IMPROVING BENEFIT COST ANALYSIS FOR MALAWI'S FARM INPUT SUBSIDY PROGRAMME, 2006/7 TO 2010/11

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Summary

This paper develops improved estimates of benefits and costs of the Malawi Farm Input Subsidy from 2005/6 to 2010/11. It sets out principles and purposes for Benefit Cost Analysis (BCA) for the programme and applies them to develop a relatively formal partial equilibrium methodology for BCA that distinguishes between real income gains to subsidy recipients, other producers, and consumers. This allows differential multipliers to be applied to these income gains to allow simple analysis of wider equilibrium and dynamic effects of the subsidy programme.

Benefit cost analysis faces difficulties due to lack of reliable data on the number of farm households in Malawi and on cropping parameters needed for estimation of the programmes' impact on production. Nevertheless the modified benefit cost analysis leads to increased estimates of returns to the subsidy programme. The benefit cost ratio averaged across 2005/6 to 2010/11 was previously estimated at 1.22, with an average fiscal efficiency of 0.31, using moderate assumptions regarding prices and yield responses to fertiliser and improved maize seed. Precise estimate of returns to the programme are difficult due to a variety of methodological and data quality difficulties, but with the revised methodology the average benefit cost ratio is estimated at around 1.6, with fiscal efficiency of around 0.45. The analysis provides important pointers to ways in which programme design and implementation can be improved to make the programme more effective and efficient. It also suggests that with good implementation the programme can provide returns that are comparable to and exceed those achievable from alternative and complementary investments in infrastructure, education and agricultural research. The programme therefore has an important role as a critical element in a strategy of balanced government investments promoting poverty reducing growth in Malawi.

1. Introduction

This paper develops benefit:cost estimates for the Malawian Farm Input Subsidy Programme (FISP, formerly known as the Agricultural Input Subsidy Programme, AISP). Previous estimates of the benefit:cost ratio have not allowed for wider consumer and growth benefits (see for example SOAS, 2008; Dorward et al, 2010; Dorward and Chirwa, 2010; Dorward and Chirwa, 2011) and this has made it difficult to compare the programme's returns against estimates of returns to other possible investments, such as in roads or agricultural research, when these other estimates may include allowance for consumer and growth benefits. In this paper we attempt to address these omissions but give emphasis to methods that have relatively simple analytical and data demands (to allow their application in practical policy analysis) but nevertheless yield reasonably robust estimates that allow valid comparisons with estimates of the costs and benefits to potential alternative investments.

The paper is structured as follows. After this introduction we first consider the purpose and principles for BCA and common methods used in BCA. We then review problems and challenges identified with previous Benefit Cost Analysis (BCA) of the FISP. This leads on to suggestions for ways of improving FISP benefit/ cost estimates and we discuss the implications of these for estimation of returns to investment over the life of the programme. We conclude with a brief discussion of

- the wider relevance of the estimated benefits from the Malawi FISP,
- implications for the design and implementation of the FISP, and
- implications for future data collection and BCA.

2. Benefit - cost analysis purposes and principles

Benefit - cost analysis (BCA) of input subsidy programmes has two main functions.

- It gives an indication of the returns to the programme as compared to returns that might be achieved from alternative investments, and thus can guide overall government investment and spending decisions. Estimates of such returns are also commonly used for more general comparisons of the returns to different types of investments (for example between agricultural input subsidies, research, and infrastructural development) in order to guide investment choices between programmes.
- It provides information about the variables that are important in determining costs and benefits of a specific programme or type of programme, and hence can guide programme design and implementation decisions to increase benefits relative to costs.

These two uses of BCA are both important, but they present analysts with something of a dilemma. The first requires that common standards are used for BCA across different programmes, perhaps in different sectors, to give comparable results across different investment alternatives. These standards generally involve standardised methods, but it is often difficult to apply such methods across programmes that affect people and the economy in different and complex ways and in different policy contexts. These difficulties need to be recognised when making comparing comparisons between BCA results obtained for different programmes. The second purpose of BCA requires not so much standards for comparable estimates of returns, but accurate estimates of the relative importance of different variables in affecting these returns in particular investments– and here there may be more value in tailoring methods to match specific programme features, and a danger that the results may not be comparable with analysis of other investments, but may nevertheless be (wrongly) used in this way.

Taking these two purposes together with an overall objective that BCA should provide rigorous, reliable, and objective estimates of benefits and costs, we suggest the following seven principles for the choice and implementation of BCA methods (these are not set out according to any prioritisation). BCA methods applied in any situation should be

1. *Practicable*: They must be applicable with data and analytical resources (skills and software for example) that are available (or can reasonably be obtained)
2. *Externally consistent*: They must provide measures that are comparable with generally accepted good practice in definitions of costs and benefits (for example in definitions of financial and economic benefits).
3. *Contextualised*: They must take account of particularities that affect the benefits and costs of a programme as regards the processes by which costs and benefits are linked, the effects of other policies and investments on these, and the conditions affecting these.
4. *Holistic*: They must take account of all the significant benefits and costs associated with a policy or investment programme, both direct benefits and costs to recipients and indirect benefits and costs to others.
5. *Internally consistent*: They must properly represent the significant relationships between investments and behaviours by different stakeholders, taking account of ‘counterfactuals’ (comparing actual behaviours and outcomes under the programme or investments against those that would have occurred in its absence)

6. *Transparent*: Assumptions, measures, data sources, shortcomings and possible bias and inaccuracies in methods and their results must be stated and discussed.
7. *Cost effective*: BCA methods should be chosen, developed and implemented to ensure that costs of analysis are commensurate with or proportional to the value of the information provided.

Cost effectiveness of methods is of course affected by the costs of BCA methods in providing information and in the value of the information provided.

- Costs are determined by resource demands for gathering extra information needed and for analysis (as discussed above under *practicability* and as we discuss below as regards demands for different methods).
- The value of the information provided is determined by its quality and by the scope for its use.
    - The determinants of quality are determined by *external and internal consistency*, *holism* and *contextualization* (as discussed above) and by strengths and weaknesses of analytical methods (which we discuss below)
    - Scope for use of information is determined by *transparency* of results (as discussed above), by the strengths and weaknesses of different methods (which we discuss below), and by the potential 'decision space' for changes in policy choices, design and implementation in the light of new information provided by BCA.

There are particular challenges in applying the first four of the principles above to the specific situation in which the FISP operates.

1. *Practicable*. There are severe limitations in data availability (for example on crop areas and yields, the yield and production effects of subsidised seed and fertiliser, and the number of farm families in the country - see for example Dorward and Chirwa, 2010 a and b). There are also limited financial and human resources available for analysis, but the determination of the "counterfactual" situation of what would have happened without a subsidy is very complex, properly requiring consideration of changes throughout the whole economy as a result of changes in farm incomes, in food prices, and in the real incomes of consumers. The data and resource limitations lead to a fundamental question about the practicability of making any reliable estimates without substantial improvements particularly in data availability.
2. *Externally consistent*. Limited availability of good quality data poses problems for the application of good practice in BCA. A further difficulty arises with the long standing history of policy interventions inhibiting maize imports and exports, as this makes it very difficult to identify true economic prices for maize – conventionally import and export parity prices should be used in economic analysis, but one may legitimately ask if liberalised market policies are a real policy option for the Malawian Government (see for example Tschirley and Jayne, 2010, for a nuanced discussion of these issues). If import parity prices are to be used in the analysis then it is very difficult to determine what national prices would actually have prevailed with and without the subsidy (this adds to the already difficult task of estimating counterfactual 'without subsidy' prices for comparison against the 'with subsidy' situation –a 'double counterfactual problem').
3. *Contextualised*. The effects of the subsidy on livelihoods are complex, widespread and in many ways specific to the problems faced by poor Malawian smallholders (see for example Dorward and Chirwa, 2011, for discussion of the low maize productivity trap and of the policy context). Analysis has to take account of these contextual issues – but this may lead to conflict with the two previous principles – requiring more complex, non-standard analysis.

