

**MODELLING THE IMPACTS OF MACRO-
ECONOMIC POLICIES ON THE SOUTH
AFRICAN AGRICULTURAL SECTOR**

by

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ABSTRACT

This study analyses the importance of macro-economic policies and other macro-economic variables on South African agricultural performance. Following the liberalization of the South African economy, the democratisation of the political environment, and the deregulation of the agricultural sector, macro-economic policies and variables have had a much more direct effect on the financial position of the agricultural sector. In the absence of government intervention, agricultural output prices are determined in the international market, and this may lead to uncertainty in the prices received by farmers for agricultural products.

Macro-economic policies that are thought to influence agricultural performance include monetary, fiscal, exchange rate and trade policies. These macro-economic policies are represented by government expenditure, money supply, real exchange rate, gross domestic product, and degree of openness. The study applies an equilibrium exchange rate and error correction model methodology to estimate exchange rate misalignment, and further extends the model to measure the impacts of exchange rate and other macroeconomic variables on the relative agricultural prices. Quarterly data between January 1988 and April 2002 are used in the estimation. The model is estimated using the Eviews statistical package.

The results show that terms of trade and government expenditure are positively related to the real exchange rate. A one percent increase in terms of trade will lead to 0.729 percent appreciation in the exchange rate in the long run. The degree of openness of the economy is also positively related to the real exchange rate (RER), and the RER appreciates by 0.555 percent in response to a 1 percent increase in the degree of openness. The technological and productivity improvement variable was found to be statistically insignificant. The speed of adjustment of the real exchange rate towards equilibrium is slow, namely, 17 percent. The results of the equilibrium exchange rate indicate that the exchange rate was overvalued between 1989 and 1998, while between 2001 and 2002 the exchange rate was undervalued.

The results also indicate that the relative agriculture prices are negatively affected by the appreciation of the effective exchange rate. A one percent increase in the actual real exchange rate leads to a 0.34 percent decline in the relative prices of agriculture. The degree of openness in the South African economy and the gross domestic product (GDP) were found to be insignificant. Most importantly, a one percent rise in money supply is associated with a 1.189 percent decline in the relative prices of agriculture in the long run. This implies that an increase in the real exchange rate and in money supply lead to a reduction of the relative prices of agriculture. The speed of adjustment of the relative prices of agriculture towards equilibrium is fairly fast at more than 0.36.

An increase in money supply and real exchange rate will result in lower agricultural prices in South Africa, thereby reducing the profitability of farms. The degree of openness and income does not appear to have any effect on the prices. This implies that the integration of the South African economy into world markets will not significantly affect domestic farmers.

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CHAPTER 1

INTRODUCTION

1.1 Background

Following the liberalisation of the South African economy, the democratisation of the political environment and the deregulation of the agricultural sector, macro-economic policies and other macro-economic variables have had a much more direct effect on the financial position of the agricultural sector than was the case before. Agricultural output prices are critical for the financial position of the agricultural sector. Currently these are determined, however, by international market forces, which lead to price uncertainty. In addition, the opening up of the South African economy has most likely increased foreign competition. So far, the empirical impact of the new macro-economic environment on the agricultural sector in South Africa has not yet been the subject of many studies.

Relative agricultural prices are affected by macroeconomic policies such as trade, and fiscal and monetary policies as they are implemented by government. These macro-economic policies will either influence relative agricultural prices positively or negatively. This study aims to investigate the determinants of the real exchange rate, and, furthermore, will look into how macro-economic policies affect the relative agricultural prices.

According to Vink (1993), the deregulation and liberalisation of the South African agricultural sector have their origins in the financial sector rather than in the agricultural sector itself. The liberalisation of the monetary policy by the South African Reserve Bank (SARB) following the De Kock Report (1985) led to the removal of subsidies on the interest rate, and this, subsequently, led to a decline in capital acquisition. In the past the interest rate on capital was subsidised to enable farmers to substitute capital for labour (Van Zyl and Fenyes, 1987). The liberalisation of the monetary policy coincided with changes in the exchange rate regimes. Townsend (1996) has summarised the various exchange rate regimes in South Africa as follows: fixed exchange rate (1947-1971), pegged exchange rate (1971-1978), and

managed floating exchange rate (1979-1994). From 1996 onwards demand and supply and a range of international factors have determined the exchange rate. Townsend has provided a number of reasons for the changes in the exchange rate regimes, such as protection of gold (1979-1988), the stimulation of exports, the reduction of inflation (1988-1994), and, lastly, to compliance with the free trade policy agenda (from 1996 onwards).

The agricultural sector in South Africa is known to be capital intensive (Van Zyl and Fenyes, 1987) and any changes in the exchange rate will, therefore, impact on the cost of capital in the agricultural sector. The ratio capital to labour has increased over the years, as will be shown in the study. Evidence of the deregulation in the agricultural sector can be found in the removal of price controls on a number of agricultural food products in early 1980s (Kirsten and van Zyl, 1996). During the middle of the 1990s, agricultural marketing schemes were abolished, thus introducing a free and deregulated marketing environment for the agricultural sector. The abolishment of the agricultural marketing schemes meant, however, that from then farmers faced price uncertainty.

In addition to the deregulation of the domestic agricultural marketing, the agricultural sector witnessed a process of trade liberalisation. Trade liberalisation in the agricultural sector took the form of tariffication of quantitative restrictions followed by reduction in the number of *ad valorem* tariffs (Cassim, 2003). According to Cassim, the process of tariffication of quantitative restrictions began in 1992 and was completed in 1994. After the signing of the Marrakech Agreement, South Africa accelerated trade liberalisation (Vink, Tregurtha, and Kirsten, 2002). The democratisation of the political environment following the 1994 democratic elections, meant that the domestic economy could no longer be treated as a closed sector. South Africa became an active member of the World Trade Organisation and offered further reduction of tariffs (Cassim, 2003).

The re-integration of the domestic economy, including the agricultural sector, into the world markets, the democratisation of the political environment, and the abolishment of marketing schemes brought both uncertainty and opportunities to domestic farmers. Different from before, demand, supply and a range of international factors determine

the prices of most agricultural products. An added factor is that trade liberalisation implies the opening of new markets and, thus, an increase in competition for domestic products. This implies that the financial position and prices of the agricultural sector are directly influenced by macro-economic policies and other macro-economic variables.

The process of trade liberalisation in conjunction with political democratisation led to an increase in openness of the South African economy. Total trade (imports and export) relative to total output, the Gross Domestic Product (GDP), began to rise. The degree of openness in the agricultural sector and in the economy as a whole was 53 percent and 46 percent of the GDP in 1999, respectively, compared to 43 percent and 39 percent in 1994 (National Department of Agriculture (NDA), 2004).

