Available online at www.sciencedirect.com
SCIENCE DIRECT®
Food Policy 31 (2006) 357–371
FOOD POLICY
www.elsevier.com/locate/foodpol

Hedging grain price risk in the SADC: Case studies of Malawi and Zambia

Julie Dana [a], Christopher L. Gilbert [a,b,*], Euna Shim [c]

[a] *CRMG (ARD), The World Bank, 1818 H Street NW, Washington, DC 20144, USA*
[b] *Dipartimento di Economia, Università degli Studi di Trento, Via Inama 5, 38100 Trento, Italy*
[c] *Fletcher School of Law and Diplomacy, Tufts University, 160 Packard Avenue, Medford, MA 02155 7082, USA*

Abstract

We use simulation methods to examine the results of hedging maize food security imports into Malawi and Zambia on the South African Exchange (SAFEX). Results show that hedging using either futures or options can spread import costs over time, thereby reducing variability, and also possibly generating lower average costs. These benefits are increased if hedging only takes place when local prices are at less than import parity and also if the hedge is levered. However, problems will remain so long as intra-regional transport costs remain high.
© 2006 Elsevier Ltd. All rights reserved.

Keywords: Grain rice risk; Malawi; Zambia; Futures; Options

Introduction

White maize is the staple food crop in much of southern Africa. However, the crop is vulnerable to droughts and occasional flooding so households require access to stocks and/or imports if they are to maintain consumption levels. We consider food security strategies for two Southern African Development Community (SADC) countries, Malawi and Zambia. Over the past decade, the SADC has had two bad grain harvests, in 1998 and 2002, when the governments of both countries imported grains at high

* Corresponding author.
E-mail addresses: jdana@worldbank.org (J. Dana), cgilbert@economia.unitn.it (C.L. Gilbert), euna.shim@tufts.edu (E. Shim).

0306-9192/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.foodpol.2006.03.007

prices. At the same time, the South African Futures Exchange (SAFEX) has seen a steady increase in maize trading volumes, suggesting the possibility of hedging regional import requirements. Here we ask whether SAFEX can be used to manage maize import risks in Malawi and Zambia.

The Malawian and Zambian grain markets

In normal harvest years, white maize production is around 2 million tons in Malawi and 1 million tons in Zambia. Exports from both countries are usually negligible and Malawian per capita maize consumption is around 80% higher than Zambia. Grain markets have been liberalized in both Malawi (1987) and Zambia (1992), but both governments maintain a strong presence. Nucifora and Lisulo (2005) discuss the continuing role of the Agricultural Development and Marketing Corporation (ADMARC) in Malawi. Jayne et al. (2002) discusses both ADMARC and the Zambian Food Reserve Agency.

Maize is planted in Malawi and Zambia during October or November and harvested from March. Adequate rain at planting and tasselling from December to February is crucial and normally apparent by mid-January, or February at the latest. In shortfall years, governments import to cover consumption needs. This is shown for Malawi in Fig. 1 and for Zambia in Fig. 2, where net imports are on a calendar year basis and production is the average of the current and previous year's production.[1] In Malawi, imports were substantial only in 1998 and 2002. Zambia imported also in 1997 and 2003.

We collected monthly data on retail maize prices in six Malawian centers and six Zambian centers, and define an "average" price series for Zambia as the median price in the six centers.[2] For Malawi there is greater regional heterogeneity and the national "average" price is defined as an average of the median prices for the three northern and three southern centers. Fig. 3 shows the resulting retail price indices, converted into a common rand/ton basis and deflated by the RSA consumer price index (CPI), together with the deflated Randfontein spot wholesale price index and the Chicago Board of Trade (CBOT) first nearby yellow maize futures price, on the same basis.[3]

Three points stand out:

- Apart from two brief periods (1996–1997 and early 2003), the Malawian and Zambian prices move closely together.
- Malawian and Zambian retail prices are more volatile than RSA wholesale prices, which are in turn more volatile than the Chicago price.
- Prices in both Malawi and Zambia were exceptionally high during 2001–2002, both absolutely and relative to world and regional levels.

[1] *Sources*: FAO and United Nations.

[2] Malawi (South): Lilongwe, Luchenza, Lunzu. Malawi (North): Kalonga, Mzuzu, Nkhotakota. Zambia: Chipata, Kabwe (urban), Kasama, Livingstone, Lusaka (urban), Ndola (rural). The data have gaps which were filled by interpolation. Data source: Famine Early Warning System. FEWSNET.