4. *Holistic*: The scale and nature of the FISP means that it has widespread, complex and varied effects on the livelihoods of different farm households, on consumers, and on maize and labour markets (see for example Dorward and Chirwa, 2011). Ideally this requires holistic consideration of dynamic and interacting changes in rural livelihoods and in rural and national markets. This presents very large data and analytical challenges. This is clearly related to the problems of contextualisation, with similar potential for conflict with the principles of practicability and external consistency – for example can simpler methods be modified to represent key effects of wider, complex changes and also generate results that allow meaningful comparison with BCA on other investments?

3. Benefit - cost analysis methods

Investment and policy analysis methods can be classified according to the extent to which they focus on direct, 'partial equilibrium' effects of an investment or policy on the beneficiaries in the relevant sector as against wider, indirect 'general equilibrium' effects on beneficiaries and non-beneficiaries across all sectors in an economy. Increasing consideration of wider indirect effect increases the analytical complexity and data requirements. However although these effects may not be important for smaller scale interventions, they may dominate the direct effects for large scale investments in the agricultural sector or for significant market policies, if these affect food prices and the productivity of large areas of land and large amounts of labour. Where more complex and demanding general equilibrium methods are used these should properly represent markets' and different stakeholders' behaviours and interactions. Where more simple partial equilibrium methods are used, then these should where possible build in simple adjustments to simulate possible wider economy effects.

It is helpful to distinguish between 3 basic methodological approaches to BCA for large scale policy investments:

a) *Regression models* which estimate returns to investments by analysing comparative data sets across different regions in a country, for example, and estimating the impacts of investments on welfare measures or economic growth (for example Fan et al, 2007), implicitly taking account of multipliers and wider general equilibrium market effects.
b) *Computable general equilibrium (CGE) and multi-market models* which analyse the effects of investments by simulating economic behaviour with and without investments – with general equilibrium models simulating economy wide effects, and multi-market models examining effects across a more restricted set of markets (for example Buffie and Atolia, 2009, describe a CGE analysis of the Malawi FISP – they use this to consider the relative benefits of investments in the FISP against investments in infrastructure but do not undertake a formal BCA of the FISP)
c) Partial equilibrium models which examine investment's welfare impacts on producers and consumers (for example Timmer, 1989, for Indonesia).

These models differ as regards their data demands, the nature of the analytical challenges they present, and their ability to allow for market failures, differential effects on different types of consumers and producers, linkages and multipliers across markets, and the interactions between these. Table 3.1 sets out the broad characteristics of these three types of model.

Table 3.1 Broad characteristics of three model types

	Regression models	CGE/ Multimarket models	Partial equilibrium models
Data demands	Time series data for different relatively independent regions: investment, welfare & other variables	National & multi-sectoral data on supply, demand, factor ownership, productivity & market performance. Direct productivity impacts of investment / policy interventions	Demand (& ideally supply) information on specific commodity/ies of interest. Direct productivity impacts of investment / policy interventions
Capacity to describe multi-market, indirect effects	Good: intrinsic in analysis of broader welfare effects	Good: the key benefit of these models, but depends on quality of model formulation & data	Weak: no explicit consideration, but can introduce *ad hoc* adjustments to allow for these effects
Capacity to describe differential market failure effects	Good: should be intrinsic in analysis of broader welfare effects but may not capture some spillovers	Weak: very challenging as regards data demands & model formulation	Weak: no explicit consideration, but can introduce *ad hoc* adjustments to allow for these effects
Capacity to isolate effects of specified intervention(s)	Depends on range of conditions in data set – difficult if covariant changes or if there are varying spillovers across regions	Good, depending on quality of model	Can be good, depending on context & processes
Strengths	Good data sets & properly executed analysis can give very holistic empirical analysis	Multimarket effects, counterfactuals	Relatively simple data & methodological demands
Weaknesses	Very demanding requirements as regards historical/ empirical data sets – this can limit breadth of application of models; assumptions / context may not be explicit or generalisable; may not account for some spillover effects	Complex & demanding; proper representation of market failures & differential behaviour of producers & consumers very challenging - otherwise misleading ; assumptions / context may not be explicit.	Does not take account of market effects – these can only be addressed with simple relatively *ad hoc* adjustments

It is clear from table 3.1 that the three different approaches have different, and in many ways complementary features and strengths and weaknesses. We can conclude from this that

- In different contexts there will be different choices of method to best follow the principles outlined earlier.
- In all cases analysts must recognise and take account of the limitations of their methods and data, and document these to ensure that those using their results are able to properly interpret them.

- Those using BCA results to compare returns from different investments must take great care to ensure that differences in analytical methods, issues and data quality are properly allowed for in these comparisons
- Those using BCA results to guide policy or investment design and implementation must also take great care to ensure that strengths and weaknesses in analytical methods, issues and data quality are properly allowed for in their considerations.
- In the particular situation of the Malawi FISP
    - it is impossible to conduct regression analysis as the empirical situations and data available do not allow this
    - CGE and multi-market models are very demanding of analytical resources and data, and consequently these models may be used for stylized analysis of possible effects, but will be too expensive in implementation, too complex in application / interpretation, and too reliant on weak data to provide a practicable method for regular and detailed year by year analysis
    - The much more limited data and analytical demands of simpler partial equilibrium models mean that they are the most practicable (though there are still significant challenges here)
    - Major concerns among decision makers within Malawi have been more with evolving, relatively detailed design and implementation questions and less with relative returns to different investments, but this may change. To date, however, the issue of external consistency has therefore been less important than in wider regional debates about the relative returns to input subsidies as compared with other possible investments.

4. Problems and challenges with Benefit Cost Analysis (BCA) of the FISP

Evaluations of the 2006/7 and 2008/9 subsidy programmes, and estimates of benefit costs ratios for other years, used a standard partial equilibrium methodology for estimating the economic benefit cost ratio and fiscal efficiency of the subsidy programme (SOAS et al, 2008; Dorward and Chirwa, 2009; Dorward et al, 2010; and Dorward and Chirwa 2010). It was recognised, however, that this method did not take account of wider benefits to poor consumers, from lower food prices and that paradoxically a lower price of maize provided a lower estimate of programme benefit when in fact lower maize prices should lead to wider growth and poverty reduction benefits.

SOAS et al (2008), Dorward and Chirwa (2009), Dorward et al (2010) and Dorward and Chirwa (2010) consistently identified a number of concerns with use of their results in comparing estimated returns from subsidies and other investment. These concerns are also relevant to the limited reports of benefit cost and related analysis by others (eg Denning et al, 2009; Buffie and Atolia, 2009) and to discussion of these results.

The concerns may be broadly classified into related problems first with data, second with methodology, and third (and sitting behind the methodological problems) are some wider theoretical concerns. These problems are of course related, as

- methodologies embody theory and require, and are limited by, data, and
- theories require, and are embodied in and limited by, methodologies

Three major theoretical questions concern

(a) the measure of benefits,
(b) extent of benefits and processes of change, and
(c) the valuation of incremental production.