The openness of the domestic economy has strong implications for the real exchange rate and the relative agricultural prices. According to Tweeten (1980), terms of trade for farmers deteriorate (improve) as the rate of inflation increases (declines). The depreciation (appreciation) of the exchange rate will lead to a decrease (increase) in the relative agricultural prices. The decline in the relative agricultural prices will, in turn, have implications for the agricultural productivity and production. The increase in the relative prices of agriculture to non-agricultural products will encourage farmers to increase their production. In addition, money supply (including government expenditure) and trade liberalisation have been recognised to have an effect on agricultural performance. The magnitude of these effects is yet to be determined, however (Lachaal and Womack, 1998).

On the fiscal side, South Africa faced serious problems in the late 1980s and early 1990s (Calitz and Siebrits, 2003). International financial sanctions that had been imposed on South Africa compounded with the political unrest in the country in the late 1980s. The ratio of final consumption expenditure by government to the GDP was 14.49 percent in 1980, which increased to 19.66 and 20.02 percent in 1990 and 1994, respectively. In 2000, this ratio declined to 18.94 percent. At the same time government debt as a percentage of the GDP increased from 35.87 percent in 1980 to 47.65 percent in 2000. In 1996 the government introduced the Growth Employment and Redistribution (GEAR) strategy, which sought to increase economic growth and

reduce unemployment through austere fiscal and monetary policies coupled with trade liberalisation (Calitz and Siebrits, 2003). Hence, from 1996 onwards government has shown restraint as far as expenditure is concerned, which is shown by the decline in the ratio of government expenditure to GDP that took place over the period 1980 to 2000.

Monetary policy in South Africa has undergone great changes over the last two decades. In the 1980s monetary policy was predominantly focused on protecting the value of the Rand and maintaining stability in the financial sector. The focus of the Central Bank in the 1990s changed to fighting inflation to a situation where the domestic currency is determined by demand and supply and other international economic factors. In the 1990s the inflation rate did not go beyond single digits, but in 2001 the Rand lost 30 percent of its value compared to the United States of America (USA) dollar.

The agricultural sector in South Africa remains an important sector in the general economy because of its forward and backward linkages. In 1980 the agricultural sector contributed 6.1 percent to the GDP compared to 4.6 percent in 1990. In the last decade the contribution of agriculture to the GDP has remained below 5 percent, that is, reaching only 4.4 percent in 2000. In 2002 the contribution of agriculture to the GDP was 4.1 percent. According to Poonyth, Hassan, Kirsten, and Calcaterra (2001), a one percent increase in the growth rate of South Africa's agricultural sector will result in the growth of more than one percent in the non-agricultural sector. In addition, Van Rooyen (1998) observed that due to the linkages of the agricultural sector with other sectors of the economy, one percent direct contribution of the agricultural sector to the aggregate GDP activates more than one percent increase in the aggregate GDP. South Africa is a net exporter of most major agricultural products, and as such, it generates a trade balance surplus in the agricultural sector, which can be used to offset a trade balance deficit in the non-farm sector, or it can be used to procure the much needed capital to enhance productivity. However, the contribution of the agricultural sector to the GDP has decreased over time, which is in line with the predictions of development economics theory (Mellor, 1995; Timmer, 1998; Abbott and McCalla, 2002).

Agricultural prices have increased over the past two decades with an index of producer prices of 21.6 recorded in 1980 compared to 178 recorded in 2002. The relative agricultural prices to non-agricultural products have fluctuated over the same period with the highest ratio of 2 recorded in 1980. The relative agricultural prices further declined to 1.38 and 1.23 in 1995 and 2000, respectively (NDA, 2004). The movement towards liberalisation in the domestic agricultural sector began in earnest with the appointment of the Kassier Committee in 1992, which recommended that agricultural marketing schemes be abolished (Bayley, 2000). Thus, prior to the 1994 democratic elections in South Africa, some agricultural marketing schemes had already been deregulated. In 1996, the Agricultural Marketing Act was formulated, which paved the way for the abolishment of the remaining agricultural marketing schemes in 1997.

1.2 Problem statement

As discussed above, the South African agricultural sector has undergone a huge transformation from being a sector that was protected and supported by tariffs, quantitative restrictions and subsidies, to becoming a sector that is fully integrated into the world market and enjoys little or no subsidies. In addition, most macro-economic and trade policies are linked exogenously to the agricultural sector. It follows that these policies are likely to have both direct and indirect effects on the agricultural sector.

Government policies that influence relative price of agriculture include exchange rates, interest rates, and fiscal and monetary policies. Schiff and Valdes (2003) have shown that an appreciation of the real exchange rate, an increase in industrial prices (caused by industrial protection) and a rise in cost of agricultural inputs will lower the relative agricultural prices. Furthermore, in order to measure the aggregate net effect of government policies on agricultural incentives these authors used an index of the ratio of internal to external terms of trade.

With the recent changes in the South African economy it can be expected that macro-economic policies and other macro-economic variables are likely to have more direct effects on the financial position of the agricultural sector. Therefore, it is imperative to

empirically estimate these impacts. Macro-economic policy variables affect the financial position of the agriculture sector through their effect on agricultural input and output prices, as well as its influence on efficiency, and on competitiveness and openness. This study will focus on these impacts on the relative agricultural prices..

1.3 Objectives

The objective of this study is to understand and determine the impacts of macro-economic variables on agricultural prices. More specifically, in this context, the study aims to:

- estimate the extent of exchange rate misalignment in South Africa
- quantify, using parametric methods, the effect of exchange rates, interest rates, fiscal and monetary policies and trade policies on the financial position of the agriculture sector
- provide a theoretical and empirical basis for the tools that are used to analyse macro-economic policies in agriculture.
- suggest policy implications based on the research findings.

1.4 Hypothesis

This section provides the basis for the development of the hypothesis for the study, which is based on previous studies done in South Africa , and on available international literature regarding exchange rate misalignment and relative agricultural prices. Hypotheses are then developed on the possible impact on the relative agricultural prices of changes in the exchange rate and of macro-economic policies

One hypothesis is that the real exchange rate in South Africa is in disequilibria, that is, it is misaligned. The value of the Rand depreciated in 1996, and, again, in 2001. The beginning of 2002 saw the Rand becoming one of the stronger currencies amongst developing countries. The appreciation of the value of the Rand has a negative effect on the relative agricultural prices, though, as, in a globalised world, a stronger currency results in lower export prices..

Another hypothesis is that an expansionary fiscal policy and a high degree of openness of the South African economy will have a negative impact on relative agricultural prices. Since the 1990s South Africa's government has practised a strong fiscal discipline in order to reduce government debt. At the beginning of the 21st century the South African government initiated the expanded public works programme, which intended to increase government expenditure and create much-needed jobs. In the same period, South Africa also reduced its trade barriers..