[3] The Chicago Board of Trade trades yellow maize ("corn") futures. SAFEX trades both white and yellow maize futures. In southern Africa, white maize is used for human consumption and yellow maize for animal consumption. Deflation by the RSA CPI is appropriate because all prices are converted into rand. This is precisely equivalent to deflation by the own CPI and conversion into rand at the real exchange rate.

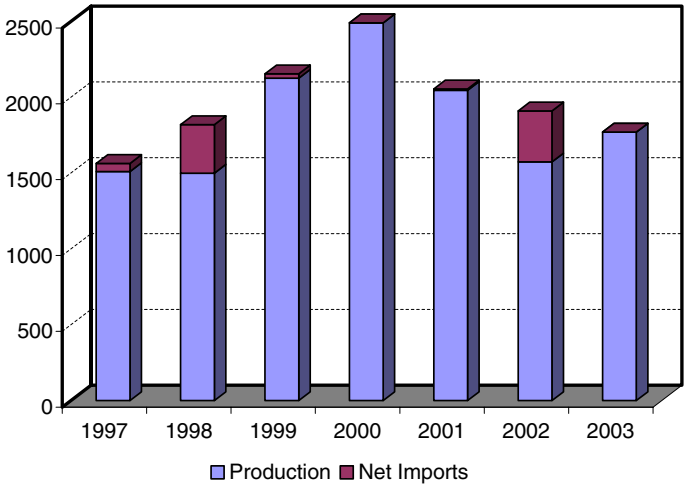

Fig. 1. Maize production and imports, Malawi, 1997–2003.

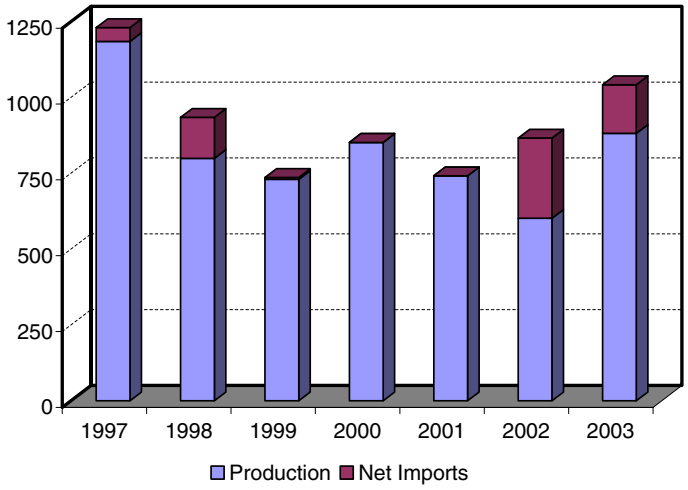

Fig. 2. Maize production and imports, Zambia, 1997–2003.

These visual features are confirmed in Table 1 which gives the volatilities and correlations of the four prices.[4] The Malawian and Zambian prices are more correlated with each other than with the RSA price, and are only modestly correlated with the Chicago price. Volatilities of this order may impose high costs on consumers because costs are proportional to the price variance, i.e. the square of the volatility (Myers, 2005).

The high volatility of retail maize prices in Malawi and Zambia reflects two factors:

- An overall SADC deficit requires imports into the region from the world market. This causes prices to jump to world levels plus transport costs to southern African ports.

[4] See Table 1 notes for definitions of volatility and correlation.

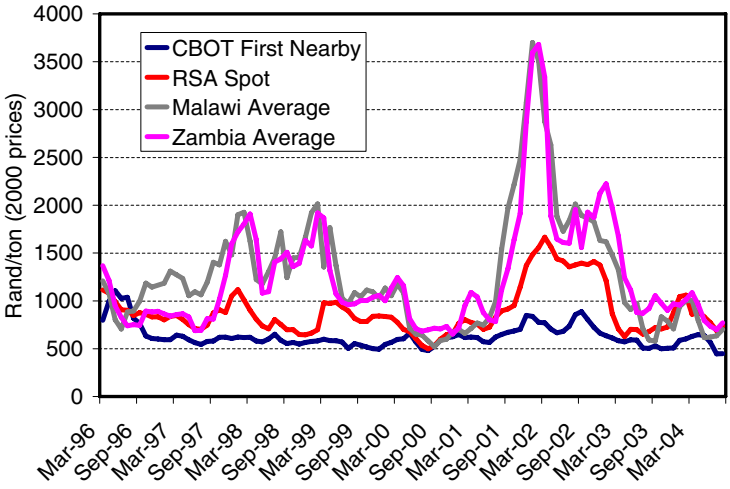

Fig. 3. Monthly average maize prices, Malawi and Zambia.