The measure of benefits: Ideally benefits should represent welfare changes to recipients and non-recipients. This, however, raises questions about the nature of welfare, methods of measurement or estimation, and the relative importance and weighting of welfare changes for different stakeholders (for example questions about the relative importance of welfare changes in poorer and less poor people, and about the relative importance of welfare changes in people now and in the future). Economic theory provides widely used measures of welfare changes through the concepts of consumer and producer surplus. There are, however, severe methodological and data difficulties in the estimation of supply curves needed for the estimation of changes in producer surplus. As a result, changes in real income are commonly used as proxy measures of welfare in benefit cost analysis, and generally provide similar answers (Sadoulet and de Janvry,1995; Alston, et al, 2000). The relatively simple analysis in SOAS et al (2008), Dorward and Chirwa (2009), and Dorward et al (2010) provides reasonable estimates of changes in aggregate real income across producers and consumers, but no information about the distribution of these benefits between producers and consumers or between beneficiaries and non-beneficiaries. This differentiation is important for the use of weights to address distributional questions about welfare changes for different types of people.

The extent of benefits and the processes of change: Dorward and Chirwa (2011) argue that subsidy programme benefits can have wide ranging and far reaching dynamic effects where they directly overcome financial market failure and investment affordability problems of recipients, address these same problems for poor non-recipients through lower maize prices and higher wages, and also provide more conventional multiplier growth effects (where for example increases in recipients' income lead to increases in consumption of locally produced goods and services, and hence increases in incomes for local providers of these goods and services). Haggblade *et al.* (2007) suggest agricultural multipliers (excluding dynamic effects from overcoming market failures) range from 1.3 to 1.5 in Sub Saharan Africa, while Davey and Davis (2008) report estimated multipliers of 2 to 2.45 from conditional cash transfers in Dowa (though these fixed price estimates may be reduced by 30% to allow for supply constraints, to yield estimates of 1.4 to 1.7). Diao *et al.,* (2003) estimate a multiplier of 1.5 from increases in grain productivity in Malawi while Benin et al (2008) estimate a multiplier of 1.1 from increases in maize productivity in Malawi.

Dynamic effects and multipliers are implicitly allowed for in BCA using regression analysis (for example Fan et al, 2007), and they should be explicitly modelled in general equilibrium analysis, although dynamic effects of overcoming market failures are seldom allowed for in such models. Multipliers and dynamic effects are not allowed for in partial equilibrium methods, and this leads to a bias underestimating returns from partial equilibrium analysis if these estimates are compared with results from regression or general equilibrium analyses.

The valuation of incremental production: The concerns discussed above about the measure of benefits and their extent and distribution are concerned with the valuing of incremental production, in a very broad sense. Here, however, we discuss two narrower issues, first the choice of prices for valuing output and second the discount rate to use.

As noted earlier, there are legitimate questions about the feasibility of liberalised market policies as a real policy option for the Malawian Government, and hence if economic analysis should use border or domestic prices. Either way there are then serious methodological challenges in determining 'counterfactual' prices for a situation without the subsidy (with a 'double counterfactual' problem if combinations of domestic and border prices are to be used). SOAS et al (2008), Dorward and Chirwa (2009) and Dorward et al (2010) used information on border prices with informed judgement to address the 'double counterfactual' problem to estimate what border prices would have prevailed with and without the subsidy in the absence of policies restricting imports.

No explicit discount rate was used in comparing the benefits and costs of the subsidy. However any comparison of the benefit cost ratio from the subsidy with internal rates of return estimated for longer term investments involves an implicit assumption that benefits are achieved one year after investment. It might, however, be argued that costs are incurred in December to January (when seeds and fertilisers are paid for and applied to the field) but benefits are obtained in June (when crops are harvested), giving a return after 6 or 7 months. It might also be considered, however, that benefits from lower maize prices and increased consumption are enjoyed over the period June to May, yielding a return over an average of around 12 months. These two alternatives have major implications for estimates of internal rates of annual return, as the former has a net Internal Rate of Return (IRR) 70-80% higher than the net BCR (net benefits divided by costs).

The discussion above addresses theoretical and related methodological concerns with the standard use of partial equilibrium analysis in BCA for the FISP. These concerns are exacerbated by and linked to difficulties with the quality and availability of critical data on yield responses to subsidised inputs, on overall production data, and on the number of rural and farm households.

5. Improving FISP benefit/ cost estimates

Consideration of these theoretical, methodological and data difficulties together with the earlier discussion of purposes and principles for BCA suggests a number of approaches to improving the BCA of the subsidy programme. These involve

1. Continued use of partial equilibrium analysis, with its relatively limited demands for data and analytical resources but formalisation of price estimation used in analysis
2. Extension of the method to distinguish between producer and consumer gains and, among producers, between subsidy recipients and non-recipients
3. Consideration of possible dynamic effects of growth and liquidity multipliers
4. Consideration of results from analysis with alternative estimates of time periods of return

All of these approaches involve elaboration of the estimation of programme benefits: estimation of programme costs is not conceptually problematic. Total costs incurred in input acquisition (including transport and distribution costs) are added to programme administration costs, with application of shadow exchange rates to non-tradable costs in the later years of the programme when the Malawi Kwacha is generally considered to have been over-valued. Costs of acquisition for subsidised inputs that displace unsubsidized inputs are subtracted from the programme costs, as these provide no incremental benefits and are simply a transfer from government to the recipients of those subsidised inputs. They therefore have little effect on the benefit: cost ratio of the programme, as they are excluded from both benefits and costs (they do, however, affect the Net Present Value (NPV) of the programme, and hence its fiscal efficiency, NPV/ fiscal costs).

5.1. Methodology for formal estimation of prices and producer and consumer gains

To improve our estimates of programme benefits, we begin by formalising price estimation, focusing on the effects of the subsidy programme on maize production[1]. Figure 5.1 shows how for an autarkic economy[2] a production subsidy causes a downward shift in the market price supply curve (S to S*) and this leads to an expansion in supply (from Q to Q*) and a fall in consumer price for the product (from P to P*).

[1] 2006/7, 2008/9 and 2010/11 household surveys reported in SOAS (2008), Dorward et al. (2010) and Dorward and Chirwa (2011) show that almost all the incremental fertiliser use as a result of the subsidy programme was applied to maize and there is no evidence of shifts in cropping patterns in 2008/9 as a result of the subsidy programme (Holden and Lunduka (2010) also find no evidence of shifts in cropping patterns, although Chibwana et al (2010) suggest some shifting into maize by subsidy recipients.)

[2] The assumption of autarky is a reasonable analytical starting point for the Malawi maize market, given the high transport costs in exporting to or importing from the world market. We consider later the effects informal imports from surrounding countries (notably Mozambique), actual or potential price ceilings from potential imports from South Africa, and exports to Zimbabwe in 2007/8.