In the late 1990s South Africa abandoned money supply as a monetary policy tool to control inflation and protect the value of the Rand. The value of the Rand is determined by demand and supply and other international factors, and the interest rate is used as a tool to control inflation. However, money supply contained the same information explained by the interest rate. An expansionary monetary policy is expected to have a positive impact on relative agricultural prices in the short run. The literature reviewed indicates that increases in money supply result in an increase in agricultural prices.

1.5 Importance of the study

This study is intended to make a contribution towards the empirical literature on the macro-economics of agriculture. The results of this study will be useful and valuable to both economic analysts and policy makers in South Africa, as well as other developing countries where economic growth and development depend heavily on agriculture. This study will guide stakeholders involved in agriculture by providing them with valuable information about the possible impacts of macro-economic policies and other macro-economic variables. Due to the recent wave of changes in both agricultural policies and macro-economic policies, an analysis of the impact of macro-economic policies on the South African agricultural sector is much needed. As remarked by Poonyth, Van Zyl and Meyer (2000), globalisation, market liberalisation and regional market integration tend to enhance the need to understand the developments in agricultural commodity markets.

1.6 Methods

In order to estimate the exchange rate misalignment and the impact of macro-economic policies on South African agricultural performance, this study applies a methodology focusing on equilibrium exchange rate and error correction model. The exchange rate model has been widely used in empirical work and this study attempts to adapt the model to the South African economy, and particularly for the agricultural sector (see Asfaha and Huda, 2002; Lachaal and Womack, 1998).

To conduct the analysis, quarterly data over fourteen years, starting in the first quarter of 1988 and ending in the fourth quarter of 2002 are used. The two-step error correction model is used to estimate the exchange rate misalignment. Series analysis such as unit root, co-integration and granger causality will be performed as well. The model was estimated using the Eviews statistical package. The study period was chosen based on the literature (Vink, 1993; Kirsten and Van Zyl, 1996; Cassim, 2003), which indicates that liberalisation of the South African economy began in the early 1980s; while the mid-1990s witnessed the abolishment of agricultural marketing schemes, and South Africa signing the Marrakech Agreement; and towards end of the last decade, the Rand depreciated its value compared to the American dollar.

1.7 Outline of the study

The study is organised into six chapters. Chapter 1 gives the background and rationale to the study. Chapter 2 presents a review of the literature on the linkage between the macro-economy and the agricultural sector. Chapter 3 reviews macroeconomic policies and other macro-economic variables in South Africa. Chapter 4 discusses the methodology focusing on model development and adaptation for the study as well as presents a discussion of parametric techniques used for quantification. This chapter also presents a description of the data used in the analysis. Chapter 5 discusses the empirical results of the study. Finally, Chapter 6 provides a summary and conclusion.

CHAPTER 2

MACRO-ECONOMIC LINKAGES WITH THE AGRICULTURAL SECTOR

2.1 Introduction

The macro-economics of agriculture involves the relationship between the general domestic economy and the domestic agricultural sector, the world economy and the domestic agricultural sector (Knutson, Penn and Barry, 2000). This definition of macro-economics of agriculture shows that the agricultural sector is regarded as integrated with other sectors in the domestic economy and with those in the rest of the world. Schuh (1976), referring to the USA, argues, for instance, that the significant structural changes in the economic environment and the dramatic integration of the domestic market with world markets indicate that the agricultural sector of the USA should no longer be treated as a closed sector.

The impact of the agricultural sector on macro-economic outcomes is known as the feed-back effect, while the impact of macro-economic events on agricultural performance is called feed-forward linkages (Abbott and McCalla, 2002). The relationship between the agricultural sector and the macro-economy and the extent and nature of feed-back and feed-forward linkages change as the economy develops. Agriculture is thought to be particularly important in the early stages of development, and in most developing countries agriculture contributes more than half of the GDP to the economy as a whole (Abbott and McCalla, 2002). The agricultural sector contributes to the economy in terms of growth, employment, fiscal revenue and expenditures, and in terms of foreign exchange earnings. Moreover, with agriculture becoming more modernized and capital intensive, more labour is released to the other sectors of the domestic economy. Also, agricultural products serve as inputs to other sectors of the economy. Comparing mature economies to developing economies, it has been found that mature economies are characterized by the agricultural sector contributing less than 5 percent to either employment or the GDP (Abbott and McCalla, 2002).

Throughout the world, changes in the macro-economic environment are considered to be the main contributors to major economic changes in the agricultural sector (Abbott and McCalla, 2002). Macro-economic policies form part of government policies, and changes in these policies, as well as other macro-economic variables will indirectly affect the agricultural sector (Ardeni and Freebairn, 2002). According to Schiff and Valdes (2002), two key relationships in the analysis of the impact of macro-economic policies are i) the relative price of agricultural to non-agricultural products - also referred to as agricultural incentive -, and ii) the price of tradables to non-tradable goods - known as the real exchange rate.

This Chapter reviews the literature related to the backward and forward linkages between the agricultural sector and the economy as a whole. Section 2.2 and Section 2.3 review the literature related to the contribution of agriculture to the economy, and the literature related to the possible impact of macro-economic policies and other macro-economic variables on the agricultural sector.

2.2 The backward linkages from the agricultural sector to the general economy

The development of most economies has been centred on finding and cultivating a “lead” sector that is capable of serving as an “engine of growth” (Schiff and Valdes, 2002). Industry has been seen as such a sector and in this view agriculture was seen as a provider of primary products required by industrial countries (Schiff and Valdes, 2002; Lewis, 1966; Mellor, 1995). Within this paradigm, the agricultural sector was viewed as a socially and economically backward sector that had no multiplier effects on the economy as a whole (Schiff and Valdes, 2002). Having said this, there is little empirical evidence, however, regarding the strength or extent of the interrelationship between agriculture and the economy as a whole (Schiff and Valdes, 2002).

There are real and monetary links, however, that originate from the contributions of the agricultural sector to the economic performance of the general economy (Ardeni and Freebairn, 2002). While agriculture contributes substantially to the economy, in most developing countries agriculture has been directly or indirectly taxed in order to promote industrialization. Because of their impact on the real exchange rate, import tariffs, for example, represent an implicit tax on agricultural exports. Poor countries

are said to tax agriculture and subsidise industry, while the reverse can be said about rich countries (Hertel, 1999). In evaluating the effects of price support in both developing and developed countries, Anderson (1995), using a small applied general equilibrium (AGE) model, finds that farmers in poor countries who received agricultural price support reaped only one-sixth to one-ninth of the percentage improvement in returns, as compared to farmers in rich countries. As countries grow wealthier, there is a tendency for relative rates of protection to shift (Hertel, 1999).

