CHAPTER 6

SIMULATION ANALYSIS

6.1 INTRODUCTION

The preceding chapter has shown it is possible to link rural farming households, traditionally deemed to have little or no backward or forward linkages, to the macro-economy using a price-linkage equation of the maize market. Such a linkage allows the simulation of policy shocks and the assessment of how such changes affect rural household incomes. This chapter employs the partial equilibrium maize model that was developed and validated in Chapter 5 to simulate the impact of a combination of macro-economic and agricultural policy shocks on rural household incomes for different household categories. In so doing, it provides credible evidence on which effective policies can be developed. The simulation period is from 2009/2010 to 2013/2014. The chapter initially presents projections for the scenario period for all the endogenous variables and the household incomes. It is on the basis of these "baseline" projections that the impact of the simulated policy shock will be measured against. Further, the chapter provides an analysis of the dynamic responses of the model to maize price changes, in order to provide a better understanding of the model behaviour and its ability to return to an equilibrium point after a disturbance. In so doing, the model is further validated as a tool that is suitable for simulating policy changes.

6.2 BASELINE PROJECTIONS

The impact of the simulated policy shocks will be measured by comparing it against a reference scenario. The reference scenario is a simulation of the Malawi maize model without the simulated policy shock in place. For the household level, this reference scenario is in the form of projected or future household incomes, against which changes in household incomes arising from the simulated policy shocks will be measured.

The baseline will provide a simulation of the maize model under a set of assumptions pertaining to macro-economic policies and climatic conditions of the country. For Malawi, the main assumption is that the current levels of macro-economic performance as well as the

existing agricultural policies will remain unchanged for the baseline period; as there are no foreseeable political changes in the country until the 2014/2015 agricultural season, when the country is scheduled to have its parliamentary and presidential elections. Furthermore, it is foreseen that this will be the case; as in the years leading up to the baseline, the country has had greater political will to improve the economy as evidenced by improved fiscal and monetary discipline. Fluctuations in the country's macro-economic variables will arise mainly from exogenous factors, such as changes in global and regional policies and markets as well as general inflation.

There are three main exogenous factors that will continue to influence the maize market over the baseline period. These are the population growth, the real per capita GDP and the exchange rate. These three variables are exogenous to the model only over the baseline period but it is possible in the scenario analysis to alter. The projections of the endogenous variables over the baseline will therefore be mainly based on the forecasted growth rates of these three macro-economic assumptions. The projected values for these variables are provided in Table 6.1.

Table 6.1: Macro-economic indicators/assumptions

	2008	2009	2010	2011	2012	2013	2014
			Millions				
Population	13.66	13.93	**14.99**	15.98	16.89	17.95	18.95
			USD/ton				
Exchange rate	142.41	146.62	**148.98**	152.07	155.80	159.41	163.04
			USD/capita				
Per capita GDP	172.67	171.49	**173.12**	181.00	186.44	190.64	196.88

Baseline projects for the endogenous variables of the model are presented in Table 6.2. These include the area of maize planted, the yield of maize, per capita maize consumption, domestic consumption, domestic production, local maize production and consumption, ending stocks, as well as both the ADMARC maize price and the local market maize price. From Table 6.2, is it clear that maize production will continue to rise over the baseline period as a result of increasing maize yields and not area of maize planted; as the latter remains fairly constant over the baseline with a very small downward trend. Hence, improvements in technology will be the key driver of national domestic production. Local maize production, however, will remain fairly constant with a slow rising pace.

Domestic and local consumption have upward trends, but the rate of growth is very slow. Figure 6.1 shows domestic maize production from 2000–2014 against the ADMARC and local maize prices.

Table 6.2: Baseline projections

	2010	2011	2012	2013	2014
		Thousand hectares			
Area planted	1141.80	1142.61	1142.68	1142.81	1142.94
		Tons/hectare			
Yield	1.77	1.98	2.00	2.03	2.06
		Thousand tons			
Domestic production	3210.00	3350.08	3391.65	3437.65	3499.65
Domestic consumption	2510.04	2394.83	2563.89	2754.00	2723.07
Local consumption	97.48	97.44	97.41	97.51	97.48
Local production	17.60	17.34	17.19	17.83	17.65
		USD/ton			
ADMARC price	194.61	205.76	215.18	220.20	225.49
Local market price	168.51	188.61	199.32	201.93	214.95

Figure 6.1, shows that prior to 2008, extreme maize price hikes in both the local and ADMARC markets were associated with years of low maize production resulting from the prevalence of droughts (2001/2002 and 2005/2006). Over the baseline period, maize prices have an upward, stable trend given assumptions pertaining to prevailing government policies and maize supply and demand dynamics.

