

Doing the Sums: Assessing the value to farm businesses of providing environmental services

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Whole Business Approach (whole not part, marginal not average)

Farm Benefit Cost Analysis (What do I give up? What do I gain? Risk?)

Technical basis

Measurement and Understanding

The economic arithmetic: Time effects on the value of future benefits and costs. (see below)

Risk and Returns

Information Assymetry (The Theory of Lemons)

Time and Money

Need to remember the time value of money. This does not refer to the effects of inflation, though this is important but to the value placed on net benefits received sooner rather than later even if there is no inflation.

For example, \$2500/ha for 100 years is not equal to $\$2500/100=\$25/\text{year}$!

A dollar today is not the same as a dollar in a years time, or in 100 years time. \$1 could grow to \$1.06 in one years time at 6% interest rate of earning. Or, \$1.06 in a years time is same as \$1 now at 6% interest rate of earning. \$1 today could grow to \$16.62 in present dollars in 100 years time at 6% interest rate of earning. \$1 in 100 years time is equivalent to $\$1/((1.06)^{100})=\0.003 – a third of a cent now. A third of a cent now invested at 6% p.a. for 100 years will grow to \$1 by year 100.

If a hectare being farmed now sells for \$2500/ha, this means the expected future net benefits in perpetuity are worth \$2500 todays dollars now. At a required rate of return of say 6%, this would mean the hectare is expected to return $\$2500*0.06= \150 ($(\$150/0.06)=\2500) net return per hectare per year every year forever. \$150 per year for 100 years is equal to \$2500 today at 6% required rate of return.

The quick test of an investment opportunity where you are going to sell the rights to use this land for farming to some other use, for perpetuity, is that the return from the alternative use has to be more than the current land value if it is a one-off lump sum, or, the same thing, more than the equivalent annual net returns.

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Introduction

Regardless of whether a proposed solution to a natural resource question is to be based on regulatory or market mechanisms, policy will be better informed if the people designing and implementing and enforcing and verifying policy know about how and why farmers may act in situations that are potentially significant for natural resources.

Equally important, farmers, who manage most of Australia's land and natural resources dedicated to agriculture, will make better decisions about resources if they are able to use appropriate methods of analysis of farm management decisions; in particular, are able to give proper consideration to whole farm, long-term dynamic and risk aspects of the decisions are pertinent issues. This is the focus of these notes. Specifically the focus is on the need for technically and economically sound analysis of farm management decisions about environmental services.

Environmental services provided by farmers refers to private activities that can have a public benefit as retaining areas of native vegetation, protecting riparian strips, growing deep rooted perennial plants to keep rising water tables at bay or growing plants to sequester carbon.

Given that public funds are likely to have to be paid to managers of natural resources for supplying environmental services instead of supplying something else, or to bribe them to do so, the methods of estimating how much to pay, for what, to whom, when, for how long, takes on critical importance. The question 'how much to pay farmers for providing environmental services?' is tricky, involving as it does the need to define plausible future scenarios for the technical and economic state of farm businesses and of the natural world, with and without certain actions that provide environmental services.

The answer to the question 'how much to pay' ought not be predicated on how much a business as it is currently operated will experience a change in profit if the farmer runs the farm differently in order to enhance national welfare and make a lot of other people happy. The correct answer to the question 'How much to pay' has to be based on the difference between the expected future profits from the farm business as it would be operated in the future without the change in ways that further enhance national welfare, and the expected future profits from the farm business as it would operate with such a change?

In farming, in a changing world, the *status quo* is not an option. Thus the *status quo* is not the appropriate point of comparison to evaluate effects of changes. The appropriate comparison is between alternative future states of affairs.

There is growing enthusiasm at state and federal government levels for natural resource policy that uses market-based solutions. The public buying back rights to areas of natural resources in markets, or purchasing water in markets, are ideas whose time has come.

Other market measures, such as the introduction of market instruments for rights to protect or use natural resource phenomena for people to trade, or maybe even farmers selling carbon sequestration services, and in doing so promote the achievement of desirable public ends, also rings true.

The cautionary note with any of these measures concerns the transactions costs that can be associated with making these measures work. Usually, the great strength of markets is the information they generate, and do so inexpensively. If market-based instruments introduced as part of natural resource policy require a lot of costly information gathering, oversight and measurement by an enforcement agency, or if they involve much uncertainty about the outcomes, the costs of achieving the end could increase markedly and reduce the net benefits to society. For example, at present the measurement and verification challenges associated with including agriculture in an emissions trading scheme are daunting.

Something that is overlooked in an increasingly polarized and rabid public debate about environmental protection is the issue of whether the benefits of achieving a change in the state of natural resources will exceed the costs. This cannot be simply assumed to be the case. If the fully-measured costs of fixing something exceed the properly measured benefits of fixing it, then it should not be fixed. That is, sometimes the fixing would reduce national welfare. Sunk costs are meant to stay sunk.

The above-mentioned examples of tackling problems of natural resource policy are but a few of many possible ways to tackle the problems of reconciling public and private wishes about natural resources, environmental services and farm production. There are a myriad of such possibilities, involving various combinations of regulatory and market activities.

It may be news to many people that good economic and environmental sense can coincide. They already do so more often than is commonly recognized. One only needs look at most agricultural irrigation schemes, or the clearing of marginal agricultural lands, to the results of poor economic analysis (or of good economic advice being ignored) causing poor environmental outcomes. Good economic decisions and good environmental outcomes are possible.

The neo-classical paradigm and the absence or failure of markets led naturally to experimentation with and development of market-based instruments (MBI's) to facilitate private owners of natural resources acting self-interestedly and yet contribute to public goals. The strength of MBI's is in enabling owners and managers of natural resources to judge best the costs and benefits to themselves of alternative uses of the natural resources they control – including providing environmental services. Good environmental outcomes are expected to result, as long as the decision-makers are sufficiently informed about the production situation when making their decisions.

