time of harvest is uncertain, and will depend on management practices carried out in the preceding years, climate conditions and so on. Likely

harvest times as advertised in investment prospectuses may not be achieved, or may be bettered.

In agribusiness investment, n can be as large as 25 years. "Agribusiness projects normally have a long lead time especially for forest products. Apart from the illiquidity of the investment, the long lead-time horizon means that it is impossible to be certain as to the validity of assumptions made, or guarantee that forecasted estimates will be achieved." (CPA Australia, 2007).

An analysis of businesses over time, following their initial listings, shows a decreasing probability of failure. Nevertheless, at any time in the life of a business there is always a finite probability of failure. This implies that, not only has the investor to consider return on investment, but also the likelihood that all will be lost should business failure occur. Failure in this paper can be generalised to mean failure of the sustainable product, and not just the total business. "Many of these [agricultural investment] schemes lose all or some of your money or fail to make a better return than money in a bank account. Crops can fail and plants and animals can lose value as more people invest in them. Of course some schemes will succeed but you need skill to pick the good ones, and even experts make mistakes." (ASIC, 2007)

This paper develops a model to assist informed investor decision making based on estimates of the probability of business failure, the probability of a

return and the probability of when that return will occur. The model is applicable whether the investor is risk prone or risk averse. The model provides input to the investor's risk management practices. CPA Australia (2007) categorises agribusiness risk as tax, agricultural, management, international and time horizon.

The model, developed in this paper, of probability of gain from investment in sustainability style businesses is composed of a number of components - business survivability, return magnitude and return timing. The component model of business survivability is calibrated against commercial data, and shown to be a good representation. Various suggested component models for returns and time of return, based on industry observations, illustrate their influence on overall investor risk.

The paper is ordered according to business survivability modelling and calibration, then modelling the return, and then modelling the timing of the return. These are combined to give a model for gain probability. Discussion, comments and closure follow.

The authors are unaware of similar treatments for sustainability-style investments. Feasibility of proposed forestry, aquaculture and similar projects follows conventional discounted cash flow analysis practices (typically deterministic present worths / net present value), for example

Pillay and Kutty (2005), Zobrist (2005) and Pearce et al (2005) where issues such as choice of discount rate, selling prices and growth rates are also mentioned. Some share-trading based approaches and options analysis (for example Dixit and Pindyck, 1994) are related but solve different problems. Numerical experimentation via Monte Carlo simulation could be used in place of the present treatment, but would provide less understanding of the underlying model parts.

Comments are given below on relevant literature dealing with parts of the overall model. The context of the work, background and relevant references are addressed in the most appropriate places within the paper.

## 2. Main Notation

The main notation used in this paper is as follows:

$\lambda$	business failure rate
$S$	survivability
$t$	time
$\alpha_0$	initial investor outlay
$\beta_n$	investment return at year $n$
$\gamma_i$	annual equivalent to $\alpha_0$ ; $i = 1, 2, \dots, n$
$i$	year counter, $i = 1, 2, \dots, n$
$n$	year of investment return, harvest
$r$	discount rate, interest rate
$P[ \ ]$	probability of the contained argument
$E[ \ ]$	expected value
$\text{Var}[ \ ]$	variance
$\text{Cov}[ \ ]$	covariance
$D$	present worth, net present value
$\Phi$	feasibility

### **3. Business Survivability**

A reasonably comprehensive review of business failure prediction is given by Laitinen and Kankaanpaa (1999) where mention is made of the methods of linear discriminant analysis, logit analysis, recursive partitioning, survival analysis, neural networks, and human information processing. Comment is also made of the applicability, strengths and weaknesses of the various methods. The method adopted within this paper would most closely fit the method termed 'survival analysis', but this paper approaches the problem from a different slant to existing treatments of, for example, Cox and Oakes (1984). See also Balcaen and Ooghe (2004, 2006) who look at the performance of alternative business failure models, and the earlier work of Altman (1984) and Altman and Narayanan (1997).

Failure in this paper can be generalised to mean failure of the sustainable product, and not just the total business, though the development below uses business failure data for justification purposes.

Consider a business (or product) subjected, over time, to causes that might bring about its demise. Such causes might be lack of capital, bad debts, insufficient return, personnel death/retirement, economic conditions, biological conditions, and market changes amongst others. Each cause is associated with a small probability of business failure.