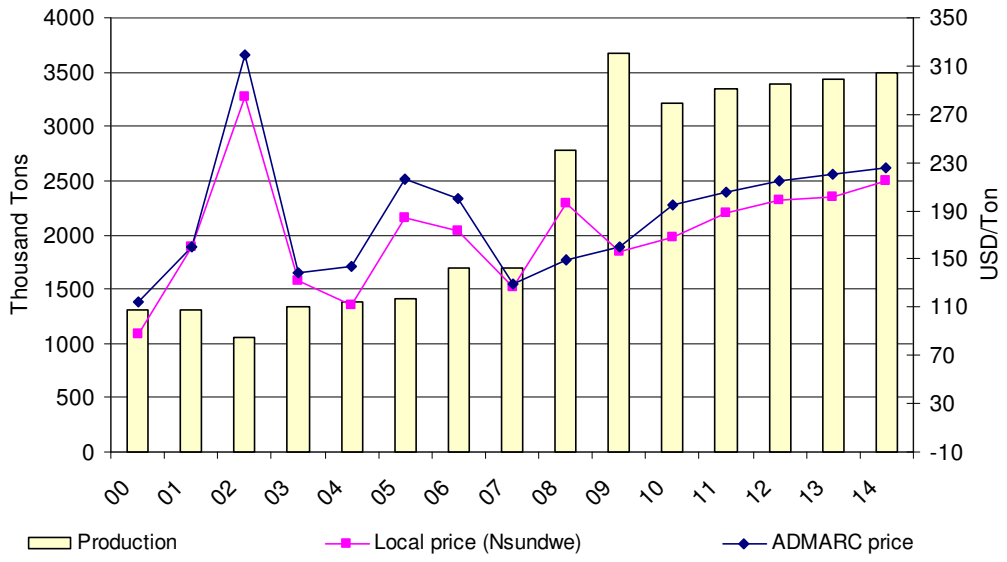

Figure 6-1: Domestic maize production and maize prices (2000–2014)

Household incomes were also projected for the baseline period (Table 6.3). Projections for household incomes are mainly driven by the local and ADMARC maize price; as they exist in the baseline projections, as well as other assumptions that have the potential to affect the dynamics of household income portfolios over the baseline period. Maize prices play a major role in the estimation of household income, as household income portfolios include the imputed and actual values of maize. There are two other main assumptions governing the projections of household incomes. Firstly, at the end of 2008, the outlook for the Sub-Saharan region in general, and Malawi in particular, was positive, with forecasts of high economic growth rates (AfDB/OECD, 2008). This was the case for Malawi as the foundations for faster economic growth had been laid by political changes in the country. However, by the end of 2009, the region had been hit by a great recession that was precipitated by the global financial crisis; which was forecasted to cause a 1 % decline in total output and a decrease of 1 % in per capita incomes by 2009 (IMF, 2009). It was, however, further forecasted that per capita incomes would start to rise once again by 2010.

Table 6.3: Average household income projections in USD

Household type	Agricultural season					
	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
	Intervention community					
Low resourced	1192.67	**1163.55**	1229.03	1190.50	1200.04	1208.30
Medium resourced	4695.28	**4725.67**	4791.32	4819.12	4865.05	4910.95
Large resourced	1603.30	**1585.54**	1636.01	1611.62	1621.97	1631.49
	Counterfactual community					
Low resourced	322.70	**321.40**	336.85	328.97	331.41	334.39
Medium resourced	600.38	**601.11**	621.01	614.25	619.32	625.02
Large resourced	2158.67	**2158.65**	2170.07	2172.33	2179.23	2186.29

The second main assumption governing the estimation of future household incomes pertains to general crop production and food security. This is because the estimation of household income, as illustrated in Chapter 4, shows that rural household income is not synonymous with cash income. Rather, it also includes the actual and imputed value of crop production. Given this, projections pertaining to crop production for Malawi were taken into account in projecting household incomes for the baseline period. These were outlooks generated by the Famine Early Warning Systems Network (FEWSNET) and the Ministry of Economic Planning and Development (EP&D) in Malawi. It is against these household income projections that changes arising from the simulated policy shocks will be measured.

6.3 MODEL DYNAMIC RESPONSES

Dynamic elasticities assess how the demand for a good would change over time in response to a change in price or consumers' income. The assessment of the behaviour of the dynamic elasticities of price is critical for a model that has been developed for assessing the impacts of price changes (Pindyck & Rubinfeld, 1991). In this study, the dynamic response of the maize market to a 10 % change in the ADMARC price and the dynamic response of the local maize economy to a 10 % change in the local maize price were analysed. The dynamic elasticities of price for 2010 and the total long-run dynamic elasticities are presented in Tables 6.4 and 6.5 for the entire maize market and for the local economy respectively, to illustrate the current effects as well as the total long-run dynamic elasticities of the price shocks.

Table 6.4: Impact of a 10 % positive change in the ADMARC maize price

Endogenous variables	2010			Total long-run dynamic elasticity (%)
	Baseline	Absolute change	% change (impact multipliers)	
Area planted (1000 hectares)	1141.80	0.00	0.00	0.50
Yield (Tons/hectare)	1.77	0.00	0.00	0.00
Domestic production (1000 tons)	2024.00	0.00	0.00	0.50
Domestic consumption (1000 tons)	2200.04	-47.5	-2.20	-1.50
Local consumption (1000 tons)	97.48	-0.10	-0.10	-0.60
Local production (1000 tons)	17.60	0.00	0.00	0.40
Local market price (USD/ton)	148.52	12.6	8.50	42.50
Intervention household incomes (USD)				
Low resourced	1192.67	0.00	0.00	14.00
Medium resourced	4695.28	0.00	0.00	1.30
Large resourced	1603.30	0.00	0.00	7.50
Counterfactual household incomes (USD)				
Low resourced	322.70	7.30	2.30	13.5
Medium resourced	600.38	8.30	1.40	8.30
Large resourced	2158.67	0.00	0.00	0.70

From Table 6.4, it can be seen that a 10 % increase in the ADMARC maize price would, in both the short run and long run lead to a decrease in both the domestic and local maize consumption. This is because consumption is dependant, amongst other factors, on prevailing market prices. In the long run, Table 6.4 shows that a 10 % change in the ADMARC maize price would lead to an increase in the acreage of maize planted, domestic maize production as well as local maize production. Yields however remain unaffected in either the short run or the long run. Table 6.4 further shows that a 10 % change in the ADMARC price would also affect the local maize economy with the local market maize price being impacted highly with a price transmission pass through rate that is very high in both the short run and the long run.

This agrees with findings from Chapter 5 which demonstrated that local maize markets are well integrated with the ADMARC market.