Information inadequacies resulting in farming systems performing in ways that do not suit some specific public interests is a form of market failure. That is, farm and market agents making decisions about the day to day things that are done with farm resources are not as well informed, or making as good decisions, as people concerned about resource use would like them to be!

As information theory holds, less informed markets lead to less efficient use of resources than could be achieved with better informed markets (Stiglitz 2004). Whilst there will always be imperfect information, and thus unsatisfactory market outcomes, because there are aspects of the farming world that will forever be

imperfectly known, for example, complex agricultural and environmental response functions or future prices and discount rates, there is also information about the farm-farmer-environment complex that is potentially knowable and capable of improving decision making. This is the rationale for insisting on sound economic analysis of farm options to sell environmental services.

Information Assymetry and the Theory of Lemons

A starting point to understanding investment is Stiglitz' (1996 pp.226-247) argument that in a well-informed competitive economy, investments with the same return, same tax treatment, same liquidity and same risk would be valued equivalently. Differences in the returns, risk, tax and liquidity cause differences in the worth of investments. Relatedly, differences in how well-informed people are about returns, risk, tax and liquidity aspects of an investment cause differences in valuations placed on investments.

Stiglitz (1969) argues that if information failures mean risk markets are deficient and thus inefficient, and governments underwrite some of the risk of particular types of investment, then more of that investment will occur than otherwise would be the case. Problems of under-investment in risky areas are thereby reduced. An example of this would be the way Managed Investment Schemes spread risks of losses over large numbers of investors, and through the mechanism of tax deductibility of losses, the State gets to share some of the risk too. Economic issues surrounding income tax law and investment in agriculture in Australia are canvassed in considerable depth in a report for the Rural Industries Research and Development Corporation by Lacey *et al* (2006). In this report, these researchers expressed concern that the MIS sector – but not all MIS - 'continues to perform poorly with respect to realistic or actual rates of return versus projected rates' (Lacey *et al*, 2006, p.vii). The important economic issues surrounding questions of investment in MIS hardwood plantation schemes arise in the literature about the economics of information, viz. asymmetry of information, moral hazard and agent-principal problems. These terms are explained briefly below.

Winner of the 2001 Nobel Prize for Economics, George Akerlof, contributed to theory about the way unequal access to information affects the behaviour of economic agents and the operation of the economy. He did this in the 1970 classic paper 'The Market for Lemons: Quality, uncertainty and the Market Mechanism'. When the quality of a purchase, or an investment, cannot be known well before the purchase or investment is made, there is an incentive for the seller to claim that a poor product or investment is good, regardless of whether it is actually of poor quality or of good quality. This is not profound. Buyers recognize this incentive for the seller to take the buyer down (Sellers would say it is good, wouldn't they!). Buyers regard the quality of the product or investment as uncertain. It might be good as the seller claims, but it is also quite likely to be of poor quality.

Rational buyers, aware of information asymmetry and resulting incentives that result from this state of affairs therefore act on the belief that only average quality products or investments are on offer. One of Akerlof's insights was that such behaviour by sellers and buyers means products or investments that are of above-average quality will be forced from the market. This happens because sellers of the high quality products or investments will never be appropriately rewarded for the quality of their product or investment, i.e. in the context of the used car market, only 'lemons' remain.

Applying Akerlof's insights about 'lemons' in the context of MIS investments, asymmetrical information could mean that where the sellers of the schemes have more information than the buyers, the market will tend towards the situation where only the 'very ordinary' performing 'products' are offered and purchased by increasingly sceptical buyers. People unwilling to risk being defrauded will either not buy the product, or

will spend less on them than they would if they were more fully informed. The market for the product about which there is seriously asymmetrical information can even disappear.

Closely related to the consequences of asymmetric information in a market are so-called moral hazard and principal-agent issues. Moral hazard refers to the situation where the risk of people behaving badly and causing bad things to happen is increased when the person who causes the problem is able to benefit from doing so. For example, having taken out fire insurance on an asset, the insured has an incentive to (i) set the asset afire or, in a marginally less criminal act, (ii) not take as much care to prevent it catching alight. This is the meaning of moral hazard. In the context of investments under incomplete information, moral hazard arises the more the investor relies on another person or entity to possess critical information; or the more autonomy is granted to an agent for the investor; or the more specialized is the knowledge required to perform a task. In all of these situations, the greater is the incentive for sub-optimal performance (moral hazard) by the agent on behalf of the investor.

The principal-agent problem is similar: this concerns problems that emerge when a principal employs an agent and information is incomplete or asymmetrical. In essence the principal agent problem is the challenge of getting an agent to act for the principal in a manner as well as the principal would act for himself or herself. This is essentially a motivation and incentive issue. This problem is particularly pronounced when the potential benefits to the principal are considerable and the costs to the agent to provide these benefits are similarly significant. And, where it is not easy for the principal to observe and monitor and influence the performance of the agent. The solution to the principal-agent/information problem is to get the incentives 'right', such that agents will act in the way that principals want.

As Lacey *et al* (2006) note, the principal-agent and moral hazard phenomena are 'closely entwined' (p.6). Asymmetry of information in investment markets imply that some degree of market failure will always feature. There will always be plenty for the Australian Securities Investment Commission (ASIC), the Stock Exchange, the Tax Office, and the Competition and Consumer Commission, to be going on with. In the following discussion of the behaviour of public and private participants in the forest plantation MIS 'game', examples and consequences of asymmetrical information and principal-agent and moral hazard issues are evident, and suggestions are made about ways to reduce these problems in the design and enforcement of public policy about Managed Investment Schemes for hardwood plantations.

Farm Management Analysis

It is well known to farm management economists that the potential contribution of natural assets to business profitability becomes clearer in the context of the whole farm. Increasingly, scientific researchers and agricultural technologists are seeing environmental services in this context, and valuable new knowledge is being generated.

