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Food import risk in Malawi:
simulating a hedging scheme for Malawi food imports using historical data

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ABSTRACT

During the 1980s and 1990s least developed countries (LDCs) encountered increasing difficulties in maintaining national food security. By the turn of the century commercial food import bills reached unprecedented heights in terms of domestic food consumption. The already precarious state of food security has been aggravated by occasional "spikes" in food import prices. Additionally, food aid has been reduced substantially by the donor community. The combination of these three developments - declines in food aid, increased commercial food imports and occasional "spikes" in food import prices - have caused a significant increase in the vulnerability of these countries. These circumstances have motivated a further and intensified investigation of policy instruments that can reduce the impact of volatile food import prices. The use of financial derivatives as instruments to hedge risks particularly deserves further exploration since these instruments are possibly cheap and do not distort physical markets. An integral part of this study is the exploration of ways in which the use of such instruments may be embedded in existing food import marketing and financial arrangements.

While food import risks have not been a large part of the recent policy debate, it is likely that the increase in the LDCs' food import bill and the increasing difficulties of LDCs to meet their food security requirements will become a major issue in the near and medium term future.

RÉSUMÉ

Pendant les années 80 et 90, les pays les moins avancés (PMA) ont eu de plus en plus de difficultés à garantir la sécurité alimentaire nationale. Au début du XXIe siècle, la facture des importations commerciales de produits alimentaires a atteint des niveaux sans précédent en comparaison de la consommation intérieure. La sécurité alimentaire, déjà précaire, a encore été compromise par des poussées soudaines des prix des importations de produits alimentaires. En outre, la communauté des donateurs a considérablement réduit son aide alimentaire. L'effet conjugué de ces trois facteurs – diminution de l'aide alimentaire, augmentation du coût des importations commerciales de produits alimentaires et poussées occasionnelles des prix des importations – se sont traduits par une aggravation marquée de la vulnérabilité de ces pays. Ces circonstances ont conduit à étudier plus en détail les instruments d'intervention qui pourraient atténuer l'impact de l'instabilité des prix des importations de produits alimentaires. L'utilisation d'instruments financiers dérivés comme moyen de couverture des risques, en particulier, mérite d'être étudiée plus avant car de tels instruments peuvent être utilisés à peu de frais et n'ont pas d'effet de distorsion sur les marchés proprement dits. À cette fin, il faudra explorer l'utilisation de tels instruments, qui pourraient être intégrés aux arrangements existants de commercialisation et de financement des importations de produits alimentaires.

RESUMEN

Durante las décadas de los ochenta y los noventa, los países menos desarrollados (PMA) hallaban crecientes dificultades para mantener la seguridad alimentaria nacional. Con el cambio de siglo los costos comerciales de la importación de alimentos alcanzaron alturas sin precedentes en términos de consumo de alimentos nacionales. El ya precario estado de la seguridad alimentaria ha sido agravado por ocasionales 'picos' de los precios de alimentos de importación. Además, la ayuda alimentaria de la comunidad de donadores se ha reducido considerablemente. La combinación de estos tres acontecimientos – disminución de la ayuda alimentaria, incremento en la importación comercial de alimentos y ocasionales 'picos' en los precios de alimentos importados - han causado un importante aumento de la vulnerabilidad de estos países. Estas circunstancias han motivado una mayor y más intensiva investigación de los instrumentos de las políticas que podrían reducir la repercusión de precios de alimentos importados volátiles. El empleo de maniobras financieras como instrumentos contra los riesgos merece, en particular, un mayor análisis ya que es posible que estos instrumentos sean de bajo costo y no distorsionen los mercados físicos. Como parte integral de esta labor, es necesario estudiar cómo el uso de dichos instrumentos pueda estar fijado dentro de los actuales acuerdos financieros y de comercialización de la importación de alimentos.

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This project is implemented simultaneously with a similar project on Tanzania (Food import risk in Tanzania: simulating a hedging scheme for Tanzanian food imports using historical data), which is assigned to Mr. Aurelien Beko.

1 INTRODUCTION

During the 1980s and 1990s least developed countries (LDCs) encountered increasing difficulties in maintaining national food security. By the turn of the century commercial food import bills reached unprecedented heights in terms of domestic food consumption. The already precarious state of food security has been aggravated by occasional “spikes” in food import prices. Additionally, food aid has been reduced substantially by the donor community. The combination of these three developments - declines in food aid, increased commercial food imports and occasional “spikes” in food import prices - have caused a significant increase in the vulnerability of these countries. These circumstances have motivated a further and intensified investigation of policy instruments that can reduce the impact of volatile food import prices. The use of financial derivatives as instruments to hedge risks particularly deserves further exploration since these instruments are possibly cheap and do not distort physical markets. An integral part of this study is the exploration of ways in which the use of such instruments may be embedded in existing food import marketing and financial arrangements.

While food import risks have not been a large part of the recent policy debate, it is likely that the increase in the LDCs’ food import bill and the increasing difficulties of LDCs to meet their food security requirements will become a major issue in the near and medium term future.

- First, most LDCs are dependent on export revenues of one or a small number of primary commodities. The secular decline in the real prices of many primary commodities has caused a substantial decrease in export revenues from primary commodities and, as a result, reduced the LDCs’ potential to finance commercial food imports. Additionally, price volatility of both exported primary commodities and food imports may on occasion – if price peaks in imported commodities coincide with price lows in exported commodities – deepen the difficulty in meeting food import demands.
- Second, volatility of domestic food prices in many countries has increased substantially. Often this increased volatility is attributed to the dismantling of marketing boards and related commodity institutions, and liberalization of commodity regulation and intervention schemes, combined with the virtual absence of a private sector trade and marketing network. The resulting weak transmission between international and domestic prices can be problematic in cases of international price spikes, as well as severe domestic production shocks.
- Third, the increased volatility of domestic food markets may create incentives for migration and changes in investment and lead to irreversible effects on domestic production, production structures and food consumption patterns. As price volatility has a macroeconomic impact on countries that are dependent on commodity exports, this applies even more to countries that are dependent on both commodity exports and food imports.
- Fourth, the liberalization of domestic markets combined with the continuing instability of international markets, creates considerable risks for the so-called low-income food-deficit countries (LIFDCs), which can lead to food insecurity and increased vulnerability of the poor.

1.1 Terms of Reference

The current study aims at investigating the scope for using financial derivatives for hedging food imports in Malawi. The objectives of this study are the following:

1. To analyze the changing nature of the risks being faced in Malawi’s food markets at the national and sector levels.
2. To analyze the efficiency of using market-based risk management instruments to better manage the food imports of the country studied.
3. To make proposals for policy interventions or strategies to better manage the food-related import risks.

The study covers the following aspects of the food import regime in Malawi.

1. Aggregate and disaggregated food consumption patterns, and patterns of consumption of those twho are vulnerable. How have food imports affected domestic food consumption patterns?
2. Domestic food production, regional distribution of food production, seasonality patterns in food production. How do domestic production and price shocks relate to food imports? What is the degree of predictability of food production shocks?
3. Description of the food import profile of Malawi (types of imported products, origin of imports, quantities and prices over time, relation to domestic food production, relation to agricultural and total exports, commercial and food aid imports, seasonality of imports, structure of the food import trade of the country). Analysis of the changing food import risks in light of the changing food import profile and international food commodity prices. Are food import risks related to other agricultural commodity export risks?
4. Domestic food prices, volatility of domestic prices relative to international prices, transmission of international food prices to domestic markets, relationship of c.i.f. prices of food imports to reference or export prices of major food exporting countries for the major products imported.
5. Institutional organization and institutional constraints.
6. Policies: national food security policies, food market intervention policies and overall agricultural and trade policies, macroeconomic policies, impact of other policies on food imports.
7. Outline of possible food import hedging schemes for major food imports using futures and options, with the objective to reduce the cost of food imports.
8. Ex post simulation of import costs combined with proposed hedging schemes, based on historic data and using actual imports or alternative (and superior) import programmes.
9. Proposals for a more efficient strategy for managing food import risks.

1.2 Organization of this study

The organization of this study is as follows. In Chapter 2 we investigate Malawi's food consumption, food production and food import profiles. This chapter is completed with a section on domestic maize prices, international maize prices and import prices of maize. In Chapter 3 we discuss institutions in the Malawi food sector and structure of Malawi food marketing and trade, and we report on the policy initiatives in the field of food security or affecting food security or food imports. Chapter 2 and 3 together constitute a quantitative and descriptive overview of the current food situation in Malawi. Part of the outline and design of the proposed hedging scheme is based on insights from these chapters. In Chapter 4 we discuss the major international commodity exchanges where food contracts are traded, and which are relevant for pricing of food imports into Malawi. Next, in Chapter 5, we propose a hedging scheme based on futures and options and run ex-post simulations of these strategies. We complete this study with conclusions and recommendations.

2 MALAWI FOOD CONSUMPTION, FOOD PRODUCTION, FOOD IMPORTS AND PRICES OF FOOD

2.1 The Malawi food consumption profile

In this section we describe the consumption profile of Malawi. The objective is to identify the major commodities in the Malawi diet in terms of calorie intake, to assess the development of the consumption profile over time, to quantify actual total calorie intake and to quantify the incidence of food shortages on total calorie intake.

Before we investigate the consumption profile in detail we summarize a number of important parameters on Malawi to characterize the current position of the country, its population, the degree of poverty, and the state of the economy. Malawi is a landlocked country in the southern part of Africa, bordered in the north and north-west by Tanzania, and in the south, south-west and south-east by Mozambique and in the east by Zambia. The size of the population is around 12 million (2004), with a density increasing from 30 people per km^2 in the Northern region to 155 in the Southern region.

Malawi is one of the poorest countries in the world: 67 percent of the population in rural areas and 55 percent in urban areas are living in poverty. In addition, 28 percent of the poor were in ultra poverty. Poverty in Malawi can be classed as deep and pervasive (see Benson et al., 2004). Per capita GNP is $US180 (UNDP, 2003). The prevalence of HIV/AIDS is high: on district level the prevalence ranges from a minimum of 10 percent to a maximum of 40 percent, with a country average of close to 20 percent (see FAO, 2002; 2003). Life expectancy in 2000 was less than 40 years and decreased in the 1990s (World Development Indicators, 2002). Stunting among children under 5 years is widespread. Illiteracy measured as a percentage of all people aged 15 and above is 40 percent (World Development Indicators, 2002). Productivity in agriculture is low and the agricultural sector - the main production sector of Malawi - is dominated by maize (subsistence crop) and tobacco (cash crop). Maize production is extremely vulnerable to droughts and flooding. Government policies to combat food shortages and liberalize the economy have a poor record, despite continuous efforts from international institutions like IMF, World Bank, USAID, DFID and EU to provide help and to give policy advice (see IMF, 2002). Both budget and current account deficits are persistent and jeopardize economic stability. The domestic currency, the Malawi kwacha, depreciated a number of times during the last decade. This sets the background for the empirical investigations in this study.

We start out with the aggregate consumption profile and investigate this on the basis of food balance data available in the FAOSTAT data set. The product composition of per capita calorie intake for the year 1990 and 2002, shown in Figures 1 and 2, underlines the dominant position of maize in the diet of the Malawi population. Between 52 and 65 percent of the total per capita calorie intake is from maize. The contribution of wheat to the Malawi diet is small and appears to vary substantially. Together with maize, wheat constitutes the major bulk crop imported in case of food shortages. The variation in the wheat share is most likely explained by the fact that it is nearly entirely imported. The contribution of cassava and potatoes to the Malawi diet is also small, but substantially larger compared to the wheat share. Cassava and potatoes are, however, not imported at all. The dominance of maize in the Malawi diet (and also in the Malawi production base, see below) constitutes a potential source of risk: a maize crop failure will affect the entire Malawi population. The bulk of the remaining part of the Malawi diet is formed by a variety of foodstuffs of vegetable origin. Animal products (meat, fish, dairy products) account for a very tiny share.

When the years 1990 and 2002 are compared it is clear that a large shift in composition out of maize into cassava, potatoes and wheat has taken place. The development of these components over the years further supports a shift out of maize into cassava and potatoes (see Figure 3). Starting in 1995 the combined share of cassava and potatoes in the Malawi diet increased to around 15 - 20 percent. The successful shift towards starchy roots suggests potential for further diversification away from maize, in order to achieve a larger spread of the risk of crop failure. Experience in other countries underscores the possibilities in this direction. A number of African countries (e.g. Ghana, and Nigeria) have successfully diversified into cassava and sweet potatoes. Other studies have also expressed the potential of risk reduction through crop diversification (see e.g. Kherallah et al. 2001; Rubin (2003)) and a number of policy initiatives have been taken in this direction (see below). More drought- and disease-resistant cereal crops, like millet and sorghum possibly qualify for this purpose.

Next, we consider the level of total daily calorie intake. Although (average) daily per capita intake of calories in Malawi is not particularly out of line with neighbouring countries, the prevalence of undernourishment is extremely high (see Table 1). Nevertheless, the past decade experienced a substantial decrease in the prevalence of undernourishment in Malawi, as in the case of Mozambique, while it remained more or less stagnant in Zambia and Zimbabwe. Tanzania has an intermediate position with a peak in the degree of undernourishment in 1995-1997. It should be noted that developing countries with an “acceptable” prevalence of undernourishment of less than 2.5 percent have an average daily per capita energy supply of slightly above 3 000 kcal, substantially above the values in the table. The Malawi Vulnerability Assessment Commission uses a minimum dietary requirement of 2 100 kcal per day per head (see MVAC, 2003). The table shows that an aggregate daily per capita dietary energy supply of close to or above 2 100 kcal corresponds to a high prevalence of undernourishment.

Total dietary calorie supply over time experienced a major setback in 1992, indicating the 1991/1992 famine (see Figure 4). However, since 1992 the total daily per capita calorie supply has been increasing. We also note that the daily per capita calorie intake accounted for by maize closely follows the setback in the total, and after 1992 remains on a more or less stagnant level. In the second part of Figure 4 (different scale) the quantitatively moderate role of wheat in the Malawi diet is demonstrated. From Figure 4 we can also infer some extent of counter-development in the contribution of wheat relative to the contribution of maize, highlighting the role of wheat imports in the case of food crises.

The question arises as to how many tonnes of maize, wheat, cassava and potatoes are sufficient to feed the entire Malawi population. We constructed estimates of the total domestic requirement of cereals and starchy roots, under a number of simplifying assumptions. We started with taking a level of 2 100 kcal per capita per day as a minimum daily energy requirement, since this figure is found in a number of studies (see e.g. MVAC (2004)). Next, we used the population estimates as provided in FAOSTAT 2004 data. Further, we used the historic composition of per capita calorie intake by food crop over the years 1996-2002. This implied that 72.2 percent of total per capita calorie intake consists of cereals and starchy roots. We used the following caloric content per crop:

- maize – 3 177 kcal per kg
- wheat – 2 725 kcal per kg
- cassava – 674 kcal per kg and
- sweet potatoes – 706 kcal per kg.

Only a limited part of the gross production of cereals and starchy roots is available for consumption, as part of this production is needed for the food manufacturing industry, some gets wasted, part is required as seed for next year's crop, and part serves as feed for animals. A net factor by food crop, averaged over the period 1996-2003, is obtained from FAOSTAT food balances:

- maize: 0.76
- wheat: 0.99
- cassava: 0.87 and
- sweet potatoes: 0.75.

These assumptions are based on the period 1996-2004 and the estimates of total domestic requirements will be used for a historic simulation, also for the period of 1996-2004[1]. The results of the calculations are summarized in Table 2. The gross requirements of maize necessary to achieve food sufficiency moved from 1.8 million tonnes in 1996 to 2.1 million tonnes in 2004.

The findings of this section are summarized as follows. In the Malawi consumption pattern the consumption of maize accounts for the largest part of total per capita calories (1990: 65 percent, 2002: 52 percent), which has, however, continuously decreased over the past 20 years. Since 1995 the contribution of cassava and potatoes to the Malawi diet has experienced a large increase, reaching a share of around 15 percent to 20 percent after the turn of the century. With the successful shift towards starchy roots at the end of the 1990s a larger spread of the risk of crop failure has been attained. The risk of crop failure would certainly be further reduced with more diversification away from maize. The contribution of wheat to the total dietary energy supply is small and fluctuating, due to the fact that wheat is not domestically produced and is imported only at times of food shortages. In order to have achieved food sufficiency in 2004 a quantity of around 2.1 million tonnes of maize would be required.

2.2 Malawi food production profile

In this section we describe the food production profile of Malawi. Food production concerns in the first place the production of maize, since maize is the most important component in the Malawi daily

[1] Nevertheless, a number of assumptions may very well be taken over directly (or with only minor adjustments) for calculations beyond this period.

per capita calorie intake.[2] The objective of this section is to quantify the domestic production of maize, cassava and potatoes, to assess how total domestic production relates to total domestic consumption needs, to establish the regional distribution of production, to identify potential deficit areas and to identify the seasonality in production. This last is specifically required in order to design hedging schemes for food imports. Finally, we measure the size of the production risk and the degree of predictability of production shocks.

Production of maize in southern Africa is dominated by South Africa, in both absolute and per capita terms, with an average 1985-2003 production of near to 9 million tonnes, and 226 kg per head. Total South African maize production accounts for slightly above 50 percent of maize production of the region (countries either bordering Malawi or otherwise relevant to Malawi from a trade perspective[3]). This compares with an average production in Malawi of 1.5 million tonnes, and 158 kg per head. The implication of the dominance of South Africa in maize production is a large impact of South African production on trade and prices of maize and close substitutes in the region (see also Dana et al. (2005)). Both poor harvests and bumper crops in South Africa will have a major impact on price formation and trade flows in southern Africa. Despite a mild positive correlation between Malawi maize production and that of Malawi's neighbouring countries[4], there is substantial international trade in maize. In fact, the larger part of Malawi cereal imports originate from neighbouring countries (see below). Also reports on informal cross border maize trade in 2003/2004 support the importance of regional trade.

The long term development of Malawi domestic maize production shows an upward trend from 0.85 million tonnes at the start of the 1960s to close to 2 million tonnes at the turn of the century. Around two thirds of this increase should be attributed to increases in area under maize, and one third to increases in land productivity.[5] A remarkable feature of the long run (aggregate) domestic production is the increase in volatility from the 1990s onwards. If we take account of the increase in harvested area, the coefficient of variation increases from 6 to 7 percent before 1990, to 28.8 percent after 1990, representing a tremendous change in production risk. Since a large part of production volatility is not visible in aggregate figures as it cancels out in the aggregation process, it is most likely that the actual size of production risk as faced by localities or districts within the country is even larger.

The Agricultural Department Division (ADD)'s figures for production of maize shown in Figure 5, suggest that it is concentrated in the Central and Southern regions. Between 87 and 92 percent of total domestic maize production originates from this region. However, population density over the country is enormously skewed. In 2003/2004 the size of the population in the Southern region (5.5 million, 46.2 percent of total population) was around four times higher relative to the Northern region (1.4 million, 12.0 percent). Population size in the Central region (5.0 million, 41.8 percent) is of the same order of magnitude as the Southern region, though slightly lower. Per capita production, shown in Figure 6, gives an entirely different insight. The Southern and Northern regions are clearly those with lowest per capita level of maize production. A similar exercise was done for cassava (Figures 7 and 8) and potatoes (Figures 9 and 10). Production of cassava is concentrated in the Northern region, the district of Mzuzu accounting for 30 to 40 percent of Malawi cassava production. Per capita cassava production in the Northern region is a multiple of per capita cassava production in the Central and

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[2] As noted above, cassava and potatoes contribute increasingly to the Malawi dietary energy supply, but these crops are not imported. Since we focus in this study on food import risk, the only role these crops play is as a substitute for (imported) cereals.

[3] For trade of maize and other food we consider Mozambique, South Africa, Tanzania, Zambia and Zimbabwe to be of key importance to Malawi (see also the section on imports).

[4] High positive correlations would imply covariance of food production: i.e. food deficits in Malawi occur simultaneously with food deficits in neighbouring countries. In this case it is impossible to overcome food shortages through regional trade. Nevertheless the relatively mild positive correlation suggests that covariance is not strong, and that there is scope for regional trade.

[5] It should be noted that part of the land productivity (namely the increase in the number of harvests in one year) is statistically recorded by increasing harvested area, and hence the figure for production per hectare is not indicated.

Southern regions. Sweet potatoes are more important in the Southern region, around 50 to 60 percent of the total production of sweet potatoes originating from this area. In crop years 2002/2003 and 2003/2004 both cassava and sweet potato production experienced a major decrease relative to the previous crop years, of around 40 percent.

To what extent is regional production of food sufficient to meet regional needs? To address this, we calculated the combined per capita caloric contribution of the production of maize, cassava and potatoes in these districts (see Table 3).[6] The potential food deficit appears to be largest in the Southern area. The combined daily per capita caloric contribution of maize, cassava and potato production in crop year 2001/2002 was near to three times as high in the Northern region compared to the Southern region in crop year 2003/2004. The potential food deficit was less, but still substantial in the Central region. The regional dimension of Malawi food insecurity is also confirmed in other studies (see Charman, 2004). Crop year 2003/2004 generated particularly low values of net food production available to consumers in the Southern region.