Let the probability of demise with each cause be  $p_f$  and the associated probability of survival be  $p_s$ , which is assumed independent of surviving previous causes.

$$p_f = 1 - p_s$$

Let the survival  $S_n$  be the probability of surviving  $n$  causes. For independence, the probability of survival is the product of the probabilities of surviving each cause. That is,

$$S_n = p_s^n = (1 - p_f)^n$$

Taking the exponential of the log of both sides,

$$\exp[\ln S_n] = \exp[\ln(1 - p_f)^n]$$

or

$$S_n = \exp[n \ln(1 - p_f)]$$

And for  $p_f \ll 1$ ,  $\ln(1 - p_f) \cong -p_f$ , giving

$$S_n = e^{-np_f}$$

That is, survivability of a business (or product) decreases exponentially with time.

Assuming that the demise causes are approximately constant in time, occurring with frequency  $\gamma = n/t$ , and introducing a failure rate  $\lambda = \gamma p_f$ , then the probability that the business will still exist at time  $t$  becomes

$$S(t) = e^{-\lambda t}$$

That is, business (product) survivability over time will follow an exponential distribution. The same result can be obtained without the restrictive assumption on cause occurrence, if instead a Poisson process is assumed where causes can occur randomly.

The parameter  $\lambda$  is estimated from business failure data, and could be anticipated to be different for different business circumstances - for all businesses, for different business types, for different business failure types, and for different time periods.

In terms of the random variable  $T$ , the time to failure,

$S(t) = P[T > t]$  = probability that failure hasn't occurred by  $t$ ; and  $S(0) = 1$ ;  $S(\infty) = 0$ .

### ***3.1 Some typical data***

The parameter  $\lambda$  can be estimated from industry data. Consider some typical data collected on business failures.

### ***3.2 Data set (a)***

Table 1 gives a summary of initial public offering (IPO) delistings and liquidations covering the period 1976-1996.

Year	No. of firms remaining	No. of firms delisted from ASX	Cumulative delistings
0	313	-	-
1	301	12	12
2	264	37	49
3	236	28	77
4	202	34	111

(i) All delistings.

Year	No. of firms remaining	No. of firms - liquidation/receivership	Cumulative liquidation/receivership
0	313	-	-
1	302	11	11
2	274	28	39
3	256	18	57
4	240	16	73

(ii) Delistings (excluding mergers).

Table 1 Summary of IPO delistings and liquidations 1976-1996 Australian Stock Exchange (ASX).

This data is plotted in Figure 1.

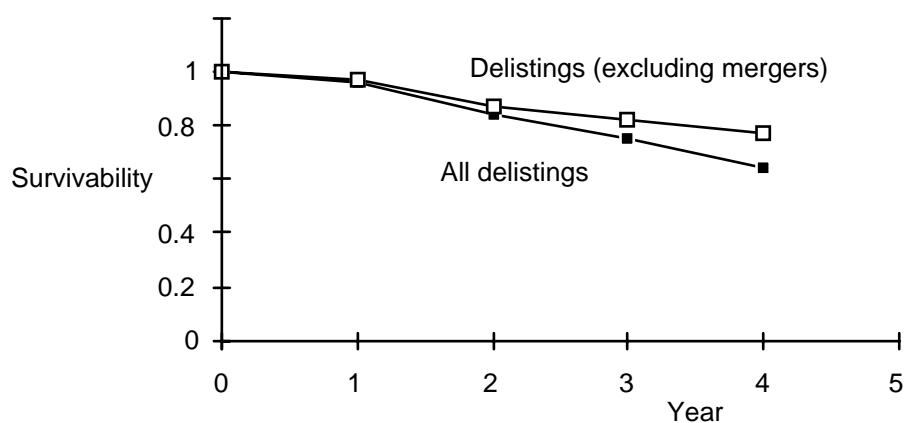


Figure 1. Data of Table 2.

There are numerous ways that  $\lambda$  can be estimated from this data. A least squares best fit over the range of the data gives  $\lambda = 0.0966$  for the 'all delistings' case, and  $\lambda = 0.0652$  for the 'delistings (excluding mergers)' case,

though it is recognised that the data does not cover failures for the complete sample of 313 firms.

### 3.3 Data set (b)

Table 2 gives a summary of ASX delistings for relevant firms from the Materials/Forest Products category over the period 1996-2006.