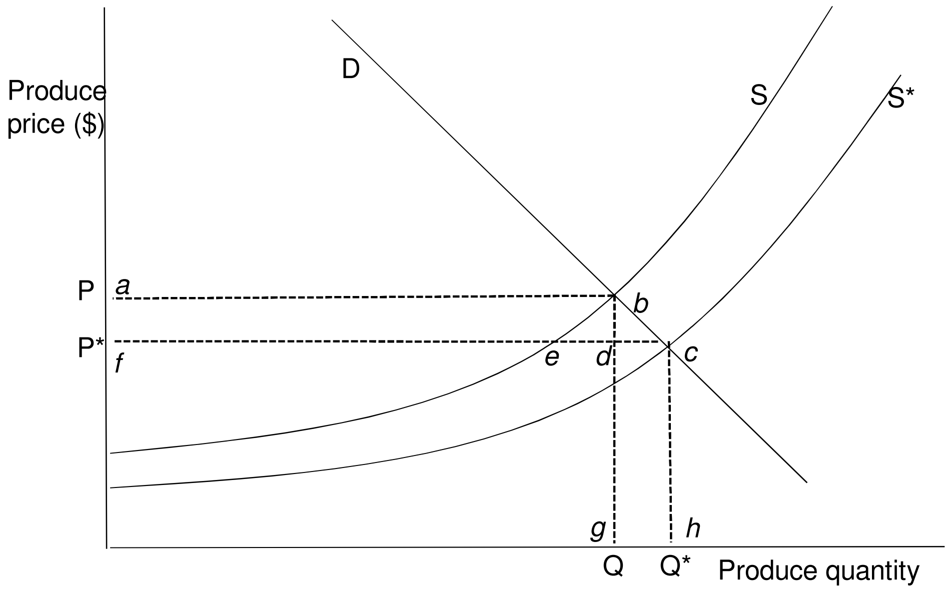

Figure 5.1 Input subsidy impacts on output supply and price
(adapted from Dorward, 2009)

The change in real income for producers is analysed in terms of the effects of changes in output prices, costs, and volumes produced and sold.

Change in producer income $\Delta Y_P = Y_P{}^* - Y_P$

$$\Delta Y_P = [QP^* + (Q^* - Q)P^* - \Delta Q_F c^* - (Q^* - \Delta Q_F)c] - [QP - Qc] \quad (1)$$

$$\Delta Y_P = (Q^* - Q)P^* - Q(P - P^*) - \Delta Q_F c^* - (Q^* - Q - \Delta Q_F)c \quad (2)$$

where $Y_P{}^*$ = producers' income after subsidy

Y_P = producers' income before subsidy

Q* = production after subsidy

Q = production before subsidy

P* = output price after subsidy

P = output price before subsidy

ΔQ_F= increase in production from use of subsidised inputs

c = producers' average unit costs for output before / without subsidy

c^* = producers' unit costs for extra output (*ie* excluding subsidised costs)

The change in producers' income therefore consists of changes in sales value less the costs of production with the subsidy plus the savings on unsubsidized production where this has been displaced by subsidised production. The change in sales value is made up of a loss due to the fall in product price for the original amount produced (area *abdf* in figure 5.1), but a gain from extra production at the lower price (area *dchg* in figure 5.1)[3]. With totally elastic

[3] In the long run the loss of producer incomes from falls in unsubsidised maize production and in prices may be smaller than estimated here as rising real incomes for consumers will raise

demand there would be no price loss and all the subsidised production would be extra production, hence under these circumstances $\Delta Y_P = (Q^* - Q)P^* - \Delta Q_F c^*$. With totally inelastic demand there would be no increase in production and all the subsidised production would displace unsubsidized production, hence $\Delta Y_P = -Q(P - P^*) + \Delta Q_F(c - c^*)$. Under these circumstances $\Delta Y_P = 0$ and hence $Q(P - P^*) = \Delta Q_F(c - c^*)$..

The change in real income for consumers consists of the savings on existing purchases due to the price fall (*abdf* in figure 5.1) plus the savings in extra purchases which are best valued in terms of savings on previous expenditures (area *bcd* in figure 5.1).

$$\text{Change in consumer real income} = \Delta Y_C = (P - P^*)Q + \tfrac{1}{2}(P - P^*)(Q^* - Q) \qquad (3)$$

Total change in producers' and consumers' real income can be estimated by the sum of changes in producer and consumer incomes:

$$\Delta Y_T = (Q^* - Q)P^* - \Delta Q_F c^* - (Q^* - Q - \Delta Q_F)c + \tfrac{1}{2}(P - P^*)(Q^* - Q) \qquad (4)$$

The method for estimating overall benefits in equation 4 is broadly that used in evaluations of the AISP (SOAS et al, 2008; Dorward et al, 2010). These used analysts' informal judgement of 'double counterfactual' prices with and without the subsidy respectively to estimate P* and P in the absence of government bans on formal imports.

P can, however, be estimated using formal estimates of price elasticity of demand (E_D), together with information on prices and production with the subsidy. $(P - P^*)$ can then be substituted as follows:

$$(P - P^*) = \frac{1}{E_D}\frac{P^*}{Q^*}(Q^* - Q) \qquad (5)$$

We can then substitute for $(P - P^*)$ into equations 2, 3 and 4 as follows:

Change in producer real income

$$\Delta Y_P = (Q^* - Q)P^* - Q\frac{1}{E_D}\frac{P^*}{Q^*}(Q^* - Q) - \Delta Q_F c^* - (Q^* - Q - \Delta Q_F)c \qquad (6)$$

$$\text{Change in consumer real income} = \Delta Y_C = \frac{1}{E_D}\frac{P^*}{Q^*}(Q^* - Q)(Q + \tfrac{1}{2}(Q^* - Q)) \qquad (7)$$

Change in producer and consumer real income

$$\Delta Y_T = (Q^* - Q)P^* - \Delta Q_F c^* - (Q^* - Q - \Delta Q_F)c + \frac{1}{2E_D}\frac{P^*}{Q^*}(Q^* - Q)^2 \qquad (8)$$

Equations 6 to 8 still present problems in that we require an estimate of $(Q^* - Q)$. However, the seasonal separation of supply and demand means that if we can initially ignore farmers' expectations of lower prices in the following season then incremental production will be equal to the increase in production from use of subsidised inputs, so that $(Q^* - Q) = \Delta Q_F$.[4] Introducing this into equations 6 to 8 gives the following estimates of changes in real income:

Change in producer real income

$$\Delta Y_P = \Delta Q_F(P^* - c^*) - Q\frac{1}{E_D}\frac{P^*}{Q^*}\Delta Q_F \qquad (9)$$

$$\text{Change in consumer real income} = \Delta Y_C = \frac{1}{E_D}\frac{P^*}{Q^*}\Delta Q_F(Q + \tfrac{1}{2}\Delta Q_F) \qquad (10)$$

Change in producer and consumer real income

prices for non-maize and non-farm goods and services, which can replace their lost and/or lower value maize production

[4] As noted above, this is the approach that was used in evaluations of the AISP (SOAS et al, 2008; Dorward et al, 2010)

$$\Delta Y_T = \Delta Q_F(P^* - c^*) + \frac{1}{2E_D}\frac{P^*}{Q^*}\Delta Q_F{}^2 \quad (11)$$

All of the analysis in this section has been derived from our initial consideration of a closed economy (Figure 5.1). It does, however, also apply for a small open economy with a wide band between import and export parity prices. Thus if increased production causes an economy to eliminate imports of Q_M so that the price falls to P*, below import parity P_M, then this can be handled by estimating gains in consumer and producer real incomes allowing for these prices.[5]

In these circumstances then assuming that $(Q^* - Q) = \Delta Q_F$ as above then

$$\Delta Y_P = \Delta Q_F P^* - (Q - Q_M)(P_M - P^*) - \Delta Q_F c^* \quad (12)$$

$$\Delta Y_C = Q(P_M - P^*) + \frac{1}{2}(P_M - P^*)(\Delta Q_F - Q_M) \quad (13)$$

and $$\Delta Y_T = \Delta Q_F P^* + Q_M(P_M - P^*) - \Delta Q_F c^* + \frac{1}{2}(P_M - P^*)(\Delta Q_F - Q_M) \quad (14)$$

Use of equations 9 to 11 or 12 to 14 depends on the relative values of P_M and P: equations 9 to 11 are used if $P_M > P$, and equations 12 to 14 are used if $P_M < P$, where P is estimated from equation 5. If, in addition, $P_M < P^*$ then P_M replaces P* in equations 12 to 14, and there are no consumer benefits or producer losses from price changes. The equations above can also be adjusted to allow for exports if P* is below the export parity price P_X. In this case P_X replaces P* in equations 12 to 13 if the subsidy would move domestic prices from above import parity to below export parity prices, or in equations 2 to 3 (with replacement of $(Q^* - Q)$ by ΔQ_F) if the subsidy would move below domestic prices which are already import parity to below export parity.

