CHAPTER SEVEN

BASELINE PROJECTIONS, MODEL COMPARISION AND SCENARIO ANALYSIS

7.1 Introduction

In this chapter, the objectives and hypotheses of the study are addressed by generating baseline projections, comparing recursively linked and unlinked models and performing policy analysis on the model, which integrated the intermediate input expenditures and other aggregate variables into the existing BFAP output model. The integrated model is thus able to comprehensively assess the net effect of all exogenous factors that affect the agricultural sector.

The endogenisation of domestic input prices in the integrated model also helps to evaluate the net impact of exogenous variables, such as the exchange rate, which affect both input and output prices, since it assesses the effect on both input expenditures and gross income of the sector. As gross value added and net farming income account for the changes in both gross income and input expenditures of the agricultural sector, they are used as the main target variables in the integrated model to evaluate the net impact of policies. Though domestic input prices are factored in influencing the area planted decision in the BFAP output model, they are not endogenised in the model. Hence, evaluating the net impact of exogenous variables, such as oil price, world fertiliser prices, exchange rate movements and higher domestic input demand that affects input prices are not possible.

The main hypothesis of the study is also tested by comparing the integrated model that recursively linked the output and input side of the agricultural sector and endogenises input costs with a model that does not capture the recursive link and treat input prices as exogenous. The recursively linked model takes into account the dynamic effects of a change in output side to input side of the agricultural sector and vice versa. The two

models are compared to evaluate their ability in replicating the dynamics experienced by the sector when exogenous shocks are introduced into the model.

Using the integrated model, a baseline outlook for the main aggregate variables such as gross value added and net farming income is also generated for the medium term (2010-2015). In addition, several financial and economic performance indicators of the agricultural sector are projected to address the second objective of the study. The previous BFAP output model could project a baseline only for variables from the output side of the agricultural sector, such as commodity prices, area planted, production volume and thus only the gross income for the agricultural sector.

This chapter is organised into four sections. The following section provides the baseline projection for the main aggregate variables and the financial and economic performance indicators of the agricultural sector. The second section compares the recursively linked and unlinked models to assess the effects of various shocks of exogenous variables on the target variables. The third section evaluates the net implication of exchange rate depreciation that affects both agricultural input and output prices on the agricultural sector. A summary of the chapter is given in section four.

7.2 Baseline Projection of the Agricultural Sector

A baseline projection refers to the outlook of the endogenous variables under the *status quo* assumptions of exogenous variables. Thus, it is mainly used as a benchmark to evaluate the effect of changes in the exogenous variables on the endogenous variables. The previous BFAP output model was able to project the commodity/animal product prices, the production volume of field crops and animal products, and the total area planted. Hence, at the aggregate level, the model was able to project the gross income of the agricultural sector by multiplying the quantity produced and their respective prices. The integrated model developed in this thesis is now able to compute various key aggregate variables of the agricultural sector by applying some basic accounting relationships since it incorporates all input expenditure into the existing BFAP output model.

Among the key aggregate variables, the gross value added of the agricultural sector, which shows the contribution of the sector to the economy, is computed by deducting intermediate input expenditure from the gross income of the agricultural sector and own construction. Net farming income, on the other hand, is the profit accrued to producers after depreciation, labour remuneration, rent and interest payment are deducted from the gross value added. The medium term (2010-2015) outlook for these and other aggregate variables of the agricultural sector is projected using the integrated model.

7.2.1 Baseline Projection of Main Aggregate Variables

The forecast values of the selected exogenous variables of the model used for producing the baseline are given in Table 7.1.

Table 7.1: Projected values of selected exogenous variables

Exogenous Variable	2010	2011	2012	2013	2014	2015
Exchange rate (R/USD)	7.44	7.80	8.14	8.47	8.80	9.09
Average annual prime rate (%)	11.10	12.00	12.50	13.00	13.00	13.00
Oil price (USD)	79.60	90.00	80.77	86.43	86.00	80.65
Inflation (%)	6.8%	6.6%	6.3%	6.3%	5.7%	6%
Yellow maize, US No.2, FOB, Gulf ($/t)	170.57	169.75	176.38	177.72	183.81	186.81
Wheat, US No2 HRW, FOB, Gulf ($/t)	210.77	206.57	215.40	225.53	229.47	228.81
Sorghum, US No 2, FOB, Gulf ($/t)	159.34	159.50	165.90	168.79	174.31	177.72
Cheese, FOB, N. Europe ($/t)	2,432.8	2,618.8	2,747.7	2,802.4	2,879.1	2,969.4
Chicken, US 12-city wholesale ($/t)	1,467.9	1,820.6	1,846.3	1,873.5	1,907.7	1,937.7
WMP, FOB, N. Europe ($/t)	1,988.4	2,183.6	2,225.3	2,283.3	2,365.2	2,462.4

Source: Adapted from BFAP model (2010).

The integrated model developed here was for the first time used in the BFAP 2008 outlook to project gross value added and net farm income of the agricultural sector. It projected that gross value added and net farming income will increase by 17 and 21% respectively from 2007 to 2008. The actual data from DAFF (2009) released in 2009 reveals that both variables have increased by 13 and 21% respectively. Similarly the model has projected the actual decline of real gross value added and net farming income in 2009. Thus, the integrated model generally performs a satisfactory outlook in tracking the trend of these target variables.

The baseline projection for the main aggregate variables of the agricultural sector is given in Table 7.2. The projection for the planted area is obtained by aggregating the projections of area planted for white maize, yellow maize, sorghum, barley, canola, sunflower and soybean, which have already been produced by the BFAP output model. The aggregate projection for the total area planted shows a decline in 2011. Thereafter, it displays an increasing trend until 2015.