The crop year for growing cereals, and maize in particular, is from August to July. August and September are particularly dry months with virtually no rainfall. The agricultural season starts in October. Main activities during the first six months of the agricultural season are successively land preparation, planting and weeding. The growing season runs from November to March, the months with substantial rainfall. Under normal circumstances, rainfall peaks in most locations in January, February and March. Harvesting of maize starts in March or April and continues until July, depending on the area. In a number of southern locations, maize harvesting starts in early March (e.g. Thyolo, Mulanje), while in most other locations, particularly northern ones, maize harvesting begins later, even as late as May (e.g. in Kasungu, Western Rumphi, Mumba, Mzimba, Shire Highlands). Maize will be in ample supply from the harvesting period, i.e. from March onwards. In the course of the year the stocks of maize and other food will be exhausted and during the growing season of the next crop any major shortages of food will become apparent. Hence, the period of two to four months before the harvesting season (November, December, January and February) will most likely be critical with respect to food security. Development of domestic maize prices underscores this claim (see section below). Price lows occur during harvest time and directly after, in the months of March, April and May, and peaks in prices are realized in the months of November, December, January and February.

We investigated the relationship between rainfall and domestic production of maize, but unfortunately lacked sufficient data to implement this rigorously. Drought and flooding are widely acknowledged to have an important impact on maize output, and both events often have a high local dimension. Because of this, their impact on maize production can only be investigated meaningfully with detailed data on a sufficiently low level of aggregation.[7] We do have part of these data (which brings us some steps in the right direction), but on the whole these are too fragmented and their time and spatial aggregations do not match nicely with each other. Nevertheless, we are in a position to show aggregate rainfall for a number of crop years (a crop year runs from August to July) and national production (see Figure 11). For a considerable number of years (in fact all years, except 2000 and 2001) the correlation is impressive, suggesting almost a one to one relationship between rainfall and domestic maize production. It must be noted that this is only a very limited piece of evidence, which requires further investigation.[8] However, indications are that lack of rainfall is likely to be a good predictor of food shortages. This has attractive implications: if a widespread shortfall in rain is identified in the

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[6] As above, we used the following caloric content per crop: maize – 3 177 kcal per kg, cassava – 674 per kg and sweet potatoes – 706 per kg. To arrive at net food production available for consumption we factored waste and other uses by multiplying gross production with respectively 0.77 for maize, 0.87 for cassava and 0.75 for sweet potatoes. (*Source*: FAOSTAT food balance data.)

[7] At the very least we require data on maize production on the level of Agricultural Development Division (ADD) or Rural Development Project (RDP), and monthly weather data (rainfall) data on a corresponding level of regional aggregation, both for a sufficiently long period, for example from 1985 to 2005.

[8] Evidence on ADD level, for an admittedly very short sample period (only three crop years!) is much less convincing.

rainy season (January, February, March) and a general crop failure is likely, there is still sufficient time to bring additional supplies into the country. In this respect, the many early warning systems that were put into place in countries that are prone to food shortages in the course of the 1990s should be mentioned. These systems use sophisticated remote sensing techniques to identify and measure the impact of climate on crops and crop output. We believe that these systems have a large role to play in generating timely predictions of coming crop failures.

The results of this section are summarized as follows. Production of maize in the southern African region is dominated by South Africa, which accounts for the bulk of production in this region. Poor harvests in South Africa affect trade and prices of cereals in the whole southern African region. It appears that Malawi production of maize has become increasingly volatile, as the volatility in (aggregate) domestic maize production in the 1990s was four times as high compared to the preceding period. Within Malawi, production of maize is concentrated in the Central and Southern region, while production of cassava is concentrated in the Northern region and production of sweet potatoes in the Southern region. Due to the distribution of the population the potential food deficit is largest in the Southern region. The potential food deficit is lower, but still substantial in the Central region. On the basis of the seasonality in maize output over the year, any food shortages are most likely to occur from November to February. Our limited evidence suggests that rainfall is a potentially good predictor of coming maize harvest, though early warning systems may do a much better job in a more efficient way.

2.3 Malawi food import profile

In this section we describe the food import profile of Malawi. The objective is to obtain a clear idea about the size and composition of food imports costs, and the burden of these costs on the national economy. In order to achieve this we quantify food imports, their development over time, and the relationship of food imports to total merchandise imports and exports. We specify the main types of food imports, identify their countries of origin and assess the size of informal across-border trade. Next, we quantify and evaluate the size and development of food aid imports as opposed to commercial imports. Finally, we construct the monthly pattern of cereal imports on the basis of the available data.

Cereal imports constitute around 65 percent of the total food import bill (1985-2003) and are the single largest component of total food imports.[9] Because of the large share of cereals in total food imports and their importance in the Malawi diet, we focus in the remainder of this section on cereal imports. Development and commodity composition of cereal imports over time, as shown in Figure 12, indicates a high level of imports in the three years after the 1991/92 famine, with annual cereals imports 435 000 and 560 000 tonnes, while peak values are also realized in 1998 (390 000 tonnes) and 2002 (323 000 tonnes). Figure 11 also shows that maize is by the far the largest component of all cereals, with wheat in second place having a substantially lower share. During years with peak imports maize accounted for the bulk of total cereal imports (around 74 percent). Wheat appears to be gaining in importance since the end of the 1990s. Rice and the category of "other cereals" are of minor importance in quantitative terms.

Apart from absolute quantities of imported cereals by tonne, relative import size may generate other insights. In order to evaluate the burden on the national economy we express maize imports as a share of total merchandise trade. This further indicates the seriousness of the food shortages in the period 1991 to 1994 (see Figure 13) when maize imports accounted for around 15 percent of total merchandise imports, and for close to 30 percent of total merchandise exports. The question arises whether there is any systematic relationship between costs of maize imports and revenues from commodity exports. The largest part of export revenue comes from exports of tobacco: these exports

[9] On the basis of 2004 FAOSTAT data, we calculate for 1985-2003 the following (period average) shares in total imports of food (excluding fish): cereals and cereal preparations - 65.2 percent, fixed vegetable oils - 11.1 percent, dairy products and eggs - 9.0 percent, fruits and vegetables - 3.4 percent. The share of cereal and cereal preparations varies between 40.7 percent (2000) and 81.9 percent (1994).

account for around 60 percent of total export revenue.[10] In order to investigate the way in which import costs are correlated with export revenues, we estimated maize import unit values on tobacco export unit values. If high maize import unit values corresponded with low export unit values and vice versa, we would have expected a negative coefficient. We could, however, find no support for this expectation - all estimates were positive, both in levels and in first differences, and with both static and dynamic specifications.

Do international import prices of maize peak during food shortages and, hence, disproportionately push up the food import bill? We have investigated how import prices of maize and wheat, expressed in US dollars, South African rand and Malawi kwacha, are related to food shortages. If shortages are widespread and coincide with pan-regional shortages, one would expect increased international prices and higher import bills. A quick way to assess this is by evaluating the correlation between maize imports and maize import unit values. The evidence (see Figures 14 and 15) suggests that there is hardly any impact of food shortages on US dollar import prices.[11] Due to large depreciation against the US dollar the relationship between import unit values expressed in either South African rand or Malawi kwacha (not shown) is different, but neither supports a systematic relationship with quantities of maize imported.

Next, we investigated the origin of cereal imports. Unfortunately we could not find bilateral trade data on a sufficiently disaggregated level at the FAOSTAT database. Hence we had to use the UNSD COMTRADE database to identify the countries of origin of Malawi cereal imports.[12] The composition of cereal, maize and wheat imports by country of origin is summarized in Tables 4 and 5. Table 4 shows imports of cereals and Table 5 the imports of maize.[13] The tables show that Malawi imports the larger part of cereals from its neighbouring countries Mozambique, Zimbabwe, Zambia and Tanzania. Since 2001 imports of both cereals and maize from Zimbabwe have dropped from substantial to negligible quantities and have virtually ceased in recent years. Other African countries (South Africa in 2001, Mozambique in 2002, and Tanzania in 2003) have taken over the role of Zimbabwe in importss. Together with South Africa,, a minimum of 60 percent and an average of over 70 percent of cereal imports originates from southern African countries. With the exception of the year 1991 this also applies to maize imports.[14]

There are indications that informal cross-border maize imports have been substantial - this informal trade has been monitored systematically only since 2004. In 2004, as much as 7 percent of the domestic maize requirement is recorded as entering the country informally from the Mozambique border. Also, comparisons of the difference between (calculated) maize requirements and observed domestic maize production with imports of maize, as reported by official statistics, gives rise to suspicion that some maize imports are not recorded in the official statistics. Apparently a larger quantity of food than that reported in official statistics is supplied by countries in the region.

In many years the financial burden of food imports is partly taken over by donors. The extent of food aid, and fluctuations in its amount will drastically affect the size of the food import bill to be covered

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[10] Tobacco plays a crucial role in Malawi's economy, accounting for 60 percent of its export revenues, 13 percent of its GDP and 23 percent of its total tax base (see Jaffee, 2003).

[11] A regression of the natural logarithm of import quantities of respectively maize and wheat on their import unit values supports a negative elasticity. Hence, a contrary influence tends to be observed, suggesting that the large inflow of cereals has depressed the US dollar import prices.

[12] There were inconsistencies both within the UNSD COMTRADE data (between data reported by importers and reported by exporters) as well as between FAOSTAT and UNSD COMTRADE data (total cereal imports do not match). We assume that there are logical explanations for these differences, which leave the quality of the data sets intact if they are used separately. Comparison of FAOSTAT and COMTRADE data on total cereals and maize imports suggests that COMTRADE data are increasingly representative.

[13] UNSD COMTRADE data on Malawi imports of wheat by country of origin are too fragmented to show in a separate table.

[14] Our investigations indicate that COMTRADE data for 1991 may not be fully representative.

by Malawi itself. Available evidence indicates (see Figure 16) that the amount of food imports funded through aid was enormously high from 1987 to 1993, and subsequently decreased quickly to almost negligible levels from 1997 to 2001. In 2002 again a substantial part of food imports was funded through aid. It is, however, unclear what the future will bring: the severity of crop failures and intensity of subsequent food crises may motivate donors to increase food aid, possibly conditional on sensible macroeconomic policies and good governance.

For the purpose of running simulations with historical data on maize imports we needed to construct monthly series of imports of maize, since such series are not directly available. In the construction of these series we partly follow Sarris et al. (2004). The monthly pattern of imports is determined on the basis of monthly aggregate import data and their annual aggregates, taken from IFS, IMF c.i.f. values). This monthly pattern, averaged over the years, reveals that relatively high shares of imports are realized in the second half of the year, from July to December. This corroborates our finding that the outcome of the harvest is known by the end of June and food shortages in the domestic market due to low harvests become apparent during the following months. Next, we used the annual share of cereal imports in total imports, based on annual FAOSTAT data, to calculate total cereal and non cereal imports (IFS data). We assume that non-cereal imports are evenly spread throughout the year. This allows us to calculate the monthly pattern in food imports.[15] Finally, we assume cereal imports to be equivalent to maize imports: although this is not entirely true (see elsewhere in this section) the remaining cereal imports (mainly wheat) are close substitutes for maize. During the period 1995-2003 Malawi food imports occurred particularly in the second half of the year, from July to December (see Figure 17). This admittedly arbitrary procedure, in particular the assumption of “no seasonality” in non-cereal imports, needs to be qualified. More detailed data on the monthly pattern of maize imports - quantities and values - are needed (possibly from ADMARC, or from the International Grain Council).

In this section we established the following results. The larger part of food imports are of cereals (on average 65 percent), and within the category of cereal imports, those of maize are by far the most important, especially during periods where peak food imports occur. Both cereal and maize imports originate mainly from the southern African region, in varying combinations. A minimum of 60 percent and an average of over 70 percent of cereal imports originate from southern African countries. Reports on substantial informal cross-border trade of maize suggest that official statistics on cereal imports and maize imports underestimate true import levels and even more maize originates from neighbouring countries. The amount of Malawi food imports funded through aid was enormously high from 1987 to 1993, but subsequently decreased quickly to nearly negligible levels from 1997 to 2001. During the period 1995-2003 Malawi cereal imports have taken place particularly in the second half of the year, from July to December.

2.4 Malawi maize prices

In this section we investigate domestic and international maize prices. The objective is to assess the volatility of domestic maize prices, to investigate to what extent domestic maize prices are correlated with each other and with international prices, to look into the transmission of domestic prices and international prices, and to identify a possible seasonal pattern in domestic maize prices.

For the empirical investigations on domestic maize prices, import prices and international prices, we use the following price series:

- Domestic monthly maize prices for a number of Agricultural Development Divisions, January 1988 - March 2004 (Ministry of Agriculture and Irrigation, National Statistical Office).
- Daily white maize spot prices of the South African Futures Exchange (SAFEX), 1996-2003, (SAFEX).

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[15] Occasional negative values of monthly food imports arise due to seasonality in non-food imports. We have corrected for this by setting the negative values to zero and reducing likewise the remaining (positive) monthly imports at the start of the year, from January to June.

- Annual import unit values, 1961-2003 (FAOSTAT data, 2004).
- Monthly and annual series on the rand/US dollar exchange rate, the Malawi kwacha/US dollar exchange rate and the Malawi consumer price index, required either to deflate price series, to convert series to the Malawi currency, or to do both, January 1960 – March 2004 (IFS/IMF).

As a first step we have shown nominal domestic and international prices, organized by region (North, South and Central), nominal international prices and (nominal) import unit values (Figure 18 a,b,c,d). Visual inspection of these series reveals that

- Domestic prices are nearly continuously above international prices.
- The difference between international prices and domestic prices varies over the years.
- Domestic prices peak in different periods, but to a different extent: maize prices in the southern region peak in 1998, 1999, 2000, 2002 and 2003, while only in 2002 and 2003 in the Central region do import unit values move continuously and substantially above international prices, reflecting the difference in c.i.f. and f.o.b. prices. The combined cost of transport, marketing and insurance of imports of maize from southern African countries doubles the landed price of maize when it arrives in Malawi. However, in the year 2000, the difference was even larger and may very well have triggered further increases in domestic prices.

Next, we calculated real maize prices by deflating with the monthly series of the Malawi consumer price index (IMF/IFS). Volatility of real maize prices by ADD, as shown in Figure 19, appears to have increased tremendously since the start of 1997. Coefficients of variation increase from 20-25 percent for the period before 1997 to 35-45 percent from 1997 onwards. Volatility of international prices (SAFEX white maize spot prices – for the purpose of comparison, converted to Malawi kwacha and deflated with the Malawi consumer price index) is much lower, and is in the range of 15 to 20 percent.

The development of a marketing and trade network for maize and the degree of integration of these markets may be measured by the degree of correlation between domestic maize prizes of different regions. If commodity markets work perfectly and are effectively connected with each other through a trading network, spatial arbitrage will generate a unit correlation of the prices on these markets. Correlation between domestic prices (see Table 6) is low and in some cases close to zero. In only a few cases is the correlation substantial, e.g. Lunzu–Luchenza and Nhkotakota-Lunzu. Hence, with a few exceptions, we may conclude that markets are isolated from each other. Correlations between domestic price and international prices are even lower, suggesting even less integration between domestic and international markets

The question arises as to why traders and stockholders are not taking advantage of the opportunity for arbitrage between different regions. The lack of correlation between prices in different localities suggests limited arbitrage between different localities, at least insufficient to smooth out price differences. This suggests that transport and trading infrastructures for the purpose of spatial arbitrage are not sufficiently developed (see also section below on domestic trade and marketing).

To what extent are domestic prices influenced by a seasonal pattern in production, by food shortages and by food imports? Seasonality is identified by estimating maize prices on a complete set of monthly dummies.[16] The significant coefficients of monthly dummies are reported in Table 7. The results indicate without exception that prices are negatively affected in the months of March, April, May, June and July, with the exact timing of the impact differing by location. For some locations prices are positively affected in the lean season, in particular in December, January and February.

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[16] Seasonality is identified by regressing the natural logarithm of monthly real maize prices on a (one month) lagged value of this real price and a complete set of monthly and crop year dummies. Nominal maize prices are deflated with monthly consumer price for Malawi, obtained from IMF/IFS. Monthly dummies have a value 1 for a specific month (say January) and zero elsewhere. Likewise, a crop year for, say the 1998-1999 crop, has a value of one from August 1998 to July 1999, and zero in other crop years.

The size of the negative impact is stronger and more systematic: most likely this is caused by the asymmetry in the market response. In the lean season, before harvesting, in the months of November, December, January and February, a shortage of food will lead to increased imports, either commercial ones or through food aid. These imports will increase domestic supply and mitigate the price response of the market. Commercial food imports and food aid may encounter difficulties in reaching remote areas of the country. This may explain why a significant positive impact is only felt in remote markets, like in the Northern region. In locations where food imports and food aid tend to arrive latest, prices will rise in the case of shortages.

On the other hand, when maize is in ample supply, directly after harvesting, in the months of March, April, May and June, available volumes exert a downward pressure on prices. With a plentiful domestic supply of maize, there is no mechanism that prevents maize prices from declining. Finally, it is also likely that food shortages occur in an erratic way, while increases in supply during and after harvest take place every year, and hence are much more systematic.

The question arises as to why traders and stockholders are not taking advantage of the opportunity for arbitrage over the season. The existence of a seasonal pattern in prices suggests insufficient arbitrage between the seasons, at least insufficient to smooth out seasonality in prices. This suggest that storage, marketing and trading for the purpose of inter-seasonal arbitrage is not sufficiently developed (see also section below on domestic trade and marketing).

Our investigations in this section have shown that volatility of real maize prices in Malawi had increased substantially by the end of the 1990s. Domestic prices are poorly correlated although a number of markets show some degree of positive correlation. Correlation of domestic prices with international prices is negligible. Finally we find a significant seasonal pattern in domestic maize prices, with low prices after harvesting and high prices just before harvesting. These findings indicate isolation of domestic maize markets from each other and from international markets and a poorly developed marketing, trade and storage structure that effectively accounts for spatial and intertemporal arbitrage. International prices are nearly continuously below domestic prices and import unit values, reflecting international transport and marketing costs.

3 MALAWI FOOD POLICIES AND INSTITUTIONS AND STRUCTURE

3.1 Malawi food institutions

In this section we discuss the major institutions in Malawi involved with food and maize marketing. The objective of this section is to obtain a clear overview of the institutional organization of the Malawi food sector and its development in the 1990s.

The Agricultural Development and Marketing Corporation (ADMARC) has played an important role in the Malawi food economy, even though recently a part of its activities have been transferred to the private sector in an attempt to make ADMARC' s activities less loss-making and in order to reduce ADMARC's marketing role in the maize market.[17] ADMARC was set up in 1971 with the objective of buying and selling agricultural products, distributing inputs and assisting smallholders in marketing activities. Additionally ADMARC was given a food security role in remote areas, which was implemented by buying and selling maize and setting up a storage, distribution and marketing network throughout the country. This network was downsized drastically in the 1990s. In 2003 ADMARC maintained a head office, 3 regional offices, 15 district headquarters offices with markets, 400 unit markets, 300 seasonal markets, 9 storage and selling depots with a total storage capacity of 468 000 tonnes. The reduction of marketing activities has created welfare losses to households in remote areas where the private sector has been unwilling to take over the role of ADMARC. Traders tend to concentrate on buying maize in the harvesting season, and have little commercial incentive to sell maize to consumers in the lean season or to provide inputs to producers. In less remote areas

[17] See World Bank 2003; much of the information on ADMARC is taken from this report.

ADMARCs activities have been taken over by a well-established private sector. In the long run there may be a role for the Government of Malawi to establish a marketing and transport infrastructure in remote areas or improve the existing one, so that private traders can also take over the role of ADMARC in these areas.

Combined with the dismantling of ADMARC and the elimination of price support operations in 1998, the National Food Reserve Agency (NFRA) was established in 1999, to handle disaster relief involving the management of the strategic grain reserve. NFRA took over the management and operation of the Strategic Grain Reserve (SGR) that had been managed and operated by ADMARC (see RESAL/MLTConsult, 2000). NFRA sold a large part of the SGR in 2001 after advice from the IMF to reduce its stocks to 30 000 and 60 000 or replenish it to that level. Some have argued that these operations have not been helpful in avoiding the subsequent food crisis (see Devereux, 2002 for further details on the 2001 food crisis). NFRA is financially and technically supported monitored and managed by almost all donors.

3.2 Malawi food marketing and trade structure

In this section we discuss the domestic marketing infrastructure, the domestic trade and transport network, domestic communication network and financial facilities, particularly in relation to food trade in Malawi. A recent IFPRI study has extensively investigated these issues and this section draws heavily on this study (see Kherallah et al. 2001, Gabre-Medhin et al. 2001). Reforms in Malawi in the 1990s resulted in increased market entry of private traders, extension of the road network, improvements of the existing road network improvement, and improvements in the processing infrastructure. Despite the improvements that have come about since the introduction of reforms, trade and marketing remains poorly developed and should improve as an integrated part of market reforms. The size of trade businesses is very small, there is lack of adequate equipment, business practices are poorly developed and backward, and transport costs are dominant. Major features of trade and marketing of agricultural products are the importance of personal travel for inspection of goods and payment of cash upon delivery, the short distance over which traders operate, the incidence of breach of contract and theft and the absence of brand names, trademarks or certified quality. Use of modern communication techniques in trading transactions (telephone, fax, etc.) is uncommon due to lack of trust. The scale of transport continues to be small and operates with small vehicles. The trucking fleet is small, and transport services in regional markets do not operate efficiently. Storage of agricultural products is limited, and this is partly related to the virtual non-existence of agricultural credit. The lack of storage activities is partly due to limited warehouse capacity. The absence of credit and the lack of storage capacity make expansion of firms difficult. Major economies of scale cannot be realized due to these constraints. Licensing and other regulatory restrictions continue to create barriers to trade. All these factors contribute to a very costly and inefficient trade and marketing system that provides limited services to consumers and producers. The evidence presented in the previous section on the lack of correlation between domestic maize prices and their seasonality matches closely the evidence presented in this section.