Increasingly policy-makers, and policies, recognize that running a farm business involves a complex mixture of human, technical, economic, financial, risk and institutional elements. These elements are formed into a productive whole business by farm families with a wide range of goals, abilities, and resources, and a wide range of capacity and willingness to respond to (re-organize) the ever-changing agricultural circumstances and societal pressures that confront them.

The argument presented in these notes is that farm management economics has the tools of proper analysis of the practical questions about using and conserving natural resources that enables better-informed decision making. This contributes to better private and public outcomes for natural resources. Note that 'analysing properly and practically' means in ways that are theoretically sound yet fully recognize the reality that decision-makers have limited time or other resources to conduct formal decision analyses. Improved decision analysis should not involve more time or effort, rather the availability and use of better information and different thinking can often bring about a marked improvement in the quality of information used in a decision.

The focus of this section is on implications for private decisions, and for private and public 'negotiation' about natural resource management once we move from the abstract 'firm' and 'resources' of 'fully informed perfect competition' to real family farm businesses where the mastery of information ranges from a lot to a little and there is much that decision-makers cannot ever know well or even at all.

It is observable that there exists in farming a wide range of performance of firms, and of partial productivity indicators of activity performance. Some of the difference performance is attributable to different capacities to command resources such as capital and management skill, and different attitudes to the risks involved.

At the same time, some of the difference in firm performance is attributable to differences in the command of knowledge and information resulting in poorer decisions than would be the case with greater knowledge. This source of efficiency loss - poorly informed decision-makers operating on lower production functions than they could be - can have implications for environmental services.

Implications of better informed decisions about farming for environmental services could be: (i) well run and eventually wealthier farm businesses can afford to undertake environmental investments and activities, (ii) development of part of farm systems can reduce environmental pressure on sites of natural resource significance, and (iii) if information problems are a cause of poor farm management decisions, the analysis of options offered for environmental purposes may not be as good as they could be and the public outcomes that result from an environmental viewpoint may not be as good as they could be.

What are environmental services worth?

The two main economic questions confronting a farmer who manages resources that have potential value in supplying environmental services are:

In what ways can this part of my business help me achieve my goals, as part of my farm system and as part of my overall farm and non-farm investment portfolio?

To what extent will supplying environmental services help me achieve my goals as part of my farm system?

Viewed another way, the question the farmer faces becomes 'How much will my aim of achieving certain goals be compromised if I set aside part of my business for environmental services and manage in a way that maximizes these values?'

Answering these questions first requires that the goals of farmers are identified, and the potential role of these resources is understood in the context of the whole business investment portfolio. It is not quite as straight-forward as this either, as goals and means are interrelated. That is, achieving an aim – and the way it is achieved – are both important. A goal may be to increase wealth, and have some overall levels of exposure to business and financial risk. The way this is done will also be a source of utility. Farmers have to weigh up the extent to which the means of achieving goals interacts with and affects the utility derived from achieving various goals.

Goals change as time passes. Goals change as the business environment changes – as too do risks as well as attitudes to them. For example, a market collapse or time of extended drought can cause some goals to be put on hold while business survival becomes imperative.

Goals can be in conflict; for instance more wealth, more leisure, less risk. As risk creates returns, low risk is not compatible with achieving high wealth. In pursuing multiple goals, farmers have to make trade-offs between the extent to which conflicting goals are pursued and achieved.

In practice farmers find a path through the maze of alternative and sometimes conflicting goals and means. They will shuffle medium and long term goals to the back of the pack at times to deal with immediate imperatives. Decisions about running the farm business and emphasizing one goal over another are being made regularly and are unavoidable.

The public too faces competing goals. Public resources can be used to obtain environmental services from farmers, or any of millions of alternative uses. The public is in a position to adopt different attitudes to risk to that of private investors.

Farm Benefit Cost Analysis

The criterion for a farmer evaluating whether or not to provide environmental services to the public on a commercial basis is expected net benefits over the planning period relevant to the owners of the business. Expected net benefits is total benefits minus total costs, with risk considered.

The magnitude of many but not all total benefits and total costs can be estimated quantitatively and valued by placing monetary values on them. Benefits and costs that cannot be well defined in quantitative terms or sensibly be given money values also need to be given weight in the decision.

Farm benefit cost analysis is conducted to identify the net benefits from a plausible range of farm futures. The process of deciding whether, or to what extent, the managers of these farms ought to contemplate changing the way they manage their system involves a number of steps.

Identifying the goals of the family and the owners and managers is the first step in analysing how a farm, is currently being run. The current annual situation with of the human, technical, financial, economic and risk state of affairs the way the system currently operates is established.

Complementary, supplementary and competitive relationships and quantities were assessed. The current state of assets, debt and equity, is established. Most likely annual operating profit and net cash flow before and after debt servicing is estimated for the system for the coming production year, based on most likely activity yields, prices and gross margins, and most likely opportunity discount rates and for financial analysis, interest rates. Expected balance sheet at end is estimated and expected growth in equity.

The sensitivity of key indicators such as efficiency (return on capital), liquidity (net cash flow) and growth (change in equity) to scenarios reflecting volatility of prices, yields and interest rates is tested. The implications of volatility for the achievement of short and medium term goals is assessed using scenario and sensitivity testing.

Having established 'what is', the next step is to investigate 'what could be'? Plausible alternative futures involving a small number of options for change are defined and analysed for the medium term.

One potential future is continuation of the current system with minimal changes, mainly to do with expected future prices and costs. The return on marginal capital in the steady state, net present value (NPV) and internal rate of return (IRR) of investment in a range of options are estimated. Annual measures of performance of the farm system in the respective steady states of the alternative futures are compared. Comparisons are made between cumulative medium term outcomes too – NPV and IRR for economic efficiency and wealth, nominal net cash flow for liquidity. These key measures are subject to risk investigation too. The implications of these analyses for decisions about management of natural resources depend on the detail of each system and each future analysed.