The real gross income is projected by multiplying the projection of each commodity (animal product) prices and the respective volume of production. The production volume for field crops is obtained by multiplying the projections of each crop's area planted and yield, which is estimated under the normal weather assumption. Since the field crops and the animal product sector represent more than 70% of the total gross value of the agricultural sector, the growth trend of the gross income from the BFAP output model is used to extrapolate the total gross income of the agricultural sector.

Table 7.2: Baseline projections of real values of main aggregate variables (constant 2000 prices)

Variable (1000 Ha/Million Rand)	2010	2011	2012	2013	2014	2015
Total Area	4,642	4,145	4,377	4,387	4,446	4,511
Gross income	68,836	69,682	71,371	72,627	74,036	76,298
Own construction	2,113	2,063	2,029	2,006	1,993	1,989
Intermediate input expenditure	33,384	33,624	34,459	35,602	36,385	36,876
Fuel expenditure	3,814	3,757	3,784	3,873	3,913	3,885
Fertiliser expenditure	3,411	3,761	3,976	4,114	4,137	4,033
Feed expenditure	7,195	7,908	8,107	8,369	8,506	8,594
Gross value added	37,374	37,905	39,176	39,134	39,546	41,514
Interest paid	3,256	3,680	4,014	4,371	4,573	4,755
Depreciation	2,647	2,814	2,959	3,087	3,220	3,330
Labour remuneration	7,426	7,370	7,332	7,284	7,240	7,214
Rent paid	328	345	367	385	400	414
Net farming income	24,442	24,662	25,200	24,984	25,438	27,038

The baseline projections for the real gross income depict an annual average growth rate of 2.08% during the baseline period. The moderate growth rate for the sector's income is largely due to the small growth rate displayed by field crops. During the baseline period, the gross income from animal products and field crops is projected to grow by an annual average rate of 2.7 and 0.8% respectively.

Intermediate input expenditure of the agricultural sector also shows an increasing trend and it is projected to grow at an annual average rate of 2% during the baseline period. The intermediate input expenditure is composed of expenditures on fuel, fertiliser, feed, maintenance and repairs, farm services and other expenditures. The growth in expenditure is largely driven by the cost of fuel and fertiliser, which are projected to increase due to the projected depreciation of the exchange rate and higher oil and world fertiliser prices. The projected rise in animal production also plays a role in increasing the intermediate input expenditure by raising the feed expenditure of the sector.

Own construction of the sector also shows marginal decline during the baseline period, spurred by little growth in the gross capital formation of fixed improvement of the sector. The gross value added of the agricultural sector, which is calculated using the accounting relationship of intermediate input expenditure taken away from gross income and own construction, largely reflects the growth displayed by these three components. Thus, it is projected to grow at an annual average growth rate of 2.12% during the baseline period. The modest growth of the gross value added is due to the relatively similar growth rate of intermediate input expenditure and gross income of agricultural sector.

Labour remuneration is expected to decline, though marginally, during the baseline period. Rent paid is projected to show a gentle rising trend following the growth in the planted area. Similarly, interest paid is projected to depict an increasing trend because of the projected rise in real total debt value and real interest rate. The total debt of the agricultural sector is expected to grow as a result of the rise in the asset value of the sector, which is spurred by the growth in the gross capital formation of the sector. Depreciation of the assets by the agricultural sector, therefore, shows an increasing trend following the rise in the total asset values.

The net effects of the changes in the expenditures on labour, land, capital and the depreciation of assets on agricultural producers is captured by the net farming income of the sector, which is computed by subtracting these expenditures from the gross value added. Its projection shows a modest growth due to the projected higher growth of these input expenditures compared to the gross value added of the sector. Thus, during the

baseline period, net farming income is expected to grow at an annual average growth rate of 1.7%.

7.2.2 Baseline Projection of Financial and Economic Indicators

Using the projections of the main aggregate variables, the financial and economic indicators that are projected for the agricultural sector are given in Table 7.3. To produce the projections of these financial indicators, the asset and debt values of the agricultural sector have been projected in the model. The asset value is estimated by adding the net capital formation to the lagged asset value. The three assets in the sector are land, fixed improvements and machinery, tractors and implements. The gross capital formation of the latter two assets is determined by the profitability of the agricultural sector and the cost of the materials, which includes interest rate and own prices. On the other hand, total debt of the sector has been estimated using the asset value of the sector and the interest rate.

Once these two major indicators of assets and liabilities of the sector are projected, together with the net farming income, they are used to compute and project key economic and financial performance indicators for the agricultural sector. Thus, while the inclusion of input expenditures is enough to produce a comprehensive baseline for the main aggregate variables, the incorporation of assets and liabilities of the sector is vital to project the economic and financial performance indicators of the sector.

The projected financial and economic indicators show that the cash flow (measured as a percentage of gross income) depicts a declining trend. Farmers' cash flow is the actual cash remaining after paying all actual expenditures, thus it excludes own construction and depreciation. Since these excluded values are trending upward, their reduction from the gross income dampen the amount of actual cash flow to producers. Similarly, the net return on assets and equity is projected to decline until 2014 due to a modest growth of net farming income and the projected rising trend of asset and equity values. A comparison of the net returns on assets and equity with the average cost of borrowing (opportunity cost) shows that the net return on assets and equity is projected to exceed the

cost of borrowing during the baseline period. Thus, compared to the previous decade, the sector's economic performance is expected to be improved during the baseline period.