3.3 Malawi Food Policies

The Malawi government, supported or in collaboration with donors, has launched various programmes in the past decade to improve the performance of the agricultural sector. The Drought Recovery Inputs Programme (1995/1996) distributed free inputs to farmers hit by drought. The Starter Pack Scheme (SPS) (jointly funded by the Malawi Government, DFID, EU and the World Bank) was introduced in the crop year 1998/99. The SPS distributed small amounts of free fertilizer and seeds to all smallholders, and was repeated in the crop year 1999/2000.

The Agricultural Productivity Investment Project (APIP) aimed at increasing productivity in agriculture, increasing the use of fertilizers and promoting food security. The interest free credit package programme was piloted among well-to-do farmers in the crop year 1997/98 and repeated in crop years 1998/99 and 1999/2000. Repeated participation in the programme has been made conditional on repayment of previous credit. Both SPS and APIP are considered to have been successful in increasing agricultural production, but are possibly not sustainable.

In the 1990s there was an increasing emphasis on crop diversification: specifically this entailed shifts from maize to cassava, pulses, groundnuts and potatoes. Because of its resistance to drought, the diversification efforts have focused on cassava, specifically after the 1993/94 drought. The area under cassava more than doubled in the 1990s. Also, some diversification out of tobacco took place, although the extent of diversification out of the traditional crops (maize in the first place, but also tobacco) on a national scale is still limited. A major cause for the reluctance of farmers to shift to other crops is the relative safety of maize as a subsistence crop and the relative riskiness of diversifying to cash crops in which marketing and trade is not well developed, and prices are obscure. Especially,, the development of markets and market institutions appear to be important factors explaining to persistence of the Malawi agricultural sector in growing maize and tobacco.

4 INTERNATIONAL MAIZE AND WHEAT PRICES

4.1 The maize terminal markets: SAFEX, CBOT and other alternatives

Hedging food import risk on an international futures exchange requires assessment of international futures exchanges where maize contracts are traded and evaluating their attractiveness for implementing hedging transactions for Malawi food imports. In this chapter we investigate international futures exchanges that trade maize contracts, investigate their liquidity and evaluate if Malawi food import prices and prices of maize contracts on these exchanges develop likewise. The objective of this section is to select a futures exchange that is suitable for implementing a hedging transaction for Malawi maize imports.

With the concentration of Malawi maize imports from the southern African continent, and the dominant position of South Africa in wheat and maize production and trade, the South African Futures Exchange (SAFEX) is an obvious candidate to consider for hedging transactions. SAFEX started operating in 1987, opened an Agricultural Derivatives division in January 1995 and introduced options on agricultural products in 1998. SAFEX trades in five agricultural commodities, that is, white maize, yellow maize, wheat, sunflower seeds and soybeans. Currently, white maize is the most liquid contract on SAFEX followed by yellow maize, sunflower seeds, wheat and soybeans. The contract specification for white maize is 100 tonnes. Five contracts are traded per year (March, May, July, September and December). Trading is fully automated. The Agricultural Market Division of SAFEX has established itself as the agricultural market leader in the maize market in southern Africa.

Another possibility, of course, is the Chicago Board of Trade (CBOT). CBOT trades both futures and options in seven agricultural commodities: there are contracts for corn, oats, rough rice, soybean, soybean meal, soybean oil and wheat. The contract specification for corn is 5 000 bushels (one bushel = 36.74 tonnes). The deliverable grade for the corn contract is yellow maize. As on SAFEX, five futures contracts are traded per year (March, May, July, September and December). There is both open auction and electronic trading.

A final possibility is the futures exchange in Zimbabwe, the Zimbabwe Agricultural Commodity Exchange (ZIMACE). ZIMACE, established in 1994, is a private sector initiative to fill the vacuum left by the dismantling of state controls in the marketing of agricultural commodities. ZIMACE trades in a variety of crops except tobacco and horticultural products. Volumes of commodities traded at ZIMACE have increased substantially since 1994, reflecting the growing popularity of the exchange as farmers take advantage of the partially liberalized agricultural marketing system. In 2001 ZIMACE ceased trading until further notice by order of the Zimbabwe government, as wheat and maize have become controlled commodities under the Grain Marketing Act. Although ZIMACE is currently not a feasible possibility, it may become an interesting option once this exchange is able to resume its activities.

4.2 Market quality

At this stage we should evaluate the market quality of SAFEX and CBOT and possible other alternatives. Market quality is associated with the liquidity of the market: higher liquidity is regarded as superior, given the higher potential of price discovery, the absence of extreme peaks and lows in prices due to limited supply and demand, and a sufficient turnover to absorb new buyers and sellers.

Market quality is measured by the annual daily trading volumes and open interest, both in futures and options, and appropriately scaled for differences in contract sizes. Unfortunately, and with the exception of open interest figures for SAFEX futures, we lack data on open interest and trade volume. The SAFEX open interest data show a tremendous growth since the start of SAFEX (which is slightly moderated in recent years), indicating improvement of liquidity over the years.

Closer inspection of SAFEX open interest per contract reveals substantial difference between contracts. Open interest per contract, averaged over trading days, is relatively low for the May and September contract (see Figure 20). These contracts appear to be less suitable for hedging purposes from a liquidity perspective. The March, July and December contracts achieve reasonable levels of open interest, with the December contract slightly lower compared to the March and July contracts. The pattern of open interest over the trading period in recent years is, for unresolved reasons, irregular for the March contract, but reasonably smooth for the December and July contract. The March 2004, the July 2004 and the December 2004 contracts have a peak open interest of 16 000, 16 000 and 12 000 contracts. If 200 000 tonnes of potential white maize imports needs to be hedged, 2 000 contracts need to be purchased and sold in the course of the year: this is a substantial volume of trade and should be carefully phased.

Since we are not in the position to distinguish between SAFEX and CBOT on the basis of liquidity (although we believe CBOT to be more liquid), we are left with basis risk calculations, which are discussed in the next paragraph. To complete this section we have shown nearby futures prices on SAFEX and CBOT, for white maize and corn, from 1996 to 2003 (see Figure 21). Price developments in both exchanges diverge substantially. For example, in the year 2001 and 2002 SAFEX prices moved substantially above CBOT prices, reflecting food shortages in the southern part of Africa. This suggests that SAFEX and CBOT serve different (regional) markets. Even if we ignore the 2001 and 2002 prices, basis risk between these markets is substantial. We have assessed basis risk between CBOT and SAFEX by calculating the correlation between three, six and nine month returns of the nearby contract (daily quotations, CBOT quotations converted to South African rand) using data for the period February 26, 1996 to September 15, 2003. The simple coefficient of correlation has values of 0.494 (3 months returns), 0.618 (6 months returns) and 0.666 (9 months returns). These results indicate a poor correlation between the two exchanges.

In this chapter we briefly discussed the international futures exchanges where maize contracts are traded, specifically SAFEX and CBOT. It was impossible to assess relative liquidity. Prices in both markets diverge substantially, presumably caused by different underlying developments in the physical markets. With the concentration of Malawi maize imports from the southern African continent, and the dominant position of South Africa in wheat and maize production and trade, we believe that SAFEX is the most suitable exchange for hedging Malawi maize import prices. Within SAFEX and from a liquidity perspective, the white maize May and September contracts appear to be less suitable, and the white maize March, July and December contracts most suitable for hedging Malawi imports.

5 RISK MANAGEMENT POSSIBILITIES FOR MALAWI MAIZE IMPORTS

In this chapter we propose a simple hedging transaction for hedging Malawi maize imports. We run an *ex-post* simulation over the period 1996-2003, in order to show the benefits of the proposed scheme. In designing the transaction we have attempted to develop a reasonably representative hedging transaction with futures and with options, that clarifies the potential of using financial derivatives. The hedging strategy entails a series of choices and assumptions that may prove to be different in practical day-to-day situations. The scope of this exercise is, however, confined to showing the potential usefulness of financial derivatives in achieving risk reduction. We discuss subsequently the basis risk of Malawi import prices and SAFEX, the quantity to be hedged, the costs of hedging and historical simulation of a futures- and option-based hedging scheme.

5.1 Basis risk

Before setting up a hedging strategy we need to assess strictly the basis risk between Malawi maize import prices and spot prices on SAFEX. If these prices are not developing sufficiently in parallel, it becomes impractical to use SAFEX for hedging purposes. Unfortunately we do not have data of maize import prices or maize import unit values on a sufficiently high frequency, in order to perform accurate basic risk calculations. The annual data from FAOSTAT are not suitable for this purpose. Hence, we have assumed that SAFEX rand spot prices are representative for the Malawi maize import prices - specifically we have assumed that basis risk between Malawi maize import price and SAFEX spot price is sufficiently small to justify a hedging transaction of Malawi maize imports on SAFEX. The hedging transaction takes the SAFEX spot price as the Malawi maize import price and applies a unit hedging ratio.

Since the lack of data on maize import prices and the impossibility to calculate basis risk is not entirely satisfactory, we have attempted to circumvent this problem following a similar approach to Sarris et al. (2004). In their work they apply a two step procedure to examine whether CBOT futures prices are effective for hedging wheat imports of a selected number of developing countries. First, annual import unit values and annual world market reference prices are used to establish the relation between border prices and world market prices. Next, the relation between monthly nearby prices on CBOT and world market reference prices – also available on a monthly basis - is investigated. The key to this approach is the use of monthly data (world market reference prices) in an estimation with monthly data and one using annual data.

Unfortunately reference prices in monthly frequencies are not available for the case of Malawi maize imports and most alternative price information is of poor quality. We propose the following variant. We calculated annual unit values for Malawi and South African maize imports and exports based on FAOSTAT data. The Malawi maize import unit value may be considered to be the border price that needs to be hedged.[18] Since South Africa is the dominant producer in the region, South African maize prices constitute the reference price – rather than world market prices - in our hedging transactions. Hence, transmission between the SAFEX white maize futures and Malawi maize import prices is assessed by investigating the relationship between Malawi and South African maize (import) unit values. South African maize prices are calculated as average export and import unit values.[19] All unit values are in US dollars per tonne and transformed logarithmically. As in Sarris (2004), we investigate the relationship between these two series, using a standard specification, both static and dynamic. We estimated:

$$p_{Malawi,t} = \alpha + \beta T + \gamma p_{SouthAfrica,t}$$

where

$p_{Malawi,t}$ = (log) Malawi maize price at the border in US dollar in year t

$p_{SouthAfrica,t}$ = (log) South Africa maize price at the border in US dollar in year t

T = time trend,

and the dynamic version of this equation:

[18] In the construction of the Malawi import unit values we have used a number of export unit values in order to make the time series as complete as possible. This applies particularly to before 1987 data points.

[19] In the construction of the South African maize unit values we have calculated averages of import and export unit values, unless import unit values are extremely out of line, reflecting South African maize shortages. For these years we have used the prevailing export unit values.

$$\Delta p_{Malawi,t} = \alpha^{*} + \sum_{j=1}^{J} \beta_j \Delta p_{Malawi,t-j} + \sum_{k=0}^{K} \gamma_k \Delta p_{SouthAfrica,t-k} + \rho\, ecm_{t-1}$$

and

$$ecm_t = p_{Malawi,t} - (\alpha + \beta T + \gamma p_{SouthAfrica,t})$$

The γ(k)'s in the equations indicate to what extent references prices are transmitted to border prices, the ρ signifies the speed of adjustment to reference prices in later years. Tests on the order of integration are performed (see Table 8): on the basis of this table we conclude that the hypothesis that both price series are I(1) in log levels and I(0) in first differences of logs cannot be rejected.

The estimation result[20] of the equation in levels is:

$$p_{Malawi,t} = -0.6219 + 0.0248\ T + 0.8161\ p_{SouthAfrica,t}$$
$$(1.3) \quad (4.6) \quad (4.9)$$
$$R2 = 0.855; \quad sample\ period: 1964-2003\ (without\ 1977-1979); \quad observations: 37$$

The estimation result of the equation in first differences is:

$$\Delta p_{Malawi,t} = 0.0247 - 0.2524\ \Delta p_{Malawi,t-1} + 0.8412\ \Delta p_{SouthAfrica,t} - 0.7571\ ecm_{t-1}$$
$$(0.5) \quad (1.2) \quad (3.0) \quad (2.5)$$
$$R2 = 0.488; \quad sample\ period: 1966-2003\ (without\ 1977-1981); \quad observations: 33$$

All estimation results indicate that the impact of current South African prices on Malawi import prices is statistically significant and large (close to 1). Hence, these results indicate that the extent of transmission of price signals of reference prices to Malawi maize import prices is substantial. The completing piece of evidence – the estimation of the relationship between SAFEX nearby maize prices and South African maize prices – is currently impossible to implement, due to lack of data.[21] However, we believe that it is highly unlikely that SAFEX white maize prices and South African maize prices are far apart.

5.2 Costs of hedging

The cost of risk management depends on the type of scheme adopted. Futures based hedging requires a margin-finance facility. Initially, only a small amount of margin need be put up (typically 10 percent of the value of the futures position), and it is possible that a broker may provide this on behalf of the client. On top of the initial margin, the holder of a future has to pay variation margin. Variation margin depends on the market movement from the time of purchase to the time of sales. The holder of a future is required to pay variation margin once the current futures price decreases below the price of the purchased future. On occasion these variation margins may make the hedging transaction expensive. This reflects the risk that the holder of the future may need to cover his position by closing out at the lower price.

In the case of a futures based hedging scheme we need to take account of these transaction costs of purchasing futures. First, the white maize futures purchase involves payment of the initial margin payment on white maize of 10 000 South African rand per contract. In the simulations we have taken into account the interest cost on this initial margin. In the calculation we have further included a brokerage fee and clearinghouse fee of 200 South African rand per contract and finally a JSE booking fee of 20 South African rand per contract.

Options-based schemes are more like insurance policies: options require the payment of a premium. The cost of a pure price ceiling scheme is limited to the premium and if this is paid on a margin basis,

[20] Absolute t values in brackets below the coefficient.

[21] Converting SAFEX data to annual series will not be helpful since we only have SAFEX data from 1996 onwards.

payments are limited to the premium. For an option based scheme we need to elaborate on the determination of option prices. The critical determinants of the price of any option are

- the extent to which the strike price is above or below the current price of the futures contract against which it is priced (i.e. the moneyness of the option);
- the term of the option;
- the volatility against which the option is priced.

Moneyness directly affects the price of an option because it determines both the probability that the option will be exercised (i.e. that the price will be above the price that triggers payment), and the amount of money that will be paid to the purchaser in that event. A high in-the-money (call) option will be expensive both because it is likely that the reference price will be above the strike price and because payment will be based on the difference between the strike price and the reference price. An out-of-the-money call option, set above the current futures price will be less expensive because it is unlikely to be exercised and will pay less in the event that it is exercised. There is general agreement that only slightly out-of-the-money call options, hence calls with a strike price above the current futures price, qualify for the purpose of hedging import price risks, otherwise the scheme would become too costly. The term of the option affects its cost because the longer the term, the more likely it is that moneyness will increase.

Option prices also depend on the volatility of the underlying futures price. The more variable the futures price, the more valuable the insurance and the more expensive it will be to provide. Volatility may either be measured in a backward-looking manner, by looking at the past variability of the futures price, or in a forward-looking manner, looking at the anticipated future variability. The backward-looking concept is known as historical volatility and the forward-looking concept as implied volatility. Implied volatility may be regarded as a forecast of volatility in the future. Although the forecasting accuracy of implied volatility figures is not high, the two measures move fairly closely together over the longer term.

Figure 22 plots implied volatility for the nearby white maize futures contracts on SAFEX from January 2002 to December 2004. Volatility is seen as typically varying between 20 percent and 40 percent on an annual basis with occasional increases up to 60 percent. The average implied volatility over the entire period January 2002 to December 2004 was 35.9 percent. This figure is not particularly high, but also not particularly low if compared to other commodities.

A final point needs to be made about the costs of options. Options are often not exchange traded and hence need to be arranged through brokers on an "over the counter" basis. These brokers will charge a commission to cover the costs of these services. The size of these costs depends on the type of option contract and the required off-setting transactions. If options need to be set up on an OTC basis along these lines, costs of an option-based hedging scheme may become higher. However, since we lack information on these costs we have ignored them in the simulations.

We can conclude with the observation that futures-based schemes are open-ended schemes which - on occasion - will make these schemes extremely expensive. Costs of option-based schemes are more like insurance schemes, with a premium payment of clearly limited size. From the perspective of administrative organization and budgetary discipline, this property of options clearly makes an option-based hedging scheme favourable relative to a futures-based hedging scheme (see also Devlin and Titman, 2004). However, costs related to setting up "over the counter" options schemes may be substantial. Further enquiries at SAFEX may resolve these issues.

5.3 Hedging with future contracts on SAFEX[22]

Hedging with futures allows one to lock in an international price at the level of futures price at the time of purchasing this future. In the proposed scheme we plan to purchase a futures contract on SAFEX at the start of the year, say in January. Hence, in our case the Malawi import price is locked in on, for example, the January price of white maize in terms of South African rand. If the price of the futures contract increases the hedging transaction is profitable: once the transaction is closed out, a higher price is received for the futures contract. The profit on the futures transaction makes up the loss of purchasing the maize in the physical market. If the price of the December contract decreases, the hedging transaction is loss-making. If the transaction is closed out, a lower price is received for the futures contract. Prices in the physical market have decreased and the loss on the futures transaction is offset by the lower price paid in the physical market. This explains also one of the drawbacks of hedging with futures: it is impossible to benefit from decreases in import prices. Use of a call option is in this respect superior since it protects the holder against price increases and at the same time allows price decreases to be taken advantage of.[23].

With respect to the volume of maize imports that are hedged, we make two different assumptions. First, we assume that futures (and options) are purchased on a continuous basis for a quantity that is exactly equal to actual imports realized later in the year. It is obvious that this is an approximation of feasible and plausible transactions, since import requirements are not known in advance with certainty and futures contracts can only be purchased for a fixed quantity (100 tonnes in the case of SAFEX). Actual monthly maize import data are also not readily available and need to be constructed (see above), which does not contribute to the reliability of these simulation results. Additionally, using actual imports restricts the hedging transactions to those months in which actual imports have taken place, and does not consider, possibly attractive, alternatives. According to our calculations, Malawi maize imports are concentrated towards the second half of the year. Assuming that import contracts and registration of imports occur on the same moment in time, this rules out hedging with the March and July contract, and only leaves the December contract as a feasible hedging instrument. Finally, variation in actually realized maize imports may obscure the background of variations in profits and losses of hedging.

In order to avoid these drawbacks and to improve comparability over the years, we have also run simulations with a hedge of a fixed volume of maize imports, purchased and closed out on specific dates (and, hence, not continuous). A reasonable estimate of total annual volume of required imports of maize is obtained either by combining the domestic requirement for achieving food security and minimum production, or by using a maximum quantity of historically observed imports (in order to stay on the safe side). The results of both methods, shown in Table 9, suggest a minimum quantity of 320 000 and a maximum of around 600 000 tonnes. These quantities correspond with 2 to 4 months' national net consumption of maize and are similar to what is found in other work (see WFP/FEWS NET 2004). Such estimates of Malawi maize import requirements are high and associated with widespread crop failure, food shortages and possibly disaster. On the basis of these calculations, we propose to hedge a fixed quantity of 200 000 tonnes of maize annually, purely to get some sense of the size of maize imports. The simulation with a fixed quantity on the one hand and realized imports on the other, also differ as the latter involves hedging on a continuous basis and the former is a one time hedge.

Maize futures contracts on SAFEX expire in five different months (March, May, July, September and December). On liquidity grounds (see above) we discard the white maize May and September contract. We assume that that a futures hedge is made 3, 6 and 9 months[24] in advance of the date when the

[22] In the design of the simulation it is attempted to stay as close as possible to the hedging schemes simulated in Sarris et al. (2004).

[23] Simulation results for an option based scheme are presented in the following section.

[24] Including a 12 month hedge in the simulations is not possible because the SAFEX white maize contracts are not always traded 12 months in advance. On top of that, liquidity and hence reliability of price formation is very low at the start of the contracts.

contract for physical delivery is signed, in which the price of imported maize is determined. Further, we have inferred from the seasonality in production that the probability of shortages is highest around the turn of the year, say from October to March. Likewise, we have learned from the evidence on seasonality of food imports, that the bulk of food imports are made in the second half of the year - from July till December. This underscores that physical quantities must be ordered a number of months before they are actually needed, because of time requirements of physical delivery, transport, distribution and retailing of the imported maize up-country (see e.g. FAO, 2003 for payment and delivery schedules of imports).