Years since listing	Number of firms remaining (not delisted)
0	7
1	7
2	7
3	6
4	5
5	4
6	4
7	4

Table 2 Summary of relevant Materials/Forest Products category delistings ASX 1996-2006.

This data is plotted in Figure 2.

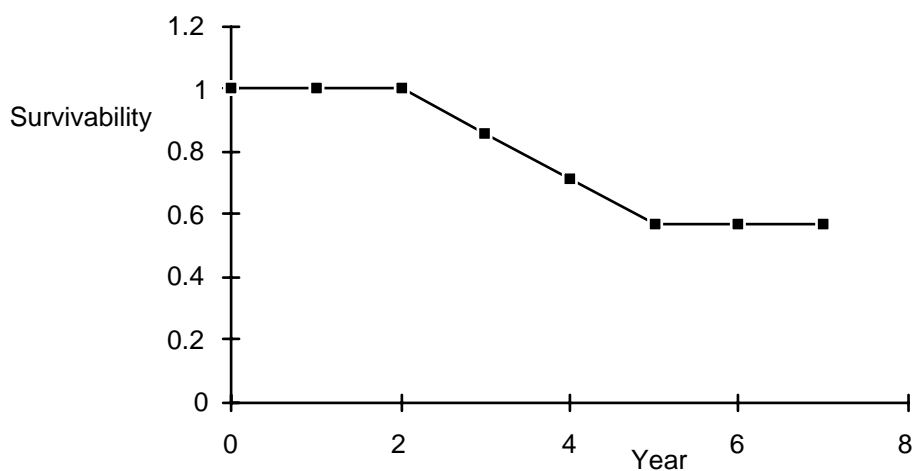


Figure 2. Data of Table 2.

A least squares best fit over the range of the data gives  $\lambda = 0.0809$ , though it is recognised that the data does not cover failures for the complete sample of 7

firms. Also the sample size is small, only comprising 7 companies, and any conclusions have to be qualified by this. The other data sets are much larger and more representative of business failures in general.

### 3.4 Data set (c)

Bickerdyke et al (2000) gives the data shown in Table 3.

<b>Year</b>	<b>Business cessations/exits</b>	<b>Cumulative business survivals</b>
0		100.0
1	9.5	90.5
2	8.6	81.9
3	6.0	75.9
4	5.4	70.5
5	5.1	65.4
6	4.7	60.7
7	4.4	56.3
8	4.0	52.3
9	3.8	48.5
10	3.5	45.0
11	2.2	42.8
12	2.1	40.7
13	2.0	38.7
14	1.9	36.8
15	1.8	35.0

Table 3. Survivals are per 100 businesses. After Table 2.6 of Bickerdyke et al (2000).

This data is plotted in Figure 3.

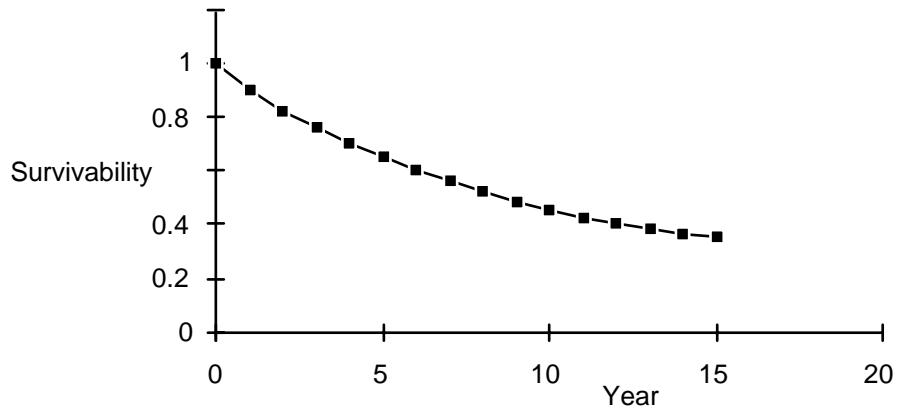


Figure 3. Data of Table 3.

A least squares best fit over the range of the data gives  $\lambda = 0.0782$ , though it is recognised that the data does not cover failures for the complete sample of businesses being studied.

### 3.5 Summary

The above data sets give  $\lambda$  values in the approximate range of 0.095 to 0.065. The higher values apply to early business failures, while the lower values to later business failures. Accordingly when establishing an investor's exposure, it is suggested that a  $\lambda$  value be chosen that reflects the length of investment anticipated. Ideally also a  $\lambda$  value based on businesses similar to that being invested in would be preferred, but is not essential because the results below show that the investor's exposure is relatively insensitive to the  $\lambda$  value chosen.