Table 7.3: Baseline projections for the financial and economic indicators of the agricultural sector

Indicators	2010	2011	2012	2013	2014	2015
Cash flow (as % of gross income)	35.5	35.4	35.3	34.4	34.4	35.4
Net return on asset (%)	14.6	14.1	14.1	13.2	12.7	13.3
Net return on equity (%)	19.1	18.4	18.5	17.3	16.7	17.5
Average cost of borrowing (%)	10.4	11.3	11.8	12.3	12.3	12.3
Real total debt (Million Rand)	31,372	32,624	34,075	35,597	37,240	38,724
Real total asset value (Million Rand)	134,156	139,069	144,139	149,138	154,880	160,307
Leverage ratio	0.31	0.31	0.31	0.31	0.32	0.32
Debt burden (%)	23.4	23.5	23.6	23.9	24.0	24.2

Derived by the projected rise of real interest rate and the asset value of the agricultural sector, the real total debt is projected to show an increasing trend. The asset value is also expected to increase because of the projected rise in the gross capital formation and land value. The leverage ratio, which indicates the share of external debt that is used to finance growth and calculated as the ratio of the debt level to total equity, is projected to remain at a relatively constant ratio of 0.31 during the baseline period.

Similarly, the debt burden, which is computed as the percentage share of debt to the total asset value, is projected to increase marginally but remain below 24.2% during the baseline period due to the parallel rise of both the asset and debt values of the sector. Hence, the baseline outlook of the financial and economic performance indicators of the sector show that in general there will be a modest improvement in the financial and economic position of the South African agricultural sector in the medium term under *status quo* assumptions.

7.3 Comparison of the Recursively Linked and Unlinked Models

To test the hypothesis of the study that argues the effect of input cost shocks converges slowly in the recursively linked input and output side of the agricultural sector two versions of the integrated model are used. The first version is the one where both sides of the sector are recursively linked and the second version is where the recursive link is 'switched off'. Hence, in the latter version the recursive effects of any changes in the input side of the agricultural sector to the output side or vice versa are subdued.

For the recursively unlinked model, the effect on the gross value added and net farming income is computed by taking the value of gross income and planted area from the output model and obtaining the input expenditures from the input model. Then, using the basic accounting relationship, gross value added and net farming income of the sector are computed. For the recursively linked model, however, the accounting relationship is established on the model so that it automatically generates the effects on the key target variables.

The result of the exogenous shocks that will be introduced on both versions of the models is compared with the baseline projections of the integrated model given in the above section. The baseline results of both versions will remain the same due to the fact that full information of projected variables is used by both output and input models to produce all the target variables in both versions of the model. Thus, the experiment will evaluate the respective impacts of the shocks that will be introduced in both models on the baseline projections of the target variables. The hypothesis of the study states that embracing the recursive effect of the agricultural inputs side to the output side and vice versa lessens and lengthens the effect of the shock introduced into the model, as the recursive effects of both sides is taken into account. Ignoring the recursive effect, however, would only analyse the impact on the first year without considering its further dynamic and recursive implications.

Generally, the integrated model that incorporates input and output sides also appropriately evaluates the effect of policies on the sector by assessing their simultaneous impact on both inputs and outputs. Economic policies that may result in a fall of area planted, for example, may entail a change in the gross income. However, its effect on the agricultural sector would not be severe if the simultaneous reduction effect of the area on input expenditures is taken into account. Conversely, the effect of policies that increase area planted would be overestimated if the simultaneous impact of the rise of area production on intermediate input expenditure is not taken into account.

To test the hypothesis of the study, two exogenous shocks are introduced in the recursively linked and unlinked models. These are shocks on increasing world fertiliser and crude oil prices. These shocks also evaluate the impact of input costs on the agricultural sector using the integrated model, which is able to analyse these effects due to the endogenisation of the domestic input prices in the model.

7.3.1 A shock of 50% increase in World Fertiliser Price

The results of a single shock of a fifty percent increase in world fertiliser price introduced on both recursively linked and unlinked models in 2010 are given in Table 7.4 and 7.5 respectively. As shown in the tables, the impact largely increases the intermediate input expenditures due to the rise in the cost of the fertiliser input. However, there is a fall in the area planted and gross income due to impact of the current input prices on the winter area planted. As a result, both gross value added and net farming income of the sector falls in the recursively linked model in 2010.

Following the year of the shock, however, the area planted and the gross income in the recursively linked model fell in 2011 due to the recursive impact of the rise in input costs on the summer area planted. The gross income fell due to the fall in the percentage of production, which exceeded the rise in the price for most of the field crops (see Appendix A). However, since the input expenditure fell following the decline in area planted in 2011, the recursively linked model shows little change in the gross value added and net farming income of the sector in 2011. The rise in output prices in 2011 also causes an

increase in the area planted and the gross income in 2012 and following small change in the intermediate input expenditure, the gross value added and net farming income shows a slight increase. Thereafter the effect of the shock on the gross value added and net farming income slowly converges in a cyclical pattern until the effect eventually disappears (see Figure 7.1 and 7.2).

For the recursively unlinked model, however, the effect of the shock was a rise in the input expenditure, which induced a fall in the gross value added and net farming income in 2010. The shock did not impact the area response, as domestic input prices are exogenous in the model. Furthermore, due to the lack of the recursive effect of the shock on the output side, the subsequent impact of the shock disappears in 2011 and thereafter. Thus, using the recursively linked model, the effect of the rise in world fertiliser price on the gross value added and net farming income shows a presence of a positive impact of the effect which is slowly dwindling than a once off plummeting effect implied by the recursively unlinked model.