Table 1
Maize *volatilities* and correlations

	CBOT (front)	RSA (wholesale)	Malawi (retail)	Zambia (retail)
CBOT (front)	*26.4%*	0.570	0.360	0.340
RSA (wholesale)		*32.8%*	0.743	0.732
Malawi (retail)			*56.3%*	0.895
Zambia (retail)				*54.5%*

Monthly average data, April 1996–October 2004. Volatilities, italicized and on the diagonal, are standard deviations of the log differences in price on an annualized basis. Correlations, above the diagonal, are between the price levels.

- Shortfalls in the domestic Malawian and Zambian markets lead to the price rising to Malawian and Zambian import parity. The large differentials which can emerge between the price of maize in the northern SADC countries and South Africa reflects a combination of transport costs, administrative restrictions, poor organization and uncertainty (Coulter and Poulton, 2001).

These two factors compound when there is a shortfall across the entire SADC region because Malawi and Zambia need to attract maize from the RSA where prices will also have risen relative to the world market.

Food security

We start from two premises:

- SADC governments only import grain in the event of a harvest shortfall. At other times, the local market functions and households are able to purchase their requirements at reasonable prices.
- Both countries have high transport costs so with normal harvests prices will be between import and export parity.

It follows that these countries only require access to inventory or imports in years there is a harvest shortfall. Our interest in this paper is how this demand can be satisfied efficiently, both in terms of the average cost and the variability of these costs over time.

A major issue is whether, in the event of a shortage, government should be responsible for grain imports or whether this should be left to the private sector. Three possible models might be considered:

- Governments decide on grain import requirements and directly contract for delivery.
- Governments decide on grain import requirements and put these out to private sector tender.
- The private sector assesses grain requirements and contracts directly.

The choice depends on whether the government or the private sector is more efficient in purchasing, transport and delivery.

Grain markets in southern Africa tend to be highly politicized which limits the likely efficiency of a pure private sector solution. The following are examples:

- Government policy and regulations regarding imports, exports and tariffs can change suddenly. When there is uncertainty about government actions, traders will not enter into deals, or make plans to supply maize across borders.
- Government may compete with the private sector in holding stocks. This can crowd out private sector storage (Miranda and Helmberger, 1988; Øygard et al., 2003).
- Traders who accumulate stocks may find that they are subjected to price controls or compulsory purchase. This limits the incentives for private storage.

Newbery (1989) showed that it may be optimal to store grains in excess of the competitive level, provided this is financed through progressive income taxation (together with a number of other technical conditions). However, given the possible inefficiency of public sector storage, it may be better to take this as an argument for subsidizing storage of grains by the private sector rather than for public storage per se. Coulter (2005) argues against governmental involvement in anything more than a small food security reserve, on the basis that this crowds out private provision. However, he also acknowledges that this policy would be more problematic in landlocked economies such as Malawi and Zambia.

Even if a pure private sector solution were the most efficient means of provision, it would probably not currently be feasible in the SADC where governments will inevitably be involved in grain import decisions over the foreseeable future. One response is to promote the importance of clarity of policy and transparency in its application – see Brunetti et al. (1997) – but a policy of doing nothing is bound to be both clear and transparent. If governments feel obliged to be involved in grain marketing over the longer term, they should make the conditions and extent of their involvement explicit. The private sector can then adjust its behavior accordingly.

In what follows, we start from the premise that government decides on import requirements. This being the case, we see governments as holding inventory against the possibility of a shortfall, arranging imports in the event of a shortfall, or adopting a combination of these strategies. In years in which the harvest is normal, the inventory strategy imposes ex

post unnecessary storage costs, and possibly capital losses. The offsetting advantage is that the grain is immediately available if a shortage materializes. The import strategy is costless in normal years but obliges governments to purchase and transport grain at times when costs will be high, and imports take several months to arrive. So import and inventory-based policies complement each other because imports cannot cope with the initial months of a crisis but inventories can.

Simulated costs of unhedged schemes

We simulate a pure inventory strategy (A), a pure import strategy (B), and a mixed strategy (C) in which half of maize requirements are met from inventory and half from imports. The simulations cover eight years, 1997–2004. This is a short sample so results are will be highly dependent on particular features of these years. The period includes two years in which the maize harvest was inadequate – 1998 and 2002. We consider the costs of 100,000 tons of maize imports in Malawi in 1998 and 2002 (strategy A), and of an inventory of 100,000 tons of maize in Malawi released in 1998 and 2002 (strategy B). The simulations for Zambia are similar but with inventory and import levels of 50,000 tons, reflecting the lower aggregate level of maize consumption. In the mixed strategy C, we simulate inventories of 50,000 and 25,000 tons in Malawi and Zambia, respectively, in conjunction with imports of the same quantities.