We assume that the price at which the physical import transaction is made is determined one month before the imports are actually needed. For the fixed quantity case we identify two contract dates for the physical import transaction, namely the June 30th and the October 31st. Prices of physical transactions are SAFEX white maize spot prices. The first import transaction is hedged with the July contract, the second import transaction is hedged with the December contract. Hence, for the end of June import, we purchase SAFEX white maize July futures on the following preceding dates: October 31st for the 9 months' hedge, December 31st for the 6 months' hedge and March 31st for the 3 months' hedge. These futures are closed out at the date of the physical import contract, June 30th. Likewise, for the end of October import, we purchase SAFEX white maize December futures on the following preceding dates: January 31st for the 9 months hedge, April 30th for the 6 months hedge and July 31st for the 3 months hedge. Also likewise, these futures are closed out at the date of the physical import contract, October 31st. Simulation results for both physical import contract dates, both using different futures contract for the hedging transaction, are presented separately. In running the simulation we take account of brokerage and booking fees per contract as well as interest payments on the initial margin (see also above).

An important question with respect to prices is the issue whether fluctuations are temporary or persistent. The answer to this question has important implications for commodity revenue stabilization and the design of related economic policies (see e.g. Devlin and Titman (2004)). In our simulation the implication is simple: if prices show mean reversion it does not make sense to hedge either with futures or options when prices are high, since both schemes will lead to losses when prices revert back to their lower levels. The standard technique of determining mean reversion or persistence is through unit root tests. Unfortunately we lack sufficiently long time series to perform these tests.[25] Mean reversion may also be tested by comparing the volatility of nearby futures prices with the volatility of distant futures prices. If price shocks are temporary the volatility of distant futures prices is less than nearby futures prices. This is corroborated by the SAFEX data (although not strongly). Hence, we conclude that prices mean revert. Practically, and following Dana et al. (2005), we assume that no futures or options are purchased if the real price moves above 900 rand (2000 constant prices, deflation with the South Africa producer price index). It should be realized that simulation results are sensitive to the level of the cut-off price. Including simulations with different cut-off prices will reveal this, but this is not implemented in this study.

The simulation results of a hedge with futures of a fixed quantity of imports are reported in Tables 10a and 10b. In 17 out of 52 hedges (32.7 percent) futures prices turn out to be too high to implement a sensible hedging transaction (8 times in hedges with the December contract (29.6 percent) and 11 times in hedges with the July contract (44.0 percent)). Especially in the years 2002 to 2004 prices are above the cut-off point and this is a major obstruction to implementing hedging transactions. For these years the simulations indicate that the hedging scheme is ineffective. Hedging with futures has a positive benefit in 21 out of a total of 35 hedges (60 percent), but this is somewhat better in hedges with the December (14 out of 19 (73.7 percent)) contract relative to hedges with the July contract (7 out of 16 (43.8 percent)). The 9 months hedge with the July contract performs particularly poorly. Hedges for longer periods show, as expected, more extreme variations in losses and profits. The simulations show that the December contract has been a more profitable instrument to be used for a futures hedge of Malawi maize imports. In Table 10c we have reported simulation results based on

[25] It should be noted that the statistical power of unit root tests is low and the results are dependent on the time frame chosen.

realized imports. Since the hedge is implemented on a continuous basis and, as imports are realized from July to December, the 9 months hedge falls for the larger part beyond the term of the December contract, we have skipped the 9 months result. The results for 2004 are not available since we could not calculate the import profile for this year. The simulation results are very similar to the fixed quantity futures hedges with the December contract, reported in Table 10a.

These simulation results should be interpreted with caution. There is no guarantee of similar outcome in the future. The positive outcome of hedges is simply due to the fact that prices are rising in these years, while they are declining in the years with a negative hedging outcome. This also indicates that it is not clear if the superiority of the December contract over the July contract is systematic. A technique to obtain more general results is to model the price formation process on SAFEX and, subsequently, to run stochastic simulations. However, this is beyond the scope of the current study.

5.4 Hedging with option contracts on SAFEX

A similar type of hedging scheme is designed based on the use of options, in particular call options. A call option is the right to purchase at a pre-specified price. The pre-specified price is known as the strike price. The cost of the option is the option price, and this price has a clear maximum, as is explained above. If the actual price is above the strike price the call option is "in the money": the holder of the call option may exercise the option and cash the difference between the actual price and the strike price. If the actual price is below the strike price the option has no value and simply lapses. The underlying instrument of the SAFEX white maize option contract is one white maize futures contract. For the purpose of simulating a hedge scheme with options, we propose to buy a call option on July or December futures. As in the case of the hedge with futures, the call option is purchased 3 months, 6 months and 9 months before the actual physical imports take place. In our option simulations we have assumed the strike price to be equal and a certain percentage above the futures price (5 percent), in order to assess the difference in hedging benefits. The value of the call option - the cost of purchasing an option - is calculated using Black Scholes.[26] Volatilities are supplied by SAFEX for a limited number of years (2001, 2002, 2003). For all remaining years we have used an average of these volatilities.

In summary, we purchase white maize call options on July and December futures, either two thousand or a quantity that equals actual imports. In the fixed quantity case the July call options are purchased on October 31st for the 9 months' hedge, on December 31st for the 6 months' hedge and on March 31st for the 3 months' hedge. The December call option is purchased on January 31th for the 9 months hedge, on April 30th for the 6 months hedge and on July 31st for the 3 months hedge. These dates are identical to the futures hedge. The call option on July futures is exercised (if "in-the-money") by the end of June, the call option on the December futures is exercised (if "in-the-money") by the end of October. Simultaneous with exercising the options, spot purchases of white maize are made for delivery respectively by the end of June and by the end of October to meet the actual import requirements. We simulate the option-based hedging scheme with an "at the money" strike price (strike price is equal to futures quotation) and a strike price that is 5 percent above the current futures quotation. As with futures, transactions are cut off if the strike price is above 900 rand, in 2000 constant prices.

The results of the option based hedging scheme are reported in Table 11a to 11f, of which Table 11a to 11d pertain to a fixed quantity hedge and Table 11e and 11 f to a continuous hedge of realized imports. The simulation results are also presented in graphical form, see Figures 23 to 31. If the strike price is 5 percent above the futures quotation no transaction takes place in 40 percent of the cases, and this

[26] White maize options on SAFEX are American type options. Values of American type options need to be calculated with a binomial numerical procedure. However, option values calculated with the binomial method and with Black Scholes are equivalent if the number of trading days until expiration of the contract is large. For the 6 and 9 months hedge this condition is met, but it is appears more problematic in the case of the 3 months hedge. Using Black Scholes is, hence, justified for the longer period hedges, and possibly less in the case of the 3 months hedge. Additionally it shiould be noted that in practice early exercise is unlikely with a flat or rising forward structure.

declines to 30-35 percent if the strike price is at-the-money. Again, especially in the year 2002 to 2004 prices are above the cut-off point of the strike price and this further emphasizes that the hedging scheme is ineffective for these years. Hedging with options has a positive benefit in 20 out of a total of 35 hedges in case of options on the December futures (57.1 percent), and only 10 out of 31 hedges in case of options on the July futures (32.2 percent). As with the futures based scheme the option on July futures has been less attractive in terms of benefits relative to the option on December futures. In the option scheme the losses are very moderate, i.e. less than 10 percent of unhedged import costs. The size of these losses is much lower than the (average) size of losses in the case of futures-based hedging. Varying the strike price suggests that (on average) the additional revenue if the option is exercised outweighs the additional costs of a lower strike price (a more "in-the-money" strike price). Simulation results based on realized imports (Table 11e and f) are similar to the fixed quantity hedges with options on December futures, with the possible exception of the 2003 loss, which is due to the concentration of imports in two months combined with a high volatility in these months.

The numerical results underline that the option-based scheme works like an insurance: if prices increase the options can be exercised offering a compensation for high priced spot purchases, if prices decrease the benefit becomes negative, although not drastically, representing the costs of purchasing this insurance. From the table it follows that the scheme allows imports to benefit from price decreases although to a lesser extent than without hedging. In case of negative benefits of hedging the unit cost may be slightly higher than the unit cost without hedging, but it is much lower than the strike price, i.e. planned unit cost. In terms of direct benefits the option-based scheme appears to be equally as attractive as the futures-based scheme: the losses incurred in futures hedging, and which are limited in option hedging schemes are partly avoided by using a cut-off price for transactions.

We have calculated a range of variants of the simulated schemes, which are not reported. An important variant concerns using different assumptions with respect to volatility. Since our calculated (historic) volatility is lower than the one supplied by SAFEX we have experimented with a volatility of 20 percent for all years. Not surprisingly, this improves the benefits of hedging with options considerably. In particular, the costs of the option scheme decrease if the option remains out of the money until expiration and hence only costs are incurred.

A final point needs to be made on the Malawi kwacha/South African rand exchange rate. All simulation results – both from the futures-based scheme and the option-based scheme - are calculated in South African rand in order to avoid the impact of exchange movements. In this way we focus on the impact of the hedge and ignore possible variations in profits and losses that are due to exchange rate movements. This is not to say whether or not exchange rate movements have an important impact on the simulation results. However, presenting results in terms of Malawi kwacha would raise the question of how to address the exchange rate risk. These issues are beyond the scope of the current study. We do not, for example, investigate the possibilities (if existent) to hedge the Malawi kwacha/South African rand exchange rate risk. Elsewhere it is argued that the exchange rate risk makes SAFEX unattractive to hedge purchases in local currency (see Gilbert, 2004).

6 CONCLUSIONS AND RECOMMENDATIONS

Maize accounts for the largest share in total per capita calorie intake in Malawi. However, the share of maize in the Malawi diet has been decreasing over the past 20 years: cassava and potatoes are becoming more important. The contribution of wheat to the total dietary energy supply is small and fluctuating, due to the fact that it is not domestically produced and only imported at times of food shortages. In order to achieve food sufficiency in 2004 a quantity of around 2.1 million tonnes of maize would be required.

Production of maize in southern Africa is dominated by South Africa, which accounts for the bulk of production in this region. Both poor harvests and bumper crops in South Africa will have a major impact on price formation and trade flows in southern Africa. Within Malawi production of maize is concentrated in the Central and Southern region. Volatility in Malawi maize production increased drastically in the 1990s. Production of cassava is concentrated in the Northern region and that of sweet potatoes in the Southern region. Due to the distribution of the population, the potential food deficit is largest in the Southern region. The potential food deficit is less, but still substantial, in the Central region. On the basis of the seasonality in maize output over the year, any food shortages are most likely to occur from October to March.

The larger part of Malawi food imports are of cereals (on average 65 percent), and within total cereal imports, imports of maize are by far the most important, especially during periods of peak food imports. A minimum of 60 percent and an average of over 70 percent of cereal imports originate from southern African countries, in varying combinations. Reports on substantial informal cross-border trade of maize suggest that official statistics on cereal imports and maize imports underestimate true import levels and even more maize originates from neighbouring countries. The amount of Malawi food imports funded through aid was extremely high from 1987 to 1993, but subsequently decreased quickly to nearly negligible levels from 1997 to 2001. On the basis of the available evidence it appears likely that actual Malawi food imports are concentrated in the second half of the year, from July to December.

Volatility of real maize prices in Malawi increased substantially by the end of the 1990s. A low correlation of Malawi domestic maize prices with each other and with international prices and a significant seasonal pattern in domestic maize prices, with low prices after harvesting and high prices just before harvesting, suggest a poorly developed marketing, trade and storage structure that if effective could implement spatial and intertemporal arbitrage.

Spot prices on SAFEX and CBOT diverge substantially, presumably caused by different underlying developments in physical markets. An acceptable basis risk between on the one hand spot prices of the corn contract on CBOT and, on the other hand Malawi maize import prices, is unlikely. With the concentration of Malawi maize imports from the southern African continent, and the dominant position of South Africa in wheat and maize production and trade, we believe that SAFEX is currently the most suitable exchange for hedging Malawi maize import prices. Due to lack of data we are unable to determine accurately the basis risk between import prices and SAFEX. Provisional evidence supports a strong transmission of South African maize prices to Malawi maize import prices and this justifies the use of SAFEX for hedging Malawi maize imports. Within SAFEX the May and September contracts appear to be less suitable for hedging purposes from a liquidity perspective.

A futures-based and an option-based scheme are proposed to hedge import price risk and these schemes are simulated for the period 1996-2003 using historical data from SAFEX. Futures based schemes are open-ended schemes which - on occasion - will make these scheme extremely expensive. Costs of option-based schemes are more like insurance schemes, with a premium payment of clearly limited size. However, costs related to setting up “over-the-counter“ options schemes may be substantial.

Hedging of Malawi maize imports is simulated, conditional on the assumption that Malawi maize import prices of maize are equivalent to SAFEX spot prices. Both futures-based and option-based hedging schemes show substantial benefits from hedging. There are two major qualifications of this result: first, there is no guarantee of similar outcomes in the future and, secondly, the outcomes are dependent on the exchange rate fluctuation of the Malawi kwacha against the South African rand.

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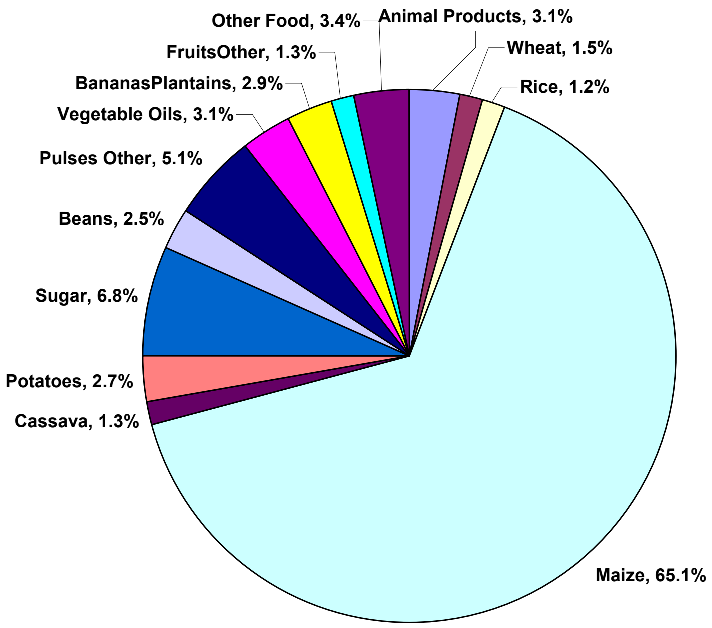
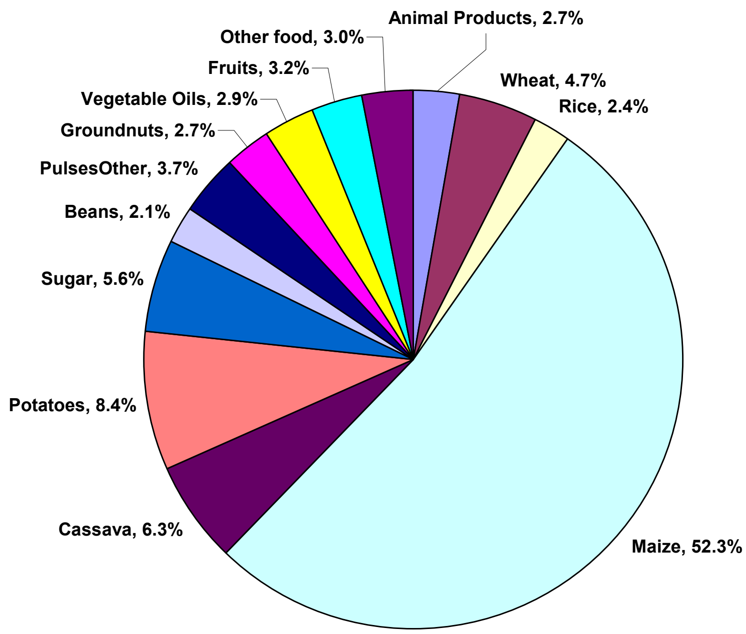
FIGURES