In evaluating whether to provide environmental services, the role of business and financial risk and return is emphasized, not just average returns; further, a whole of business investment portfolio perspective is used. The questions asked, and answered, are:

what alternative futures face these businesses?

What are the time, risk, profit, and wealth implications for profit and risk of these businesses operating in ways that ensure particular environmental services are supplied.

What are the implications for the natural phenomena that are providing the environmental services in these alternative futures of these farm businesses

Risk analysis simulation tools ('Crystal Ball', @Risk) can be used to establish distributions of the values of key variables in the farm performance instead of single values in the analysis. The performances of farm systems are measured by the distribution of possible net present values (addition to wealth) and returns to capital that result from running the farm in alternative ways over the planning period.

The planning period should include the effects of say, a one per cent per annum 'squeeze' in real terms on costs paid and prices received. That is, costs of production are forecast to increase at three per cent per annum with inflation and other influences and prices received rise at two per cent per annum in nominal terms. This approach has the effect of imposing downward pressure on real farm net returns unless changes are implemented to increase productivity and overcome the effects of the 'cost-price squeeze'.

Comparison of the expected net wealth arising from each of the alternative futures explored provides information to the farm owners as to (i) which farm plan promises the most net wealth for the risk involved over the planning period; (ii) how much net wealth for the risk involved is likely to be foregone if a farm plan is pursued that protects conservation values of the high conservation value areas; and (iii) the implications for net wealth and risk of the 'do little different' option.

In weighing up the merit of the alternative farm plans the extra annual return on extra capital invested to make the change is computed. The farmer needs to judge whether the investment in farm development is worth doing in light of the rewards and risks from alternative uses of the capital involved.

The information provided by such analyses can help farmers form judgements about how to run the farm as part of their whole investment portfolio over the next decade. Or, for how much to sell the rights to use parts of the farm. This economic information can be combined with other information, such as the amount the public might pay to ensure the environmental services are supplied. The potential returns and risk spreading benefits if extra capital invested on the farm was instead invested in a non-farm use; the non-pecuniary values the landowner may place on having the area of high conservation value land on the property; the rewards from being involved with others who are doing their 'environmental bit', and so on.

Measures of performance to use

The operating return on the capital invested in the farm system is estimated for the relevant planning period. This is called the Internal Rate of Return (IRR). To estimate the IRR it is necessary to invest capital to 'purchase' the farm assets at the start of the analysis, add further capital to change the farm system and increase productivity, and 'salvage' the remaining capital at the end of the planning period.

The Net Present Value (NPV) is another criteria used to judge investments on the farms. Net Present Value is the sum of all the benefits minus all the costs after they have been converted into their equivalent present values. The analytical technique called discounting is used to convert the value of future benefits and costs into their equivalent present values. Present value (PV) is calculated as follows:

$$PV(x) = x/(1+r)^t$$

where x is the future amount of a benefit or cost, r is the discount rate expressed as a proportion, t is the number of years it will take to receive the benefit.

The difference between the present value of benefits and costs is called the Net Present Value (NPV)

$$NPV = PV(\text{benefits}) - PV(\text{costs})$$

Decision makers want investments that provide a NPV greater than zero when the NPV is calculated using a cost of capital or discount rate that represents the return foregone from a realistic alternative investment. Net Present Value allows for the fact that when a resource is allocated to one investment, it is no longer available for use in other investments. The process of discounting captures this effect by deducting the amount that the resource could earn in its best alternative use, or, if the capital is borrowed, deducting the interest cost.

Suppose a project has a NPV equal to \$1 million when the cost of capital/discount rate is five per cent per annum in real terms (no inflation). The fact that the NPV is greater than zero means the capital invested in the project is earning more than five per cent real return.

Suppose that the real discount rate that makes the NPV of this investment equal to zero is 10 per cent. This 10 per cent return then is the Internal Rate of Return (IRR). A NPV of zero at 10 per cent discount rate means that the project has earned a 10 per cent real rate of return over its life.

Where there are several alternative uses for a set of resources, involving different patterns of cash flow, the use that gives the highest *NPV* for a defined discount rate is the one that returns the highest net benefits.

Understanding what *NPV* is or means is not easy. Imagine buying and running a business and borrowing all the capital involved at the market interest rate. If all the flows of cash out and in over a time period will recover all the capital and pay all the interest, with no net benefits remaining, the net present value of the investment is zero.

If *NPV* was positive, this would represent the present value of the net benefits above the cost of capital over the life of the investment. A positive *NPV* calculated using a particular cost of capital is the net addition to wealth expressed in current value dollars above the wealth that would be generated in the alternative investment that has been foregone.

Annual Return on Marginal Capital in the steady state is the third economic measure used. This indicator shows the performance of the extra capital that is added to the Status Quo farm plan. This figure can be compared with what the extra capital that is invested could earn in other uses on the farm or off the farm as part of the farmers overall investment portfolio. Annual Return on Marginal Capital is estimated using a partial development budgeting method, where only the extra returns and extra costs and extra capital invested are analysed.

Risk associated with each of the farm plans over the planning period is incorporated in the analysis mainly by using probability distributions of key variables such as yields, prices and interest (discount) rates instead of single value estimates. That is, risk is incorporated through having a range of values for prices, yields, costs, carrying capacity etc.

Levels of key variables such as wool price, interest rates, inflation rates, supplementary feed expenditure are defined as most likely, highest and lowest levels expected for each case study. In practice in decision making, the decision-maker's subjective probability distributions about key risky variables are the relevant probabilities. The distributions of possible levels of risky variables form the basis for the probabilistic outputs of the analysis, such as returns on capital and additions to net wealth.