Table 2 summarizes results. All values are in millions of 2000 rand. Comparison of schemes A and B suggest that, in both countries, food security inventories have higher costs than import-based schemes. This reflects higher interest costs (inventory is carried for a longer period than imports require financing), offset by lower transport costs. However, this conclusion depends crucially on the assumptions employed and it is easy to obtain results with the reverse implication. The third row of Table 2 gives results for the mixed scheme C which, as expected, are close to an average of those in schemes A and B. The conclusion is that the import scheme is less costly than a food security inventory, but a mixed inventory and import scheme is the most effective in terms of spreading costs across years.

The averages in Table 3 disguise considerable variation across time. The import scheme (B) incurs costs only in the two years that imports were required (1998 and 2002), but these costs are high. By contrast, the inventory scheme (A) incurs high costs in the years in which inventory is built up (1997) or the year following a build-up (2000, 2004) when price falls result in mark-to-market losses. The mixed inventory and import scheme (C) incurs highest costs in years in which imports take place but total costs are spread over time.

Table 2
Simulation results (million Rand) – unhedged schemes

		Malawi		Zambia	
		Average	Standard deviations	Average	Standard deviations
A	Imports	51.0	94.5	26.5	49.0
B	Food security inventory	67.8	71.3	35.6	37.2
C	Mixed: inventory + imports	62.6	46.1	32.6	23.8

The table reports averages and standard deviations, in millions of Rand at 2000 prices, over the eight years 1997–2004. For simulation details, see Appendix A.

Table 3
Cost summary

	Malawi		Zambia	
	Average	Standard deviations	Average	Standard deviations
Unhedged imports	51.0	94.5	25.8	47.9
Non-discretionary futures-hedged imports	44.5	80.3	23.2	41.8
Discretionary futures-hedged imports	36.2	81.4	19.0	42.5
Levered discretionary futures hedge	12.5	72.2	7.2	37.7
Options-hedged import scheme	43.6	86.0	22.8	44.8
Levered options-hedge scheme	35.5	82.4	18.7	42.9

The table reports averages and standard deviations, in millions of Rand at 2000 prices, over the eight years 1996–1997 to 2003–2004. For simulation details, see text and Appendix A.

Variability in inter-annual costs is borne out by the standard deviations reported in Table 2. The greater predictability of costs in the mixed scheme (C) is a strong argument in its favor, but the pure import scheme still has lower average costs. It appears there is little appetite among national or multilateral agencies for subsidizing either national or regional grain stockpiles at present. In the remainder of the paper, we therefore concentrate on schemes which rely on imports.

Hedging

Imports may be hedged either through the purchase of futures contracts or financial call options. Purchase of long futures positions fixes the eventual SAFEX price basis. Purchase of call option puts a ceiling on the purchase price (at the option strike price). Both are paper transactions and will be closed out either by offsetting sales or by option expiration. Neither contract results in purchase of the physical grain. Further, futures and options only provide protection against changes in the SAFEX price basis. Hedging using these instruments alone cannot protect against changes in transport costs, storage costs or financing costs, all of which may fluctuate widely and which account for close to 50% of the total cost of Malawian and Zambian maize imports from South Africa. This creates an important element of basis risk.

We first consider use of futures contracts. The futures-augmented import strategy has the potential to be effective because imports are only required in the event of a harvest shortfall, in which case the market price will have risen yielding profits on the long futures position. However, although this strategy reduces import costs in the event of a shortfall, it does this by spreading costs over good and bad years, not by magically eliminating them. The balance of costs and benefits depends on the frequency of shortfalls.

The futures-augmented import strategy is sometimes called "synthetic storage" – see Culp and Miller (1995). This term reflects the fact that, in taking a long futures position, the agent is requiring the market to undertake storage on its behalf, the incentive provided by a rise in the futures price relative to the cash price. This usage emphasizes that a futures-based strategy does not reduce the requirement for inventory, but simply transfers that responsibility to the market. Synthetic storage will be advantageous relative to physical storage when the market can carry inventory at lower cost than government, or has access to lower cost finance than government. Otherwise, by adding an additional layer of costs it is likely to be less attractive than physical storage. Note that synthetic storage will typically induce storage at a central location (say Johannesburg) while physical stocks

can be held near the point of consumption (Lilongwe or Lusaka). Physical storage therefore gives more immediate availability.