Figure 1 Food composition of per capita calorie intake in Malawi, 1990



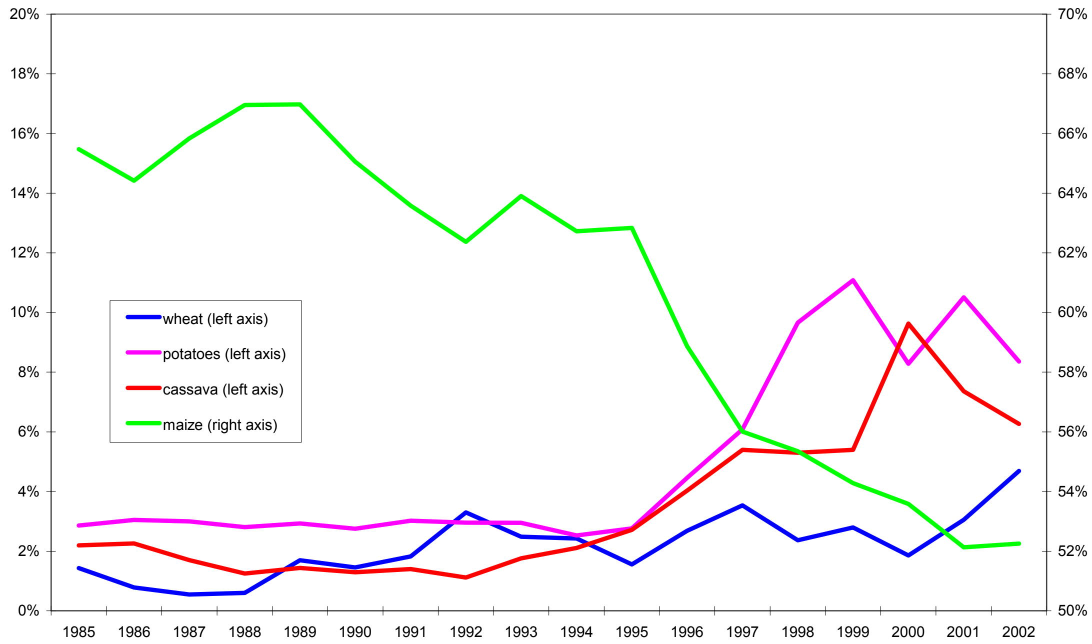
Source: FAOSTAT data, 2004

Figure 2 Food composition of per capita calorie intake in Malawi, 2002



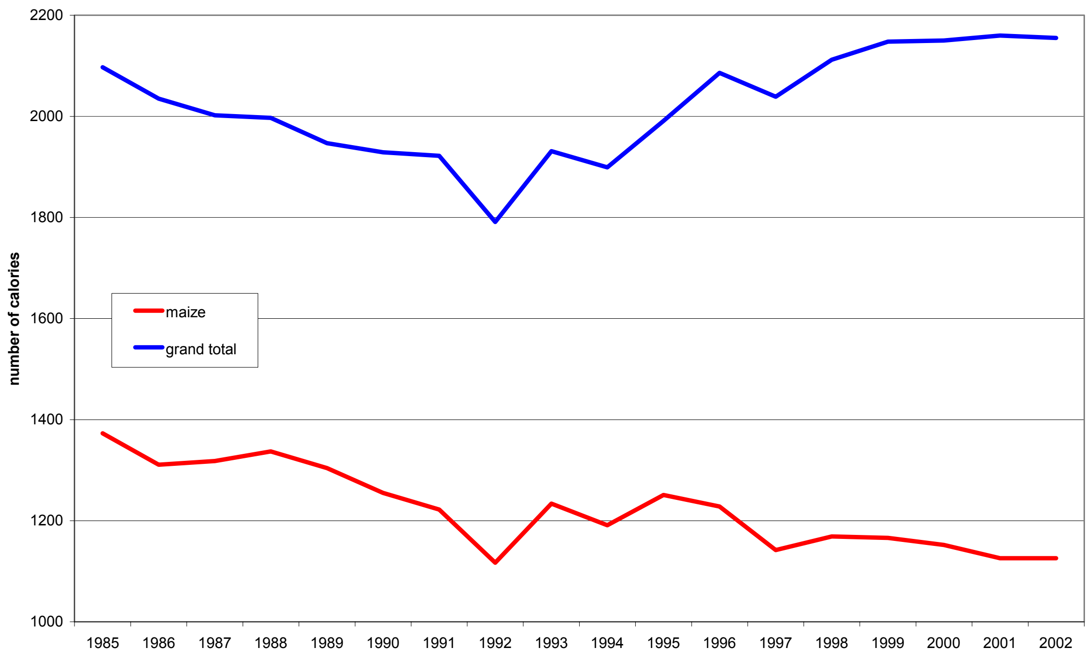
Source: FAOSTAT data, 2004

Figure 3 Major components of Malawi per capita calorie intake



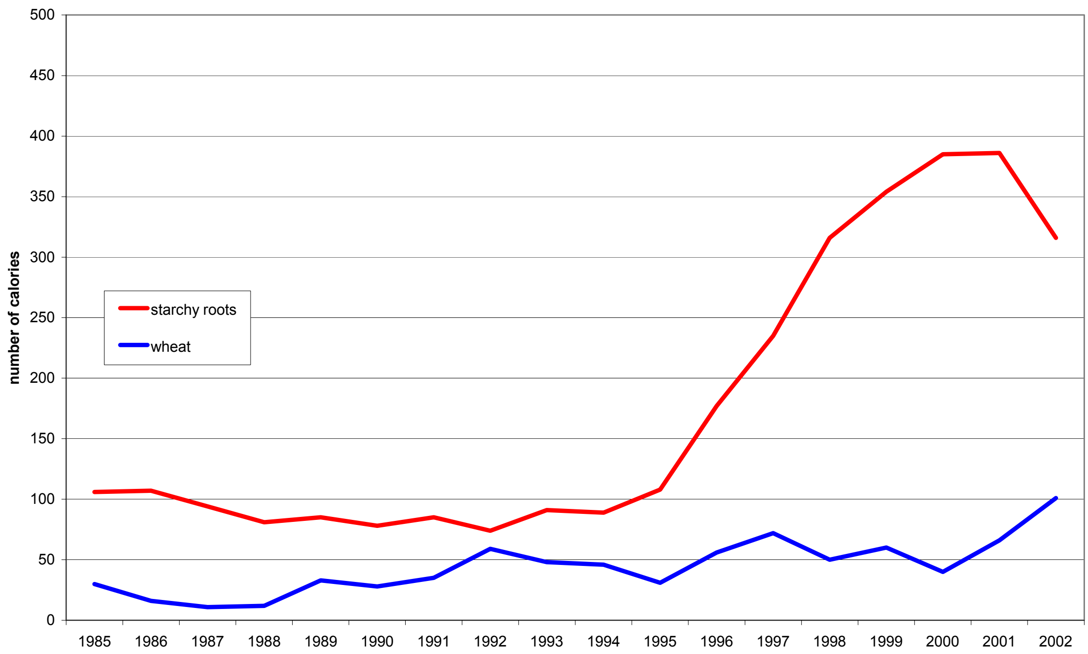
Source: FAOSTAT data, 2004

Figure 4 Malawi per capita calorie intake



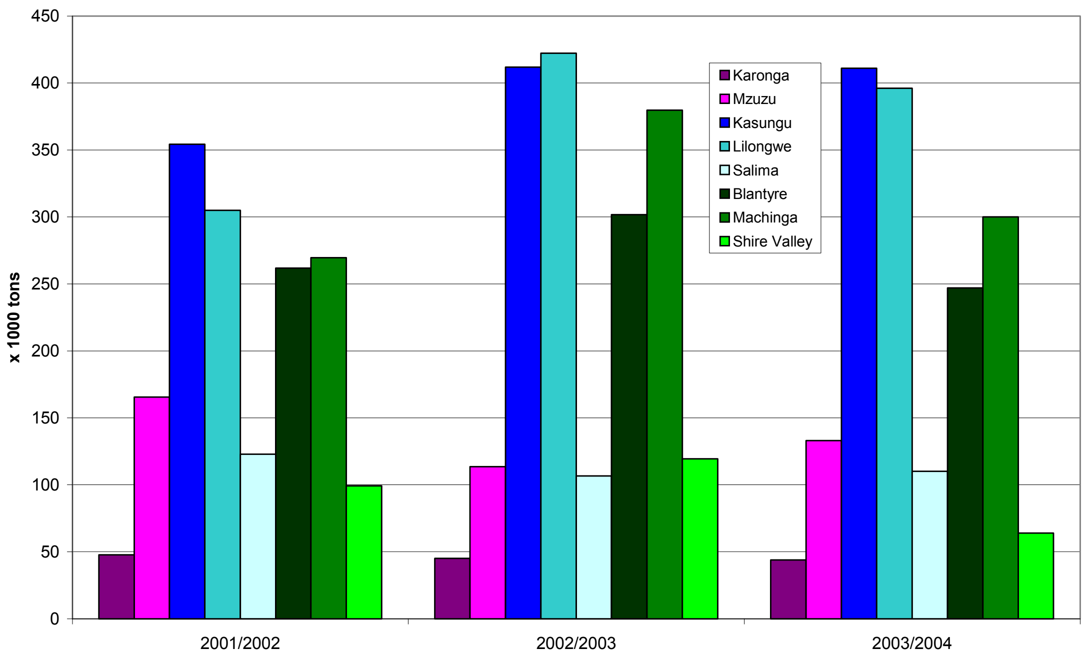
Source: FAOSTAT data, 2004

Figure 4 Malawi per capita calorie intake (continued)



Source: FAOSTAT data, 2004

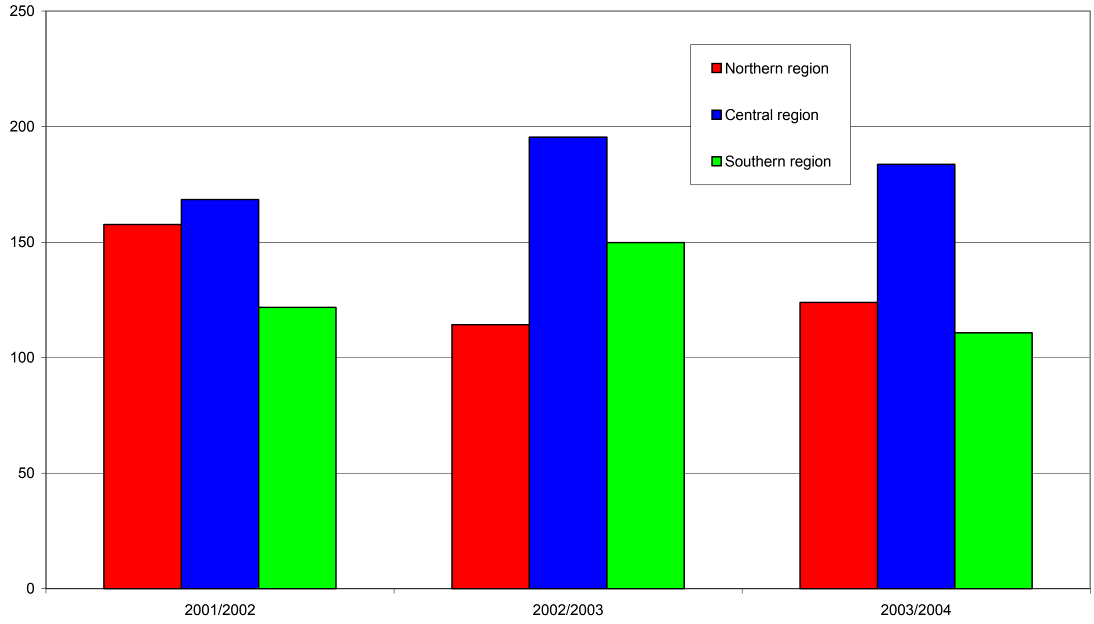
Figure 5 Malawi production of maize by agricultural development division



Karonga and Mzuzu: Northern regions
Kasungu, Lilongwe and Salima: Central regions
Blantyre, Machinga and Shire Valley: Southern regions

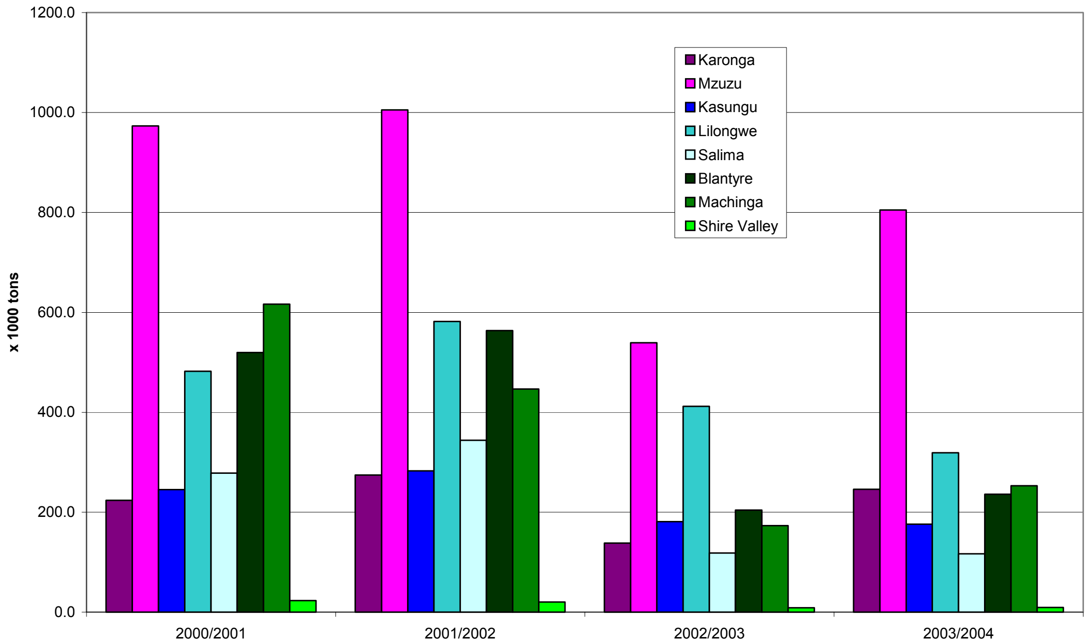
Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 6 Per capita Malawi production of maize by region



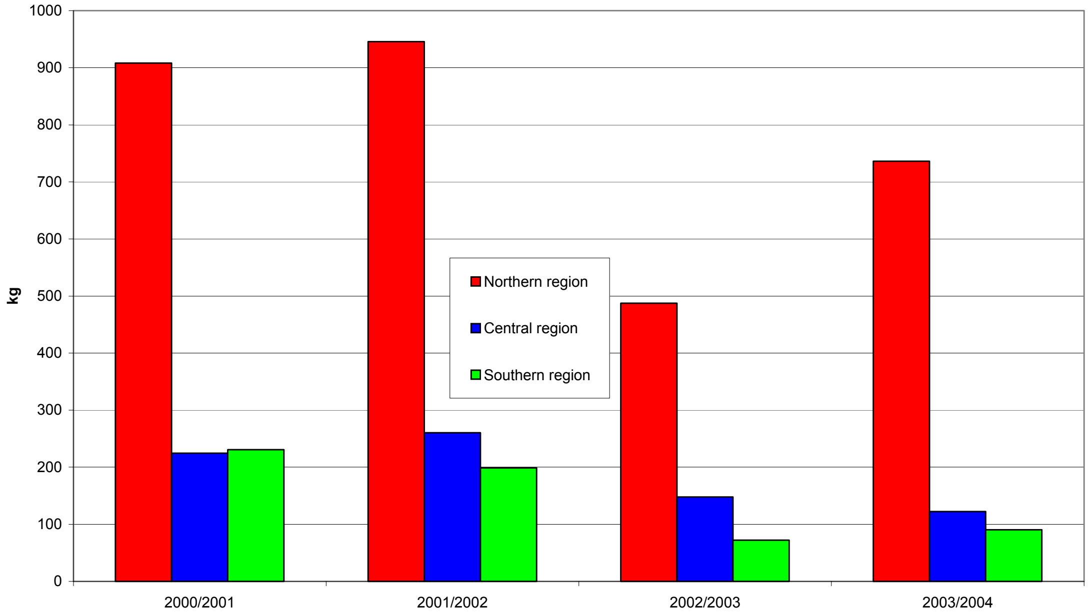
Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 7 Malawi production of cassava by agricultural development division



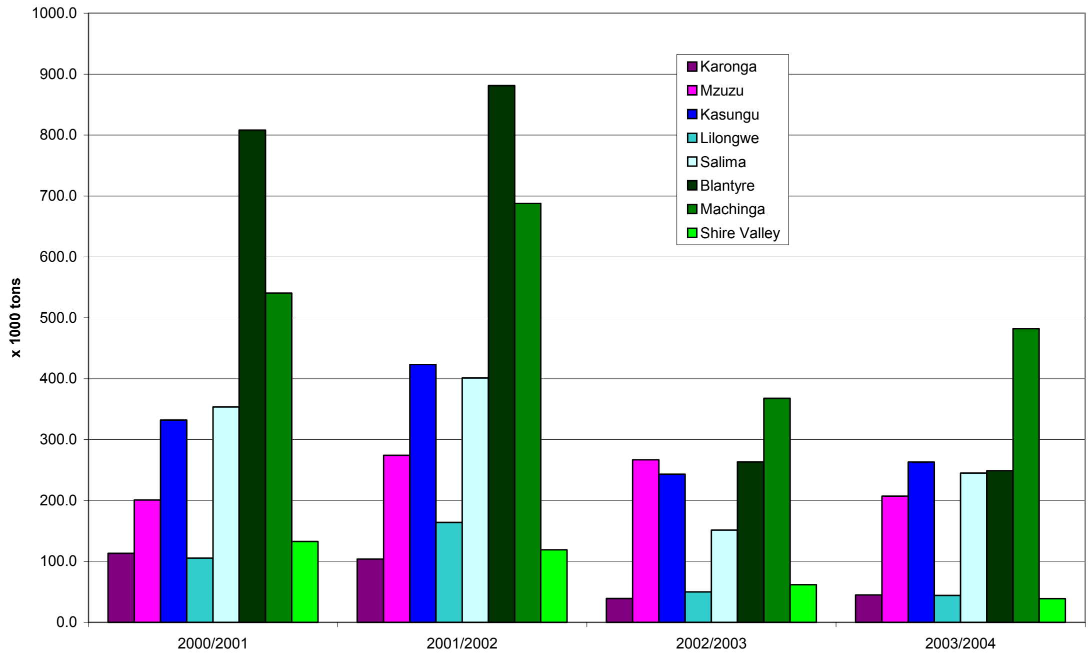
Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 8 Per capita Malawi production of cassava by region



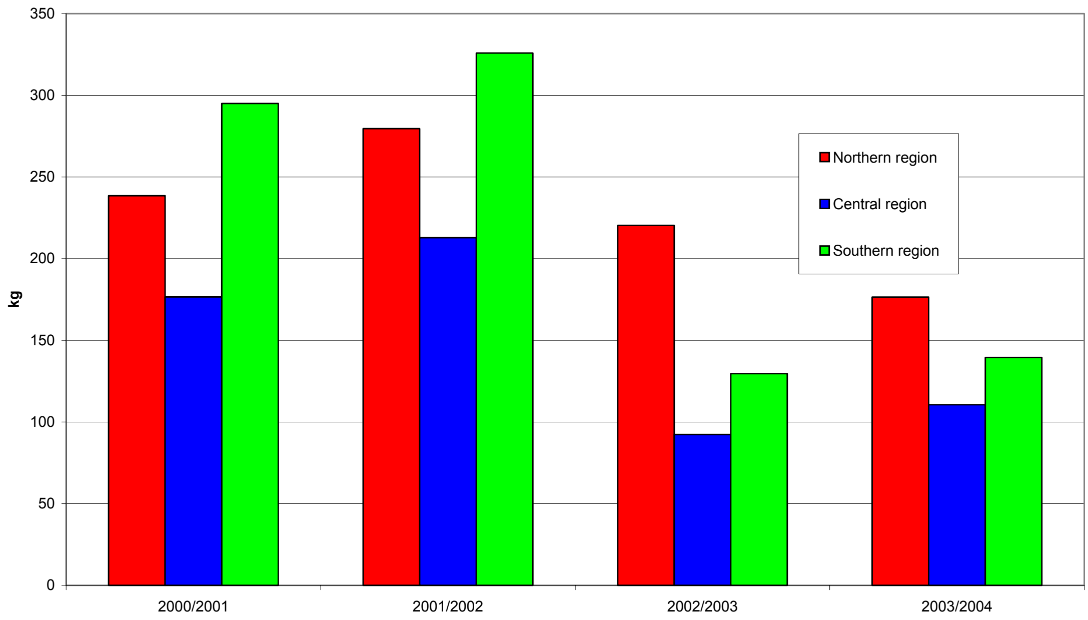
Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 9 Malawi production of sweet potatoes by agricultural development division



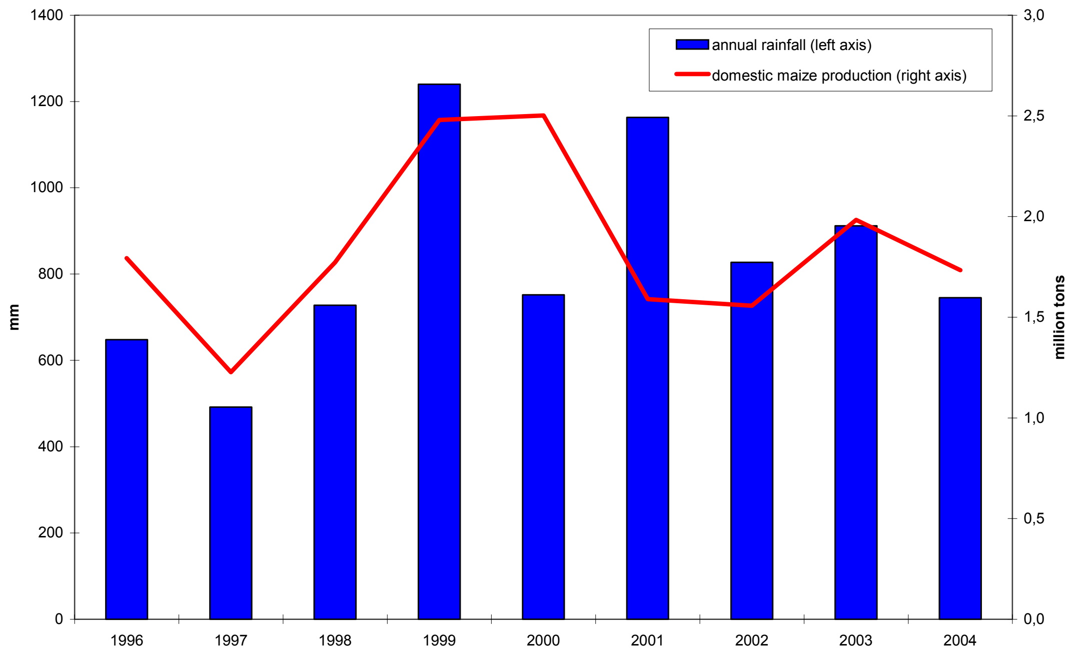
Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 10 Per capita Malawi production of sweet potatoes by region



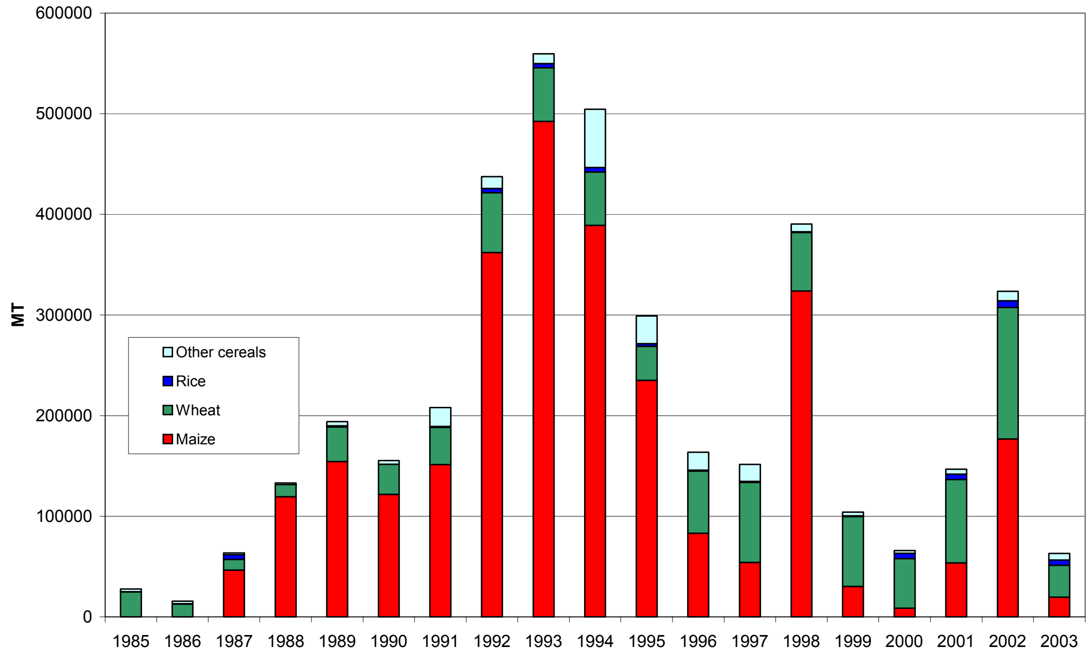
Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 11 Malawi maize production and rainfall