The profitability of farming activities drops as the relative prices for inputs and outputs adjust to international market prices in contexts where the traditional cushion of credit subsidies and tax concessions is absent (Brooks and Nash, 2002). It follows that it is to be expected that deregulation of agricultural marketing and trade liberalisation will affect domestic agricultural output prices. Policymakers in developed market economies have also experienced difficulty in shifting from protected economies to approaches that are more consistent with a globally integrated agricultural economy (Brooks and Nash, 2002).

2.3 Impact of macro-economic variables on the agricultural sector

This section studies the relationship between macro-economic policies and the agricultural sector. Subsection 2.3.1 defines and analyses the relative agricultural prices and Subsection 2.3.2, discusses the macro-economic variables and policies influencing the agricultural sector.

2.3.1 Analysis of relative agricultural prices

The ability of the agricultural sector to compete for resources domestically and globally is directly affected by economy-wide policies, since through the real exchange rate and the price of non-agricultural tradable activities; these policies have significant effects on relative agricultural prices (Schiff and Valdes, 2002). The relative agricultural prices represent incentives offered by the agricultural sector to the farmers. The prices of agriculture relative to non-agricultural products are calculated as the ratio of the index of agricultural prices to the price of non-tradables (CPI).

Micro-economic theory emphasises the importance of using relative, as opposed to absolute levels of economic variables (Hertel, 1999). Hertel gives the example that a higher tax for agriculture may not discourage agricultural activities if the tax rates for the non-agricultural sector increase more. In this case, the relatively lower taxes for agriculture act like an implicit subsidy because non-agricultural sectors are paying more tax than the agricultural sector does. This is the reason that incentives in the agriculture sector are also compared to incentives in other sectors of the economy. Most studies have taken price of non-agricultural products as a given, however, and have analysed the impact of sectoral or direct policies on agricultural prices (Schiff and Valdes, 2002).

Any intervention by government contributes to greater volatility of agricultural assets relative to the non-agricultural assets (Hertel, 1999). Thus, many agricultural product markets are characterized as flex-price variability or auction markets, in which prices will adjust to equilibrate a situation of fairly inelastic supply and demand (De Janvry and Sadoulet, 1987; Frankel, 1986). On the other hand, the prices of manufactured goods and services are usually thought to be more fixed-price or customer market related (Frankel, 1986). Therefore, although aggregate demand stimuli flow into larger price increases in the short run for agriculture commodity prices than for manufactured prices, these increases in prices are washed-out in the long run due to a high degree of competitiveness and price flexibility of the agricultural sector (Ardeni and Freebairn, 2002; Ruttan, 1979; Penson and Gardener, 1988).

The flex-price of the agricultural product markets leads to what most researchers have called “overshooting” of prices (Dornborsch, 1974; Ardeni and Freebairn, 2002). In developed economies, the impact of overshooting is greater than in developing economies because of large country effects (Abbott and McCalla, 2002). This implies that the impact of overshooting might be more limited for countries that are considered to be smaller, or that are thought of as price takers. In the short run agricultural prices will overshoot upward, and in the long run agricultural prices will overshoot downwards into equilibrium (Frankel, 1986).

Empirical estimates by Tweeten (1980) indicate that a 15 percent increase in the general price level will result in the rise of the index of prices paid by farmers by 1

percent, which, essentially, will leave the prices received by farmers unchanged. According to Starleaf, Meyers and Womack (1985), an unanticipated increase in inflation benefits those people whose money income is flexible, which will be at the expense of those whose money income is fixed. Empirically, Starleaf *et al.* found that a percentage point increase (decrease) in the rate of inflation of prices paid by farmers was systematically associated with a 1.6 percentage point increase (decrease) in the rate of inflation in the prices received by farmers. Discussion in the model will attend to the problem of overshooting by agricultural prices.

2.3.3 The impact of macro-economic policies and other macro-economic variables on agricultural incentives

Agricultural incentives have been defined as the prices of agriculture relative to non-agricultural products (Schiff and Valdes, 2002). A number of analyses have suggested that the indirect effects of economy-wide policies on agricultural incentives have been more profound than the policies that are specifically directed to agriculture.

According to Penson and Gardener (1988), the domestic macro-economic variables that are the most important for agriculture include the rate of inflation, real rate of growth in gross national product, and the interest rate. By the same token Knutson *et al.* (2000) mention that the implications of macro-economic conditions are transmitted to agriculture through four variables, namely, income growth, inflation rate, interest rate and the value of the currency (exchange rate). Government decisions can also affect agriculture directly through sector-specific measures such as tariffs, input and credit subsidies, price controls, quantitative restrictions, and government expenditures and taxes. Indirectly, agricultural incentives are affected by policies such as industrial protection, exchange rates, interest rates and other fiscal and monetary policies (Schiff and Valdes, 2002). These macro-economic variables that influence the agricultural sector are outline in Figure 2.1.

Chambers and Just (1981) and Rausser, Chalfant, Love and Stamoulis (1986) among others, have studied the channels of influence between international macro-economic variables and agricultural sectors. Chambers and Just (1982) have used a structural econometric model to examine the effects of the exchange rate fluctuation on USA's

wheat, corn and soybean markets, and found that exports and agricultural prices are sensitive to movements in the exchange rate. Rausser *et al.* argue that in the absence of government intervention, farmers are faced with an adjustment tax because of the capital intensive nature of agriculture and the dependence on international trade. High interest rates and a strong currency serve as adjustment tax and will lead to decline in agricultural income as well as in the demand for agricultural export.

Gardner (1981) has used an econometric method to examine the effect of macro-economic linkages to agriculture through net farm income in the USA. Gardner finds that an appreciation of exchange rate leads to a 4.3 percent decline in net farm income while the accompanying inflation was found to be insignificant. Gardner then concludes that the significance of macro-economic events for the agricultural sector depends upon what macro-economic variables are most strongly linked to agriculture and how these linkages function.