The notion is that decision makers' attitudes to risk and the risk situation of their business investments on farm and off farm affect how an extra investment is judged. For instance, a farmer who is strongly averse to increasing the risk profile of their business may look favourably at a change that looks highly likely to increase their wealth or return to capital a lot but increase their risk only a little. Equally, they may look askance at a change that added a lot of risk and added only a little extra return to capital or net wealth.

A method known as 'Monte Carlo' sampling from these probability distributions for 1000 'runs' of the 10 year farm plan enables random combinations of prices, yields and interest rates to occur, and probability distributions of the criteria of *IRR*, *NPV* and *NCF* to be estimated. From this the probability of *IRR*, *NPV* or *NCF* being above or below critical levels is revealed.

Risk can be defined as business risk and financial risk. Business risk is refers to the volatility of factors affecting the business such as yields, prices, costs, weather events, disease events, accidents and so on. Financial risk exists separately to business risk. Financial risk is the risk associated with the level of debt and equity of the business, and the debt servicing obligations this entails. The level of gearing (debt to equity) of a business exacerbates business risk.

In making a decision, the effect of the investment on overall financial risk of the business also comes into play. The financial risk associated with the development options analysed are individual to each case, and affected by the existing gearing ratio and financial risk of each of the case study businesses. Financial risk comes into the overall judgement about the risk of the investment and whether to adopt the change or not. Judgements about the particular changes analysed are formed in the context of overall risk of the total investment portfolio and strategy of the decision maker.

Presenting Results

The results of analysis are presented as the cumulative distribution function of outcomes and the average (mean) values and standard deviations of the distributions of outcomes, for the following:

- Return to Total capital invested (IRR) over life of investment
- Return to Marginal (Extra) capital invested in changing the farm plan
- Net present value at opportunity cost discount rate (ranks the farm investments according to addition to wealth);
- Financial: cumulative net cash flows, peak debt and payback period

Interpreting probabilistic results

Results of the analysis are produced from a large number, say 1000, runs of the farm plans over the planning period, with randomly selected values of key risky variables such as prices, yields, interest rates. Results are presented in terms of the total distribution of outcomes. The farm plans are evaluated by comparing the Cumulative Distribution Function (CDF) of the possible outcomes for each investment, as explained below.

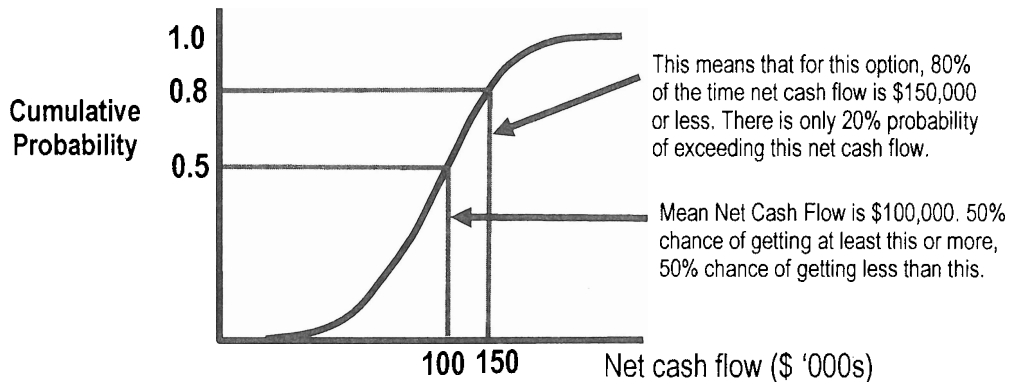


Figure 1 An example cumulative distribution function and how to interpret it (diagram not to scale)

The CDF's of the NPV and IRR of each farm plan – SQ, Future Options - are able to be plotted together. This enables alternative strategies for each farm to be compared directly in terms of business risk and returns. A cumulative distribution function for one option located to the right of the CDF of another option is said to be stochastically dominant option. This means that for the same level of risk, the option promises higher return, or, for the same return, lower risk. The investment that promises greater return at any given level of risk is said to 'stochastically dominate' the other investments. For someone who does not prefer more risk to less, the stochastically dominant option is preferable.

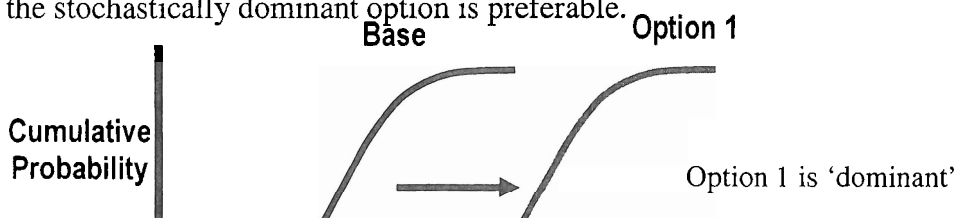


Figure 2 Cumulative distribution function for option one is stochastically dominant over the base case (*status quo*).

'Less than' CDF results are presented. This shows that for dollar value of NPV or return on capital, there is a particular probability that the investment will perform at less than or better than some defined levels. For example, it has no chance (zero probability) of being less than some minimum level; it is certain (probability of one) of being less than some maximum level; and so on. For instance, there might be only 20 per cent chance (200 of the 1000 runs of the 10 year farm plan) that the outcome will be less than \$100,000 and 80 per cent chance (800 of the 1000 runs of the 10 year farm plan) that the outcome will be less than \$150,000. This suggests there is 60 per cent chance (600 of the 1000 runs of the 10 year farm plan) that it will be between \$150,000 and \$100,000, with 20 per cent chance (200 of the 1000 runs of the 10 year farm plan) of getting more than \$150,000.

How to relate the distribution of outcomes from 1000 runs of the farm investment budget (called a model) to the reality that the farmer will experience only one such run of 10 years in practice? The analysis identifies the likelihood of each of the different runs of years and events, and the corresponding outcomes or results, occurring. The investor is informed about the likelihood of each of the 1000 outcomes occurring. He or she can form a judgement that if the probability is sufficiently high for enough good outcomes, the investment can be considered a good bet, or *vice versa*.