Table 7.4: Results of the recursively linked model for the shock of a 50% rise in the world fertiliser price in 2010

Variable	2010	2011	2012	2013	2014	2015
Area planted	-0.21%	-2.03%	0.34%	0.03%	0.06%	-0.03%
Gross income	-0.06%	-0.29%	0.17%	0.00%	0.07%	-0.06%
Intermediate input expenditure	2.06%	-0.64%	-0.05%	0.09%	-0.04%	0.02%
Gross value added	-1.84%	0.03%	0.36%	-0.08%	0.17%	-0.12%
Net farming income	-3.42%	0.09%	0.82%	-0.17%	0.48%	-0.32%

Table 7.5: Results of the recursively unlinked model for the shock of a 50% in the world fertiliser price in 2010

Variable	2010	2011	2012	2013	2014	2015
Area planted	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Gross income	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Intermediate input expenditure	2.14%	0.00%	0.00%	0.00%	0.00%	0.00%
Gross value added	-1.79%	0.00%	0.00%	0.00%	0.00%	0.00%
Net farming income	-3.32%	0.00%	0.00%	0.00%	0.00%	0.00%

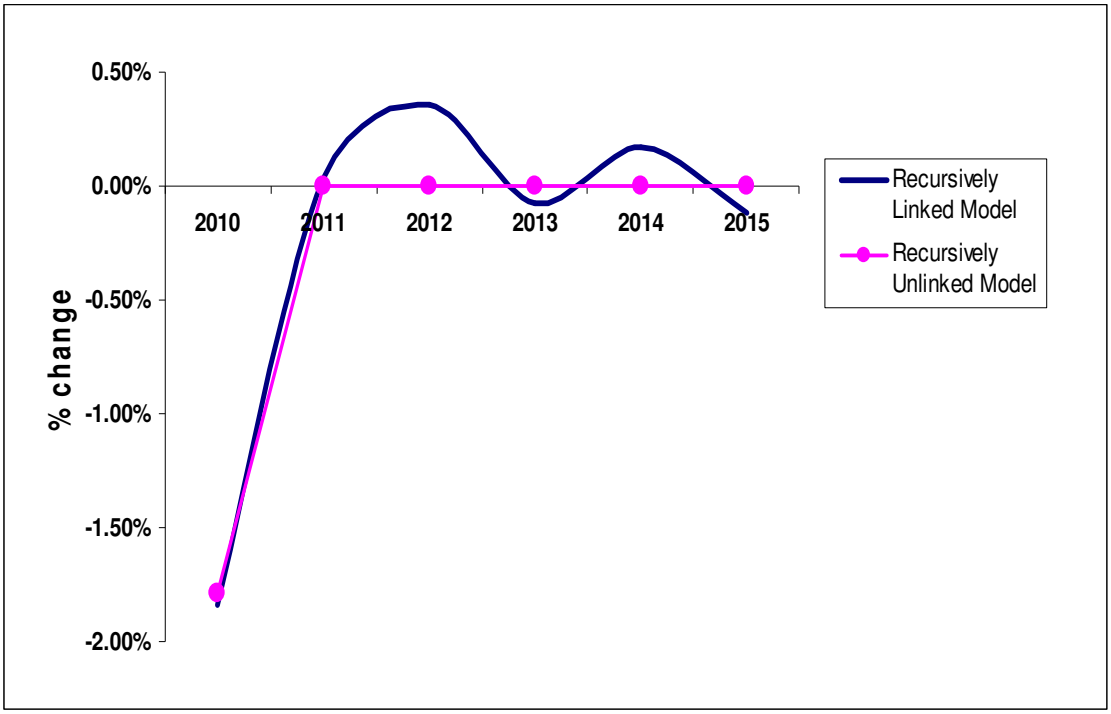

Figure 7.1: **The impact of a 50% shock in the world fertiliser price on the gross value added of the agricultural sector.**