Further analysis shows that the 10 % change in the ADMARC price translates into changes in household incomes in both communities. In general all the different categories of households are positively affected by the change in the ADMARC price with households in the counterfactual community being affected more in the short run than households in the intervention community. This can be attributed to that maize contributes a larger share to the income of households in the counterfactual community as compared to the intervention community households. In the long run, however, it is households in the intervention community that are affected more by the increase in the ADMARC maize price as compared to their counterparts in the counterfactual communities as demonstrated by slightly larger total long-run dynamic elasticities especially for the low resource and large resource-endowed household categories. This is attributable to that in general; households in the intervention community had higher maize harvests as compared to counterfactual community households. Hence in the long run, incomes for the intervention community households emanating from maize are affected to a larger extent by the increase in the ADMARC maize price. This is because both the real and imputed values of the maize that they market and keep for home consumption or exchange for goods and services would be larger respectively.

Table 6.5 presents the dynamic price elasticities for 2010 and the total long-run elasticity arising from a direct 10 % change in the local maize price. From Table 6.5 it can be seen that a direct 10 % change in the local maize price will lead to a similar decrease in local maize consumption and no change in local production in the short run. In the long run however, the decrease in local consumption is slightly larger as compared to the decrease that occurred from the 10 % change in the ADMARC price. In addition, local production, in the long run, increases by the same percentage (0.40 %) as it did with the 10 % change in the ADMARC price.

Table 6.5: Impact of a 10% positive change in local maize price

	2010			Total long-run dynamic elasticity (%)
	Baseline	Absolute change	% change	
Local consumption (1000 tons)	97.48	-0.10	-0.10	-0.80
Local production (1000 tons)	17.60	0.00	0.00	0.40
Household incomes (USD)		**Intervention**		
Low resourced	1192.67	0.00	0.00	16.5
Medium resourced	4695.28	0.00	0.00	1.50
Large resource	1603.30	0.00	0.00	8.80
Household incomes (USD)		**Counterfactual**		
Low resourced	322.70	0.86	0.27	1.59
Medium resourced	600.38	0.99	0.16	1.97
Large resourced	2158.67	0.00	0.00	0.18

In terms of household incomes, Table 6.5 shows that a 10 % increase in the local maize price leads to larger impacts on household incomes in the long run than a 10 % increase in the ADMARC maize price; with the total long-run dynamic elasticities for all household categories being much larger with the 10 % change in the local maize price than with the 10 % change in the ADMARC maize price. In general, in both communities, households in the lowest resource group had the largest dynamic elasticities in the long run, and in the counterfactual community, this is also observed in the short run.

In conclusion, an analysis of the dynamic response of the Malawi maize model suggests that increases in the ADMARC maize price will in the long run largely affect maize production; with the other variables also being affected, but to a lesser extent. Another major observation from the analysis of the dynamic responses of the model is that direct changes in local maize prices within local maize markets impact upon household incomes to a larger extent in both the short run and the long run. In addition, households in the intervention communities are affected more in the long run by maize price increases occurring in either the local maize markets or national maize markets. Finally, households that fall within lower income groups are more affected by changes in maize prices occurring either at the national or local levels; and this is generally the case in both the short run and the long run.

6.4 IMPACT OF POLICY SHOCKS ON HOUSEHOLD INCOME

Simulation analysis involves the modelling of a system that is in existence and the execution of a scenario on the basis of the model in order to obtain a better understanding of the problem and its potential outcomes. Simulation analysis allows for the quantification of

changes in the well-being of different groups within an economy. As such, it has been used widely to plan complicated systems as well as to predict the effects of different interventions on inter-related systems and phenomena (Haveman & Hollenbeck, 1978; Csáki, 1985). This section provides a description of a scenario that is based on existing and real economic events in Malawi as reported in local and international media as well as published and grey literature.

The Malawi economy is highly susceptible to exogenous shocks as a result of the country being highly dependent on donor aid, with over 40 % of the total fiscal budget between 2004 and 2008 being donor funded (Mangani, 2010), and because of it being land locked. Hence, the global financial crisis led to a reduction in donor aid as well as foreign remittances and this resulted into the severe shortage of foreign currency. In addition in 2008 the country had an import bill of approximately USD250 Million arising from increasing fuel and fertilizer costs. The country was unable to fully pay the import bill due to shortage of foreign exchange and as such as by the end of 2010, the situation had not improved and led to the crippling of the economy due to the dependence on imported goods and services. Given this situation the government takes the decision to devalue the Malawi Kwacha by 35 %.

Secondly, in anticipation for the 2014 presidential and parliamentary elections; and in order to ensure votes for the 2014 elections, the main platform for the campaign becomes the fertiliser subsidy programme and government ensures voters that the subsidy in its current form will continue into the foreseeable future. In addition the government puts in place in 2011 a new policy to increase support for smallholder maize irrigation schemes in order to compliment the subsidy program. This has been put in place as evidence has demonstrated that although the ‘smart’ subsidy was a success in Malawi, water availability was a major factor to sustained productivity. In order to have continued donor confidence, the government further takes on recommendations (from the donor community) to further liberalize national parastatals that are currently responsible for maize trade.

The scenario analysis has three shocks which can be categorized into macro-economic policy shocks and agricultural sector shocks as follows:

Macro-economic policy shocks:

- A 35 % sustained exchange rate devaluation of the Malawi Kwacha

Agricultural sector shocks:

- ADMARC liberalization (dummy variable) (Appendix 5 for the historical explanation of ADMARC liberalization and reforms)
- Change in legislation to increase financial and technical support for smallholder maize irrigation (shift variable)

The three shocks filter differently within the model to affect household incomes. The exchange rate devaluation directly affects the import parity price (IPP) which has a direct and positive effect on ADMARC maize prices (Equation 5.1). Changes in the ADMARC maize price will positively impact the local maize prices (Equation 5.2). Local maize prices directly determine estimation of household incomes.