Regardless of the situation, the steps in farm benefit cost analysis as outlined above remain the same. The particular focus, when emphasis is on supplying environmental services, is on investigating an alternative future among others for the farm business in which public objectives have a chance of being achieved to some extent.

The key measures associated with this future, when compared to other alternative futures, indicate the magnitude of private net benefits or opportunity costs of pursuing a change to the system that also contributes to meeting public objectives.

One of the key aims when carrying out these analyses is to identify where within the system if environmental services are competitive or complementary or supplementary to the activities.

It might be the case that the best return to marginal capital is to invest in improving the productivity of the existing areas that are not directly valuable for environmental services, to the extent that is compatible with retaining associated environmental values. The superiority of this plan might be clear-cut.

In another case the superiority of the environmental services plan might not be marked but could be made more so by contributions from the public, or by values farmers might place on these goals themselves.

Another case: it might make no business sense to run the farm in a way that is compatible with supplying environmental services. More likely, there will be some degree of compatibility, but also a point above which devoting more resources to managing part of the farm primarily for environmental services begins to carry significant risks for the business.

It is not the expected sum foregone that determines the price suppliers of environmental services will require to provide those services. This is because the net benefits foregone by supplying environmental services is not a fixed annual sum, but instead fluctuates from year to year. The comparison then is between the value placed on a fixed annual sum in compensation for foregoing a variable stream of net benefits.

What does it all mean for the farmer?

Considering risk in establishing the 'right' price for farmers selling environmental services to the public.

The approach to considering supplying and selling environmental services to the public is not much different to considering supplying and selling any other farm product. Simply the questions are: what do I gain?, what do I lose?, what are the risks?, and, is it worth it? Risk adjusted extra net benefits (profit and unmeasurable gains) and financial feasibility are the criteria.

Commonly, crude partial approach to evaluating decisions about supplying environmental services are applied. For example, average annual gross margin foregone from an activity that was previously undertaken compared with annual payment for supplying the environmental service is often the estimate of net benefits. This approach to deciding whether or not to supply environmental services is inadequate because partial approaches leave out much important information and annual averages are artificial constructs – it is only relevant if you plan to live forever and don't much care what happens along the way. The whole portfolio of activities, risk and net benefits over time, all matter.

Whole business

The way to answer questions about supplying environmental services is in the context of potential for changes in the whole farm and off-farm 'system', over a relevant planning period. Such considerations may involve a series of changes, including changes to parts of the whole system that are not about supplying environmental services but which, if made, make the option of supplying environmental services profitable and financially feasible. If one part of the business is further developed and profit and cash flow and debt servicing ability is increased, the option of providing environmental services from another part of the farm may become feasible.

The whole changed profit, finance and risk profile of the changed whole system that includes supplying some environmental services, over time, is the relevant criterion to use to judge the merit of supplying environmental services.

Risk over time

Further, what matters is the expected pattern of the future stream of net benefits over the planning period in question. This stream of net benefits will fluctuate around the calculated average, and such fluctuations

matter. Two different streams of net benefits can have the same average, but not be equally attractive to the recipient of them. One stream may be more uncertain and more volatile than the other and different people will have different feelings about receiving each of these two streams of net benefits.

In a farm business, a farm activity and an activity supplying environmental services will represent streams of future net benefits that have different certainty and different variability. Certainty and volatility of expected net benefits over time have to be taken into the consideration of the change. Simply comparing average annual expected net benefits from the alternative activities is not good enough.

The degree of certainty and expected variance of these streams of net benefits matters. This has implications for the public trying to acquire as much environmental services as possible with limited resources with which to do so.

A farmer considering selling environmental services to the public may find it attractive to introduce into his/her whole mix of streams of net benefits from their range of activities an activity that is more stable than the streams of net benefits in their existing portfolio.

For example, it may be attractive to a farmer to have the chance to introduce a guaranteed and stable stream of net benefits in place of a less certain, more unstable stream of expected benefits from a substitute activity in the portfolio of streams of net benefits that combine to form whole business net benefit.

The portfolio approach means that a farmer might be willing to sell the right to the resources that currently make up an activity that has a medium term expected net present value of \$0.5m with a variance of 40% for an activity supplying environmental services that has a guaranteed net present value of \$0.3 and a variance of zero.

This might be attractive to a farmer because having a portion of the whole portfolio of activities of the business that is certain may enable some other riskier venture that has potentially high net benefits to be undertaken as well.

The principle of constant risk is relevant here. This holds that farmers will assemble a mix of activities that gives them an overall exposure to risk that they are willing to bear.

Thinking carefully through the whole business risk implications of changes to their business is essential if farmers are to put the 'right' price on their environmental services; and the public is to get the most environmental services from their limited budgets.

Farmers and an emissions trading scheme

Few people are making the argument that agriculture should never be part of an ETS. The opposite is the case. For an ETS to operate efficiently and achieve fully the potential outcomes, coverage across activities in the economy should be as wide as possible. This ideal has to be set against the reality that the participants in the ETS are operating on the basis of sound information. So far, around the world, ETSs have worked as predicted by economic theory when this has been the case, e.g. a few polluters emitting well defined quantities of pollution, doing this year in year out relatively unaffected by external environmental and economic conditions, and with well-defined instruments to trade. Agriculture could hardly be further from this situation. Extrapolating from successful ETSs operating with highly measurable and efficiently enforceable emissions to applying the same concept to situations that are in essence unmeasurable and unenforceable would be folly. Caution is well-warranted.