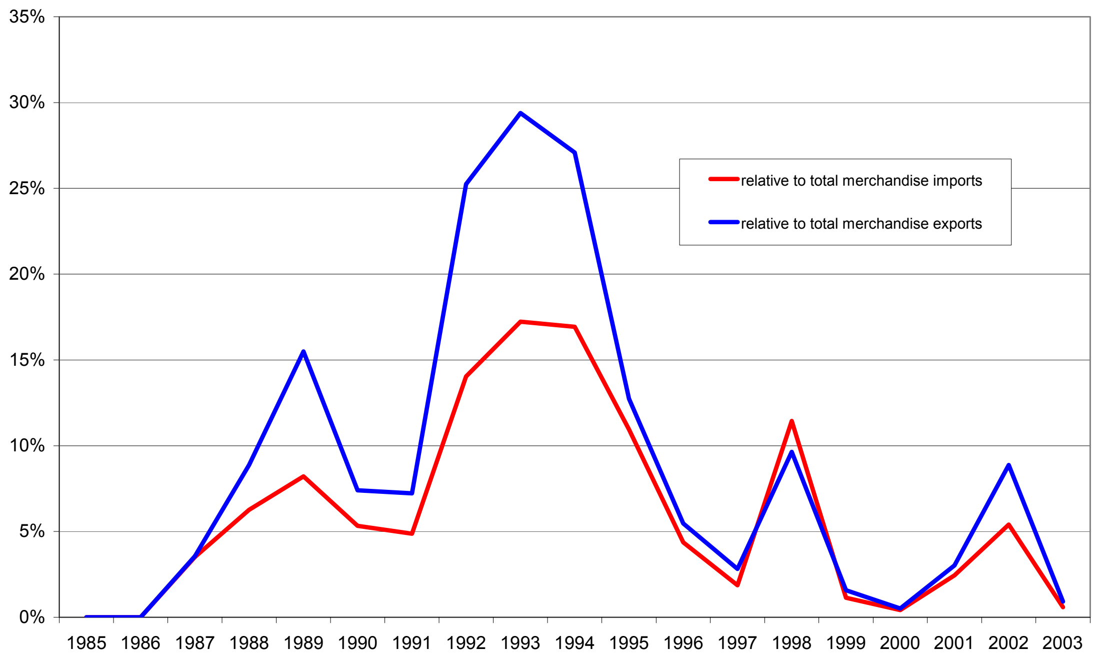
Source: FAOSTAT 2004 and IERF data (FAO/ARTEMIS)

Figure 12 Malawi cereal imports by commodity



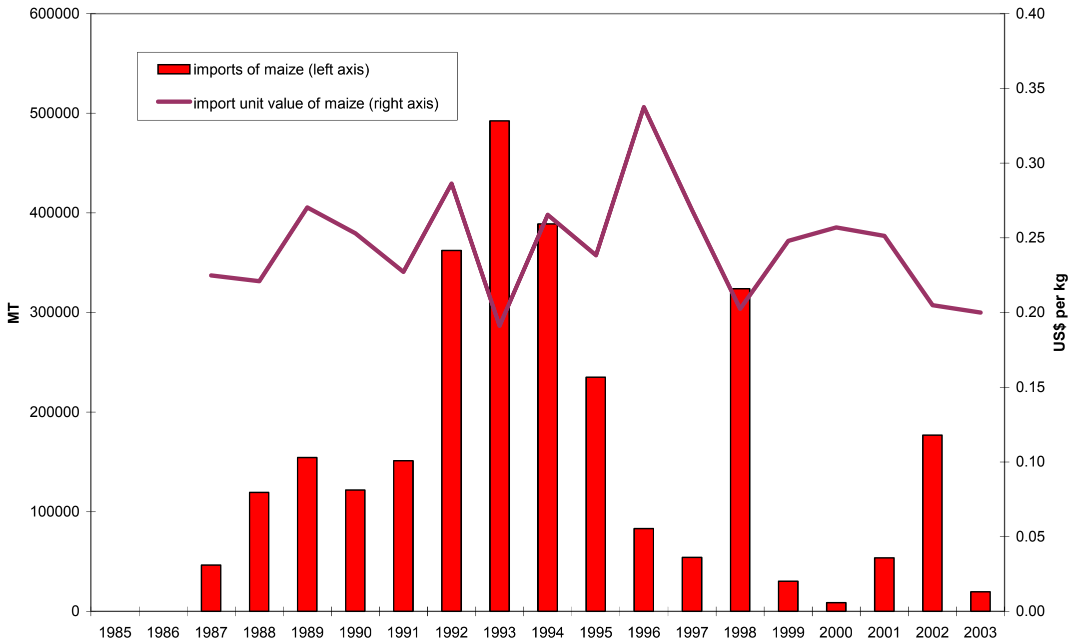
Source: FAOSTAT data, 2004

Figure 13 Malawi maize imports as a percent of total merchandise trade



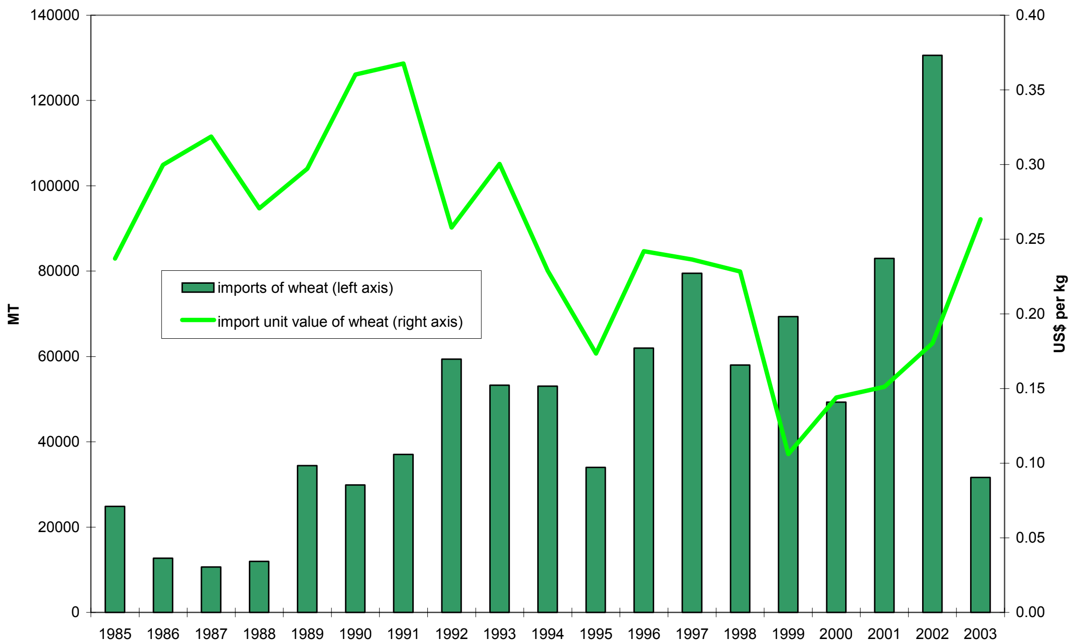
Source: FAOSTAT data, 2004

Figure 14 Malawi import and import unit value of maize



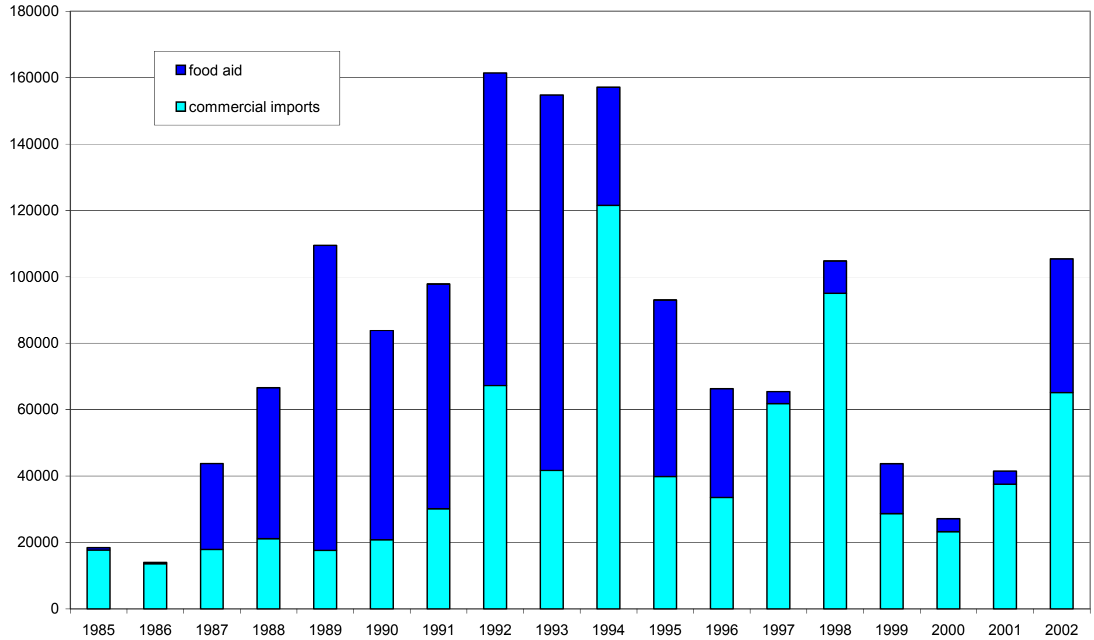
Source: FAOSTAT data, 2004

Figure 15 Malawi import and import unit value of wheat



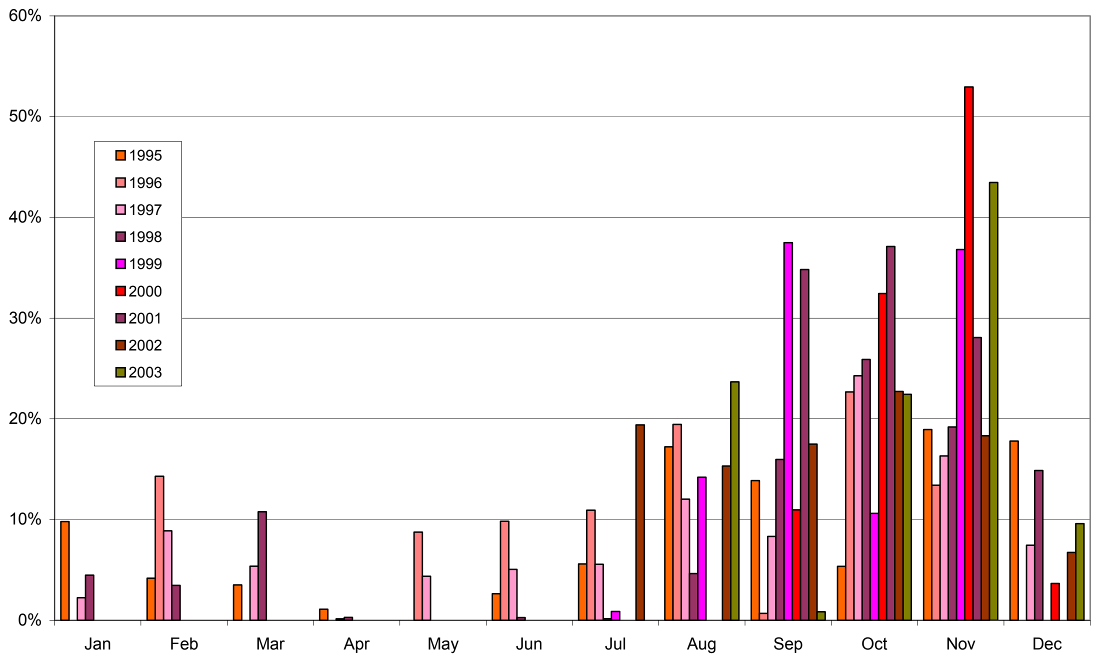
Source: FAOSTAT data, 2004

Figure 16 Commercial food imports and food aid



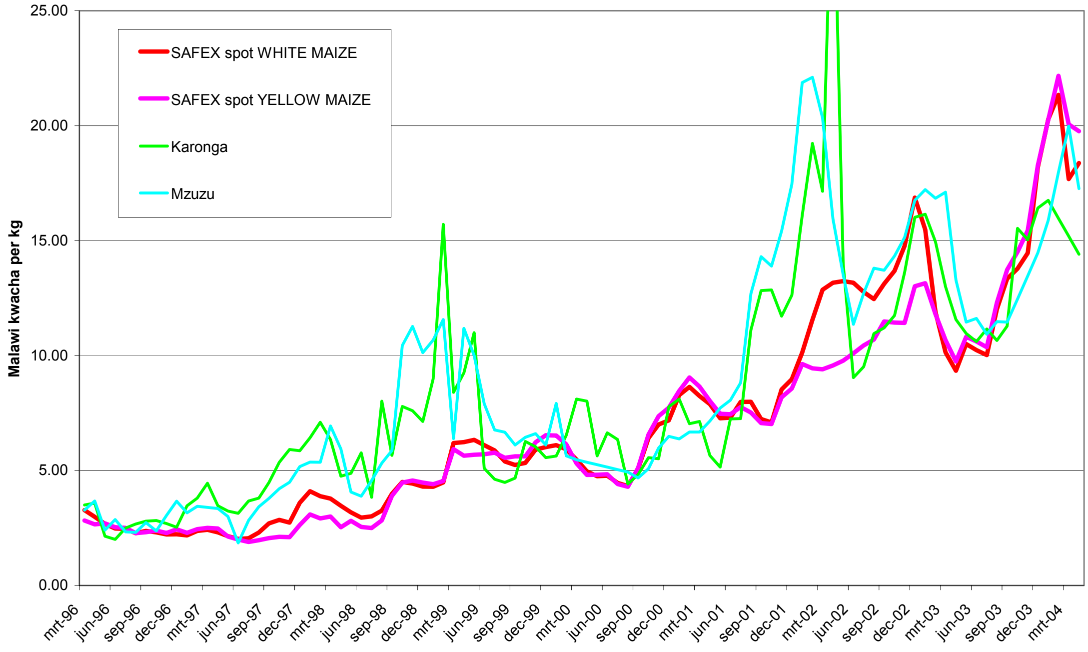
Source: FAOSTAT data, 2004

Figure 17 Distribution of Malawi cereal imports over the year (constructed)



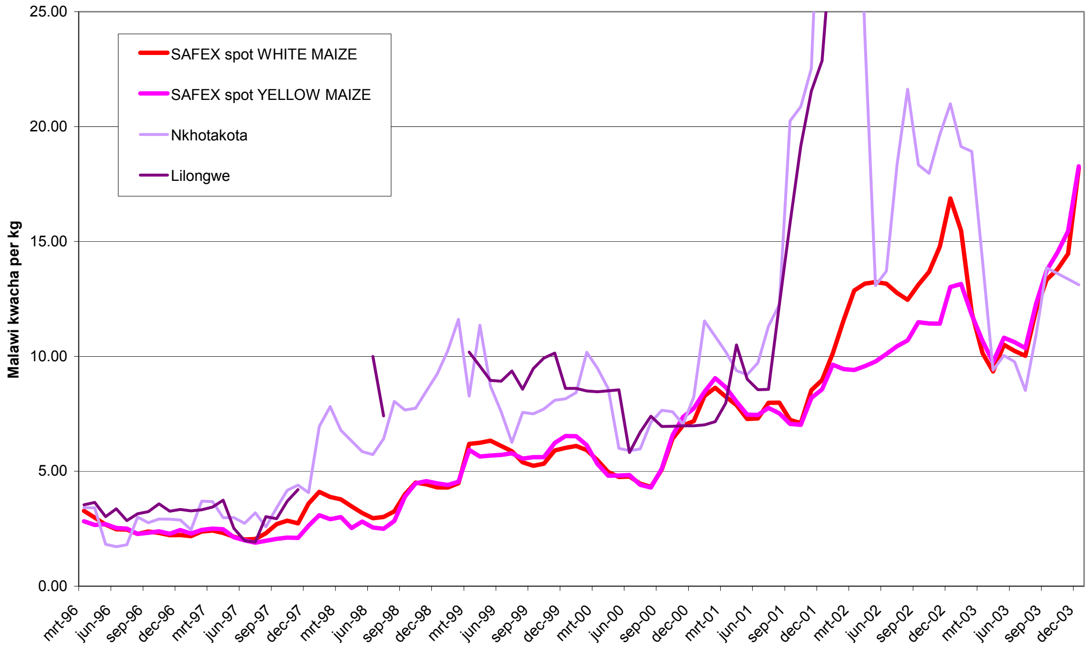
Source: own calculations based on IFS, IMF and FAOSTAT data

Figure 18a Maize prices: domestic, international and import



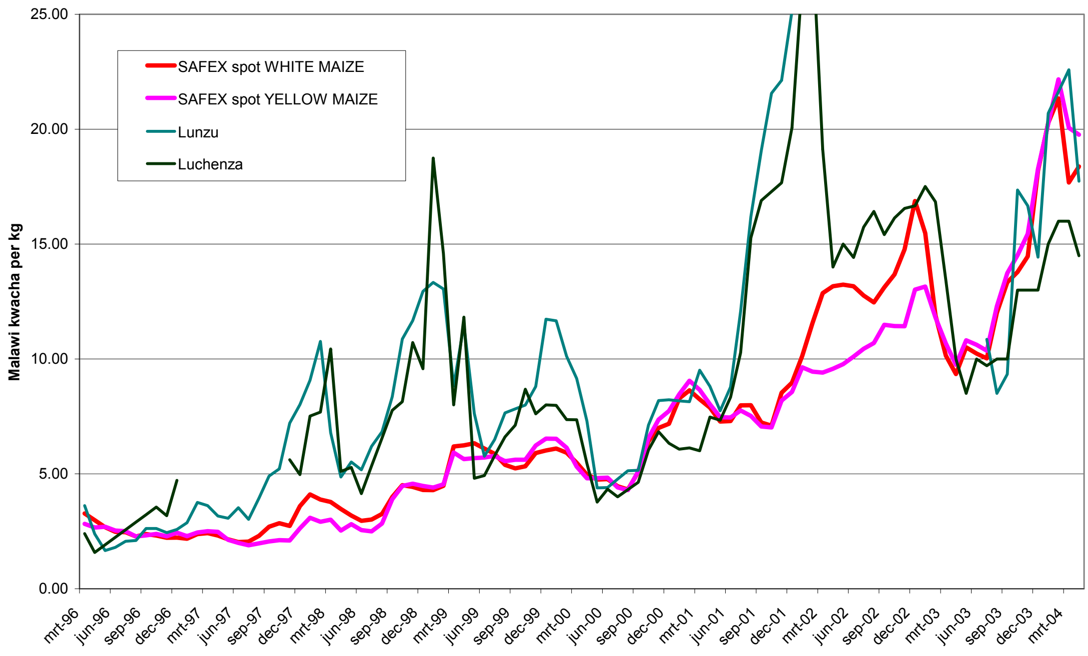
Source: SAFEX, NSO and MoAI, 2004.