The methodology developed in this sub- section demonstrates the basic validity of the BCA approach used in SOAS et al, 2008 and Dorward et al, 2010, but also allows a breakdown between producer and consumer benefits with more formal estimates of P and Q* if estimates of ΔQ_F and of price elasticity of demand (E_D) are available.

5.2. Estimation of price and quantity demand relations and of incremental production

We now develop estimates of overall returns to the subsidy and of separate producer and consumer benefits using the methodology developed above. First, however, estimates are needed of price elasticity of demand (E_D) and of ΔQ_F. These estimates are unfortunately not without their own difficulties.

We first consider the estimation of price elasticity of demand (E_D) or (more generally) of the relationship between price and quantity demanded. Figure 5.2 shows maize price (average annual prices from MoAFS market surveys) against estimated quantity consumed per capita over the period where quantity consumed per capita is calculated from Ministry of Agriculture and Food Security crop production estimates, census data, and exports and import estimates compiled from various sources.

[5] Note that where producers outside an economy export into that economy but at prices largely determined within the economy (as is broadly the case with Mozambiquan exports to Malawi) then the loss of producer income suffered by these producers due to the price fall is not a loss to the domestic producers and the domestic economy.

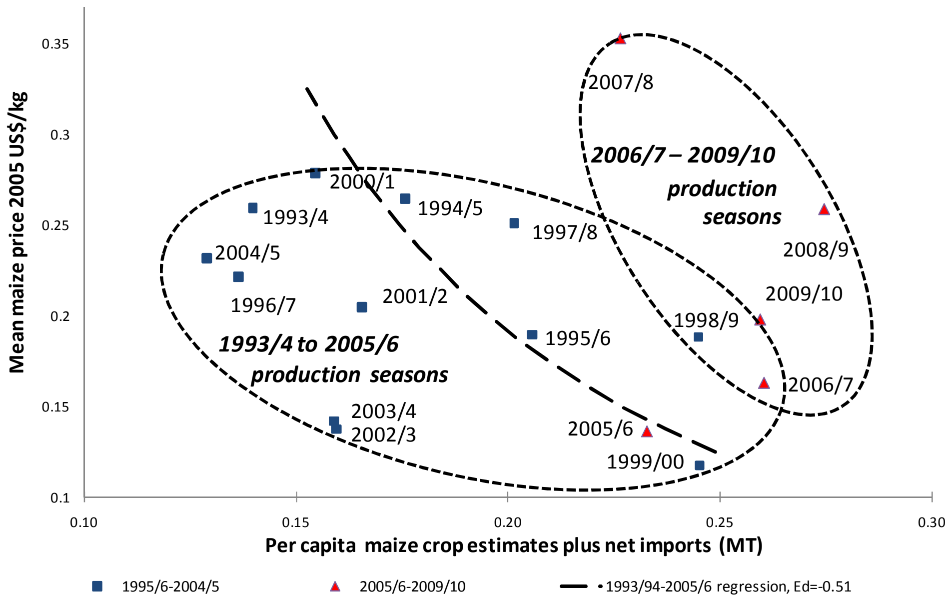

Figure 5.2 Maize prices and estimated quantity consumed per capita from 1993/94 to 2009/10 production seasons

(adapted from Dorward and Chirwa, 2011)

Dorward and Chirwa (2011) discuss the possible causes for the apparent discrepancy between the 1993/4 to 2005/6 and 2006/7 to 2009/10 series: increasing storage losses, increasing on-farm storage and thinner markets in the later years, inconsistency in production estimates (possibly inflated in later years), and higher nominal wages in later years with falls in real maize prices relative to income not captured in these years. The last point raises wider questions regarding appropriate maize prices to use in real income calculations[6]. If the latter two explanations are the two main causes, and if production estimates from 1993/4 to 2005/6 are broadly correct, then this suggests that the 1993/4 to 2005/6 data should provide a reasonable estimate of price elasticity of demand with constant wages – but that there will be a shift in demand where wages rise.

Three regression models were estimated of log quantity on log price quantity from maize price data and supply estimates from 1993/94. The first is derived from data from the 1993/4 to 2009/10 seasons with the inclusion of a dummy variable for subsidy effects from 2005/6 onwards and of a time variable to allow for changing base per capita demand over time. This gave an estimate of price elasticity of demand of -0.24 (n=17, t= 1.5, R^2=0.56).Given concerns about the reliability of data from 2006/7 to 2009/10 as discussed above and implausibly high estimates of 'without subsidy' prices when subsequently applying this model, it was rejected. The second model regressed log quantity on log price quantity from the 1993/4 to 2005/6 seasons[7] and gives an estimate of price elasticity of demand of -0.38 (n=13, t= 1.9, R^2=0.24). The third used the same data set with the inclusion of a time variable to allow for changing base per capita demand over time, and gives an estimate of price elasticity of demand of -0.51 (n=13, t=2.2, R^2=0.33). The third model was preferred as

[6] Dorward (2011) provides a wider discussion of the benefits of indexing food prices against income.

[7] Restriction of the data series to the 1993/4 to 2005/6 seasons (a) provides more consistent estimates than are obtained from the 1993/94 to 2009/10 series and (b) standardises for the effects of possible inconsistency in production estimates and of higher nominal wages in later years.

regards its better fit and inclusion of a time effect, and was therefore used in the analysis that is reported below and is shown in figure 5.2.

Having considered the estimation of the relationship between price and quantity demanded and hence of price elasticity of demand (E_D), we now consider the estimation of ΔQ_F , incremental production from the subsidy programme. The difficulties with obtaining reliable and precise estimates of ΔQ_F are discussed extensively in Dorward and Chirwa (2010). Previous estimates of the benefit:cost ratio in SOAS (2008), Dorward and Chirwa (2010) and Dorward and Chirwa (2011) have therefore estimated incremental production assuming that every kg nitrogen (N) in incremental fertiliser application leads to 12 kg incremental grain production when applied on local maize and to 18kg incremental grain production when applied on hybrid maize[8]. This approach was followed here, with incremental fertiliser application as a result of the subsidy programme estimated from 2006/7, 2008/9 and 2010/11 survey estimates of displacement of unsubsidised fertiliser sales by subsidised fertiliser sales.

5.3. Formal estimation of prices and producer and consumer gains

Using these estimates of the relationship between price and quantity available and of the incremental production from the subsidy we can now estimate changes in overall incomes from equations 11 and 14 over a range of assumptions, as shown in table 5.1 for the years 2005/6 to 2010/11[9].

Table 5.1 presents for each year the border adjusted prices estimated in one row with the demand elasticity discussed earlier (and shown in figure 5.2) and, in another row, using analysts' judgements. Different columns then show estimates of net benefits, benefit cost ratios (BCRs) and fiscal efficiencies (FEs) without any growth multipliers.