The liberalization of ADMARC will directly and negatively affect the ADMARC maize price (Equation 5.1). This is because one key element of the liberalization of ADMARC is the closure of satellite depots throughout the country. Historically this has led to an increase in private traders in local rural economies (Appendix 5). Due to the lack of regulation, information asymmetries and isolation of many rural households, private traders offer a price that is below the ADMARC maize price. Hence the majority of smallholder producers get a lower price than the ADMARC maize price as a result of ADMARC liberalization. It is this negative effect which is being reflected by the ADMARC liberalization policy shock in the model.

Since ADMARC maize prices have historically approximated import parity prices (Figure 5.6), the negative effect of the simulated policy shock of liberalization of ADMARC entails that ADMARC maize prices shift towards export parity prices. In theory when domestic prices approximate export parity prices, it implies that domestically produced goods become more competitive either regionally or globally (depending on the reference price used in the estimation of parity prices). This provides incentives for export trade which has the potential

to stimulate productivity-which in turn can lead to overall growth[11]. This, in theory, is the key driver of the liberalization movement (CIE, 2009).

In the model, the liberalization of ADMARC is captured as a dummy exogenous variable having 0 and 1 for without and with liberalization, respectively (Equation 5.1). This modelling technique can cause problems as it is possible that the price dynamics (such as the actual magnitude of the change in the ADMARC price) arising from the liberalization of ADMARC maybe not be captured by the dummy variable. The linkages in the model that is developed in this study are such that any positive change in the dummy variable for ADMARC liberalization has a negative effect on the ADMARC maize price. The estimated coefficient of the dummy variable of ADMARC liberalization (Equation 5.1) entails that the decline in the ADMARC price arising from liberalization of ADMARC is approximately equal to USD70.00/Ton or MK14.00/kg[12]. An analysis of the import and export parity maize prices for Malawi shows that the difference between import and export parity prices from 1988 to 2009[13] was approximately on average equal to MK15.47/kg. The estimated equation for ADMARC maize prices (Equation 5.1) is therefore able to effectively capture the magnitude of change that would occur in ADMARC maize prices if policy shifted towards greater liberalization of ADMARC.

This entails that the linkages in the model effectively capture the price dynamics in the maize commodity market in the country. This is because the dummy variable for ADMARC liberalization approximates the average magnitude of change; that would be required to shift ADMARC maize prices towards export parity prices[14]; with a small margin of error (-10.55%). The negative effect of the liberalization of ADMARC on the ADMARC maize price will filter to the household incomes through the direct linkage between ADMARC maize prices and local market maize prices-which are linked to household incomes.

The change in legislation to increase financial and technical support for smallholder maize irrigation will directly and positively affect the national maize yields (Equation 5.5). Changes in national maize yields will impact positively upon national maize production (Equation

[11] This may not be case in the presence of government controls which regulate the importation and exportation of goods as is the case in the Malawi maize market.
[12] This is using the exchange rate of USD1:MK200 prevailing in 2011.
[13] Based on 2005 average MK: USD exchange rates.
[14] This is based on historical average differences between import parity prices; export parity prices and ADMARC maize prices from 1988 to 2009.

5.3). The changes in national maize production will affect the production to consumption ratio which has a direct negative impact on the ADMARC maize price. The changes in the ADMARC maize price will filter to household incomes via the local maize price which determines household incomes. The positive effect of the changes in maize yields outweighs the negative effects of the production to consumption ratio on the ADMARC maize price. Hence the irrigation variable will have a positive overall effect on household income as a result of the linkages in the model.

6.4.1 ADMARC liberalization and exchange rate devaluation

The shocks were introduced into the model firstly one by one and then in different combinations. The results of the percentage changes in household incomes for the shocks being introduced one by one are given in Tables 6.6 to 6.8 below.

Table 6.6 presents the percentage changes in household income arising from the shock pertaining to the liberalization of ADMARC to allow greater private sector participation in maize trade. These reforms are introduced into the model from 2011 onwards.

Table 6.6: Income impacts – ADMARC liberalization only

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
Intervention community					
Low resourced	0.00	0.00	-11.68	-10.79	-10.70
Medium resourced (high income)	0.00	0.00	-1.23	-6.06	-6.03
Large resourced (low income)	0.00	0.00	-6.68	-1.09	-1.08
Counterfactual community					
Low resource	0.00	-8.78	-9.55	-8.77	-8.65
Medium resourced	0.00	-5.55	-6.15	-5.56	-5.51
Large resourced	0.00	0.00	-0.68	-0.60	-0.60

Table 6.7 presents the percentage changes in household income arising from the change in legislation to increase financial and technical support for smallholder maize irrigation. This shock is introduced into the model from 2011 onwards.

Table 6.7: Income impacts – Smallholder maize irrigation shock only

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
	Intervention community				
Low resourced	0.00	0.00	2.12	1.83	1.70
Medium resourced (high income)	0.00	0.00	0.22	0.19	0.17
Large resourced (low income)	0.00	0.00	1.21	1.03	0.96
	Counterfactual community				
Low resourced	0.00	1.59	1.62	1.39	1.40
Medium resourced	0.00	1.01	0.88	0.89	0.81
Large resourced	0.00	0.00	0.12	0.10	0.10

Table 6.8 presents the percentage changes in household income arising from a 35% sustained devaluation of the Malawi Kwacha to the US Dollar. The exchange rate shock is introduced into the model from 2011 onwards.