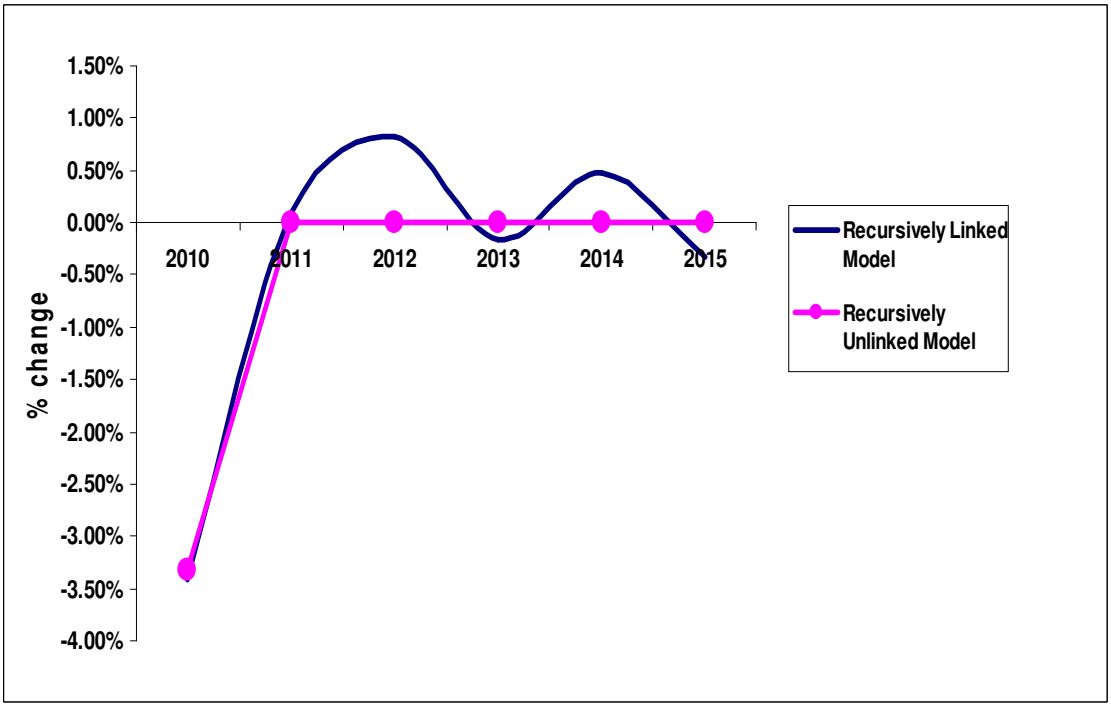

Figure 7.2: **The impact of a 50% shock in the world fertiliser price on the net farming income.**

7.3.2 A Shock of 50% Increase in Crude Oil Price

The results of the impact of a single fifty percent increase in crude oil price introduced in 2010 on the agricultural sector using the recursively linked and unlinked models are presented in Table 5.4 and 5.5 respectively. The impact of the shock entails a fall of the gross value added and net farming income due to the rise in input expenditure. Unlike the effect of the shock in world fertiliser price, however, the crude oil price shock showed a marginal increase in the gross income of both versions of the model in 2010. This is because the shock raised the domestic prices of some commodities by increasing the transport cost, which is captured in both models.

In 2011, the unlinked model shows a marginal increase in the area planted and the gross income due to an increase in output prices in 2010, but the area planted and gross income fall in the recursively linked model since it takes into account the full effect of the change in fuel prices during 2010, when the summer planting area decision was made for 2011. Similar to the above scenario, the gross income falls because the percentage of production has exceeded the rise in price for most of the field crops (see Appendix B).

The reduction in input expenditure following the decline in area planted, however, augments the gross value added and net farming income. In 2012, the gross value added and net farming income also grows after the effect of the change in gross income and input expenditures are taken into account. Gross income rises in 2012 due to the rise in the area planted following the rise in price in 2011. Thereafter, the impact of the shock on the gross value added and net farming income slowly converges in a cyclical pattern until it slowly disappears (see Figure 7.3 and 7.4). Thus, the effect of the rise in the crude oil price on the agricultural sector may not be a once-off fall in the gross value added and net farming income when the recursive effect is fully taken into account. If the impact of oil price on world commodity price were included, the positive effect on the agricultural sector would also be more than the result obtained in this scenario.

Table 7.6: Results of the recursively linked model for the shock of a 50% rise in the crude oil price in 2010

Variable	2010	2011	2012	2013	2014	2015
Area planted	-0.29%	-2.51%	0.74%	-0.07%	0.12%	-0.06%
Gross income	0.24%	-0.06%	0.25%	-0.03%	0.11%	-0.09%
Intermediate input expenditure	2.75%	-0.75%	-0.01%	0.07%	-0.07%	0.03%
Gross value added	-1.86%	0.56%	0.46%	-0.11%	0.26%	-0.19%
Net farming income	-3.46%	1.17%	1.02%	-0.28%	0.70%	-0.58%

Table 7.7: Results of the recursively unlinked model for the shock of a 50% rise in the crude oil price in 2010

Variable	2010	2011	2012	2013	2014	2015
Area planted	0.00%	0.38%	0.07%	0.00%	0.00%	0.00%
Gross income	0.34%	0.18%	0.02%	0.00%	0.00%	0.00%
Intermediate input expenditure	2.83%	0.00%	0.00%	0.00%	0.00%	0.00%
Gross value added	-1.77%	0.34%	0.04%	0.00%	0.00%	0.00%
Net farming income	-3.29%	0.70%	0.10%	0.00%	0.00%	0.00%