Figure 18b Maize prices: domestic, international and import



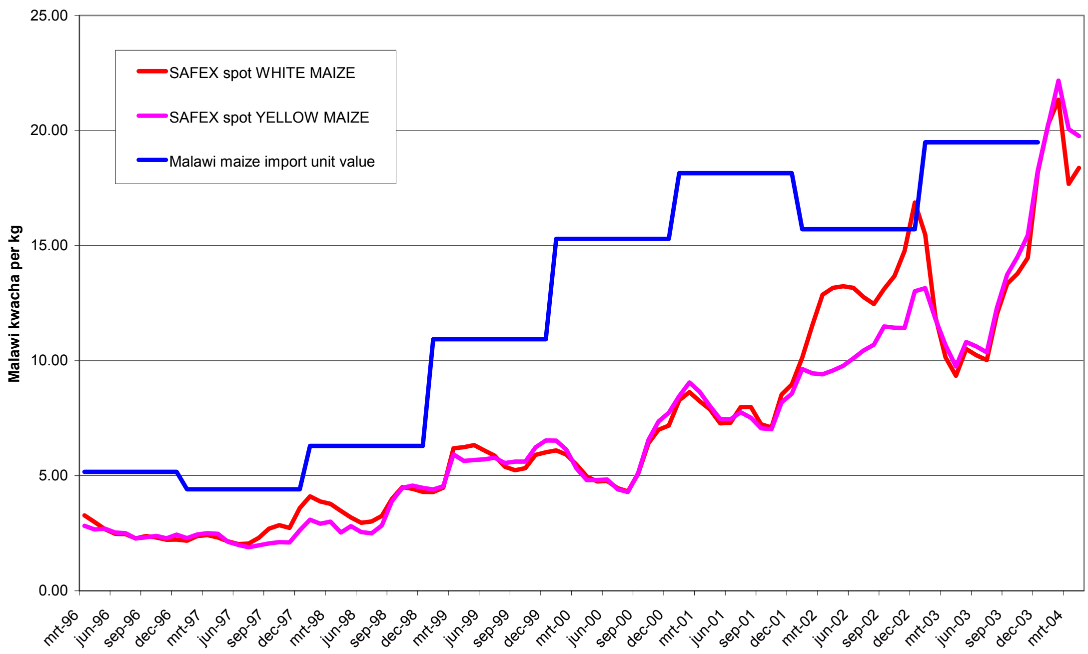
Source: SAFEX, NSO and MoAI, 2004

Figure 18c Maize prices: domestic, international and import



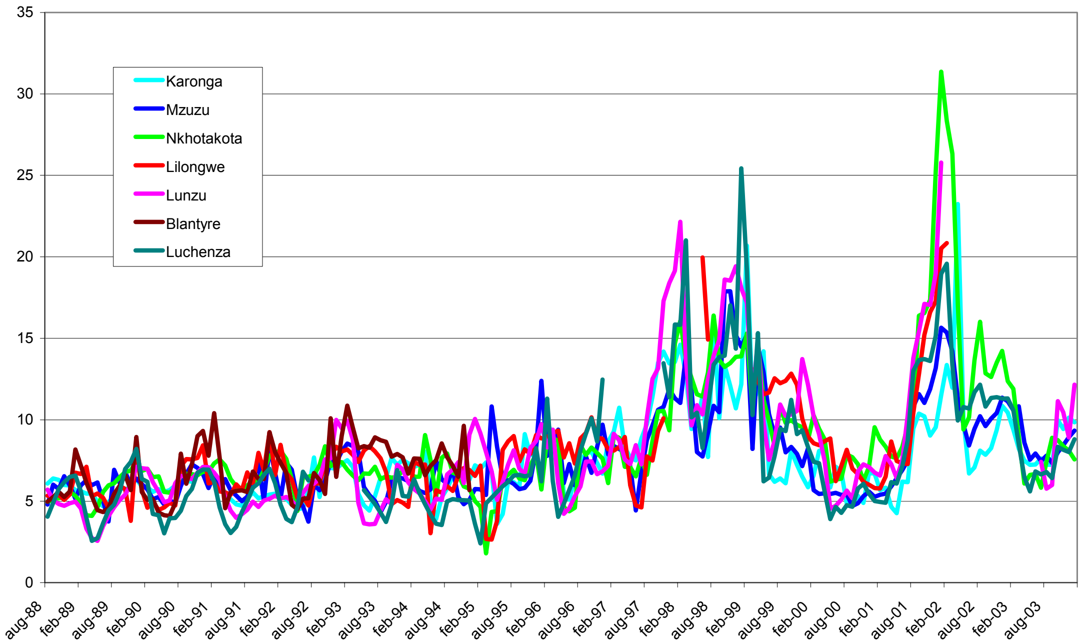
Source: SAFEX, NSO and MoAI, 2004

Figure 18d Maize prices: domestic, international and import



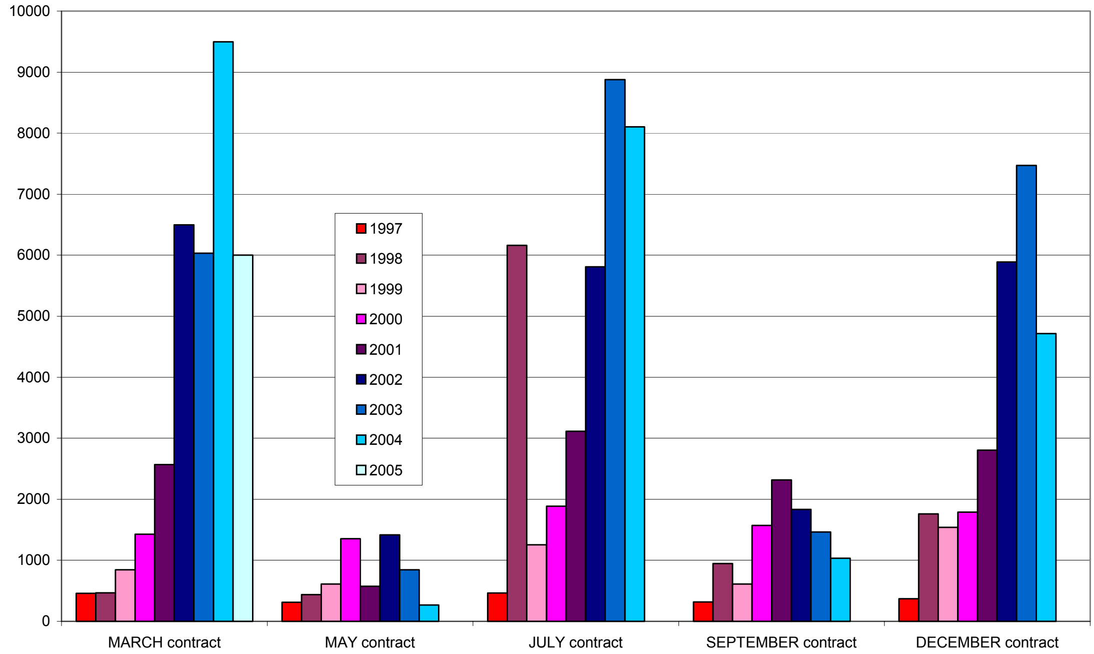
Source: SAFEX and FAOSTAT data, 2004

Figure 19 Malawi domestic real maize prices (2000=100)



Source: National Statistical Office and Ministry of Agriculture and Irrigation, 2004

Figure 20 SAFEX white maize futures contract: open interest per contract, averaged over trading days



Source: SAFEX

Figure 21 SAFEX & CBOT nearby white maize and corn futures quotations

Source: SAFEX, CBOT

Figure 22 SAFEX daily volatility of white maize futures

Source: SAFEX

Figure 23 Benefits of hedging Malawi maize import costs futures hedge, SAFEX December contract, fixed quantity

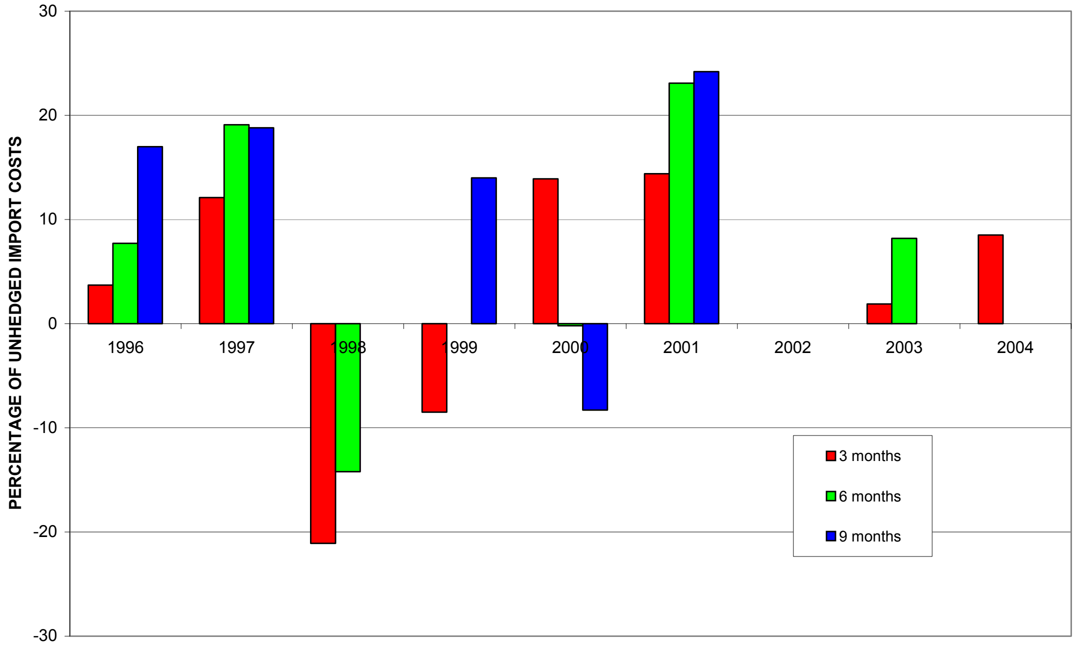


Figure 24 Benefits of hedging Malawi maize import costs futures hedge, SAFEX July contract, fixed quantity

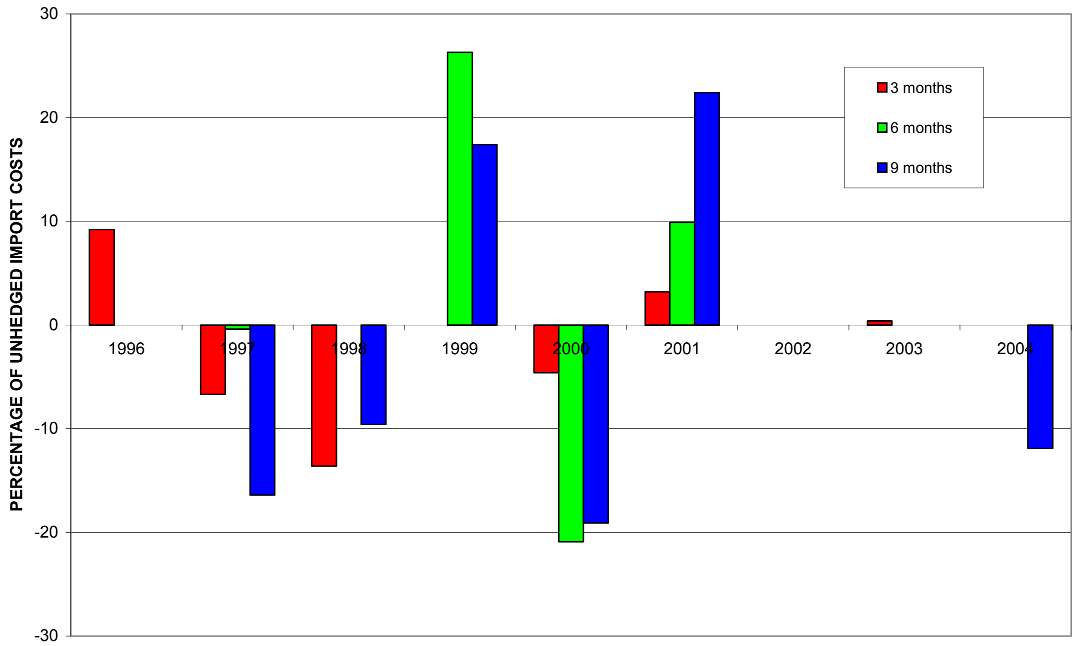


Figure 25 Benefits of hedging Malawi maize import costs
futures hedge, SAFEX December contract, realised imports

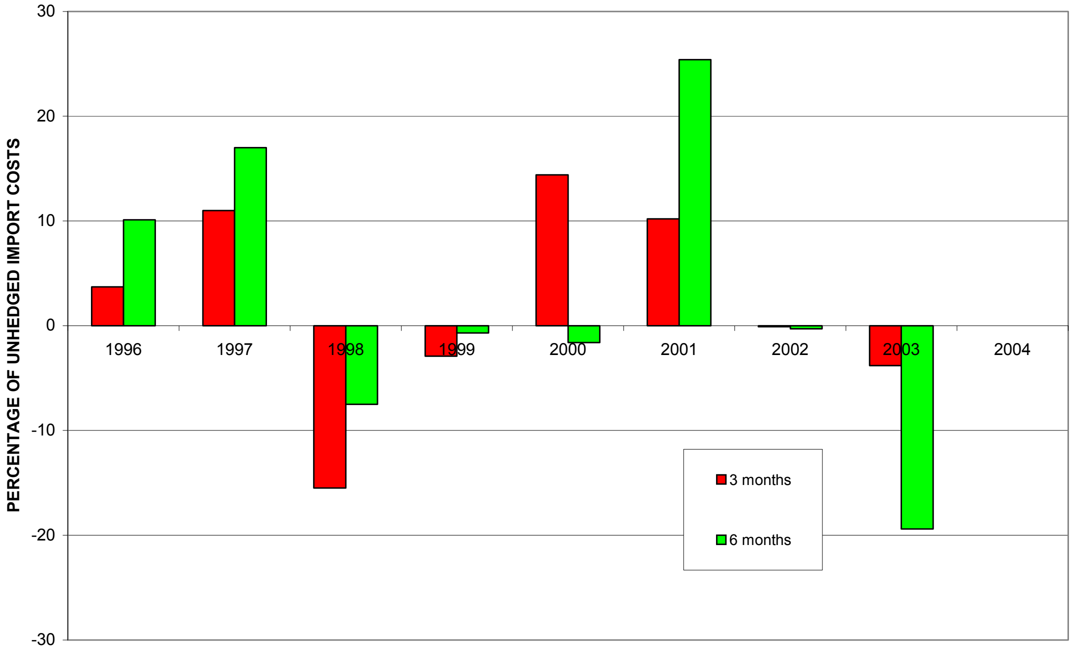


Figure 26 Benefits of hedging Malawi maize import costs
option hedge, option on SAFEX December futures, fixed quantity, strike price: +5 percent

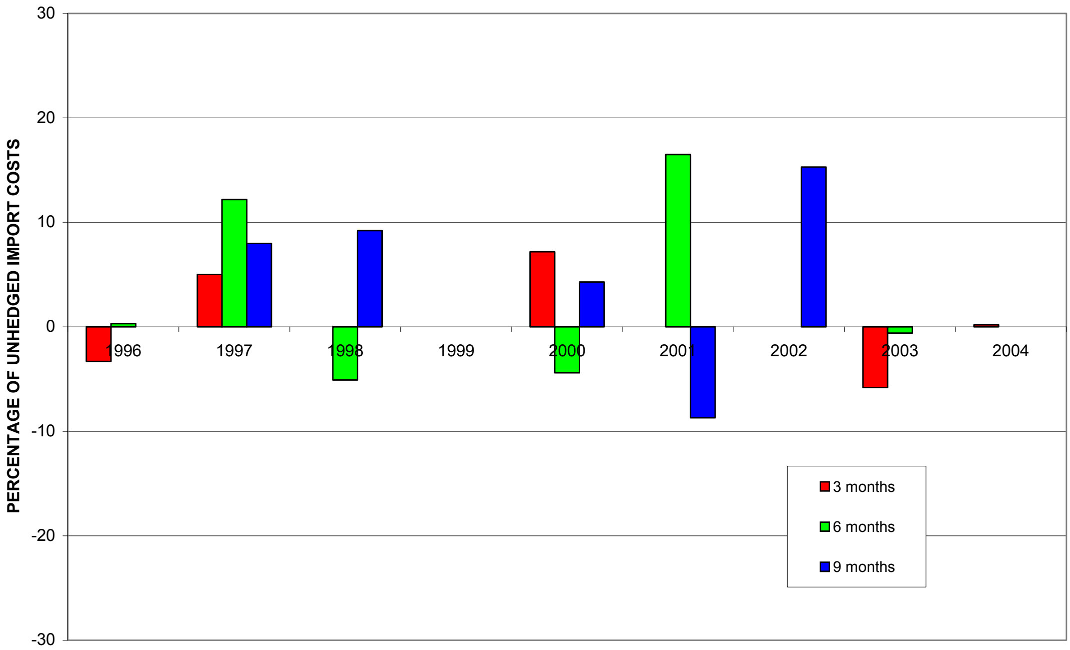


Figure 27 Benefits of hedging Malawi maize import costs
option hedge, option on SAFEX December futures, fixed quantity, strike price: 0 percent

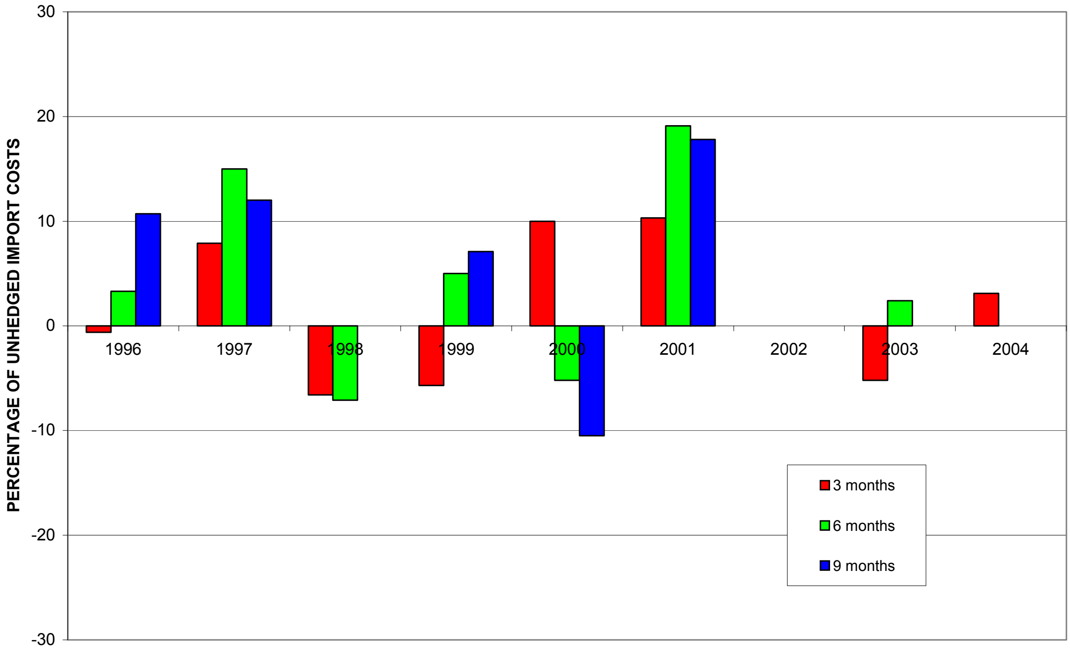


Figure 28 Benefits of hedging Malawi maize import costs
option hedge, option on SAFEX July futures, fixed quantity, strike price:+5 percent

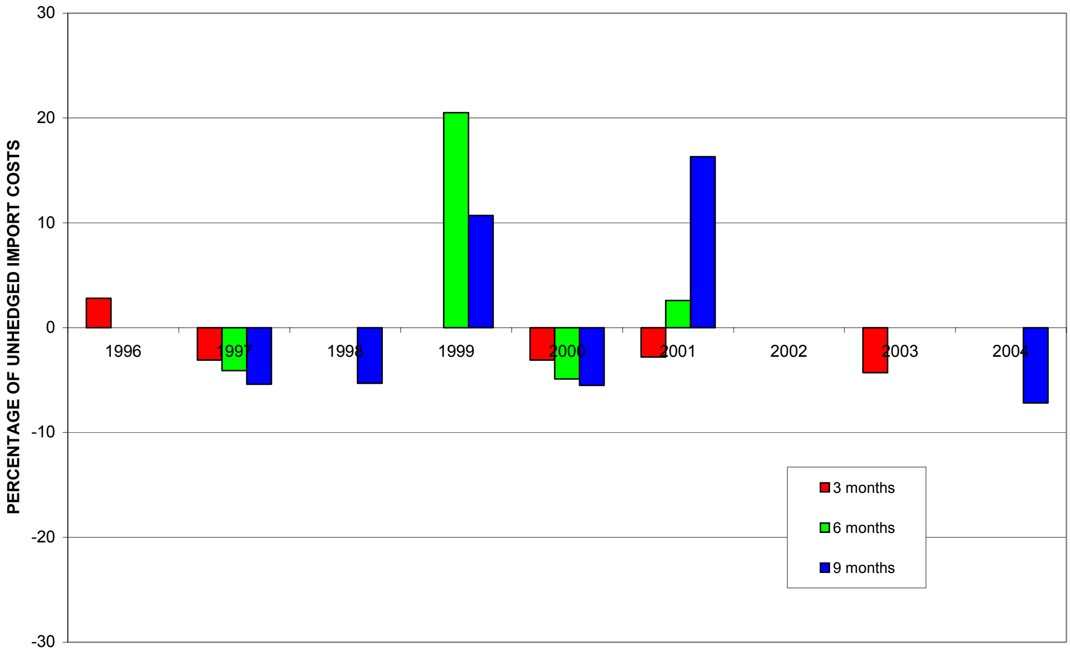


Figure 29 Benefits of hedging Malawi maize import costs
option hedge, option on SAFEX July futures, fixed quantity, strike price:+0 percent

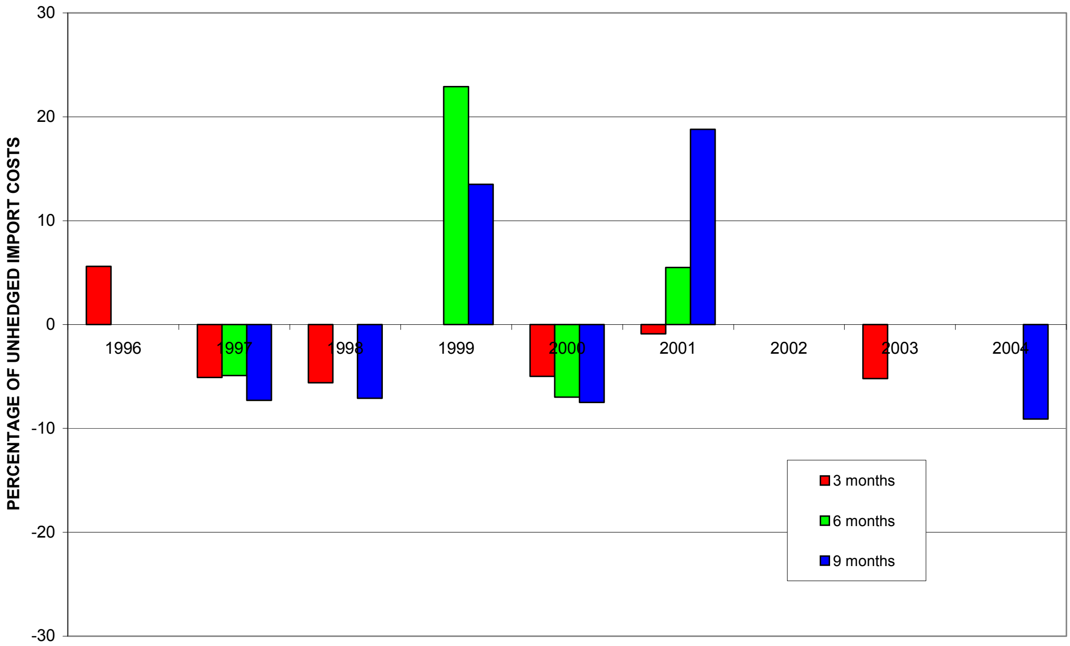


Figure 30 Benefits of hedging Malawi maize import costs
option hedge, option on SAFEX December futures, realised imports, strike price:+5 percent