The second possibility is to hedge imports through the purchase of call options. In return for payment of a premium, the call option provides the user with the opportunity to take advantage of lower prices if the market moves in that direction. The advantage of the options hedge is that the cost is limited to the upfront premium, perhaps less if positions are closed out prior to expiration. However, this advantage may be offset by a higher bid-ask spread. A priori, it is unclear whether these disadvantages are sufficiently important to offset the advantage of cost limitation.

The ultimate decision to use futures and/or options will be a cashflow and management decision. Futures transactions create credit risk for the provider through the possibility of non-payment of margin in the event of a fall in the futures price. A provider's willingness to assume this risk will be subject to internal controls in the providing company. Access to futures contracts, therefore, may require a large credit guarantee or the deposit of a significant amount of cash (or liquid securities). Monitoring the day-to-day size of the credit exposure to futures trading also imposes an administrative cost, and it is unlikely a government ministry would ever have the requisite degree of discretion, even in a developed economy. The purchase of call options through full up-front payment avoids these problems and is likely to be the only feasible means of hedging for most SADC governments.

Hedged schemes – design

We consider three classes of scheme:

- Non-discretionary futures hedges.
- Discretionary futures hedges.
- Financial options hedges.

To evaluate the costs and benefits of hedging we need to specify:

- The contract in which the hedge is placed.
- The date at which the position is purchased.
- The date (or circumstances) at which it is closed.
- The way in which discretion is exercised (in the case of the discretionary scheme).

The non-discretionary futures-hedged import scheme

We assume the hedge is placed on the ''Mar'' SAFEX white maize contract (i.e. March deliver date). The Mar contract is the first contract in the new (southern hemisphere) crop year and is the principal SAFEX contract on which price discovery for the new crop takes place. The Mar contract starts trading around eighteen months prior to maturity but attracts little interest until the middle of the following year. Its price tends to be fairly flat until information about the new crop starts to emerge around mid-December. Discovery is reasonably complete by mid-February.

The SAFEX contract is for 100 tons of maize so a one-to-one hedge requires 1000 contracts to cover Malawi's 100,000 ton import program, and 500 contracts to cover Zambia's 50,000 tons. We assume that Malawi places these contracts at the rate of five per day and Zambia at five per two days starting on the first trading day of July in the year prior to the potential import requirement. The positions are marked to market daily and interest is paid or received daily on outstanding positions at the Rand money market rate. The positions are lifted the following February at the rate of 20 contracts per day for Malawi and 10 per day for Zambia. The rapid sale is feasible because at that time the Mar contract will be in the roll process. Mark-to-market profits and losses are credited to the cost account. We assume a bid-ask spread of ± 5 Rand/ton.

The discretionary futures-hedged import scheme

Commercial organizations which hedge almost invariably do so on a discretionary (or even opportunistic) basis. Discretion makes sense with regard to Malawian and Zambian maize requirements because maize is only traded in significant quantities across national boundaries in the event of a poor harvest, in which case local prices jump to import parity. It seems likely that there will be an advantage in following different strategies in periods in which the market has moved to import parity.

A difficulty with evaluating discretionary policies is to know what policy will be followed. We investigate a simple rule which appears to offer benefits relative to the non-discretionary program.

- At the start of the year (i.e. in the first quarter) the relevant agencies decide whether there is already a shortage defined in terms of a regional requirement for imports. On this basis, we classify 1998 and 2002 as *shortage* years. The remaining years are *normal*.
- Import requirements are fully hedged in normal years, but not hedged at all in shortage years.

This rule is motivated by the fact that, in a shortage situation, regional prices will be at import parity. In the absence of a second successive bad harvest, they will drop back once normal conditions return. The consequence is that there is no hedging against import requirements in 1999 or 2003. Note that the discretionary scheme makes no provision for an inadequate harvest in two successive years, an event which did not take place in our (short) sample.

The options-hedged import scheme

Options strategies are defined to be as similar as possible to the futures strategies, so that differences in outcome will not be attributed to program implementation. However, options are more complicated than futures because options have a range of different strikes. Further, when the hedge is being closed out, it is necessary to decide whether to sell positions prior to expiration or to exercise at expiration and, in the former case, in what order options with different strikes will be sold. Although in practice traders will make these decisions opportunistically, we need to specify a sensible rule for simulation purposes.