Table 6.8: Income impacts – Exchange rate devaluation only

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
	Intervention community				
Low resourced	0.00	7.71	8.91	8.54	8.83
Medium resourced (high income)	0.00	0.70	0.84	0.78	0.80
Large resourced (low income)	0.00	4.08	4.82	4.55	4.71
	Counterfactual community				
Low resourced	6.37	6.49	7.46	7.07	7.24
Medium resourced	3.91	3.96	4.62	4.33	4.43
Large resourced	0.00	0.38	0.46	0.43	0.44

From Table 6.6 to Table 6.8, there are three main observations. First, the shock that leads to a decrease in the maize prices (the ADMARC reforms shocks) has a negative impact on household incomes and the shocks that lead to an increase in the ADMARC maize price (the exchange rate devaluation and the irrigation shock) leads to an increase in household incomes. This can be attributed to the fact that rural household income includes the real and imputed value of maize as such changes in maize prices can affect a household either negatively or positively depending on the composition of a households' income portfolio with the share of income that comes from maize being a key factor and the percentages of maize production that the household actually markets and keeps for home consumption determining the extent to and direction in which they are affected.

The second observation from Tables 6.6 to 6.8 is that the shock that decreased household incomes (the liberalization of ADMARC) negatively affected all household categories in both communities. The effect was however more pronounced in the medium to long term than in the short term with households in both communities exhibiting lower percentage losses of incomes in the first year of the shocks being implemented than in subsequent years. Also in

each specific community it is further observed that the households with the lowest resources are more negatively affected by the policy shocks than households that have more resources. This effect can also be attributed to the differences in composition of income portfolios for the different household types. This is because maize generally contributed to a larger share of income for households with lower resource endowments. The better off households had more diversified income portfolios. Hence, any decreases in the price of maize affected the incomes of poorer households to a larger degree because of the greater contribution of maize in their income portfolios. However, further observation shows that this effect is more pronounced in the intervention community than in the counterfactual community; with intervention community households in each specific resource category exhibiting greater losses in income than the corresponding counterfactual community household group for most of the years. This can be attributed to households in the intervention community having larger maize harvests as well as greater participation in the market economy and, as such, having greater linkages with the market economy thus making them more vulnerable to market forces.

The third observation is that the shocks that positively affect incomes (exchange rate devaluation and irrigation legislation shock) lead to increases in incomes for all household categories. In each community it is further observed that households with the least resources have the largest proportional increases in household incomes as compared to better off households. Also it is households in the intervention community that benefit the most as compared to households in the counterfactual communities. This effect can also be attributed to households in the intervention community being more linked to the market economy but in this case these linkages allow them to take advantage of market incentives such as higher maize prices.

6.4.2 The impact of policy coordination on household incomes

The different policy shocks were also introduced into the model in different combinations. Tables 6.9 to 6.12 present the results of the different combinations of the policy shocks on household income. Table 6.9 presents the percentage changes in household income arising from a combination of the shock pertaining to the liberalization of ADMARC and the shock

pertaining to change in legislation to allow greater financial and technical support for smallholder maize irrigation. Both shocks are introduced from 2011 onwards.

Table 6.9: Income impacts – both agricultural sector shocks

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
	Intervention community				
Low resourced	0.00	0.00	-9.75	-9.13	-9.16
Medium resourced (high income)	0.00	0.00	-1.03	-0.92	-0.93
Large resourced (low income)	0.00	0.00	-5.58	-5.13	-5.16
	Counterfactual community				
Low resourced	0.00	-7.33	-8.08	-7.51	-7.42
Medium resourced	0.00	-4.64	-5.20	-4.76	-4.71
Large resourced	0.00	0.00	-0.57	-0.51	-0.52

Table 6.10 presents the percentage changes in household income arising from a combination of the shock pertaining to the liberalization of ADMARC with the 35 % sustained exchange rate devaluation. Both shocks are introduced from 2011 onwards.

Table 6.10: Income impacts – Exchange rate devaluation and ADMARC

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
	Intervention community				
Low resourced	0.00	7.71	-4.32	-3.61	-3.26
Medium resourced (high income)	0.00	6.70	-0.41	-0.33	-0.30
Large resourced (low income)	0.00	4.08	-2.34	-1.93	-1.74
	Counterfactual				
Low resourced	6.37	-3.15	-3.16	-2.61	-2.38
Medium resourced	3.91	-1.92	-1.95	-1.60	-1.45
Large resourced	0.00	0.38	-0.22	-0.18	-0.16

Table 6.11 presents the percentage changes in household income arising from a combination of the shock pertaining to the change in legislation to allow greater financial and technical support for smallholder maize irrigation with the 35 % sustained exchange rate devaluation. Both shocks are introduced from 2011 onwards.

Table 6.11: Income impacts – Exchange rate devaluation and irrigation shock

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
	Intervention community				
Low resourced	0.00	7.71	11.23	10.54	10.69
Medium resourced (high income)	0.00	0.70	1.06	0.96	0.97
Large resourced (low income)	0.00	4.08	6.08	5.61	5.70
	Counterfactual community				
Low resourced	6.37	8.18	9.20	8.56	8.73
Medium resourced	3.91	4.99	5.20	5.23	5.34
Large resourced	0.00	0.38	0.58	0.53	0.54

Table 6.12 presents the percentage changes in household income arising from a combination of all the three shocks. All shocks are also introduced from 2011 onwards.