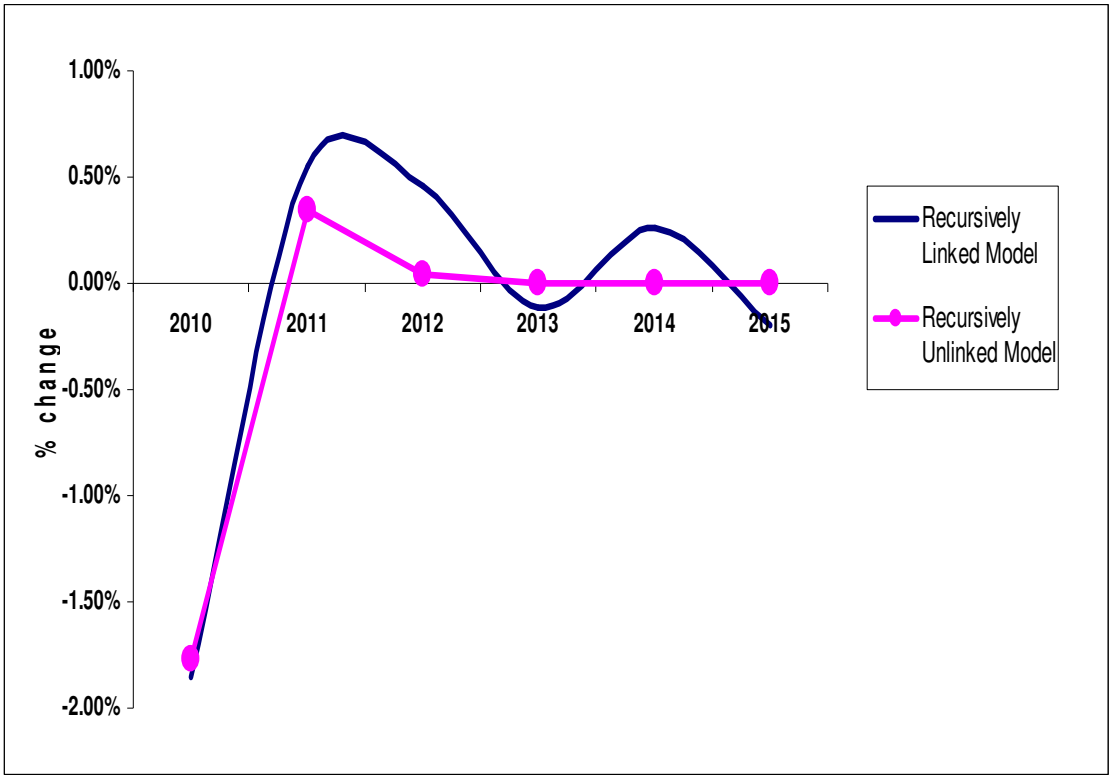

Figure 7.3: The impact of a 50% increase in the crude oil price on gross value added of agricultural sector

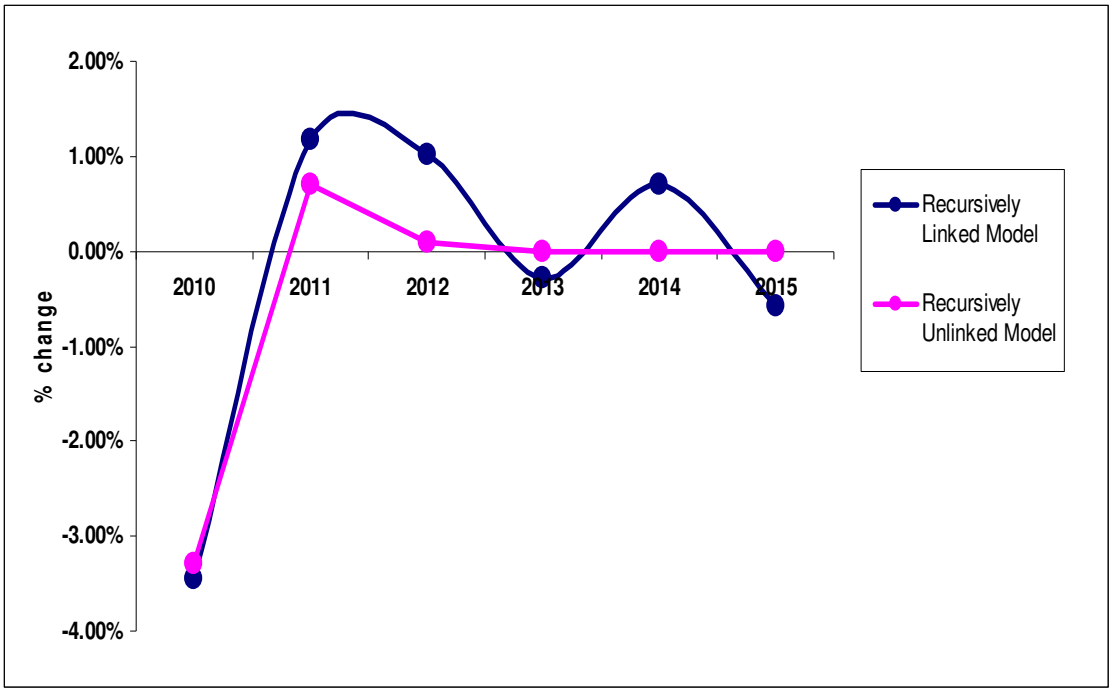

Figure 7.4: The impact of a 50% shock in the crude oil price on net farming income

7.4 Applying the Recursively Linked Model for Analysing the Impact of Exchange Rate Depreciation on the Agricultural Sector

Since in the previous BFAP output model domestic input prices were exogenous, the impact of change in input prices that might occur due to a change in exogenous variables such as world fertiliser prices, crude oil price, changes in exchange rate and growing domestic input demand could not be analysed. The recursively linked integrated model, however, links the domestic input prices with world markets, macro variables and domestic demand, and is therefore suitable for analysing the impact of exogenous factors that affect both output and input prices of the agricultural sector. Hence, the net impact of exchange rate depreciation on the sector is evaluated to assess the factors that affect both input and output prices simultaneously.

The results of a single shock of 50% exchange rate depreciation introduced in 2010 on the recursively linked model are given in Table 7.8. As shown in the table, the model showed little change in the area planted in 2010, since current prices and costs affect only

the winter area planted. However, the exchange rate depreciation affects largely the gross income and input expenditure in 2010. Intermediate input expenditure rises by 5.6% due to the increase in the prices of fuel, fertiliser and feed. The rise is relatively modest as the depreciation of the exchange rate does not affect much the current planted area and not all agricultural input costs that may be affected are incorporated in the model.

The gross income also shows an increment of 24%, induced by the rise in output prices. Thus, the net effect of the shock increases the gross value added and net farming income by 39 and 72% respectively. The net farming income increases more due to the fact that most of the expenditures like depreciation, labour remuneration, rent and interest payments will remain unaffected for 2010. A significant increment of net farming income is also observed in 2001, when the 41% depreciation of the exchange rate induces a 50% rise in net farming income.