## 4. Investment Return

The following development is in terms of probabilistic discounted cash flows. A comprehensive review of developments in this area is contained in Carmichael and Balatbat (2007).

Of particular relevance to the present development is the seminal work of Hillier (1963) which gives an analytical method for determining the probability distribution describing present worth for periodic cash flows described as mutually independent and/or completely correlated random variables. The present worth will follow a normal distribution where the periodic cash flows are normally distributed, while the central limit theorem would indicate that the distribution for the present worth should, for increasing time, approach that of a normal distribution irrespective of the distributions for the periodic cash flows. See also Hillier (1969) for comment on the normal distribution assumption.

The comment is made by Hillier that data would generally not be available on the covariances or correlations of the cash flows, or if it was available, accurate values could not be anticipated. Nevertheless, suggestions for obtaining estimates for correlation coefficients between cash flows in different periods have been advanced. See, for example, Hillier (1969), Kim and Elsaid (1988) and Kim et al (1999).

Hillier and Heebink (1965) give some numerical examples to Hillier's approach. Van Horne (1977) discusses Hillier's approach. Kim and Elsaid (1985) apply a safety margin to the uncertain periodic cash flows, and look at the impact on present worth. Keeley and Westerfield (1972) take issue with Hillier's approach and argue that it misstates distant cash flows.

Tung (1992) performs a numerical experiment in attempting to identify the appropriateness of various commonly used probability distributions in describing the probabilistic behaviour of the present worth. Tung's results indicate that the adoption of a normal distribution for present worth should be acceptable.

Reisman and Rao (1973) give extensive second order moment derivations of various discounted cash flow relationships allowing for cash flows and the discount rate as random variables, for both continuous and discrete time discounting. Independence assumptions are used.

The scenario assumed in this paper is that of an investor providing an initial outlay  $\alpha_0$ , and in year  $n$  receiving a return  $\zeta_n$ . Alternatively the return could be spread over a few years, and the initial outlay  $\alpha_0$  may be spread over  $n$  years as an annual amount  $\psi_i$ ,  $i = 1, 2, \dots, n$ . Both alternatives can be accommodated in the following development.  $n$  and  $\zeta_n$  are the random

variables in this formulation. Taxation influences can be accommodated within this formulation.

The present worth,  $D_n$ , of a sum  $\zeta_n$  in year  $n$  is given by

$$D_n = \frac{\zeta_n}{(1+r)^n}$$

where  $r$  is the discount rate.

The expected value and variance of  $D_n$  become,

$$E[D_n] = \frac{E[\zeta_n]}{(1+r)^n}$$

$$\text{Var}[D_n] = \frac{\text{Var}[\zeta_n]}{(1+r)^{2n}}$$

Where the return  $\zeta$  occurs over several years  $n_1, n_1+1, \dots, n_2$ .

$$D_n = \sum_{i=n_1}^{n_2} \left[ \frac{\zeta_i}{(1+r)^i} \right]$$

and

$$E[D_n] = \sum_{i=n_1}^{n_2} \frac{E[\zeta_i]}{(1+r)^i}$$

$$\text{Var}[D_n] = \sum_{i=n_1}^{n_2} \frac{\text{Var}[\zeta_i]}{(1+r)^{2i}} + 2 \sum_{i=n_1}^{n_2-1} \sum_{j=i+1}^{n_2} \frac{\text{Cov}[\zeta_i, \zeta_j]}{(1+r)^{i+j}}$$

It is anticipated that  $\zeta_i$  and  $\zeta_j$  will be close to being perfectly correlated. In which case,

$$\text{Var}[D_n] = \left( \sum_{i=n_1}^{n_2} \frac{\sqrt{\text{Var}[\zeta_i]}}{(1+r)^i} \right)^2$$

Consider the case with the single return  $\zeta_n$  further. Where the term  $n$  itself follows a probability distribution, the expected values and variances are combined over this distribution of  $n$  to give the unconditional expected value and variance of the present worth of  $\zeta_n$ .

$$E[D] = \sum_{n=N_1}^{N_2} p_n E[D_n]$$

$$\text{Var}[D] = E[D^2] - \{E[D]\}^2$$

$p_n$  is the probability that the investment goes to  $n$  years, and  $N_1$  and  $N_2$  are the limits of the distribution of  $n$ . See for example, Wagle (1967) and Canada and White (1980).