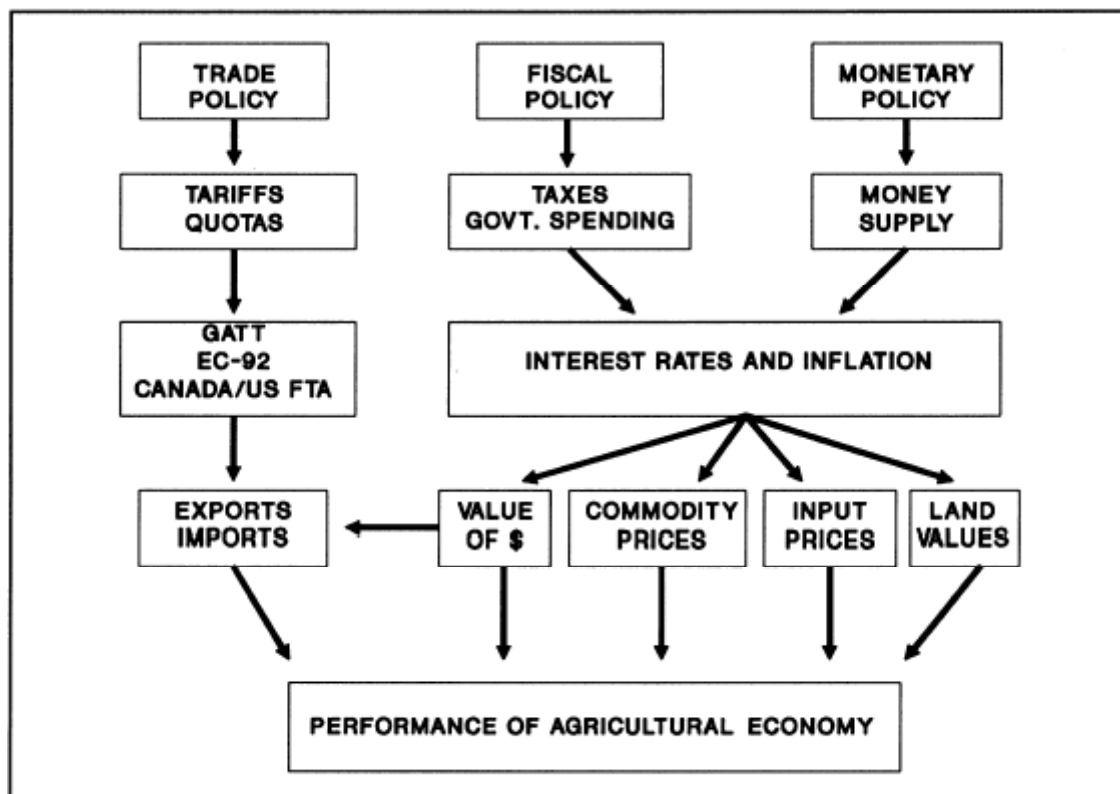


Figure 2.1: Macro-economic policy linkages to agriculture

Source: Snell, Marchant and Infanger. (undated)

The following section discusses the linkages of macro-economic policy to the relative agricultural prices. The macro-economic variables mentioned above and that are considered to influence the agricultural sector are discussed.

2.3.3.1 Exchange rate

Schuh (1974) argues that, with reference to the USA, high exchange rates adversely affected agricultural exports and that the successive devaluations of the US dollar ended the discrimination in economic policy against the agricultural sector. On the same topic, Ardeni and Freebairn (2002) found that low interest rates and low exchange rates in the USA in the 1970s were responsible for good agricultural outcomes; this in comparison with the result of the tight monetary policies of the 1980s.

The real exchange rate (RER) reflects the competitiveness of the tradable sector (Schiff and Valdes, 2002). The factors that result in a shift in the real exchange rate include policy-induced domestic forces (such as changes in technology and productivity) and policy-induced exogenous international forces (such as changes in a country's foreign terms of trade). Terms of trade are defined as the prices of a country's imports relative to its exports.

Dornbosch (1974), Lachaal and Womack (1998), Uribe (2002), Schiff and Valdes (2002) and Coricelli and Jazbec (2003) define RER as the relative price of tradables in terms of non-tradables, whereby the tradables are represented by importables or exportables. The increase in the relative price of non-tradables keeping the price of tradables constant implies that there is deterioration in a country's competitiveness level. In this study, the price of non-tradables will be represented by the consumer price index (CPI) and the price of tradable goods is represented by either the price of imports or the price of exports. Lachaal and Womack (1998) have also used the CPI to represent the price of non-tradables. The data show that the contribution of the non-tradable sector to the GDP is more than 60 percent (NDA, 2004). The non-tradable sector includes the services sector (electricity, gas, water, construction, transport, storage, communication, finance, real estate, business) and the wholesale and retail trade, and the catering and accommodation sector.

Mathematically, Schiff and Valdes (2002) represent RER as follows:

$$RER = \frac{P_T}{P_H}$$

Where P is prices, T is tradable and NT is a non-tradable. The effect of an increase in the RER (depreciation) will be that a country's international competitiveness will improve. In empirical studies, the RER is often proxied as:

$$RER = \frac{E_0 P^*}{P}$$

Where E_0 is the nominal exchange rate, P^* is the foreign price index for tradables and P is the price of non-tradables (in most cases the CPI). Other factors that have an impact on the RER include internal factors such as import and export taxes, quantitative restrictions (QRs), subsidies, exchange rate control measures, and the level and composition of government expenditure. External factors include international prices, international transfers and world interest rates. An increase in the world price of importables because of higher import tariffs relative to exportables (reduction or deterioration in terms of trade) leads to a decrease in the quantity demanded of importables and an increase in non-tradables and exportables according to the hypothesis that resources flow follows incentives in different sectors. The end result will be a decline in the RER, which is equivalent to an appreciation in the exchange rate (Schiff and Valdes, 2002).

Schiff and Valdes use the following equation to investigate the impacts of an exchange rate change on the relative agricultural prices:

$$\frac{P_A}{P_{NA}} = \frac{P_A / P_H}{\alpha (P_{NA} / P_H) + (1 - \alpha)}$$

Where $\alpha < 1$

In this equation P_A represents agricultural prices; P_{NA} non-agricultural prices and P_H represent prices of non-tradables. The equation indicates that relative agricultural

prices are influenced by agricultural prices, non-agricultural prices and prices of non-tradables. Protection of industries in the form of increases in import tariffs will lead to an increase in the RER, which, in turn, will lead to a decline in relative agricultural prices.

In and Mount (1994) argue that appreciation of the exchange rate is another way of taxing agricultural products. Chambers and Just (1981) find that exports and agricultural prices are sensitive to movements in the exchange rate, while domestic factors are responsive, although they are less sensitive. Liebenberg, Vivier and Groenewald. (1991) find that exchange rate changes can influence the economic performance of agriculture in a variety of ways and this includes the performance of export realisations and prices of imported inputs. Schuh (1974) finds that in the USA the combined effect of the devaluation of the US dollar and the currency realignments has been that the price of tradable products (exports and imports) increased.

