Portfolio Analysis

Summary

- Portfolio Analysis (PA) is a methodology focused on designing and evaluating portfolios of adaptation options, and enables the identification of portfolios that have the highest possible expected return for a given risk, or the lowest degree of risk for a given rate of return.
- PA is a particularly attractive approach in the adaption context because it offers a clear way to handle climate uncertainty. It does so by selecting options which are effective together over a range of possible future scenarios, instead of selecting one best option for one future.
- On the other hand, the methodology involved with PA is resource intensive, requiring a high degree of expert knowledge. Furthermore, it relies on the use of probabilities and the availability of quantitative data, both of which can be challenging with climate change.
- The methodology of PA allows for benefits to be assessed using different metrics, including economic terms, or physical effectiveness, where applicable. This is helpful when applying PA in areas with both market and non-market sectors.
- PA is most applicable in cases where adaptation options have the potential to be complementary in their aim of reducing climate risks.

What does Portfolio Analysis do?

Portfolio Analysis is a methodology that helps examining the value of incorporating a diverse set of options in adaptation strategies, as opposed to relying on a single one. It is based on the idea that diversification is an important risk management response: the benefits of a strategy relying on a portfolio of adaptation options are likely to be higher than for a strategy that relies on a single option. It also aims to minimise the risk of failure on the assumption that lower performance of one option is compensated by the better performance of another.

PA emphasises the trade-offs that can be expected between risks and benefits of various strategies. In the context of adaptation, risk preferences often relate to the uncertainty of future climate scenarios: it is desirable to select strategies which perform well over a range of plausible futures, and so PA can help to identify a group of strategies which match that preference.

When should I use Portfolio Analysis?

PA can used to compare multiple portfolios of options against the uncertainties of future socio-economic conditions across multiple climate change scenarios and models. It can be used for the design and evaluation of adaptation policies and strategies, and has a clear application in cases where different adaptation actions are likely to be complementary in reducing climate risks. It can be used for economic analysis, but can also work with non-monetary metrics and therefore can be applied in non-market sectors, such as for ecosystem based adaptation.

PA requires benefits to be expressed in quantitative terms, either as economic values or physical benefits, thus it is more applicable in cases where data availability is reasonable. Furthermore, the application of the technique requires probabilities, which makes it more applicable to cases where climate information is good, and some information on climate uncertainty exists.

What are the key strengths and limitations of Portfolio Analysis?

Key strengths

- Provides a structured way of quantifying portfolios of options to address climate change uncertainty.
- Can use various metrics, including physical effectiveness or economic efficiency, thus has broad applicability in market and non-market sectors.
- Provides an effective way of visualising results and the risk-return trade-offs.

Potential weaknesses

- Resource intensive and requires a high degree of expert knowledge.
- Relies on the availability of quantitative data.
- Requires probabilistic climate information to be imposed, or an assumption of likelihood equivalence between alternative scenarios.

What does it involve?

At the core of PA is the consideration of the risk that the actual benefits of a strategy will differ from expected benefits. Risk is calculated via the variance of proposed adaptation strategies: the higher the variance, the higher a given strategy may not achieve expected benefits.

Benefits in PA refer to either economic efficiency (calculated as Net Present Value) or effectiveness (as non-monetary metric). PA typically involves the following steps:

- Defining a number of adaptation options and constructing possible adaptation strategies (i.e. combinations of options);
- For each option, evaluating the expected benefits of each option, and their variance ;
- For each strategy, calculating the expected benefits and its variance, by multiplying the expected benefits of each option in the strategy by the proportion (of cost) of each option in the strategy;
- Plotting benefit data against variance and identifying strategies which either maximise benefits for a given level of variance (risk) or minimise variance (risk) for a given level of variance.

Trade-off between benefit and variance (risk) can be thought of as the potential for high effectiveness is addressing climate risks, and the possibility that the strategies will fail to be effective over a given range of future scenarios. Ultimately, the decision-maker defines preferences with respect to benefits and variance (risk).