The procedure we adopt is as follows:

- Options purchases start on the first trading day of July in the year prior to the potential import requirement. Malawi purchases calls at the rate of five per day and Zambia at five per two days starting on the first trading day of July in the year prior to the potential import requirement.
- Options are purchased on the May contract (Jul in 2004). May is preferred to Mar because SAFEX Mar options expire into the corresponding Mar future in the last week of February, and this forces rapid liquidation.
- SAFEX trades options with 20 Rand strikes. We adopt the rule of purchasing the closest out-of-the-money option, i.e. the option with the lowest strike strictly above the futures price of the day. This rule results in a portfolio of options with the same expiration but different strikes.
- SAFEX publishes implied at-the-money volatilities but not option prices. We price options using the Black (1976) formula for prices of options on futures using a volatility spread of $\pm 5\%$, i.e. on a day that the implied volatility is reported as 25%, we price purchased options at a volatility of 30% and sold options at a volatility of 20%. A spread of $\pm 5\%$ is high but not unreasonable if markets are illiquid.[5]
- When an option is purchased the full premium is paid upfront. We assume options purchases are financed through a Rand bank loan with interest at the money market rate. This parallels the treatment of futures cash flows.
- Options positions are closed starting the first trading day of February but only if, on average, the options are in-the-money, i.e. if the futures price of the day is above the average strike price. Options positions are sold off at the rate of 20 per day for Malawi and 10 per day for Zambia starting with options which are deepest in-the-money.[6] Options remaining unsold at the contract expiration date are either exercised (if in-the-money) or abandoned (if out-of-the-money).
- The net futures cash flows are discounted back (at the Rand money market rate) to the date at which the options positions are closed to give full comparability with the futures and options results.

Hedged schemes – simulated costs

Simulated hedge costs are reported in Table 3. Comparing the non-discretionary futures hedge (row 2) with the unhedged scheme (row 1), hedging is shown to give a small average cost reduction. There is considerable year-to-year variability – positive hedge profits in 2002 and 2004 are more than sufficient to offset the 2003 loss. The earlier years in the sam-

[5] SAFEX was only able to provide daily implied volatilities from 1998. We used a constant volatility of 30% for the May 1997 and May 1998 contracts. Although this procedure is crude, the pattern of prices in these 2 years is such that it is unlikely that a more sophisticated imputation would have substantially changed the results.

[6] We assume that only options with a single strike are sold on any one day. We start with sets of 80 (Malawi) or 40 (Zambia) which are deepest in the money, and subsequently, when there are less than 80 (40) options remaining at any strike, move to sets of 60 (30) options, again starting with those deepest in-the-money, then sets of 40 (20) options and finally sets of 20 (10) options.

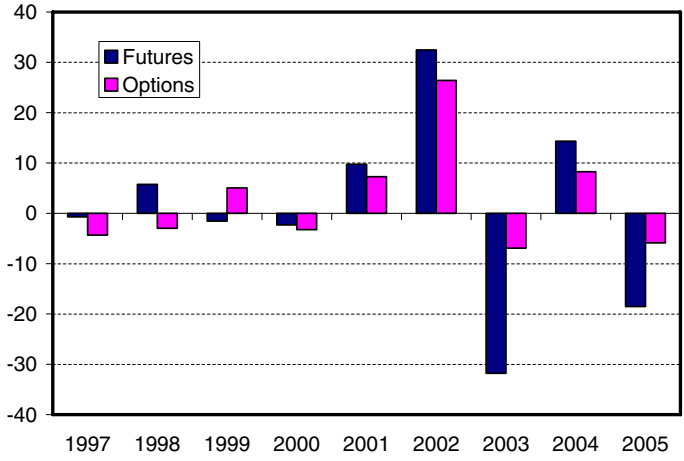

Fig. 4. Futures and options hedge cashflows Malawi, 1997–2005 (million Rand, 2000 prices).

ple contribute little to the average outcomes. The result that hedging reduces average import costs is dependent on this particular historical experience and may not extrapolate to the future. The more robust finding is that hedging reduces cost variability. Overall, hedging does appear to be feasible and to offer improvement over the unhedged imports. However, this improvement is more from a reduction in the inter-annual variability of food security costs (and hence an increase in their predictability) than by unambiguously reducing cost levels.

The third row of Table 3 reports results for the discretionary futures hedge. Comparing these costs to those for the non-discretionary scheme confirms that discretion lowers the average cost of food security in both countries, but does little to change the inter-annual variability of these costs.