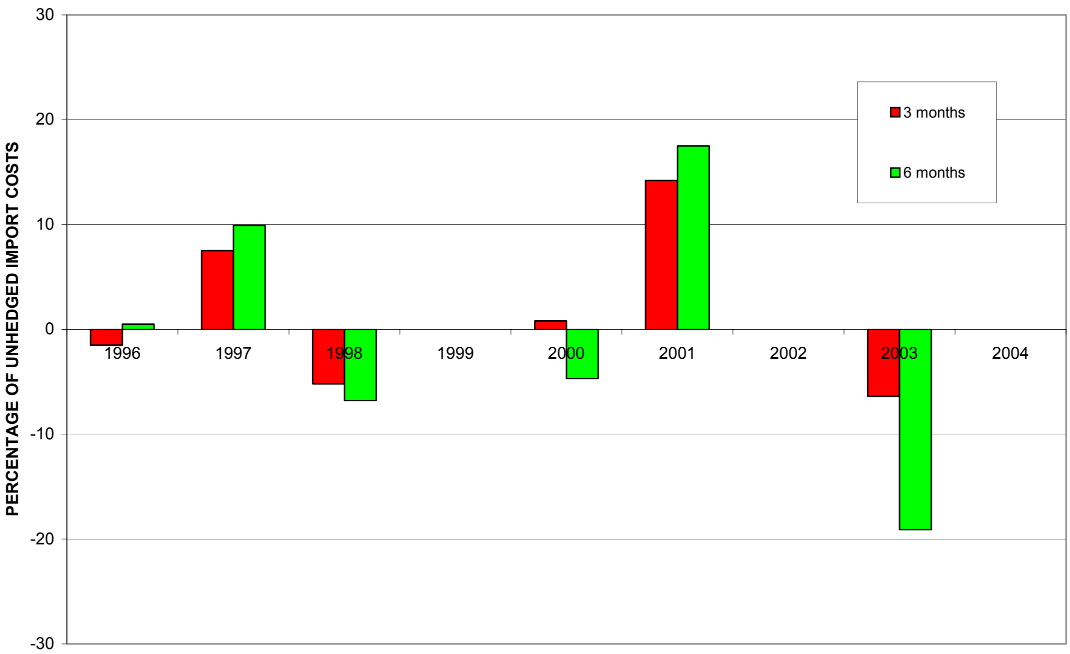


Figure 31 Benefits of hedging Malawi maize import costs
option hedge, option on SAFEX December futures, realised imports, strike price:+0 percent

TABLES

Table 1 Daily per capita dietary energy supply and percent share of undernourished

	1990-1992	1995-1997	2000-2002	1990-1992	1995-1997	2000-2002
Malawi	1 881	2 038	2 155	50	40	33
Mozambique	1 735	1 854	2 033	66	58	47
South Africa	2 827	2 801	2 917	na	na	na
Tanzania	2 050	1 875	1 959	37	50	44
Zambia	1 929	1 922	1 904	48	48	49
Zimbabwe	1 975	1 963	2 024	45	47	44

Source: FAOSTAT data, 2004 and FAO, 2004

Table 2 Gross domestic requirement for cereals and starchy roots in 1000 tonnes

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Maize	1 776	1 820	1 871	1 922	1 971	2 015	2 058	2 098	2 140
Wheat	87	90	92	95	97	99	101	103	105
Cassava	830	851	875	899	921	942	962	981	1 001
Potatoes	1 231	1 262	1 297	1 333	1 366	1 397	1 426	1 454	1 484

Table 3 Daily per capita caloric contribution of production of maize, cassava and sweet potatoes

	2001/2002	2002/2003	2003/2004
Northern region	2 888.7	1 930.7	2 307.1
Central region	1 767.7	1 814.5	1 523.1
Southern region	1 538.1	1 561.3	1 052.1

Source: own calculations

Table 4 Malawi imports of cereals by country of origin (percent)

	1990	1991	1994	1995	1999	2000	2001	2002	2003
Botswana						5.6	0.0	0.0	0.0
Kenya	0.1	0.1	0.0				0.3	1.8	
Mozambique			4.4	30.7	2.1	5.6	6.8	34.1	18.3
Swaziland							0.4		0.1
Tanzania			0.0	2.3	0.1	1.1	0.1	0.1	12.1
Zambia			14.9	4.9	2.8	2.8	2.2	1.0	9.5
Zimbabwe	21.7	28.0	39.0	27.2	46.2	19.3	4.4	1.9	0.9
SADC*	**21.8**	**28.1**	**58.4**	**65.1**	**51.2**	**34.4**	**14.2**	**38.9**	**40.9**
South Africa	49.9	36.3	4.5	14.0	37.6	36.4	55.9	32.1	21.8
SADC & South Africa**	**71.7**	**64.4**	**62.8**	**79.1**	**88.8**	**70.9**	**70.0**	**71.0**	**62.7**
United States & Canada	3.4	0.0	10.3	8.0		3.4	2.2	13.9	11.9
Europe	24.6	21.1	23.9	11.1	6.7	16.6	3.8	12.0	11.4
Australia		13.2			1.7		0.1	0.6	1.7
Argentina							21.6		
Other countries	0.2	1.3	3.0	1.8	2.8	9.2	2.3	2.6	12.3

Source: UNSD Comtrade Database; based on trade values reported by Malawi.
(SADC = Southern Africa Development Community; SA = South Africa)

Table 5 Malawi imports of maize by country of origin

	1990	1991	1994	1995	1999	2001	2002	2003
Botswana							0.1	0.0
Kenya							2.3	
Mozambique			6.6	45.7	9.7	27.7	37.6	12.1
Swaziland								0.3
Tanzania				3.7		0.4	0.1	31.4
Zambia			22.6	8.0	10.0	2.9	1.0	3.2
Zimbabwe	86.1	36.9	55.0	41.6	60.5	0.5	0.5	0.1
SADC*	**86.1**	**36.9**	**84.3**	**99.0**	**80.2**	**31.5**	**41.6**	**47.2**
South Africa	0.1	0.3		0.0	19.8	48.4	26.9	12.8
SADC & South Africa**	**86.2**	**37.2**	**84.3**	**99.0**	**100.0**	**79.9**	**68.5**	**60.0**
United States & Canada	13.8		15.7	1.0		18.3	17.4	19.0
Europe		56.2				1.8	14.2	6.0
Other countries		6.6	0.0			0.0	0.0	15.0

Source: UNSD Comtrade Database; based on trade values reported by Malawi.

Table 6 Correlation between domestic and international maize prices[1]

	Sample period: March 1996 – March 2004: Malawi domestic maize prices					SAFEX	
	Mzu	**Nkh**	**Lil**	**Lun**	**Luc**	**White**	**Yellow**
Karonga	0.152	0.214	0.015	0.251	0.172	0.045	0.028
Mzuzu		0.190	0.202	0.183	0.275	0.119	0.164
Nkhotakota			0.109	0.297	0.242	0.109	0.074
Lilongwe				0.177	0.129	0.040	0.019
Lunzu					0.425	0.188	0.160
Luchenza						0.065	0.074

Source: own calculations.

[1] We transformed all prices in first difference of natural logarithms. Then we regressed price of region i, on current price of another region (or current SAFEX spot price) and a one period lagged price (of the other region). The table reports the R2 of this exercise. Testing the integration of markets is often implemented on the basis of cointegration tests. Analysis along these lines is possible but beyond the scope of this study (see e.g. for recent work in this field Baffes et al., 2003). For the moment we have preferred to run the above alternative.

Table 7 Seasonality in Malawi domestic maize prices

	Negative impact					Positive impact		
	March	**April**	**May**	**June**	**July**	**Dec**	**Jan**	**Feb**
Karonga			-0.148	-0.16			0.115	0.141
Mzuzu			-0.104	-0.112	-0.119	0.089		
Nkhotakota			-0.141		-0.221			
Lilongwe			-0.185					
Lunzu		-0.185	-0.256					
Blantyre		-0.205						
Luchenza	-0.182	-0.256	-0.276					

Source: own calculations.

Table 8 Testing for the order of integration (Dickey Fuller test)

	Test statistic	1 percent critical value	5 percent critical value	10 percent critical value
P_{Malawi}	-2.103	-3.682	-2.972	-2.618
$P_{SouthAfrica}$	-1.694	-3.634	-2.952	-2.610
ΔP_{Malawi}	-9.642	-3.696	-2.978	-2.620
$\Delta P_{SouthAfrica}$	-6.080	-3.641	-2.955	-2.611

Table 9 Potential annual imports of maize (x 1000 tonnes)

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gross domestic requirement (1)	1 776	1 820	1 871	1 922	1 971	2 015	2 058	2 098	2 140
Minimum domestic production (2)*	1 167 (7.9)	1 232 (8.1)	1 297 (8.3)	1 362 (8.5)	1 426 (8.7)	1 490 (8.9)	1 554 (9.1)	1 617 (9.2)	1 680 (9.4)
Potential imports (1)-(2)*	609 (4.1)	588 (3.9)	574 (3.7))	561 (3.5)	545 (3.3)	525 (3.1)	504 (2.9)	481 (2.8)	460 (2.6)
Observed maximum imports 1996-2003*	320 (2.2)	320 (2.1)	320 (2.1)	320 (2.0)	320 (1.9)	320 (1.9)	320 (1.9)	320 (1.8)	320 (1.8)

* in brackets the number of months of maize consumption that corresponds with the quantity.

Table 10a Hedging Malawi maize imports with SAFEX futures[1]
(December contract, fixed volume, settlement 31/10)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	131	131	148	163	112	193		176	185
(x10e6 South African rand)	NH	136	149	122	150	130	226	361	179	202
Unit cost of maize imports	H	655	655	739	814	560	967		879	926
(South African rand / kg)	NH	680	745	610	750	650	1130	1806	896	1012
Benefit of hedging (in percent)*		3.7	12.1	-21.1	-8.5	13.9	14.4		1.9	8.5
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	125	120	139		130	174		164	
(x10e6 South African rand)	NH	136	149	122	150	130	226	361	179	202
Unit cost of maize imports	H	627	602	696		651	868		822	
(South African rand / kg)	NH	680	745	610	750	650	1130	1806	896	1012
Benefit of hedging (in percent)		7.7	19.1	-14.2		-0.2	23.1		8.2	
9 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	113	121		129	141	171			
(x10e6 South African rand)	NH	136	149	122	150	130	226	361	179	202
Unit cost of maize imports	H	564	605		645	704	856			
(South African rand / kg)	NH	680	745	610	750	650	1130	1806	896	1012
Benefit of hedging (in percent)		17.0	18.8		14.0	-8.3	24.2			

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging
The simulation results are also presented in graphical form: see Figures 23 to 31.

Table 10b Hedging Malawi maize imports with SAFEX futures (July contract, fixed volume, settlement: 30/6)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	125	124	145		121	160		165	
(x10e6 South African rand)	NH	138	116	128	171	115	166	353	166	185
Unit cost of maize imports	H	627	619	727		604	802		826	
(South African rand/kg)	NH	690	580	640	854	577	828	1767	829	925
Benefit of hedging (in percent)*		9.2	-6.7	-13.6		-4.6	3.2		0.4	
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	Na	116		126	139	149			
(x10e6 South African rand)	NH	138	116	128	171	115	166	353	166	185
Unit cost of maize imports	H	Na	582		629	697	746			
(South African rand / kg)	NH	690	580	640	854	577	828	1767	829	925
Benefit of hedging (in percent)		Na	-0.4		26.3	-20.9	9.9			
9 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	Na	135	140	141	137	128			207
(x10e6 South African rand)	NH	138	116	128	171	115	166	353	166	185
Unit cost of maize imports	H	Na	675	701	705	687	642			1035
(South African rand/kg)	NH	690	580	640	854	577	828	1767	829	925
Benefit of hedging (in percent)		Na	-16.4	-9.6	17.4	-19.1	22.4			-11.9

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 10c Hedging Malawi maize imports with SAFEX futures (December contract, realised imports, settlement 31/10)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
Total Import Cost	H	116	96	216	93	41	161	538	53
(x10e6 South African rand)	NH	120	108	187	91	48	179	537	51
Unit cost of maize imports	H	658	630	696	776	567	1025	1764	931
(South African rand / kg)	NH	684	707	602	754	662	1142	1761	897
Benefit of hedging (in percent)*		3.7	11.0	-15.5	-2.9	14.4	10.2	-0.1	-3.8
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
Total Import Cost	H	75	82	200	91	49	134	539	60
(x10e6 South African rand)	NH	83	99	186	91	48	179	537	51
Unit cost of maize imports	H	606	597	647	759	672	851	1766	1071
(South African rand / kg)	NH	674	720	602	754	662	1142	1761	897
Benefit of hedging (in percent)		10.1	17.0	-7.5	-0.7	-1.6	25.4	-0.3	-19.4

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 11a Hedging Malawi maize imports with SAFEX call options
(options on December futures, strike price +5 percent, fixed vol., exercise 31/10)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	140.5	141.6			120.6			189.6	202.0
(x10e6 South African rand)	NH	136.0	149.0	122.0	150.0	130.0	226.0	361.2	179.2	202.4
Unit cost of maize imports	H	702.4	707.9			603.2			947.9	1010
(South African rand / kg)	NH	680.0	745.0	610.0	750.0	650.0	1130	1806	896.0	1012
Benefit of hedging (in percent)*		-3.3	5.0			7.2			-5.8	0.2
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	135.6	130.8	128.3		135.8	188.6		180.3	
(x10e6 South African rand)	NH	136.0	149.0	122.0	150.0	130.0	226.0	361.2	179.2	202.4
Unit cost of maize imports	H	678.1	654.1	641.3		678.9	943.0		901.4	
(South African rand / kg)	NH	680.0	745.0	610.0	750.0	650.0	1130	1806	896.0	1012
Benefit of hedging (in percent)		0.3	12.2	-5.1		-4.4	16.5		-0.6	
9 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	125.1	135.3		143.6	141.3	191.5			
(x10e6 South African rand)	NH	136.0	149.0	122.0	150.0	130.0	226.0	361.2	179.2	202.4
Unit cost of maize imports	H	625.7	676.7		718.0	706.6	957.5			
(South African rand / kg)	NH	680.0	745.0	610.0	750.0	650.0	1130	1806	896.0	1012
Benefit of hedging (in percent)		8.0	9.2		4.3	-8.7	15.3			

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 11b Hedging Malawi maize imports with SAFEX call options
(options on July futures, strike price +5 percent, fixed volume, exercise 30/6)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	134.1	119.6			118.9	170.3		172.9	
(x10e6 South African rand)	NH	138.0	116.0	128.0	170.8	115.4	165.6	353.4	165.8	185.0
Unit cost of maize imports	H	670.7	598.1			594.7	851.5		864.3	
(South African rand / kg)	NH	690.0	580.0	640.0	854.0	577.0	828.0	1767	829.0	925.0
Benefit of hedging (in percent)*		2.8	-3.1			-3.1	-2.8		-4.3	
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H		120.7		135.7	121.1	161.3			
(x10e6 South African rand)	NH		116.0	128.0	170.8	115.4	165.6	353.4	165.8	185.0
Unit cost of maize imports	H		603.7		678.7	605.4	806.4			
(South African rand / kg)	NH		580.0	640.0	854.0	577.0	828.0	1767	829.0	925.0
Benefit of hedging (in percent)			-4.1		20.5	-4.9	2.6			
9 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H		122.3	134.8	152.5	121.8	138.7			198.4
(x10e6 South African rand)	NH		116.0	128.0	170.8	115.4	165.6	353.4	165.8	185.0
Unit cost of maize imports	H		611.4	673.8	762.6	609.0	693.4			991.8
(South African rand / kg)	NH		580.0	640.0	854.0	577.0	828.0	1767	829.0	925.0
Benefit of hedging (in percent)			-5.4	-5.3	10.7	-5.5	16.3			-7.2

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 11c Hedging Malawi maize imports with SAFEX call options
(options on December futures, strike price 0 percent, fixed vol., exercise 31/10)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	136.9	137.2	130.0	158.6	117.0	202.7		188.5	196.2
(x10e6 South African rand)	NH	136.0	149.0	122.0	150.0	130.0	226.0	361.2	179.2	202.4
Unit cost of maize imports	H	684.3	686.1	650.1	792.9	585.1	1014		942.4	980.8
(South African rand / kg)	NH	680.0	745.0	610.0	750.0	650.0	1130	1806	896.0	1012
Benefit of hedging (in percent)*		-0.6	7.9	-6.6	-5.7	10.0	10.3		-5.2	3.1
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	131.5	126.7	130.7		136.8	182.8		174.9	
(x10e6 South African rand)	NH	136.0	149.0	122.0	150.0	130.0	226.0	361.2	179.2	202.4
Unit cost of maize imports	H	657.7	633.3	653.4		684.1	914.2		874.3	
(South African rand / kg)	NH	680.0	745.0	610.0	750.0	650.0	1130	1806	896.0	1012
Benefit of hedging (in percent)		3.3	15.0	-7.1	5	-5.2	19.1		2.4	
9 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	121.4	131.1		139.3	143.6	185.7			
(x10e6 South African rand)	NH	136.0	149.0	122.0	150.0	130.0	226.0	361.2	179.2	202.4
Unit cost of maize imports	H	607.1	655.4		696.4	718.1	928.5			
(South African rand / kg)	NH	680.0	745.0	610.0	750.0	650.0	1130	1806	896.0	1012
Benefit of hedging (in percent)		10.7	12.0		7.1	-10.5	17.8			

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 11d Hedging Malawi maize imports with SAFEX call options
(options on July futures, strike price 0 percent, fixed volume, exercise: 30/6)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H	130.3	121.9	135.2		121.2	167.1		174.4	
(x10e6 South African rand)	NH	138.0	116.0	128.0	170.8	115.4	165.6	353.4	165.8	185.0
Unit cost of maize imports	H	651.5	609.6	675.9		605.9	835.4		872.0	
(South African rand / kg)	NH	690.0	580.0	640.0	854.0	577.0	828.0	1767	829.0	925.0
Benefit of hedging (in percent)*		5.6	-5.1	-5.6		-5.0	-0.9		-5.2	
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H		121.7		131.7	123.5	156.5			
(x10e6 South African rand)	NH		116.0	128.0	170.8	115.4	165.6	353.4	165.8	185.0
Unit cost of maize imports	H		608.7		658.5	617.4	782.3			
(South African rand / kg)	NH		580.0	640.0	854.0	577.0	828.0	1767	829.0	925.0
Benefit of hedging (in percent)			-4.9		22.9	-7.0	5.5			
9 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**
Total Import Cost	H		124.4	137.1	147.8	124.0	134.4			201.8
(x10e6 South African rand)	NH		116.0	128.0	170.8	115.4	165.6	353.4	165.8	185.0
Unit cost of maize imports	H		622.2	685.4	739.1	620.0	672.1			1009
(South African rand / kg)	NH		580.0	640.0	854.0	577.0	828.0	1767	829.0	925.0
Benefit of hedging (in percent)			-7.3	-7.1	13.5	-7.5	18.8			-9.1

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 11e Hedging Malawi maize imports with SAFEX call options (options on December futures, strike price 5 percent, realised imports)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
Total Import Cost	H	122.0	100.2	196.4	90.7	47.4	153.9	537.4	53.9
(x10e6 South African rand)	NH	120.3	108.3	186.6	90.7	47.8	179.4	537.4	50.7
Unit cost of maize imports	H	693.8	654.0	633.8	754.1	656.7	979.7	1761	953.9
(South African rand / kg)	NH	683.8	707.2	602.4	754.1	661.8	1142	1761	896.9
Benefit of hedging (in percent)*		-1.5	7.5	-5.2	0.0	0.8	14.2	0.0	-6.4
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
Total Import Cost	H	82.6	89.2	198.4	90.7	50.0	148.0	537.4	60.3
(x10e6 South African rand)	NH	83.0	98.9	185.7	90.7	47.8	179.4	537.4	50.7
Unit cost of maize imports	H	670.8	648.7	643.4	754.1	692.7	942.3	1761	1068
(South African rand / kg)	NH	674.2	719.7	602.1	754.1	661.8	1142	1761	896.9
Benefit of hedging (in percent)		0.5	9.9	-6.8	0.0	-4.7	17.5	0.0	-19.1

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

Table 11f Hedging Malawi maize imports with SAFEX call options (options on December futures, strike price 0 percent, realised imports)

3 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
Total Import Cost	H	119.0	98.0	200.6	90.7	47.4	150.5	537.4	52.8
(x10e6 South African rand)	NH	120.3	108.3	186.6	90.7	47.8	179.4	537.4	50.7
Unit cost of maize imports	H	676.4	639.9	647.6	754.1	656.8	958.1	1761	934.7
(South African rand / kg)	NH	683.8	707.2	602.4	754.1	661.8	1142	1761	896.9
Benefit of hedging (in percent)*		1.1	9.5	-7.5	0.0	0.7	16.1	0.0	-4.2
6 months hedge		**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
Total Import Cost	H	80.1	86.4	202.1	90.7	50.5	143.4	537.4	59.2
(x10e6 South African rand)	NH	83.0	98.9	185.7	90.7	47.8	179.4	537.4	50.7
Unit cost of maize imports	H	650.6	628.2	655.3	754.1	699.4	912.6	1761	1049
(South African rand / kg)	NH	674.2	719.7	602.1	754.1	661.8	1142	1761	896.9
Benefit of hedging (in percent)		3.5	12.7	-8.8	0.0	-5.7	20.1	0.0	-16.9

H = hedged, NH = not hedged; * reduction of import costs divided by import cost without hedging

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