Interestingly, the results below show that the investor's exposure is relatively insensitive to the distribution for  $n$ .

Using Tchebycheff's inequality, Wagle (1967) gives that the probability of  $D$  lying outside the bounds  $E[D] \pm 3\sqrt{\text{Var}[D]}$  is less than 0.11, or if  $D$  is normally distributed the probability is less than 0.0028.

Feasibility of an investment is defined as the probability that the present worth exceeds zero. That is,

$$\Phi = P[D > 0]$$

For normal distribution assumptions on  $D$ , Figure 4 shows the typical variability in  $\Phi$  with time, for some example values.

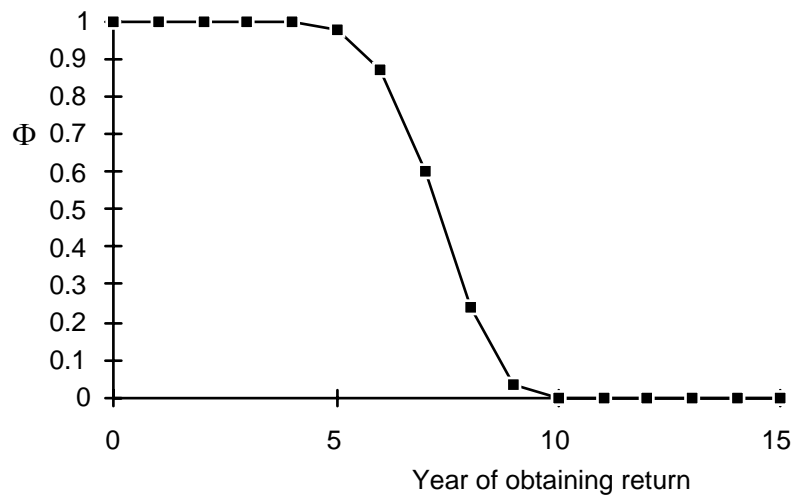


Figure 4. Example distribution of  $\Phi$ ; standard deviations 10% of mean;  $\zeta_n = 2\alpha_0$ ;  $n_1 = n_2$ ;  $N_1 = N_2$ ; normal probability assumptions.

## 5. Probability of Gain

In a present worth sense, the probability of gain from an investment depends on the probability of business survival (that is, survivability) and the probability that present worth is positive (that is, feasibility)

For probabilistic independence of survivability and feasibility,

$$P[\text{Gain}] = S\Phi$$

$$P[\text{Loss}] = 1 - P[\text{Gain}] = 1 - S\Phi$$

Figure 5 shows the variability in  $P[\text{Gain}]$  with time, for some example values.

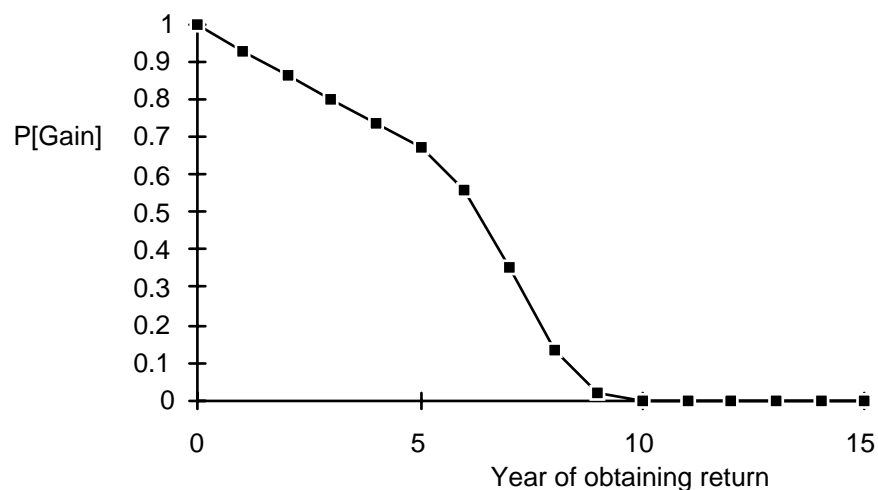


Figure 5. Example distribution of  $P[\text{Gain}]$ ; standard deviations 10% of mean;

$$\zeta_n = 2\alpha_0; n_1 = n_2; N_1 = N_2; \text{normal probability assumptions; } \lambda = 0.075.$$

## 6. Trends and Sensitivity

The formulation can be demonstrated to be quite robust to changes in underlying assumptions. Figures 6 to 10 show the trends and sensitivity to changes in assumptions. The base case is Figure 5 assumptions, namely - standard deviations 10% of mean;  $\zeta_n = 2\alpha_0$ ;  $n_1 = n_2$ ;  $N_1 = N_2$ .