Table 6.12: Income impacts – all shocks

Household category	% changes				
	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
Intervention community					
Low resourced	0.00	7.71	-2.21	-1.80	-1.58
Medium resourced (high income)	0.00	0.70	-0.21	-0.16	-0.14
Large resourced (low income)	0.00	4.08	-1.19	-0.96	-0.84
Counterfactual community					
Low resourced	6.37	-1.01	-1.57	-1.27	-1.03
Medium resourced	3.91	-0.98	-0.98	-0.77	-0.63
Large resourced	0.00	0.38	-0.11	-0.09	-0.08

From Tables 6.9 to 6.12 it is possible to see that the different combinations of policy shocks lead to the same observations in terms of impact on household income with the poorest households either gaining or losing most income depending on the effect of the policy combination. Also households in the intervention community either gain the most or lose the most from a policy combination and the positive or negative effects are more pronounced in the medium to long term as opposed to the short term.

There are two key observations from the different combinations of policies. First it is only the combination of the exchange rate devaluation with the legislation pertaining to smallholder maize production that produces income gains for all household categories in both communities in the medium to long term. Second, all other combinations of the macro-economic policy shock with the liberalization of ADMARC, or with both shocks and a combination of only the agricultural sector shocks leads to losses in incomes for all households in both communities. The losses in incomes from a combination of all the shocks are slightly lower as compared to the losses incurred from any other different combinations of the policies that produced losses; with the combination of the two agricultural sector shocks leading to the highest losses in incomes for all household categories in both communities.

Given that in any economy, macro-economic policy shocks concurrently occur with agricultural sector policy changes, it is important that policy makers make a deliberate concerted effort to analyse the potential impacts of concurrent policy implementation. This also applies to policy making at the sector level. This is because this study has demonstrated that implementing different sector level policies with macro-economic policies or with other sector level policies can lead to negative outcomes for rural smallholder farmers although

some of the policies have the potential to benefit households if implementation is done in different combinations.

Furthermore in the face of more agricultural research and development programs moving towards an innovation systems perspective, this is more so imperative as households participating in AIS driven research and development initiatives are more likely to incur greater losses from a combination of policies that negatively affect the pricing of staple food markets because of their greater linkages with the market economy in the medium to long term. All the simulation results have shown that households in the intervention community are affected the most in the face of policy shocks that negatively affect the market. This is so because all household categories in the intervention community had lower decreases in household income than households in the counterfactual community. Given that intervention community households had more diversified income portfolios, these results demonstrate that households that have participated in agricultural research interventions driven by innovation systems concepts are more vulnerable in the long term to market forces as a result of the greater linkages to the market economy. In addition, the simulation analysis has shown that intervention community households are also able to benefit from policies that provide positive market incentives. This is also the result of participating households having greater linkages with the market economy and hence being able to take advantage of market incentives.

The implications of the simulation analysis is that in the face of macro-economic and agricultural policy shocks, AIS driven research interventions have the potential to increase the vulnerability of rural households; particularly households with the lowest resource endowments. Hence, poorer households that participate in AIS driven research interventions are more likely to be negatively affected in the face of macro-economic and agricultural policy distortions than households that are better off. At the same time, participating households are also in a better position to take advantage of market incentives given the implementation of well-coordinated policies.

Therefore in the face of the paradigm shift in agricultural research towards innovation systems perspectives; it is imperative that there be coordinated national policy making. This will require that there be political commitment that will enable mobilization of resources for developing policy guidelines to govern macro-economic and micro-economic policy

coordination. In addition, it will also require the establishment of technical institutions to lead the policy coordination and to carry out robust assessments of the possible welfare gains and losses. In addition, technical institutions would be needed to track the general contribution of innovation systems concepts at not only the micro-level but also the macro-level. This will assist to determine the level and type of coordination that is needed but will also provide insight of the depth of innovation systems usage in agricultural research policy and practice within the country.

The findings of the simulation do not in any way invalidate the innovation systems perspective as a means of improving rural livelihoods. However they reflect the potential impact of greater market orientation on rural households-which can occur with any other programs of linking farmers to markets. It is for this reason that AIS driven developmental initiatives focus on strengthening rural livelihoods from not only a market orientation but also from a social and food security perspective; thus reducing the vulnerability of rural household.

6.5 CHALLENGES FACED AND LIMITATIONS

The study was faced with three major challenges. These can be categorised as conceptual understanding of the concept of innovation systems; logistical difficulties encountered in primary data collection; and methodological difficulties. Firstly, the concept of AIS and its practice is still evolving and, as such, misconceptions of its field application existed amongst and between the different stakeholders working in the community where primary data was collected. This problem also arose mainly due to high staff turnover in the organisations that were part of the original innovation platform for the Enabling Rural Innovation (ERI) initiative, which was used as a case study for this research.

Secondly, logistical difficulties were mainly faced during the collection of primary data. The logistical challenge of identifying and tracing programme beneficiaries that were no longer in the study area, such as those who had migrated to other parts of the country, posed a challenge for primary data collection. In many instances, beneficiaries who were no longer in the study area were untraceable and hence not included in the study. Further, the unavailability of the male member of the household during data collection hours was also a major challenge; as the female member, who was more readily found at the household, often

lacked the detailed information required in the study arising from her non–involvement in decision making and planning. This problem was rectified by ensuring that, where possible, both the spouses were present for the interview. In many cases, this required revisiting a household.

Another major logistical challenge that was faced arose due to the timing of the study, which coincided with traditional practices of the main tribe in the study area. The data was collected just prior to the beginning of the 2009/2010 cropping season, a time in which the people of the area who are of the c*hewa* tribe hold traditional festivities of the *gulewamkulu* cult in commemoration of the dead, and in which outsiders are not welcome. As a result of the *gulewamkulu* dances, data collection was often delayed as interviews for specific villages where festivities were under way had to be rescheduled. In addition, the country was hit with a crippling fuel crisis in November of 2009 and this delayed data collection immensely.