The results discussed so far use a unit hedge ratio. Because the SADC countries import maize only in shortage years, when prices are relatively high, their exposure is to the entire price and not just its increment. This suggests considering a hedge ratio in excess of one, i.e. a futures position which is a multiple of imports. The argument against this is that, if the hedge ratio is overestimated, levering can increase rather than reduce risk. With this caveat, the fourth row of Table 3 gives the cost associated with a levered hedge using a variance-minimizing hedge ratio of 2.6.[7] This results in a more substantial average cost reduction and a further reduction in cost variability.

The final two rows of Table 3 report results for the unlevered and levered options-hedged import schemes, respectively. The average cost and variability reductions are comparable to those obtained from the non-discretionary futures scheme, but lower than those from the discretionary futures scheme. The distribution of costs shows

[7] This hedge ratio is obtained by numerical minimization of the inter-annual cost variance. The optimal hedge ratio for Zambia is close to that for Malawi. For simplicity, we used the same number. The estimated hedge ratio may be highly dependent on the 2002 experience.

the only substantial cost reduction occurs in 2002, but there is a much lower hedging cost in 2003 relative to the non-discretionary scheme. As with the futures hedge, greater risk reduction may be obtained by levering. The variance-minimizing hedge ratio is 2.1 and the average hedged import costs are reported in the final row of the table.

Fig. 4 graphs the simulated hedge cash flows for Malawi (million Rand at 2000 prices), based on an overall hedge of 1,000 contracts. Those for Zambia, where we assume a 500 contract hedge, would be identical but scaled by one half. Except for 1998–1999, the sign of the cash flows are the same for both instruments. When cash flows are substantially positive (2000–2001, 2001–2002 and 2003–2004), the futures hedge generates the larger cash flow. However, in years in which the cash flow is substantially negative (2002–2003, 2004–2005) the options cash flow is capped at the premium level and so losses are lower than for futures. The average cash flow over the seven years is higher for the options hedge (2.6 million Rand as against 0.8 million Rand), but the difference is not statistically significant ($t = 0.29$). However, the cash flow from the options hedge is substantially less variable (10.6 million Rand as against 18.5 million Rand) and this difference is statistically significant at the 10% level ($F_{8,8} = 3.04$).

Conclusions

The simulation results demonstrate:

- Reliance on a food security inventory is very expensive for Malawi and Zambia because inventory ties up capital for too long.
- A combination of a food security inventory and imports remains expensive but spreads costs over time giving enhanced budgetary stability.
- It is possible to obtain a reduction both in the average level and variability of food security costs through futures hedging on a non-discretionary basis, relative to a simple import strategy. However, cost variability with the hedged import scheme remains greater than with the inventory-based scheme.
- Use of a discretionary futures hedge reduces average costs relative to the non-discretionary case but has little impact on variability.
- The pattern of costs across years shows that almost all of the benefits from hedging come from the 2001–2002 regional shortage. By contrast, hedging would have provided little or no benefit in the shortage of 1997–1998, which was confined to the northern SADC region.
- Options-based hedges perform comparably with futures-based hedges, but less well than discretionary futures schemes in which no hedge is placed in years following a shortage.
- There appears to be some advantage in levering up both futures and options hedge positions.

The simulation results support the use of either futures or options to hedge food security requirements. However, they also caution against over-optimistic assessments – hedging would only have been massively effective in one of the eight years examined,

and in only one of the two shortage years in recent history. Further, if the objective is to reduce the variability of food security costs, a combination of a food security inventory and (possibly hedged) imports may be superior to a scheme which relies purely on imports.

There are two important qualifications:

- The design and management of a hedging strategy for food imports is complex and, in practice, hedging operations are discretionary and opportunistic. Further, hedging does not solve the problem of needing to have physical access to grain in Lilongwe and Lusaka. It follows that any hedging strategy must be carried out in parallel with the physical import process.
- Any program which aims to ensure grain availability under all circumstances will be very expensive, because from time to time this will involve purchasing or taking futures positions when grain prices are already high. Food security costs are reduced substantially by not purchasing for inventory or taking futures cover when there is already a shortage. This leaves the countries exposed to the possibility of a second successive poor harvest. In the SADC region, this is a low probability event. However, it is important to have safety net procedures available to deal with this eventuality.

Finally, any policies and interventions should be designed to enhance the ability of the private sector to deliver the required grain. SADC governments are likely to achieve more through clarity of policy, transparency of execution, and a reduction in transport costs than through hedging.

Appendix A

The appendix lists the assumptions used in the simulation exercises.