The characteristics of the activity emitting carbon and the design of the system determine whether or not an ETS works effectively. There are numerous difficulties and significant potential costs of knowing and verifying what carbon is emitted from particular farm systems, when agriculture comprises a large number of small sources of emissions. There are significant impediments to useful estimates of emissions: emissions from each agricultural system will vary from season to season with the same activity according to seasonal conditions, and will change over time with changes in way activities are conducted.

This is a major impediment to the effective operation of an agricultural component of an ETS.

Some relatively low cost carbon abatement exist, while the potential and outcomes for agriculture of the higher cost abatement measures is highly uncertain. Overall, the abatement supply curve will differ from farm to farm and industry to industry and time to time, and is largely unknown. Further, how this will change as firms adapt throughout the economy is unknown.

Much uncertainty surrounds estimates of agricultural emissions. At present Australia does not have measurements of agricultural emissions that have tolerable discrepancies between estimates and actuals to be useful for the purposes for national inventory purposes. The Australian Greenhouse Office view that agriculture can make a 25 per cent contribution to emissions warrants verification.

Emissions trading has implications for competitiveness, profitability and future prospects of agriculture, and agriculture's inclusion in an ETS will create incentives for carbon leakages.

If agriculture is included in an ETS then it would be fully exposed to increased costs from all markets and to paying a price for emissions and earning income from sinks. A variation on this would be if heavily trade-exposed activities were shielded from bearing fully their carbon costs.

If agriculture was left out of an ETS, agriculture will still be affected by increased costs of energy inputs and of energy intensive inputs. At the same time, demand for forest sink activities grows with an ETS. So too does demand for bioenergy sources of feedstock.

Including agriculture in an ETS adds cost burdens that, if not matched by competitors, makes for leakage of greenhouse gas emissions to the non-burdened producers who respond by increasing output and emissions. Farm activities that are 'trade-exposed' are eligible for compensation. This is necessary to prevent such leakage and to protect against the possibility of agricultural production being reduced beyond the level it ought to be if all competitors also incurred the burden of emission charges.

The exposure of agriculture to carbon costs, even if it is not in an ETS, could come from upstream where energy and other input costs are affected, or downstream where agricultural outputs are affected, or by agriculture being able to participate in voluntary abatement by selling offsets for sinks or reducing emissions beyond business as usual.

Policy and subsequent firm actions and reactions need to be based on sound information about what is actually happening, as against what is thought might be happening. Economic theory about the consequences and practical outcomes of information asymmetry can be usefully invoked.

The danger is that market mechanisms in which participants act on imprecise measurement will cause inefficient outcomes, outcomes that may be no better than the unsatisfactory outcomes that are predictable and inevitable from regulatory approaches. The issues of the point of liability and whether agriculture should be included in an ETS directly or indirectly via upstream and downstream proxies are critically important. For example, input and output-based proxy estimates of farm emissions are not closely correlated with actual farm output of carbon. Indirect measures can generate inefficiencies similar to those associated with the regulatory approaches.

Even voluntary schemes are fraught with problems, such as establishing the with-without situation that is apt in order to determine the validity of claimed 'additionality'. The baseline plus credit method requires a tight monitoring and compliance regime, and are fraught with difficulties such as defining what is additional, above what would have happened anyway because actions were beneficial regardless of carbon value.

The question is: how much uncertainty surrounding agricultural emissions is acceptable? Some of the degrees of uncertainty reported in the literature seem decidedly low and unrealistic – and probably are. There are inefficiencies and dangers of emitters and sellers of carbon sinks acting on estimates of emissions that are poor approximations of actual emissions, e.g. scope for roting is introduced by such discrepancies.

Even if estimates of agricultural emissions by farm firms were thought to be adequate 'on average' (i.e. errors will roughly cancel), this means that some producers are paying too much and others are paying too little - or, equally, farmers would be over-responding and under-responding abate emissions. The 'on average' approach would achieve the dubious double of being both inefficient and inequitable.

There is a considerable body of economic theory about the economics of information that support concerns about the inefficient and inequitable consequences arising from information asymmetry. This theory would come into full play with agriculture with poorly understood carbon emissions included in an ETS.

An ETS works well when there are few sources of emissions that can be measured accurately and cheaply, and pricing is possible on a large scale. When these conditions are not extant, major impediments to efficiency ensue. The clear conclusion is that in NZ, Canada, the US and the EU the approach to including agriculture in carbon emission abatement schemes is cautious and tentative. NZ is the only country with plans to mandate the inclusion of agriculture in an ETS in the near future – 2013 was the date. This plan has since been put back to 2018 because the difficulties encountered created doubts about the workability of such a plan – problems that would apply to agriculture in Australia.

There are positives and negatives of a mandatory emissions trading arrangement. An ETS will affect agriculture whether agriculture is in it or not. Costs of energy and energy intensive inputs will rise. High cost or inaccurate measurement of emissions will impose financial burdens on agricultural firms, and cause transfers of income and losses of efficiency. As well, opportunities will be created as relative prices in

markets change (e.g. grain and bio-energy feedstocks) and opportunities to sequester carbon arise (at this stage, almost solely via forestry).

The notion put forward in the Garnaut 'Emissions Trading Scheme Discussion Paper' is that agricultural activities should be subject to the same set of carbon prices and abatement incentives faced by other sectors of the economy. The significant qualification put forward by both Garnaut is that, to date:

The measurement, monitoring and verification of emissions are handicapped by 'technological uncertainties', which prevent the sectors being 'measured and verified at reasonable cost and with reasonable accuracy' (Garnaut 2008, p.5, p.19, p.20 reported in Consultant report p.72.).

The focus for future efforts to bring agricultural emissions into an ETS should be on practicalities that tackle the prohibitively expensive direct measurement of agricultural emissions.

Concluding comments about agriculture and an ETS:

The best advice regarding inclusion of agriculture in an ETS seems to be 'not yet because it is impractical and has a high probability of being a costly mess'. No other conclusion seems possible. The potential of including agriculture in an ETS creating a Common Agricultural Policy-style administrative and operational economic mess may have an unacceptably high probability.