Methodological challenges included difficulties in reaching service providers involved at the onset of the intervention who possessed critical qualitative information needed in the essential step of approximating a robust, valid analytical model of programme participation for establishing a valid counterfactual. This was overcome by tracing staff who had left the institutions working in the study area as well as interviewing new staff members who were working with the same communities. Finally, the research does not include the development of a dynamic household model. As such, feedback effects from the household level to the macro-economy level were not captured.

6.6 CHAPTER SUMMARY

This chapter has demonstrated that a combination of macro-economic and agricultural policy shocks have the potential to negatively affect the incomes of rural households that participated in AIS research interventions. This is because participating households are made more vulnerable to market forces as a result of the greater linkages with the market economy. In addition, it has been demonstrated that rural households with lower resources participating in AIS driven research interventions are more vulnerable in the face of policy shocks.

However, at the same time, households in intervention communities, especially the poorest households, also stand to gain the most from combinations of policies that provide market

incentives because of their greater linkages with the market as strengthened by innovative agricultural research interventions. Thus in order to ensure that the micro-economic level work of AIS driven research and development initiatives is not eroded by macro-economic and agricultural sector policies; it is essential that policies be implemented only after rigorous analysis of the potential gains and losses to different households.

Finally, in order for innovation systems perspectives in agricultural research and development to achieve long-lasting tangible impacts on rural livelihoods, AIS driven research should foster diversification out of agriculture for income, while supporting productivity improvements for food security. There should also be efforts to strengthen the rural household asset base, and, in so doing, building some resilience of the households to risks and shocks associated with agricultural-based livelihood systems. But there is also need for policy coordination to ensure that positive rural livelihood outcomes are not eroded by uncoordinated policy implementation.

CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY

The first objective of this study was to quantify the impact of AIS driven research interventions on rural livelihood outcomes in Malawi. This objective was tackled by using quasi-experimentation with propensity score matching to establish a valid counterfactual and single differencing to measure impact on livelihood outcomes. This objective aimed to demonstrate that AIS driven research interventions have contributed towards changing the rural livelihood economy, as farmers have greater dependence on the market which improves some but not all household livelihood outcomes.

This objective was adopted for this study because, despite the increasing dominance of AIS driven research in Africa, there is a lack of robust quantitative empirical evidence of its impacts. Therefore, this study tested as its first hypothesis the following:

The livelihood outcomes of rural households in communities with AIS driven research programs are higher compared to similar outcomes for rural households in communities without such interventions.

Given that AIS driven research program change the rural household economy by strengthening the linkages that these households have with the market economy, the second objective of the study was to determine the effects of the resultant greater linkages to the macro-economy and to demonstrate the impact of uncoordinated policy making and implementation on rural livelihood outcomes for participating households. The second objective was achieved by using a combination of quantitative and qualitative statistical and econometric tools to delve into the dynamics of the maize market at the farm/household, local economy and national levels; to develop a model that is capable of capturing the maize market dynamics at both the national and local level and the linkages existing within the maize market in the country.

Finally, given the development of a tool that is capable of capturing the dynamics of the maize market and the linkages existing at different levels, the last objective of this study was to simulate macro-economic and agricultural policy shocks in order to provide relevant policy recommendations for informing food and agricultural policy development and for agricultural research programme formulation and implementation in Malawi. In addition, the simulation demonstrated the need for a concerted effort in policy making and thus the need for using a combination of both macro-economic and micro-economic tools in policy analysis especially with respect to policies pertaining to the use of AIS concepts in agricultural research and development.

In order to achieve these last two objectives, the study tested as its second hypothesis the following:

The degree to which rural livelihood outcomes are affected by policy shocks; which transmit through maize market prices; will to a large extent depend upon the socio-economic characteristics of the household; participation in AIS driven research interventions as well as the nature of macro-economic and agricultural sector policy coordination.

7.2 CONCLUSIONS

The findings of this study are that, first, AIS driven research interventions have a positive and significant impact on the livelihood outcomes of rural smallholder farmers in Malawi. Using the Enabling Rural Innovation (ERI) initiative as a case study, this study has shown that AIS driven research interventions have a strong positive impact on some but not all aspects of rural livelihoods, with stronger positive impacts being seen for incomes, upland crop production and fertiliser use, given the absence of government policies that provide subsidised fertilisers. In the presence of a subsidised fertiliser policy, innovative research interventions have a weaker positive impact on fertiliser use. In addition, weaker positive impacts are seen for maize production and training opportunities, given similarities in the geographical location.

Innovative agricultural research interventions therefore have the potential to positively influence the production, incomes, and training opportunities of rural households by increasing the opportunities for networking, information sharing and capacity building. The

main shortfall of the ERI was, however, found to be that the sustainability of the positive livelihood outcomes were threatened by the phasing out of the programme. This was because local public agricultural extension agents lacked both the human and financial capacity to maintain the higher level of contact and innovative strategies employed in implementing the intervention. This however could also be a reflection of weaknesses of implementation of the ERI initiative in the study area. This is because Innovation Systems orientation is centred on enhancing the ability of participants to better utilize knowledge and information. This is to be the case even; and especially; in the absence of external assistance. Therefore there is need for further research to analyse the processes and interactions between actors within the ERI framework in order to first validate its shortcomings and second to provide practical solutions.