Case Study: Portfolio analysis for adaptation in Rwanda

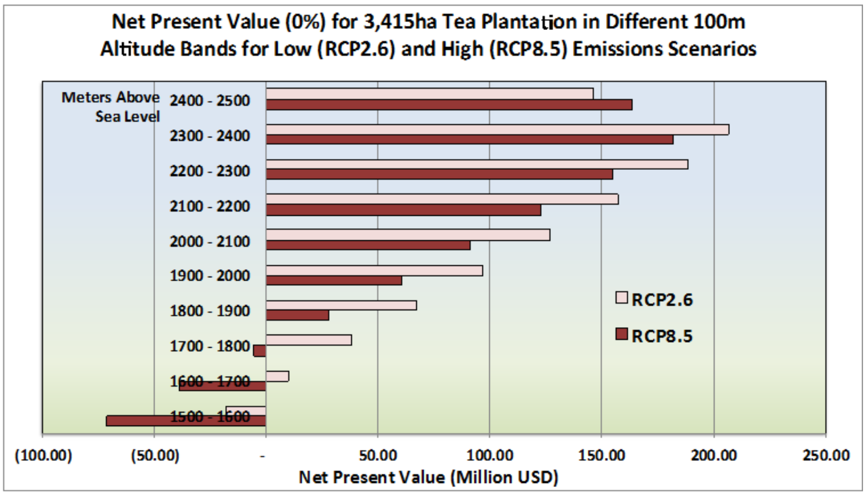
Portfolio analysis was used to evaluate investment in tea plantations at different altitude bands. The longevity of the assets in question, in this case tea plants, are similar to infrastructure investments with large sunk costs and can remain economically viable for over 50 years. Decisions about the location of new plantations are therefore well advised to consider the impacts of climate change.

Average temperatures decline with altitude. Combined with the varying tea yield and price at different temperatures, this means that tea plantations in one altitude band may perform differently to tea plantations in another. Without climate change, the relative performance of tea plantations in different altitude bands is likely to remain the same because the yield and price outcomes for tea in different altitude bands are constant. However, with climate change the yield and price of a tea plantation in a given altitude band is likely to change. The optimal altitude band for planting tea in a scenario without climate change may therefore be suboptimal in a future scenario with climate change.

This study evaluates how the information gained from climate risk mapping could change the plantation portfolio chosen by the tea investors. Portfolios are the different combinations of these options (altitude bands) that investors can choose to form their “plantation portfolio”. The decision criteria used in this study are the financial internal rate of return and economic efficiency (measure as the Net Present Value and the Benefit-Cost-Ratio). These criteria are tested for multiple investments across different future climate scenarios.

Without climate risk mapping, the investors can only use the Government of Rwanda’s current tea expansion maps to decide where to plant tea. This is the business as usual (BAU) case where the optimal plantation portfolio is chosen under the assumption of no climate change. With climate risk mapping, the investors have additional information about the suitability of planting tea in different altitude bands under different future climate scenarios. This study first assesses the BAU plantation portfolio in climate scenarios 1 and 2, before considering how the climate risk mapping investment may change the investors’ planting decision.

The risk assessed in traditional portfolio analysis is represented by the difference in returns between the two scenarios aggregated into one single “expected value”. This usually requires assigning a probability weight to each climate scenario. Since there is no reliable data or local scenarios on which these weights could be based, the approach did not aggregate the information; rather, we present results for each of the two climate scenario selected (see figure). This allows the tea investors to see the difference in returns between climate scenarios, rather than aggregating information into one “expected value”.



The figure shows that planting tea at an altitude between 2,300 and 2,400 metres above sea level is expected to produce the highest financial and undiscounted economic returns in both climate scenarios. However, at a 0% social discount rate, the absolute difference in returns between the two climate scenarios is lowest for plantations between 2,400 and 2,500 metres above sea level. In addition, the undiscounted economic results show that planting below 1,800 metres above sea level is expected to yield negative returns in the high emission scenario, and below 1,600 metres above sea level is expected to yield negative returns in both scenarios.

This study shows positive returns to climate risk mapping across a wide range of these uncertainties; the worst-case scenario is no climate change and the tea investors choosing a plantation portfolio that is similar to the BAU portfolio. However, even this scenario has positive financial and economic returns (Internal rate of return of 47%, or USD 6.7 m at a 0% discount rate, and USD 0.6 m at 13%). In the “best-case scenario” with climate change, the returns to climate risk mapping are just over 20 times greater.

More information on the application of Portfolio Analysis to tea plantation can be found here.

Tool

Portfolio Analysis is suggested as a potentially useful decision-support technique in the climate change adaptation context since it is judged that it may be wise to adopt a range of alternative adaptation measures that, between them, can be effective across the range of uncertainty. This approach has been formalised in portfolio theory which has its origins in financial asset management. The theory utilises the principle that since individual assets are likely to have different and unpredictable rates of return over time, an investor should ensure that she maximises the expected rate of return and minimises the variance and co-variance of her asset portfolio as a whole rather than aim to manage the assets individually.

The following tool includes main steps to involve in undertaking in Portfolio Analysis. It combines the estimate the Expected Net Present Value and the variance of the Net Present Value.

Econadapt insights
Prioritisation of adaptation in the development context: Rwanda
Uncertainties and causes of uncertainties in climate change adaptation
Uncertainties and risk analysis in climate change adaption
Sourcing and using climate information for economic assessments of adaptation
Integrated uncertainties and risk management for robust decision making