Imports

Purchase: Imports are purchased in RSA over a six week period from mid-January ending on the last weekday of February of the year in which the imports prove necessary. The price paid is the average of the Randfontein spot market prices over this period. We assume in all schemes that purchases have no impact on the RSA price.

Transport: We use the 1999 estimate of $190/ton for transport from RSA to Lusaka reported by Coulter and Poulton (2001, p.195). This converts to a cost of Rand 720 per ton. Transport costs from RSA to Malawi are a little lower than those to Zambia. We use a figure of Rand 648 per ton.

Interest: We assume that imports are purchased on rand credit with interest paid at the South African short term interest rate plus 3% over a four month period.

Delivery: We assume that imported maize is delivered over the eight month period May–December.

Food security inventory

Purchase: Imports are purchased in RSA over the three month period starting the first weekday of June and ending on the last weekday of September. The price paid is the average of the Randfontein spot market prices over this period.[8]

Transport: Transport costs from RSA to Zambia are at Rand 648 per ton and those to Malawi at Rand 576 per ton. These costs are 90% of those assumed in the import strategy A with the saving due to the more relaxed delivery schedule.

Deterioration: We assume physical losses of 2% per annum.

Warehousing: We assume an annual warehousing cost of Rand 80/ton in Malawi and Rand 73/ton in Zambia, both in constant 1999 prices.

Interest: We assume that inventory is purchased on rand credit with interest paid quarterly at the South African short term interest rate plus 3%.[9] In the event of a positive balance, interest is received at the same rate less 1%.

Mark-to-market: In years in which inventory is not released, it is marked to market at the average Randfontein spot price for the first quarter of the year, plus transport costs to Malawi or Zambia as calculated above. A mark-to-market profit is an addition to revenues while a mark-to-market loss is a reduction in revenue.

Delivery: We assume that imported maize is delivered over the twelve month period January–December of the year in question.

Mixed import and inventory scheme

Purchase and distribution: This is the same as in schemes A and B, except that inventory is released over the six month period January–June and imports are made available over the subsequent July–December period.

Transport: As in the pure inventory case (B).

Interest: As in A and B, with adjustment for different holding periods.

References

Black, F., 1976. The pricing of commodity contracts. Journal of Financial Economics 3, 167–179.

Brunetti, A., Kisunko, G., and Weder, N., 1997. Institutional obstacles to doing business: region-by-region results from a worldwide survey of the private sector. Policy Research Working Paper, 1759, Washington, DC, World Bank.

Coulter, J.P., 2005. "Making the transition to a market-based grain marketing system", paper prepared for the World Bank-DfID workshop, "Managing Food Price Risks and Instability", Washington, DC, 28 February–1 March 2005.

Coulter, J.P., Poulton, C., 2001. Cereal market liberalization in Africa. In: Akiyama, T., Baffes, J., Larson, D., Varangis, P. (Eds.), Commodity Market Reforms: Lessons of Two Decades. World Bank, Washington, DC.

Culp, C., Miller, M., 1995. Metallgesellschaft and the economics of synthetic storage. Derivatives Quarterly 1, 7–25.

Jayne, T.S., Govereh, J.K., Mwanaumo, A., Nyoro, J., Chapoto, A., 2002. False promise or false premise: the experience of food and import market reform in eastern and southern Africa. World Development 30, 1967–1986.

Miranda, M.J., Helmberger, P.G., 1988. The effects of commodity price stabilization programs. American Economic Review 78, 46–58.

[8] *Source*: SAFEX.

[9] *Source*: IMF, *International Financial Statistics.*

Myers, R., 2005. The costs of food price fluctuations in low-income countries. Paper prepared for the World Bank-DfID workshop, ''Managing Food Price Risks and Instability'', Washington, DC, 28 February–1 March 2005.

Newbery, D.M.G., 1989. The theory of food price stabilization. Economic Journal 99, 1065–1082.

Nucifora, A., Lisulo, A., 2005. Lessons in managing policy dialogue in Malawi: reforming the agricultural development and marketing corporation (ADMARC). Paper prepared for the World Bank-DfID workshop, ''Managing Food Price Risks and Instability'', Washington, DC, 28 February–1 March 2005.

Øygard, R., Garcia, R., Guttormson, A., Kachule, R., Mwanaumo, A., Mwanawina, I., Sjaastad, E., Wik, M., 2003. The maze of maize: improving input and output market access for poor smallholders in southern African region, the experience of Zambia and Malawi. Agricultural University of Norway, Department of Economics and Resource Management Report, 26.