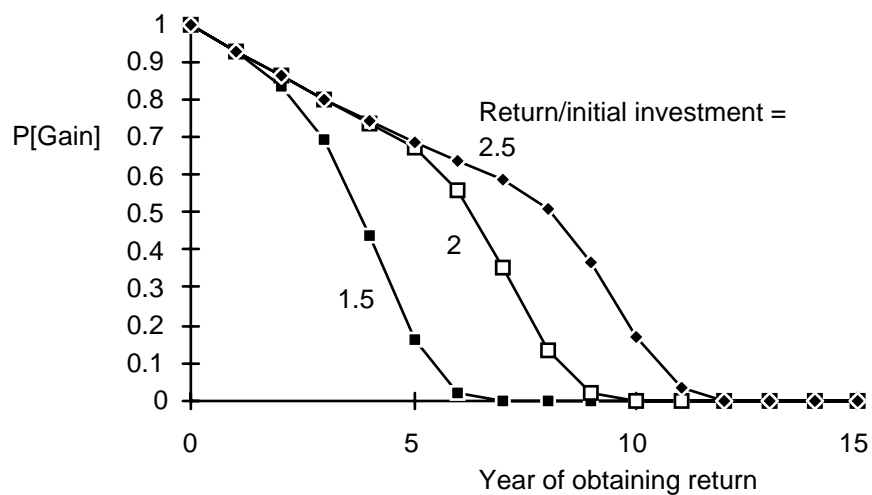


Figure 6. Influence of magnitude of return  $\zeta_n$  on P[Gain].

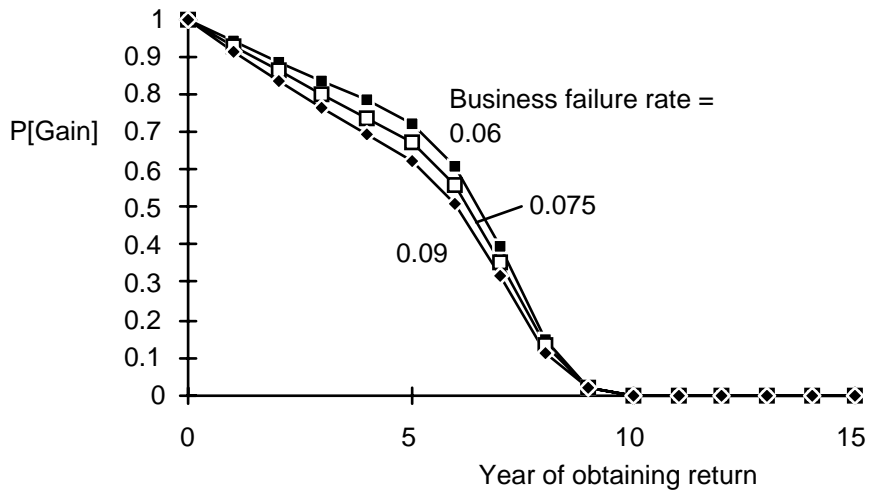


Figure 7. Influence of business failure rate  $\lambda$  on  $P[\text{Gain}]$ .