Second, this study also finds that rural households who are traditionally classified as having little or no backward or forward linkages can be linked to the greater macro-economy through maize markets. Such a linkage is possible as it was demonstrated that prevailing local farm/household maize prices in rural communities are, to a great extent, determined by national level maize prices, which are the result of not only government policies but also supply and demand structures at the national level. Hence, macro-level policy changes that affect demand and supply as well as the pricing of maize at the national level ultimately transmit to the rural household economy. This study therefore developed a functioning multi-equation partial equilibrium model of the Malawi maize market, given government price controls. Using understanding of the inter-relationships between farm/household, local economy and national maize market prices, as well as economic theory and existing empirical evidence, it has been possible through a local area consumption loop to create a recursive system of the local maize market that is linked in a top-down unidirectional manner through a price-linkage equation with the ADMARC maize price to the national maize market. The linkage of rural households to the macro-economy through the maize price is an appropriate mechanism, as changes at the rural economy entail that smallholder farmers have greater dependence on the market.

Using the partial equilibrium model, it was possible to simulate changes occurring within national maize markets to assess the impact of macro-economic and agricultural policy changes on rural households that are involved in the production and marketing of maize. The simulation analysis demonstrated that a combination of macro-economic and agricultural

policy shocks has the potential to either positively or negatively affect the incomes of rural households; particularly households that have participated in AIS driven research interventions. Also, the poorest households tended to be affected the most. This was the case in either community and regardless of whether the policy effects were positive or negative. Similarly the poorest households in participating communities were also affected the most in any case. Hence, the stronger market linkages that allow participating households to take advantage of market incentives also make them more vulnerable to policy shocks that transmit through the market.

In conclusion, this study has empirically demonstrated that AIS driven research interventions impact positively upon the livelihood outcomes of rural households by strengthening households' linkages with the market economy. This allows them to take greater advantage of market incentives but also at the same time makes them more vulnerable to macro-economic policy shocks. This study has therefore shown that the analysis of the impacts of the paradigm shift in agricultural research towards AIS orientation cannot be solely contained at the household level; as this would lead to the formulation of inadequate policies that do not take into account the effects of greater market linkages of the rural households.

7.3 POLICY RECOMMENDATIONS

The policy implications of the findings of this study are first that increasing production and productivity and linking farmers to markets may not in itself be enough for long-term sustained livelihood improvement. This is because the resultant greater linkages to the market economy may be detrimental to household livelihood outcomes in the face of macro-economic and agricultural policy shocks. To ensure livelihood improvements and innovation, there is the need for AIS driven research to increase the scale of operation in order to have larger impacts but also to work towards fostering the diversification out of agricultural enterprises for income; while supporting productivity improvements for food security. In addition, any AIS driven research that aims to achieve long-lasting tangible impacts on rural livelihoods should work towards strengthening the rural household asset base; in so doing, building to some extent the resilience of the households to risks and shocks associated with agricultural-based livelihood systems. The household asset base can be strengthened through

micro-economic agricultural development programs that encourage greater investment in the farm enterprise in higher value assets.

Second, this study recommends that in order to ensure the sustainability of the positive effects on rural livelihoods and the use of innovation systems concepts, there is the need for grassroots-level agricultural extension staff, such as village technicians and public extension agents, to be supported through increased budgetary support for intervention implementation and capacity building; to enable greater understanding and application of AIS concepts. To ensure that the use of AIS concepts is not isolated to parts of the country where private research and development organisations are working, it is further recommended that there is need to mainstream AIS concepts in all public agricultural research and development initiatives. This will, however, require that there be deliberate and greater budgetary support towards innovation systems mainstreaming in all public agricultural extension and research programmes, and the re-alignment of public agricultural extension and research policy documents. The re-alignment of existing public agricultural extension and research policy documents should be done concurrently with the capacity building of extension agents and the increased budgetary support, in order to ensure effectiveness of the mainstreaming process. Without concurrent implementation of these three strategies, mainstreaming of innovation systems concepts in public agricultural policies runs the risk of becoming synonymous with changing the rhetoric and policy documents, but with no real implementation.

More macro-micro analyses of the impacts of AIS research need to be conducted. Such research should go beyond this study by looking at developing dynamic household-level models that can provide feedback to the macro-component of the model. In addition, future research should work at creating an aggregate household income variable as a means of creating dynamism in macro-micro studies of this kind. Apart from income, future studies should also work on using other welfare indicators such as household food consumption and food security dynamics to analyse the impacts of greater market linkages. These indicators may be in a better position to provide insight into household vulnerability and resilience. In addition, it is also recommended that future studies should aim to assess the use of household expenditure as a means of linking rural smallholder farmers to the macro-economy; thus quantifying linkages of rural households to agricultural input markets. This is an important area of research, as the use of innovation systems in agricultural research changes not only

farmers' linkages with the output sector or their incomes, but also the linkages with the input/supplier sectors and household expenditure patterns.

Future agricultural research, policy and practice should also ensure that rigorous impact evaluation plans are put in place during program conceptualization. This is because the ability to demonstrate causality greatly increases the effectiveness of econometric results for influencing policy (Sadoulet & de Janvry, 2010). However absolute causality can only be achieved with the use of randomized control trials (Sadoulet & de Janvry, 2010). Therefore future program design and research should take this into account by designing programs on a roll out basis for equally eligible end users thus ensuring the validity of the counterfactual. Alternatively the use of other methods; which require additional assumptions to demonstrate rigorous causality; need to ensure statistical regularity and robustness checks; thus guaranteeing the validity of the additional assumptions and dismissal of confounding factors (Sadoulet & de Janvry, 2010).

In order for the paradigm shift in agricultural research towards an innovation systems perspective to be effective in sustaining rural livelihoods in Africa, interventions should be implemented only after systematic analysis of the potential consequences of the resultant macro-micro linkages. This will ensure that there is no mismatch between macro-economic policies, agricultural sector policies and livelihood improvement strategies that are driven by innovation systems concepts.