The main point of interest in table 5.1 is the differences between results obtained with prices estimated using demand elasticity calculations and those obtained with analysts' judgements[10]: estimated returns are generally higher with prices estimated using demand elasticity calculations than with those obtained from analysts' judgements. This arises partly from lower prices in analysts' estimates, particularly in the earlier years, due to more weight being given to the possibility of substantially lower price imports from Mozambique in 2005/6 and 2006/7 (to a lesser extent) in 2007/8 and 2009/10.[11]

[8] See SOAS (2008) for summary of a range of different studies from which these estimates were derived

[9] Elasticities of demand *per se.* were not used in these calculations, due to averaging problems over price and quantity ranges, instead the estimated equations were used to calculate price and quantity changes. Preliminary estimates for 2010/11 pending further information on seasonal maize prices and on displacement estimates.

[10] Differences in results across different years are due to variation in maize prices (with high domestic prices from 2007/8 requiring analysis using import parity prices for the without subsidy situation – and even for the with subsidy situation in 2007/8), and in fertiliser prices (which rose steadily from 2005/6 to a peak in 2008/9) - as discussed for example in Dorward and Chirwa (2011),.

[11] Where without subsidy domestic prices would be higher than import parity, the formal price estimation also allows for part of the subsidised production to substitute for imports (so that consumer benefits are not derived from a simple average of import parity and the with subsidy domestic price).

Table 5.1 Base Benefit Cost Analysis 2005/6 to 2010/11

Year	E_D	P	P*	P_M	P_X	BENEFITS: Net benefit, US$ mill	BCR	FE
		US$/kg						
2005/6	0.51	0.24	0.14	0.29	0.14	42.2	1.58	1.16
	Original	mean=	0.14	N/A	N/A	8.7	1.12	0.24
2006/7	0.51	0.25	0.13	0.32	0.17	47.1	1.48	0.64
	Original	mean=	0.15	N/A	N/A	6.0	1.06	0.08
2007/8	0.51	1.83	0.35	0.30	0.15	113.1	1.86	1.19
	Original	mean=	0.25	N/A	N/A	69.5	1.53	0.73
2008/9	0.51	1.27	0.26	0.28	0.13	-39.0	0.87	-0.16
	Original	mean=	0.28	N/A	N/A	-40.2	0.87	-0.16
2009/10	0.51	0.67	0.22	0.28	0.13	47.9	1.27	0.34
	Original	mean=	0.26	N/A	N/A	35.4	1.20	0.25
2010/11	0.51	0.86	0.19	0.35	0.20	144.3	1.76	0.99
	Original	mean=	0.27	N/A		95.7	1.50	0.66

Notes: E_D, P, P* P_M and P_X represent respectively demand elasticities, without and with subsidy maize prices (in current US$), and import and export parity maize prices (calculated from SAFEX prices with import and export transport costs of $100/MT and $50/MT respectively). BCR (Benefit Cost Ratio) is calculated as total economic benefit divided by total economic costs; FE (Fiscal Efficiency) as net benefit (total economic benefit less total economic costs) divided by total fiscal costs. Under E_D, 'AE' stands for Analyst Estimates as used reported in earlier evaluations and Dorward and Chirwa (2011). 'n.a.' indicates 'not applicable'.

We now use equations 9, 10, 12 and 13 to estimate producers' and consumers' relative gains.

Table 5.2 Consumer and producer benefits

Year	E_D	FISCAL COSTS	ECONOMIC COSTS: Gov't etc	Recipients	Total	BENEFITS: Producers: Recipients	Others	Consumers	Total
		US$ mill							
2005/6	0.51	36.4	28.4	44.4	72.8	77.8	-167.1	204.4	115.0
	Original	36.4	28.4	44.4	72.8	N/A	N/A	N/A	81.5
2006/7	0.51	73.9	53.1	44.6	97.7	111.3	-139.5	173.1	144.8
	Original	73.9	53.1	44.6	97.7	N/A	N/A	N/A	103.7
2007/8	0.51	95.4	82.1	50.0	132.1	245.2	0.0	0.0	245.2
	Original	95.4	82.1	50.0	132.1	N/A	N/A	N/A	201.6
2008/9	0.51	248.2	224.1	78.4	302.5	240.5	-16.8	39.8	263.5
	Original	248.2	224.1	78.4	302.5	N/A	N/A	N/A	262.2
2009/10	0.51	140.3	122.5	53.0	175.5	175.0	-70.0	118.3	223.3
	Original	140.3	122.5	53.0	175.5	N/A	N/A	N/A	210.9
2010/11	0.51	145.3	134.2	56.0	190.2	213.2	-134.8	256.1	334.5
	Original	145.3	134.2	56.0	190.2	N/A	N/A	N/A	285.9

Notes: E_D represents demand elasticities. Economic costs exclude costs of displaced fertilisers. Prod'n (Production) gains accrue to recipients. Data as from earlier evaluations, Dorward and Chirwa (2011) and table 5.1.

5.4. *Effects of growth and liquidity multipliers*

There is no particular methodology for building of growth and liquidity multipliers into partial equilibrium analysis, but the estimated economic benefits and costs from partial equilibrium analysis can simply be multiplied by relevant estimates of agricultural multipliers. As discussed earlier, a number of studies estimate agricultural multipliers of around 1.4 in Sub Saharan Africa and Malawi. We therefore initially introduce multipliers by multiplying farm benefits and costs by 1.4. It is also important to allow for possible multiplier effects of alternative use of resources invested in the programme. We use a multiplier of 1.2 for alternative investments (the lower number to allow for the high multiplier effects of increases in income to poor rural people), and multiply non-farm costs by this. Table 5.3 shows the results of this analysis together with results without the use of multipliers (also shown earlier in table 5.2).

Table 5.3 Benefit Cost Analysis without and with growth multipliers

		BASE			Growth Multiplier		
Year	E_D	Net benefit US$ mill	BCR	FE	Net benefit US$ mill	BCR	FE
2005/6	0.51	42.2	1.6	1.2	59.1	1.7	1.6
	Original	8.7	1.1	0.2	12.2	1.2	0.3
2006/7	0.51	47.1	1.5	0.6	76.6	1.6	1.0
	Original	6.0	1.1	0.1	9.4	1.2	0.1
2007/8	0.51	113.1	1.9	1.2	174.7	2.0	1.8
	Original	69.5	1.5	0.7	107.4	1.7	1.1
2008/9	0.51	-39.0	0.9	-0.2	-9.7	1.0	0.0
	Original	-40.2	0.9	-0.2	-9.8	1.0	0.0
2009/10	0.51	47.9	1.3	0.3	91.5	1.4	0.7
	Original	35.4	1.2	0.3	67.2	1.3	0.5
2010/11	0.51	144.3	1.8	1.0	228.9	2.0	1.6
	Original	95.7	1.5	0.7	150.0	1.7	1.0

Notes: E_D represents demand elasticities. BCR (Benefit Cost Ratio) is calculated as total economic benefit divided by total economic costs. FE (Fiscal Efficiency) is calculated as net benefit (total economic benefit less total economic costs) divided by total fiscal costs. Under E_D, 'AE' stands for Analyst Estimates as used in BCA reported in earlier evaluations and Dorward and Chirwa (2011). Economic costs exclude costs of displaced fertilisers. Data from earlier evaluations, Dorward and Chirwa (2011) and table 5.1.

The table shows substantially improved BCA results with allowance for the effects of multipliers. This is also shown in table 5.4, which compares results using three different sets of multipliers. The first of these is identical to that shown in table 5.3, the second two are calculated with different multipliers for different types of people, distinguishing between consumers (who are dominated by poor rural people), producers (where less poor rural people dominate in production for sale – SOAS et al, 2008) and subsidy recipients. For the latter, results are compared with two different multiplier values, the first with a lower value reflecting a bias in subsidy distribution to the less poor (as observed in 2006/7 (SOAS, 2008)), the second with a higher value to investigate possible effects of more effective targeting of subsidised inputs to poorer households.