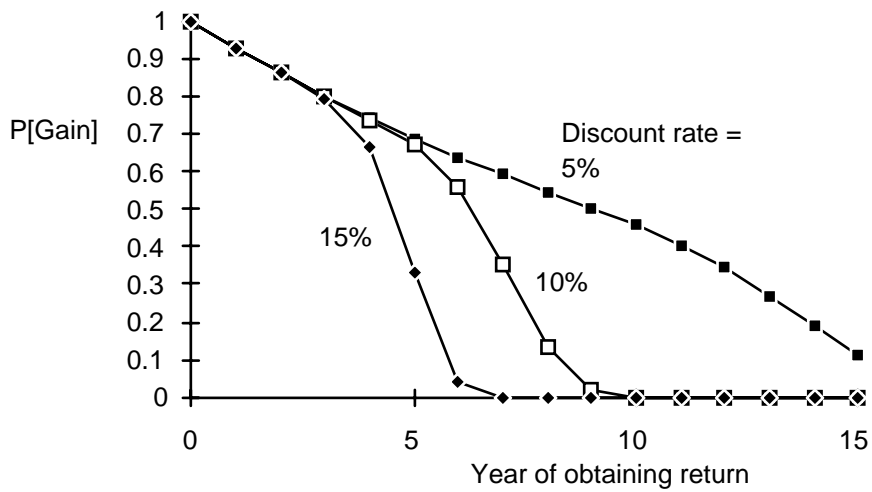


Figure 8. Influence of discount rate  $r$  on  $P[\text{Gain}]$ .

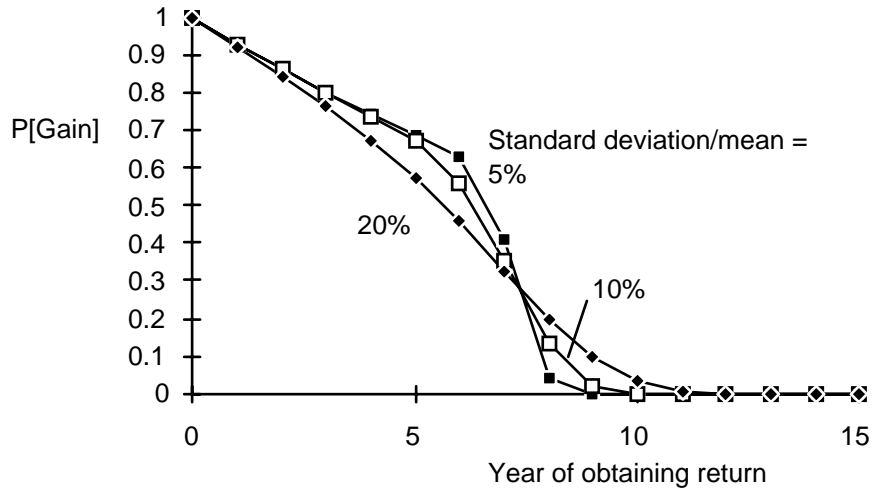


Figure 9. Influence of degree of uncertainty (standard deviation) in the return on P[Gain].

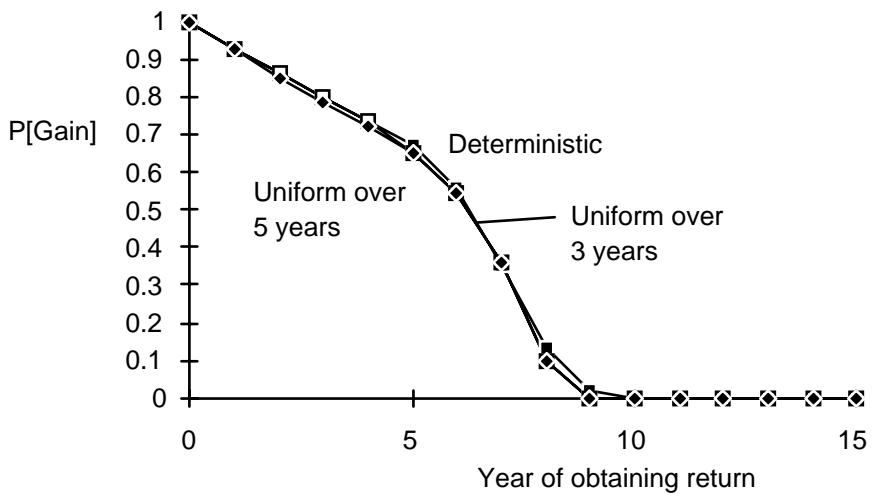


Figure 10. Influence of return time distribution on P[Gain].

## 7. Risk

The P[Gain] curve is seen to have two transitions and three regions. A suggested distinction between lower and higher risk investments could be made based on these transitions. For example, Figure 11 shows where such a distinction in risk levels might be made based solely on the first occurring transition. But other suggestions are possible, based on the value system of the investor. Risks could also be divided into high, medium and low based on the transitions.