Some debate exists, however, on whether domestic agricultural prices rise by a rate that is below the rate of devaluation (Grennes, Johnson and Thursby, 1980; Frankel, 1986; Chambers and Just, 1981). Grennes *et al* (1980) conclude that the domestic prices will rise by more than the rate of devaluation only if the foreign price rises, but this remains an empirical question. Furthermore, they argue that a 10 percent devaluation of the Canadian dollar would have a different impact on wheat prices compared to a similar devaluation of the US dollar. They find that 10 percent devaluation raises the wheat prices by 7 percent in the USA. Amongst researchers there exists consensus that domestic prices may not respond in the same way to exchange rate changes as they do to changes in foreign prices. Chambers and Just (1981) have discussed in detail how to model the effects of exchange rate adjustments on agricultural prices. This will further be discussed in the section focusing on model development. Rausser *et al* (1986) discuss an econometric model to estimate the linkages between macro-economic policies and the agricultural sector. Frankel (1986) argues that real commodity prices, in the absence of government interventions, are sensitive to real interest rates and the real exchange rate, while Batten and Belongia (1986) conclude that there is little doubt that the real value of the US dollar contributed to the decline in the export of farm products from the USA.

2.3.3.2 Exchange rate misalignment

Real exchange rate misalignment or disequilibria refers to a sustained departure of the actual RER from its long-run equilibrium real exchange rate (ERER) value. Edwards (1987) also refers to equilibrium exchange rate as "justified" exchange rate, which does not require government intervention, and to disequilibrium as "unjustified", which does require some form of government intervention. The ERER is defined as the value of the RER that is consistent with a simultaneous attainment of internal and external equilibrium for given sustainable values of other relevant variables such as taxes, international terms of trade, commercial policies, capital and aid flows, and technology (Asfaha and Huda, 2002; Elbadawi and Soto, 1997; Edwards, 1987). Internal equilibrium refers to a situation where the non-tradable goods market clears in the present and is also expected to clear in the future. External equilibrium, on the other hand, is attained when the current account balance is compatible with long-run sustainable capital flows (Edwards, 1987).

The determinants of the exchange rate (or exchange rate fundamentals) can be classified into external and domestic exchange rate fundamentals. The external fundamentals include external terms of trade, foreign aid flows and world real interest rates. Domestic fundamentals include policy and non-policy fundamentals. Policy fundamentals include trade taxes, exchange rate and capital controls, other taxes and subsidies, and government expenditure. Non-policy fundamentals include technological progress (Edwards, 1987).

Empirically, an exchange rate is labelled "overvalued" when it is more appreciated than its equilibrium level and "undervalued" when it is more depreciated than the equilibrium level (Asfaha and Huda, 2002). When the actual exchange rate is below its equilibrium value, then overvaluation is taking place, and when the equilibrium exchange rate is below its actual value then undervaluation is taking place.

There are two types of exchange rate misalignment, namely, macro-economic-induced misalignment and structural misalignment (Edwards, 1987). Macro-economic-induced misalignment occurs as a result of inconsistencies between macro-economic policies (especially monetary) and the official nominal exchange rate. An increase in money

supply will result in increases in prices, which, in turn, will either appreciate or depreciate the exchange rate. Structural misalignment takes place when in the short run changes in the equilibrium exchange rate fundamentals are not translated into changes in the real exchange rate. For instance, the decline in external terms of trade will result in changes in the ERER. But when the changes in the ERER are not accompanied by changes in the RER, then exchange rate misalignment will take place.

Misalignments occur both under fixed and floating exchange rate regimes. In fixed exchange rate systems, misalignment reflects poor policy fundamentals that prohibit the exchange rate to adjust to changes in economic fundamentals. The RER in fixed regimes does adjust. Whereas in floating exchange rate regimes, the primary cause of misalignments are factors such as speculative attacks that move the exchange rate too much in relation to economic fundamentals (Asfaha and Huda, 2002), Kemme and Roy (2002) argue that the movement from a fixed to a managed peg and then to a floating exchange rate tends to reduce both the magnitude and the volatility of the misalignment, while Edwards (2000) finds that floating exchange rates can be both effective and efficient.

Generally, large misalignments are attributed to poor policy fundamentals. Questions pertaining to the misalignment of exchange rates have become central issues in the analysis of macro-economic policies in emerging and developing countries. The two main reasons for this are, firstly, persistent overvaluation of currency is seen as a powerful early warning for impending currency crises. That is, situations of protracted real exchange rate misalignment have been associated with poor economic performance in a number of developing countries. Although the impact of overvaluation is more accentuated, undervaluation of a currency also suppresses economic performance through a higher inflation and through discouraging consumption and investment (Asfaha and Huda, 2002). In this regard Kemme and Roy (2002) find, however, that, for example, in the case of Russia the misalignment measures are coincident to the exchange rate crisis and do not serve as a good forecaster of the crisis.

The literature shows that different methodologies are used to estimate equilibrium exchange rate and exchange rate misalignment. The methodologies most often used are the purchasing power parity (PPP) approach and the equilibrium RER (ERER) approach. MacDonald (2000) and Dae Cho, Kim, Sun, Jin and Koo (2003) discuss the use of the PPP, while Elbadawi and Soto (1997), Aron, Elbadawi, and Kahn (1997), and Asfaha and Huda (2002) discuss the use of the ERER approach.

This study has adopted the ERER approach because it takes into account that the equilibrium RER is affected not only by the current value of fundamentals, but also by anticipations regarding the future evolution of these variables. Elbadawi and Soto (1997) argue that the ERER approach is the most relevant approach when estimating exchange rate misalignment because this approach has the properties most desirable:

- ERER is consistent with a behavioural model specifying the equilibrium RER as a forward looking function of the fundamentals;
- ERER allows for flexible dynamic adjustments of the RER towards the equilibrium;
- ERER allows for the influence in the short-to-medium run of macro-economic policies and exchange rate policies on the RER
- the stochastic nature of fundamentals allows their time-series decomposition into permanent (sustainable) and transitory components and a relatively straightforward computation of the equilibrium RER.

2.3.3.3 Government expenditure

Expansionary fiscal policies usually aim to stimulate output in the economy. Since the agricultural sector has a low-income elasticity, this will only increase agriculture output prices in the short-run (via the overshooting model), and, therefore, a tight fiscal policy will have reverse effects on government expenditure (Ardeni and Freebairn, 2002). Unlike expansionary fiscal policies, contractionary fiscal policies are less popular with politicians (Penson, Capps and Rosson, 1999).