Table 5.4 Benefit Cost Analysis with different growth multipliers

		Simple growth multiplier = 1.4			Differentiated: Consumers= 1.4; Producers = 1.2					
					Recipients = 1.1			Recipients = 1.4		
		Net benefit	BCR	FE	Net benefit	BCR	FE	Net benefit	BCR	FE
Year	E_D	US$ mill			US$ mill			US$ mill		
2005/6	0.51	59.1	1.7	1.6	88.0	2.1	2.4	98.0	2.0	2.7
	Original	12.2	1.2	0.3	18.0	1.5	0.5	19.3	1.5	0.5
2006/7	0.51	76.6	1.6	1.0	53.5	1.5	0.7	65.0	1.5	0.9
	Original	9.4	1.2	0.1	7.9	1.1	0.1	8.8	1.1	0.1
2007/8	0.51	174.7	2.0	1.8	116.2	1.8	1.2	174.7	2.0	1.8
	Original	107.4	1.7	1.1	71.4	1.4	0.7	107.4	1.7	1.1
2008/9	0.51	-9.7	1.0	0.0	-55.0	0.8	-0.2	-6.4	1.0	0.0
	Original	-9.8	1.0	0.0	-55.4	0.8	-0.2	-4.8	1.0	0.0
2009/10	0.51	91.5	1.4	0.7	68.9	1.3	0.5	105.5	1.5	0.8
	Original	67.2	1.3	0.5	53.6	1.3	0.4	79.4	1.4	0.6
2010/11	0.51	228.9	2.0	1.6	198.6	1.9	1.4	251.6	2.0	1.7
	Original	150.0	1.7	1.0	137.1	1.7	0.9	168.9	1.8	1.2

Notes: See notes for table 5.3. ‘Differentiated’ results with different growth multipliers for benefits and costs for different categories of people as shown. Multiplier of 1.2 for government costs throughout.

Lower multipliers for less poor people and higher multipliers for poorer people reflect a general pattern observed in growth multipliers, and may also result from dynamic benefits from subsidy receipt and lower prices and higher real incomes relaxing seasonal finance constraints.

Two broad observations can be made from the results presented in Tables 5.3 and 5.4. First, both tables show that estimates of net benefits, benefit cost ratios and fiscal efficiencies generally increase when the effects of multipliers are allowed for, and these increases can be substantial. Second, Table 5.4 shows that if different types of household have different growth multipliers then this can affect returns to investment. Since poorer households generally have higher multipliers and account for a higher share of consumption than they do of production, subsidies that lead to domestic price falls will, other things being equal, generally lead to higher returns. Similarly, greater targeting of the poor as subsidy recipients will also generally raise returns.

5.5. Effects of alternative estimates of time periods of return

It was noted earlier that the use of benefit cost ratios implies an annual return on investment. However, it might be argued that returns are achieved over a shorter period, for example 7 months from fertiliser purchase and application to harvest. Table 5.5 shows the effects of shorter returns on annual rates of return for different BCRs.

Table 5.5 Annual Rates of Return for benefit cost ratios achieved over different periods

	Annual Internal Rate of Return					
Months	7	8	9	10	11	12
BCR						
1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.05	1.09	1.08	1.07	1.06	1.05	1.05
1.10	1.18	1.15	1.14	1.12	1.11	1.10
1.15	1.27	1.23	1.20	1.18	1.16	1.15
1.20	1.37	1.31	1.28	1.24	1.22	1.20
1.25	1.47	1.40	1.35	1.31	1.28	1.25
1.30	1.57	1.48	1.42	1.37	1.33	1.30

As table 5.5 shows, if returns are achieved over shorter periods than a year then this can lead to substantial increases of the annual rate of return above the BCR – and these increases are larger for higher BCRs over shorter periods.

5.6. Sensitivity of BCA estimates to higher and lower yields and higher displacement

In this subsection we consider how for a given initial 'without subsidy' situation, changes in actual yield and displacement affect returns to investment. Annex table A provides information on estimates for the different scenarios.

Higher yields lead to higher returns from increased volumes of incremental production, but they also tend to lead to lower prices – increasing returns to consumers and losses to producers. This becomes important where differential multipliers are used. Where prices are very high and remain above import parity price then this does not occur, and its effect is also reduced where prices fall to the export parity price.

Increased displacement reduces incremental production, with opposite effects to those discussed above with increasing yields. Reduced returns are, however, counteracted to some extent by reduced costs, and this means that the BCR falls less than the Fiscal Efficiency (indeed if costs fall by a smaller proportion than benefits then the BCR may rise slightly while the FE falls significantly,).

6. Conclusions

We conclude with a brief review of the findings in this paper and discussion of their wider relevance to considerations of the economic viability of the Malawi FISP (and other subsidy programmes), and of their implications for the design and implementation of the FISP, and for future data collection and Benefit Cost Analysis.

6.1. Review of findings

In this paper we have considered purposes, principles and alternative methodologies for benefit cost analysis against particular theoretical, methodological and data challenges faced in BCA of the FISP. In light of this, we have put forward a formal methodology for improving the estimation of producer and consumer gains and losses and used this to provide alternative estimates of the programmes' annual net benefit, benefit cost ratio and fiscal efficiency from 2005/6 to 2009/10. The effects of multipliers (from growth linkages and liquidity benefits for poor households) and allowing for returns over a shorter investment period were also investigated. The results (using a simple average over the five years) are summarised in table 6.1.

Table 6. 1 Alternative estimates of returns to FISP investments, 2005/6 to 2009/10

		Annual return			Annualised return
	E_D	NB	BCR	FE	BCR
Basic estimate	0.51	60.38	1.48	0.70	1.59
	Original	30.01	1.22	0.31	1.27
Simple multiplier	0.51	106.04	1.62	1.15	1.78
	Original	57.41	1.34	0.52	1.42
Differentiated (a)	0.51	79.59	1.57	1.01	1.71
	Original	39.72	1.32	0.42	1.39
Differentiated (b)	0.51	114.74	1.68	1.31	1.86
	Original	63.16	1.40	0.58	1.50

See notes on earlier tables. Averages are simple (unweighted) averages.
Annualised return if BCR is achieved over 10 months.

Considering the different estimates for the base scenario (that is with estimated displacement for each year and incremental fertiliser yielding 18kg grain per kg N on hybrid maize and 12kg grain per kg N on local maize) there are a range of different estimates for different years. Without consideration of any growth multipliers, the estimated average BCR of the six years of the subsidy programme ranges from 1.21 (the estimates using analysts' estimates of prices) to 1.47 (with formal estimation of demand and an elasticity of demand of 0.51). Adding in multipliers raises the estimated BCRs to 1.32 to 1.4 using analysts' price estimates and 1.56 to 1.68 with formal demand estimation. Further allowance for returns over less than 12 months gives a range of the annual rate of return from 1.39 to 1.86, with multipliers. These are high estimated returns and support caveats in SOAS (2008), Dorward et al. (2010) and Dorward and Chirwa (2011) that their reported returns (using analysts' estimates of prices) were downwardly biased by exclusion of important effects of growth multipliers.