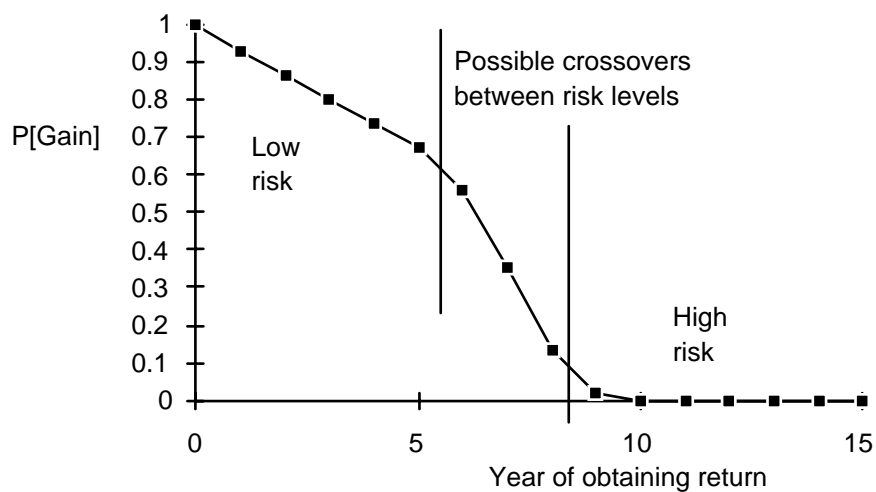


Figure 11. Possible distinction between lower and higher level risk drawn on Figure 5 as an example.

CPA Australia (2007) suggests asking questions such as: "How will the client feel if the capital invested is lost entirely? Does the return provide a premium

for the higher risk involved given the illiquid nature of the investment, the long lead time, the current absence of a secondary market and the unique risks associated with agribusiness MIS investments?" ASIC (2007) details related lists of questions to ask in order to establish the true risk of the investment.

## **8. Tax**

The effect of any tax concessions and taxation on money earned can be taken into consideration in the above analysis by suitably altering the values of  $\alpha_0$  and  $\zeta_n$ . Also, the above figures are presented in non-dimensional terms and can be used with or without taxation concession and taxation inclusions.

Rulings, from time-to-time over the duration of the investment, by the Australian Taxation Office will impact the tax risk. See CPA Australia, 2007 for commentary on this, as well as the different taxation status afforded to forestry and non-forestry investment.

## **9. Summary Approach for an Investor**

The following summary of steps is given for investors to follow, in calculating the risk associated with any sustainable-style investment:

1. Estimate a failure rate  $\lambda$ .
2. Calculate survivability,  $S$ .
3. Estimate a discount rate,  $r$ .
4. Calculate the expected value of the present worth of the return,  $E[\zeta_n]$ .

5. Calculate the variance of the present worth of the return,  $\text{Var}[\zeta_n]$ .
6. Use standard normal distribution tables to calculate feasibility,  $\Phi = P\{D > 0\}$ , taking into account the initial outlay  $\alpha_0$ . Or use a different preferred distribution.
7. Calculate the probability of gain from the investment,  $P[\text{Gain}] = S\Phi$ .

The whole process is readily done on a spreadsheet, where also alternative investment scenarios can be investigated with minor changes in assumptions.

## 10. Comment and Closure

Businesses fail with time, and the paper argues that the uncertainty associated with this should be factored into any investor analysis. Failure here can be generalised to mean failure of the sustainable product, and not just the business. As well, the returns and the timing of returns are uncertain, and these too should be factored into any investor analysis. The paper gives a useful tool for investing in sustainable-style businesses, and for establishing what should be reasonable risks to accept. The analysis may also be looked at from the point of the view of a business trying to attract investors, indicating what needs to be offered in order for investing to appear attractive.

The approach smooths the data across businesses, with the investor making no distinction between which businesses to buy shares in. In effect, the investor is assumed not to have any inside or arcane knowledge of a business, or be able to distinguish businesses from each other. Gains could be improved if some knowledge was available on management, operations and performance of a particular business; in such a case the investor would choose

businesses that s/he believed would have a lower probability of failure compared to the general average.

Interestingly though, the investment model, is largely insensitive to assumptions on business failure rates, the distribution describing the time of receiving a return, and variability in this return about some mean.

Investors can take the model and, by using their particular data, examine the risk of their intended investments.

Future developments of the methodology would look at alternative investment scenarios, and business characteristics indicating where the probability of investment gain could be improved.; alternatively from a business' viewpoint how its characteristics could be adjusted to make investment more attractive.

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