During 2011, however, area planted increases by 11% as the result of the lagged higher returns. Gross income, therefore, increases, by 3.5%. The modest rise in gross income is due to the price inelastic demand of agricultural products, which lowers the prices due to the rise in production. Following the rise in planted area, intermediate input expenditure also increases. Hence, the gross value added and net farming income will rise respectively by 5.3 and 10.3% in 2011. After 2012, the effect of the exchange rate shock will follow a cyclical pattern where the rise in gross value added and net farming income is followed by a fall until the total effect of the shock slowly disappears.

Table 7.8: Results of the recursively linked model for the shock of a 50% depreciation in exchange rate in 2010

Variable	2010	2011	2012	2013	2014	2015
Area planted	0.30 %	11.17 %	-1.49 %	0.41 %	-0.13 %	0.08 %
Gross income	24.39 %	3.50 %	-0.57 %	0.71 %	-0.51 %	0.43 %
Intermediate input expenditure	5.49 %	1.10 %	-1.63 %	-1.01 %	-0.27 %	-0.48 %
Gross value added	38.98 %	5.35 %	0.40 %	2.25 %	-0.68 %	1.22 %
Net farming income	72.50 %	10.36 %	-0.47 %	3.68 %	-4.20 %	0.92 %

7.5 Summary

This chapter addresses the main objectives of the study by providing baseline projections for the main aggregate variables and for the financial and economic performance indicators of the agricultural sector. Moreover, it tests the main hypothesis of the study, which states that the impact of input cost shocks on the agricultural sector is lengthened and converged slowly when the agricultural input and output sides are recursively linked by comparing the results of exogenous shocks introduced in the two versions of the integrated model. While the first version recursively links the agricultural input and output sides, the second version of the model 'switches off' the link.

The baseline projections for the main aggregate variables and the financial and economic performance indicators of the agricultural sector based on the projected values of exogenous variables show that the sector's gross income, intermediate input expenditure and gross value added will grow at an annual average growth rate of roughly 2%. Net farming income, however, shows a modest growth of 1.7% due to a higher rise in input expenditure compared to the growth of gross income. In addition, most of the financial and economic indicators show a modest improvement except the debt burden that shows little growth and leverage ratio, which remain relatively constant at 0.31 respectively.

Comparing the results of exogenous shocks introduced in the recursively linked and unlinked versions of the integrated model shows that the effect of exogenous shocks on the recursively unlinked model quickly die after the year of the shock due to the lack of a recursive effect between the output and the input sides. For the recursively linked model, however, the effect slowly converges in a cyclical pattern until it disappears due to the consideration for the recursive effect between the input and output side. Thus, the effect of increasing input cost may not be only a fall in gross value added and net farming income, as shown by the recursively unlinked model, but also a growth in subsequent years when the recursive effect of the impact is fully accounted for.

Using the recursively linked integrated model, the effect of exchange rate depreciation that affects the price of input and output simultaneously is evaluated. The result of a fifty

percent shock introduced in the model reveals that the devaluation augments the gross income due to the increase in domestic prices for most agricultural products. Similarly, it increases input expenditure as a result of the rise in the cost of fuel and fertiliser. Due to the overwhelming rise in gross income, however, the net impact shows a significant rise of gross value added and net farming income in 2010. The rise in area planted in the subsequent year also induces a rise in gross income. However, the expansion of area planted and animal production also augments the input expenditure. Thus, the net effect on the gross value added and net farming income during 2011 remains positive because of the relatively higher growth of gross income *vis-à-vis* the input expenditure. After 2012, however, the impact converges slowly until the effect eventually disappears.

CHAPTER EIGHT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

8.1 Summary

This study integrated a detailed model of agricultural input expenditures into the existing South African multi-market partial equilibrium model in order to evaluate the net impact of economic policies that especially affect input costs in the agricultural sector. Evaluating such impact by integrating inputs and other key aggregate variables with the output model and endogenising input costs would enrich the results of standard partial equilibrium models by enabling them to generate several economic and financial indicators to conduct a comprehensive assessment of the net effects of economic policies on the agricultural sector.

The main focus of most partial equilibrium models is the output side of the agricultural sector. Thus, sufficient attention has only been paid to incorporating inputs in a few of these models. Moreover, in most partial equilibrium models, the recursive linkage of the input and output sides of the sector and endogenising of input costs is overlooked in analysing the net impact of policies that affect both sides of the sector. Hence, the main objective of the study was to address both issues by extending the existing South African multi-market model to comprehensively evaluate the net impact of economic policies on the agricultural sector.

Since using few indicators to evaluate and assess the performance of the sector often provides little insight, applying several financial and economic indicators sheds more insights on the impact of economic policies on the sector, as this captures the effect from various angles. To obtain these indicators, however, it is crucial to integrate agricultural inputs into a multi-market output model and to incorporate the key aggregate variables of the agricultural sector (like asset value, debt level and gross capital formation of the sector).

Since the data used for the variables in the model is on aggregate level and the main objective of the research is for the purpose of policy analysis and projections, a single-equation method is used in the study. The approach is based on Hendry's methodology, where the data generation process starts from the general ADL (1) model specification, which allows testing of various nested and rival models. Thus, this method avoids data mining problems associated with the simple-to-general method and it allows the short-run dynamics of the model to be determined by the data.