Making a precise estimate of the BCR remains difficult, for reasons that are clear from this paper, but leaving aside the possibility of achieving returns in less than a year, and taking the formal estimation as more reliable suggests that the average BCR is likely to be around 1.6 after allowing for the effects of multipliers, with fiscal efficiency of around 0.45. This is sensitive to yield responses (and hence both programme implementation and weather), and international maize prices. The latter have been higher in recent years, and are likely to remain high, and there is considerable potential for higher yield responses than those assumed here. Higher displacement would not affect the BCR very much but would lower fiscal efficiency.

6.2. Economic viability of the Malawi FISP

Overall these returns are high and suggest that the FISP provides a good return on investment– with scope for improved efficiency and effectiveness to make returns much higher in the future. However there are, of course, also risks of poor implementation, unfavourable weather and changes in prices that depress returns (see section 6.3 below and Dorward and Chirwa, 2011).

The extent to which the FISP represents the best use of investment funds depends upon competition for funds between different investments and their relative returns. Buffie and Atolia (2009) find, using CGE analysis, the net benefits of the FISP depend critically upon the relative returns to fertiliser use and to investments in roads, and upon the extent to which investment in FISP crowds out investments in infrastructure. They conclude that a strategy of mixed investments is probably best. Fan et al (2007) report that investments in education, roads, agricultural research and development, credit subsidies, and input subsidies (in that order) all yielded high returns in such a mixed investment strategy in the early stages of the green revolution in India[12].

There is very limited specific information on returns to alternative investments such as in roads and in agricultural research and development in Malawi, and it is common to rely on estimates from other African countries or from Asia. These tend to show very high returns to these investments. Buffie and Atolia (2009) use returns to infrastructure investment of between 10 and 30% (a BCR of 1.1 to 1.3), citing evidence from Fan et al (2003) and Pohl and Mihaljek (1992). Alston et al (2000) report a modal rate of return of 43% to agricultural research from a meta analysis of studies but report very wide ranges in estimates with some possible biases indicated by lower estimates in peer reviewed and *ex ante* (as opposed to *ex post*) studies and in studies in LDCs. Estimated returns from the FISP are comparable with these estimates.

6.3. Implications for FISP design and implementation

The formal price analysis and introduction of multipliers in the BCA in this paper reinforces and adds to previous studies' discussions of the lessons from BCA for FISP design and implementation (SOAS, 2008; Dorward and Chirwa, 2009; Dorward et al., 2010): returns will be improved by measures that increase yield responses to fertiliser (for example earlier input delivery, greater emphasis on integrated soil fertility management, improved application, more cost effective formulations, more technical advice, more targeting to the poor) and that reduce displacement (for example better regional and household targeting, better control of diversion and fraud, earlier registration and input delivery). The inclusion of multipliers in the BCA strengthens the importance of all of these issues, as gains from improved efficiency and effectiveness are multiplied. It also adds further weight to the importance of targeting, of ensuring that maize marketing policies allow increased maize production to lower maize prices (as benefits to poorer subsidy recipients and consumers tend to have higher multipliers) and suggests that to maximize linkages and reduce leakages (Dorward et al, 2003) there should be complementary investments in measures facilitating the growth of the non-farm economy and of non-staple agriculture (for example horticulture, legumes and livestock) in response to subsidy-led growth real in real incomes.

6.4. Implications for future data collection and Benefit Cost Analysis

The partial equilibrium methods developed in this paper have sought to follow and find appropriate compromises between the six principles set out in section 2, being practicable, externally consistent, contextualised, holistic, internally consistent, transparent, and cost effective. The method is relatively simple in terms of its data needs and the calculations required but nevertheless it takes account of the context and complex processes affecting FISP returns, and it also addresses the key questions that policy makers and technicians ask (regarding both FISP's overall returns – for comparison with other investments - and the critical variables that determine its effectiveness and efficiency). It could be improved by further research leading to better estimates of maize price determinants and of growth multipliers.

[12] Buffie and Atolia do not model the effects of the FISP on overcoming poor recipients' and consumers' liquidity constraints. Rationing of large unit subsidies in the FISP should make it more efficient than India's universal subsidies, and its impact on liquidity constraints in the absence of a credit programme should mean that it generates some of the benefits that Fan et al report for credit subsidies in India. Fan et al's estimates of returns to subsidies relative to roads may be under-estimated to some extent as a result of higher cross region spill-over effects from subsidies, not captured in the model.

Its application does, however, highlight the need for good data on the yield and production effects of subsidised inputs. This is a major challenge. Malawi has excellent data on market prices, and the biennial AISP/ FISP evaluation surveys have provided valuable information on targeting and use of subsidised inputs. However there are continuing difficulties with data on the total number of farm households, on cropping areas and yields, and on yield responses to inputs and agronomic management (Dorward et al, 2010; Dorward and Chirwa, 2010). Improved data on these variables is critical not just for the evaluation of the FISP, but for much wider policy development, monitoring and evaluation.

Abbreviations and acronyms

AISP	Agricultural Input Subsidy Programme
BCA	Benefit cost analysis
BCR	Benefit cost ratio
FE	Fiscal efficiency
FISP	Farm Input Subsidy Programme
IRR	Internal rate of return
MoAFS	Ministry of Agriculture and Food Security
NB	Net benefit
NPV	Net present value
NSO	National Statistical Office

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Annex table A1 Sensitivity of BCA to higher and lower yields and higher displacement

Year	ED	P	P*	P_M	P_X	Base scenario			Yield increase 20%				Diversion increase 25%			
						NB	BCR	FE	P*	NB	BCR	FE	P*	NB	BCR	FE
			US$/kg			US$ mill			US$/kg	US$ mill			US$/kg	US$ mill		
2005/6	0.51	0.24	0.14	0.29	0.14	42.2	1.58	1.16	0.12	62.5	1.86	1.72	0.15	34.3	1.61	0.94
	Original	mean=	0.14	N/A	N/A	8.7	1.12	0.24	0.14	23.8	1.32	0.66	0.14	4.7	1.08	0.13
2006/7	0.51	0.25	0.13	0.32	0.17	47.1	1.48	0.64	0.12	74.0	1.75	1.00	0.15	34.0	1.45	0.46
	Original	mean=	0.15	N/A	N/A	6.0	1.06	0.08	0.15	25.5	1.26	0.35	0.15	2.1	1.03	0.03
2007/8	0.51	1.83	0.35	0.30	0.15	113.1	1.86	1.19	0.29	161.4	2.21	1.69	0.48	81.5	1.80	0.85
	Original	mean=	0.25	N/A	N/A	69.5	1.53	0.73	0.25	108.4	1.81	1.14	0.25	48.8	1.48	0.51
2008/9	0.51	1.27	0.26	0.28	0.13	-39.0	0.87	-0.16	0.21	5.1	1.02	0.02	0.34	-37.0	0.84	-0.15
	Original	mean=	0.28	N/A	N/A	-40.2	0.87	-0.16	0.28	9.9	1.03	0.04	0.28	-37.7	0.84	-0.15
2009/10	0.51	0.67	0.22	0.28	0.13	47.9	1.27	0.34	0.18	80.5	1.45	0.57	0.27	36.9	1.27	0.26
	Original	mean=	0.26	N/A	N/A	35.4	1.20	0.25	0.26	75.8	1.43	0.54	0.26	22.2	1.16	0.16
2010/11	0.51	0.86	0.19	0.35	0.20	144.3	1.76	0.99	0.16	200.8	2.05	1.38	0.26	120.1	1.81	0.83
	Original	mean=	0.27	N/A	N/A	95.7	1.50	0.66	0.27	151.0	1.79	1.04	0.27	67.0	1.45	0.46

See notes on earlier tables.