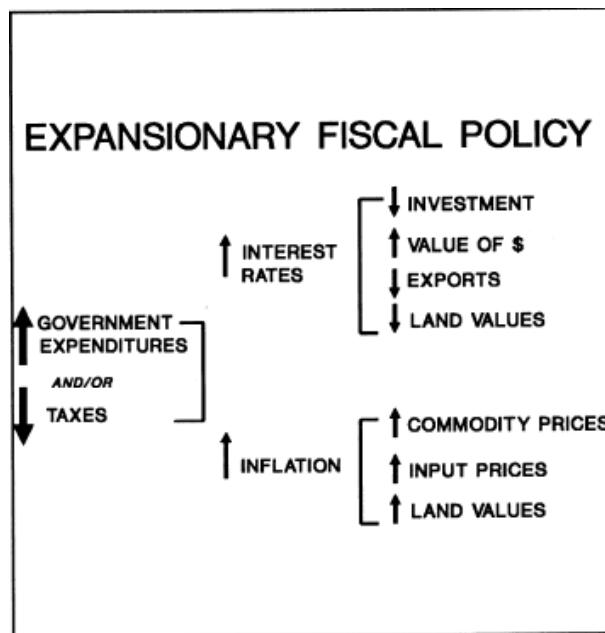


Figure 2.2: Summary of the impact of expansionary fiscal policy
 Source: Snell *et al.* (undated)

Figure 2.2 summarises the impact of an expansionary fiscal policy on prices, the value of exports and on land values. Structural adjustments such as those associated with a decline in government expenditure and with trade liberalization will have a significant effect on relative agricultural prices (Ardeni and Freebairn, 2002). The decline in government expenditure will have a negative effect on the RER and will result in higher prices of agricultural relative to non-agricultural goods. Trade liberalization will lead to increases in the relative prices of agricultural goods through higher industrial prices and a decline in the RER.

2.3.3.5 Money supply

Monetary policies have real and nominal effects on the general economy and the agricultural sector in both the short and medium run but, generally, have no effect in the long run (Ardeni and Freebairn, 2002). Expansionary monetary policies induce a short run combination of faster real output growth and high inflation. Interest rates have a direct effect on the agricultural sector through their effect on the cost of capital. The agricultural sector is capital intensive and is very dependent on credit finance. Any increase in interest rates will raise the cost of borrowing and, thereby, the costs of capital acquisition (Ardeni and Freebairn, 2002). An increase in inflation

will increase the prices of agricultural products. The removal of subsidies on interest rates for the agricultural sector in the early 1980s led to an increase in the cost of capital in South Africa.

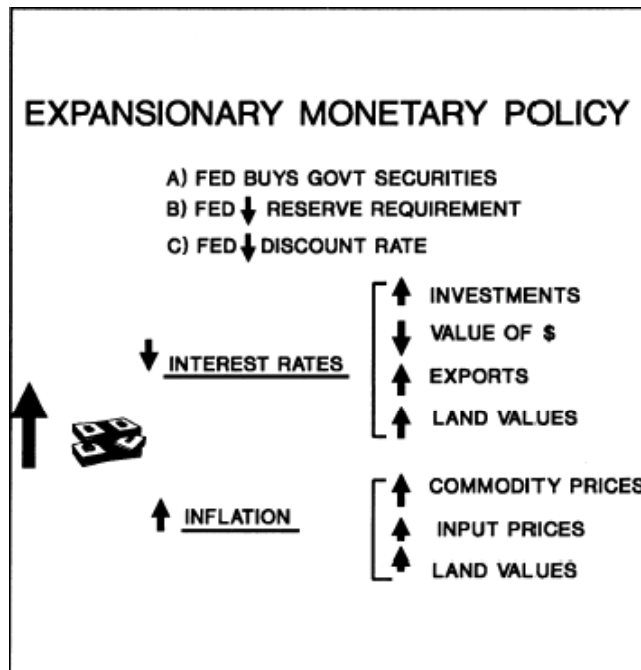


Figure 2.3: Summary of the impacts of expansionary monetary policy
 Source: Snell *et al.* (undated)

Figure 2.3 presents a summary of the impact of monetary policies on input and output prices including land values. Expansionary monetary policies result in lower interest rates and higher inflation rates, which also lead to higher commodity prices and higher input prices. In empirical studies conducted in the USA, changes in money supply were found to have a greater effect on the agricultural sector than exchange rates did, and it was found that agricultural prices tend to increase more than non-agricultural prices under the influence of monetary expansion policies (Chambers and Just, 1982; Barnett, Bessler and Thompson, 1983). Contractionary monetary policies will lead to a rise in the interest rate and an appreciation of the exchange rate (Batten and Belongia, 1986). In contrast to this, Chambers (1981) concludes that contractionary monetary strategies have negative effects on the agricultural sector in the short run.

According to Bordo (1980), a change in money supply causes a fast response in crude (raw materials and unfinished products) commodity prices than manufactured

(finished) product prices do, and higher agricultural output prices than industrial output prices. Frankel (1986) proposes a model that takes account of high exchange rates, money supply, interest rates and the aggregate demand that determines commodity prices. Frankel finds that an increase in money supply leads to a decline in the interest rate, which in turn depresses agricultural commodity prices. In the short run, expansionary monetary policies generally cause farm commodity prices to increase more rapidly than it influences the input and non-farm prices. This results in an increase in returns for the agricultural sector (Snell *et al*, undated). The commodity prices will “overshoot” their long run equilibrium in a downward fashion. In contrast to this, Saunders (1988) finds that agricultural prices are not affected by changes in the stock of money. In an empirical analysis conducted by Taylor and Spriggs (1989) it was found that agricultural prices respond more quickly to a monetary shock in the short run, but also that this is offset by a more rapid response of manufacturers’ prices in the long run.

2.3.3.6 Interest rate

The agricultural sector in South Africa is more capital intensive than the non-agricultural sector, and higher interest rates will, thus, lead to increases in the cost of capital, which will affect agriculture negatively. For this reason, agriculture is highly sensitive to interest rates but less sensitive to changes in the cost of labour. An increase in the interest rate will increase the value of the domestic exchange rate against foreign currencies (Schiff and Valdes, 2002). When the interest rates are low relative to foreign interest rates, investors will invest in alternative assets, thus decreasing the demand and value of the local currency. A lower value of the local currency will make foreign agriculture imports expensive and will, thus, discourage importing goods into the country, thereby strengthening domestic competitiveness (Snell *et al*, undated). Higher interest rates in agriculture remain largely responsible for hindering farmers’ access to commercial finance, which, in turn, constrains the response of farmers to available opportunities (Brooks and Nash, 2002).

2.4. Conclusion

The literature reviewed has shown that there are feed-back and feed-forward linkages between the macro-economy and the agricultural sector. In the early stages of development, agriculture employs more labour and contributes more than 50 percent to the GDP. This decreases in later stages of development. Recent studies have shown, however, that agriculture remains an important sector in developing countries' economies with strong feed-back and feed-forward linkages, with some researchers arguing that 1 percent investment in the agricultural sector will result in more than 1 percent investment in the non-agricultural sector.