The estimated input expenditures and other aggregate variable models are used to project the baseline for the agricultural sector, based on *status quo* assumptions for the exogenous variables, after passing many statistical diagnostic tests and model validation procedures. The baseline projections of the main aggregate variables of the agricultural sector showed a modest growth for the gross income, intermediate input expenditure and gross value added of the agricultural sector. The growth of real net farming income is relatively low during the baseline period, due to a relatively modest growth of gross income compared to all input expenditures. However, compared to previous decades, a modest improvement in the economic and financial position of the agricultural sector is projected during the baseline period.

From the comparative results of the impact of exogenous shocks on the agricultural sector using the recursively linked and unlinked models, it is revealed that an integrated model that recursively links the input and output sides of the agricultural sector and endogenises input costs subdues and lengthens the effect of shocks slowly and cyclically, due to the consideration it gives to the recursive effect from the output side to the input side and vice versa. The impact of a fifty percent devaluation of the exchange rate is also examined to evaluate the net impact of a variable that simultaneously affects both input and output prices. The result of the experiment indicates that the increase in gross income by far exceeds the rise in the expenditure effect. Thus, the net effect on gross value added and net farming income is very positive. Hence, this scenario showed that the net impact would have been overestimated if the simultaneous impact of the depreciation on input expenditure is not taken into account in the model. Similarly, the effect on the sector

would have been concluded to be detrimental if the impact is evaluated only on input costs and expenditures.

8.2 Conclusions

Since the growth of the gross value added and net farming income do not exactly match the growth of the gross income due to the incorporation of input expenditures, economic and sectoral policy analyses that are based only on the gross income could reach a misleading conclusion. Moreover, since economic policies and exogenous factors that affect the gross value (output and prices) of agricultural sector could also affect input expenditures (inputs and costs) of the sector simultaneously and recursively, incorporating the impact of these policies on both outputs and inputs is essential to uncover their net effect on the sector.

Hence, this study extended the partial equilibrium sectoral model developed by Bureau for Food and Agricultural Policy (BFAP) by integrating input expenditures and other components of aggregate variables and endogenising input costs into the model in order to improve its ability to comprehensively assess the full impact of policy changes and exogenous shocks. Thus, the developed integrated model is now able to project a baseline for the gross value added, net farming income and several financial and economic performance indicators of the agricultural sector. Stated differently, the integrated model has extended the economic policies impact assessment on the South African agricultural sector, which was limited only on gross income (production, area planted and prices) to input expenditures, gross value added and net farming income of the sector. In addition, the integrated model has further extended the analysis to evaluate the financial and economic position of agricultural sector by assessing the implication of the policy on the asset and debt values of the sector.

The integrated model has also recursively linked the input and output side of the sector and endogenised input costs. Hence, the dynamic effects of policies on the agricultural sector are well captured due to the recursive linkage. Moreover, the model is now able to

analyse the net effect of policies and exogenous factors that simultaneously affect both input and output prices.

Comparing the results of exogenous shocks introduced on the recursively linked and unlinked versions of the integrated model shows that the effect of exogenous shocks on the recursively unlinked model quickly die after the year of the shock due to the lack of the recursive effect between the output and the input side. For the recursively linked model, however, the effect is lengthened and slowly converged in a cyclical pattern until it disappears due to the account for the recursive effect between the input and output side of the agricultural sector.

In conclusion, this study shows that a partial equilibrium model that integrates input expenditures into the output side of the agricultural sector will be able to generate baseline projections for key aggregate variables. Moreover, incorporating other main aggregate variables into the partial equilibrium model enables the model to produce several indicators that can be used to evaluate the economic and financial position of the agricultural sector. Endogenising domestic input costs in the partial equilibrium model also enables the model to comprehensively analyse the net impact of exogenous factors that simultaneously affect both sides of the agricultural sector. From the results of several shocks and policy scenarios, it can also be concluded that a recursively linked output and input models of agricultural sector replicates the dynamics of the agricultural sector better than the unlinked one.

The model developed in this study, therefore, improves the result of the standard partial equilibrium models by producing a comprehensive assessment of the effects of policies than obtained by models that have few/no inputs components, assess the effects separately, or treat input costs as exogenous to the model. Moreover, by simultaneously encompassing the impact of policies on both output and input sides of the agricultural sector, the integrated model serves as a powerful tool to investigate the effects of various economic policy analyses and answers several ‘what if’ questions. Ignoring the dynamic and recursive interaction within the sector in evaluating the implication of economic policies often leads to a biased conclusion.

8.3 Limitations of the Study and Areas of Further Research

This study attempts to provide a modelling framework that could be used to comprehensively analyse the net impact of economic policies on the South African agricultural sector by integrating agricultural input expenditures into a multi-market commodity model. The modelling framework, however, could be further refined in the following aspects.

- Dealing with aggregated data often conceals the difference in the impact of economic policies across sub-sectors and at a commodity or animal product level. Therefore, it is recommended that disaggregating the input expenditure component and assessing the net farm income at a lower aggregation level would be able to capture the diverse implications of these policies on each sub-sector and product level.

- This study also assumes that the rise in input costs will affect all commodities equally. In reality, however, there is a wide difference in input utilisation by each commodity. The inclusion of variable input cost composition for each commodity, therefore, would give more accurate policy impacts at a commodity level and it would also make it possible to project the profitability trend of the commodity production.

- Incorporating several variable input costs for each commodity would also make the recursive effect of the input side to the output side of the agricultural sector more pronounced than the findings of the study, which used only fuel and fertiliser costs as a proxy.

- Embracing the possible yield effects of the rise in input costs would also enhance the analysis of the impact of these costs on the agricultural sector.