There are serious doubt that benefits will exceed costs sufficiently given the uncertainties; the implications it will hold for production and competitiveness; the uncertainty surrounding the measurements causing outcomes no better than crude regulatory methods; and because of the inevitable inefficiencies and inequities that will be created.

There are too many unknowns; unacceptably high risk of high cost; unacceptably high risk of failure to achieve objectives; unacceptably high risk of leakage overseas; unacceptably high risk of inequity; and unacceptably high risk of agriculture being forced to contract more than would be warranted if competitors were bearing carbon costs too.

Acting precipitously in the face of many unknowns and great uncertainties is folly. There is merit in the adage 'wait and see'. The concerns with the measurement problems of including agriculture in an ETS are far from trivial. Each farm system is unique at any point in time. The conditions under which farmers operate change constantly through time. Carbon emissions from a farm system will be different regardless of management intentions, simply because of the seasonal conditions that apply at any time. Over time, the systems are constantly evolving in response to human, economic, technical and environmental changes. Obtaining approximations of carbon emissions from any particular farm system over some time that would be even roughly right is nigh on impossible, even at considerable cost, which it could well be. Including agriculture directly in an ETS and expecting the estimates of emissions for a time period across the great number of farm systems to be near the mark seems unduly optimistic. Using the indirect points of obligation is probably a 'less bad' approach, but these approaches too are fraught with potential for great distortions, counter-productive incentives and moral hazards.

The question of appropriate perspective for analysis of effects of greenhouse gas policy is critical. There are two issues involved: time horizon and incidence of additional costs. The appropriate time horizon is medium to long term; well beyond first-round effects of a change in costs have impacted on farmers and consumers and everyone in between. Much current focus of work, seems more short-term than should be the case.

Furthermore, transparent consideration of the incidence of additional costs imposed anywhere in a production or marketing system is fundamentally important to the carbon cost debate. Ultimately, additional costs of carbon pollution will be borne either by producers or consumers, shared according to the relative price elasticity of demand and supply for the good or service affected by the added cost. If long run supply of a good is more elastic than long run demand for it, then the largest share of the incidence of carbon costs will be borne by consumers. Added cost burdens, contrary to intuition, are not fully paid where they are laid. Recognition of this is in the expectation that most of added carbon costs of energy say will be passed on by energy producers to energy consumers with relatively price inelastic demand. Farmers in Australia, facing price elastic international demand, whether short, medium or long term price elasticity of demand, are unable to pass on added costs to international consumers so must bear the full burden themselves. Nor can they pass on costs to domestic consumers under conditions of free trade.

Getting the comparison of with-without right is the essence of correct economic analysis. Comparing the status quo with an alternative future is never the proper comparison, because the status quo is not an alternative future in a dynamic world. The correct comparison is between the alternative futures that could exist, with and without the change in question. Unfortunately, so far, most work assessing possible impacts on agriculture of carbon costs has estimated the additional burden on farm systems as they currently operate, which is not how they will operate in the future when carbon costs are part of their farm costs. Future farm systems will operate under higher real costs of inputs, higher productivity of inputs, and different real prices, all as a result of economic growth throughout the world. The correct comparison is the performance of these future farm systems under these changed conditions of real costs, prices and productivity that are a consequence of economic growth without a direct carbon charge on emissions and with a carbon charge. This approach identifies the impact on agriculture of the introduction of an ETS.

Care is needed when considering the scope for low cost options to reduce emissions. Reductions in methane emissions are possible through feeding management strategies, and these strategies have both costs and benefits that can reduce the net cost. These options will develop and be viable for some intensive ruminant animal industries. As in all agricultural innovation, the extent of the effectiveness varies system by system, operator by operator. Similarly with potential for carbon sequestration by soils. There are some particular circumstances where net carbon can be sequestered, such as sowing cereal crops into low producing native pasture. This concept is being oversold though. First, this benefit only applies up to the new carbon equilibrium that is reached. The payment is for the net addition only above what would be beneficially done anyway, which has then to be maintained. Not fully recognized is that sequestering carbon in the soil has adverse effects of locking up nutrients, thereby imposing an offsetting cost to the farmer. Further, it increases nitrous oxides emissions, offsetting some of the carbon capture effect. It is noteworthy that Australia kept land out of the Kyoto Agreement because under dry conditions, or with bushfires, land becomes a net emitter of carbon not a sink. The rules of Kyoto also require that if soil carbon capture is included in national carbon accounting, all soils have to be included. Also, the rules of Kyoto mean that if soil carbon capture is included in national carbon accounting, all soils are included. Skepticism about the contribution soil carbon capture can make to emission abatement seems warranted.

Voluntary engagement though is one means of allowing opportunities to emerge and indicate potential benefits to agriculture of being included in an ETS. Information asymmetry and scope for sharp practices abound though.

Finally, discussions of abatement at farm level need to be put in the context of the best use of farmers resources. To succeed, investment in carbon capture still has to offer a better return on marginal capital than alternative investments. At some carbon prices, this is highly unlikely to be the case in many farm systems.

Conclusion

There will be a certain amount of compensation from the public that the farmers will be willing to accept in compensation for foregoing the variable potential benefits of farming their resources in some other way.

When a farmer who owns potential environmental services and the public negotiate to supply environmental services, the farmers make offers that represent the cost they would incur if they forego the right to use the resources of their business in a way that changes its environmental status in a way the public does not want to happen. This sum is what they need to be compensated to manage areas with high environmental value in ways that meet the goals of the public, instead of running their these areas in a different manner.

The public weighs up the price being asked and the environmental values that would be achieved. More explicitly incorporating consideration of future opportunities foregone, business and financial risk, and the time value of money, into these negotiations will make for a more informed negotiation process. More informed bargains lead ultimately to more efficient outcomes. More goals, public and private, are achieved.

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