Macro-economic policies and other macro-economic variables also have an impact on the agricultural sector. The literature indicates that government policies indirectly impacting on agriculture include exchange rates, industrial policies, and monetary and fiscal policies. Amongst the factors that impact directly on agriculture are quantitative restrictions, and import and export tariffs. In addition, other macro-economic variables influencing government policies and macro-economic variables have an impact on the agricultural sector are the real exchange rate, money supply, interest rate, trade liberalization, industrial protection, government expenditure, and taxes.

The exchange rate is one of the most dominant and most researched variables that impact on the agricultural sector. Although most studies conclude that a devaluation of the exchange rate leads to a rise in agricultural prices, there is no consensus on the magnitude of this effect. An increase in money supply will only raise agricultural prices in the short run and prices will be neutral in the long run.

The effect of macro-economic policies and other macro-economic variables on agriculture has been studied by means of analyses of prices of agricultural relative to non-agricultural products. Most authors argue that agricultural prices are highly flexible and non-agricultural product prices are fixed. Researchers have found that, hence, agricultural prices respond more quickly to a monetary shock in the short run, but that this effect is offset by a more rapid response of manufacturer prices in long run.

CHAPTER 3

REVIEW OF MACRO-ECONOMIC POLICIES AND OTHER MACRO-ECONOMIC VARIABLES IN SOUTH AFRICA BETWEEN 1980 AND 2002

3.1 Introduction

The objective of this Chapter is to review the linkages between agriculture and macro-economic policies and other macro-economic variables in South Africa. The role of agriculture in the South African economy between 1980 and 2002 is reviewed in Section 3.2. Macro-economic policies critical to the South African agricultural sector in the study period are discussed in Section 3.3. This Section will outline important macro-economic policies and events that have influenced developments and incentives in the agricultural sector. Section 3.4 provides a summary of the Chapter.

3.2 The role of agriculture in the macro-economy in South Africa

This Section focuses on the contribution of agriculture to the economy, both in terms of income and exports. The agricultural employment and capital intensity of the sector are also discussed, as this is a root issue of agricultural profitability. Lastly, agricultural output prices are discussed.

3.2.1 Contribution of agriculture to the economy

The relative contribution of the agricultural sector to the South African economy has been in decline between 1980 and 2002. Table 3.1 shows the shares of the different sectors in the GDP between 1980 and 2002. The share of the agricultural sector has declined from 6.1 percent in 1980 to 4.2 percent of the GDP in 2002 with the lowest ever contribution of 3.9 percent in 1995. While the contribution by the mining sector has also declined, the manufacturing and wholesale sectors have maintained their share of domestic output. In absolute terms, however, the gross value of agricultural products has increased in the period under review. The largest sector of the South African economy is the services sector. The contribution by the services sector to the South African economy has increased from 52.1 percent in 1980 to 67.3 percent in

2002, with the highest contribution by this sector to the GDP stands at 70.9 percent (recorded in 1999). Looking at these facts, the economy appears to have moved through various stages of growth from primary to secondary to tertiary sector.

Table 3.1: Share of sectors in the GDP in South Africa

	Agriculture, forestry and fishing	Mining and quarrying	Manufacturing	Services
1980	6.1	20.4	21.4	52.1
1985	5.1	14.0	21.4	59.5
1990	4.6	9.0	23.3	63.1
1995	3.9	7.0	21.2	67.9
1999	3.5	7.1	18.5	70.9
2000	3.3	7.6	19.0	70.1
2001	3.5	8.3	19.1	69.1
2002	4.2	8.7	19.8	67.3

Source: NDA (2005)

3.2.2 Agriculture exports and imports

Table 3.2 demonstrates the trend in the values of agricultural output and agricultural trade. In monetary terms, the gross value of agricultural production has increased from R 7 024.8 million in 1980 to more than R71 800 million in 2002. At the same time the contribution of agricultural exports to the total export in South Africa has declined from 10.3 percent in 1980 to 7.6 percent in 2000, and, again, increased to 8.1 percent in 2002. The ratio of agricultural exports to agricultural production increased from 29.2 percent in 1980 to 35.4 percent in 2002. In this same period, agricultural imports, as a percentage of the total imports into South Africa, increased from 5.3 percent in 1980 to 20.8 percent in 2002.

Table 3.2: Trends in South Africa's agricultural output and exports, 1980 - 2002

	1980	1990	2000	2002
Gross value of production (R million)	7 024.8	21 952	51 670	71 827
Gross domestic product (R million)	59 658.0	266 783	838 218	1 059 788
Exports				
Total SA exports (R million)	19 915.4	60 770	210 022	314 927.1
Total agricultural exports (R million)	2 052.5	4 625	15 820	25 460.2
Agricultural exports as % of total exports	10.3	7.6	7.5	8.1
Agricultural exports as % of total agricultural output	29.2	21.1	30.6	35.4
Imports				
Total SA imports (R million)	14 381.3	44 141.5	186 345.1	273 701.6
Agricultural imports (R million)	369.2	1 936.2	9 643.7	14 939.1
Agricultural imports/total imports (%)	2.6	4.4	5.2	5.5
Agricultural imports as % of total agricultural output	5.3	8.8	18.7	20.8
Agricultural terms of trade (Ag exports/Ag Imports)	5.6	2.4	1.6	1.7
Degree of openness (%)				
Agriculture	34.5	29.9	49.3	56.2
General economy	57.5	39.3	47.3	55.5

Source: Adapted from Vink and Kirsten (2003a) and NDA (2005)

Figure 3.1 (below) illustrates the degree of openness in the agricultural sector and in the whole economy. The degree of openness in the agricultural sector was calculated as the total agricultural trade (exports and imports) divided by the gross value of agricultural production. In the general economy, the degree of openness was calculated as a ratio of total trade relative to the GDP (Baldwin, 1989). The degree of openness for the South African agricultural sector has increased in the period under study from 34 percent in 1980 to 56 percent in 2002. This shows that – in total - the South African agricultural trade has become more open to international trade, which was also evidenced by the rise in agricultural imports as shown in Table 3.2. Having said this, the degree of openness for the South African economy declined from 57 percent in 1980 to 39 percent in 1990. This was largely due to external economic sanctions and an inward-oriented trade policy. After 1990, the degree of openness for the South Africa economy rose to 57 percent in 2002. This rise is an indication of the important role trade policies and the deregulated agricultural trade market play in the agricultural sector. In 1995, South Africa signed the Marrakech Agreement, and during the late 1990s, South Africa abolished agricultural marketing schemes.

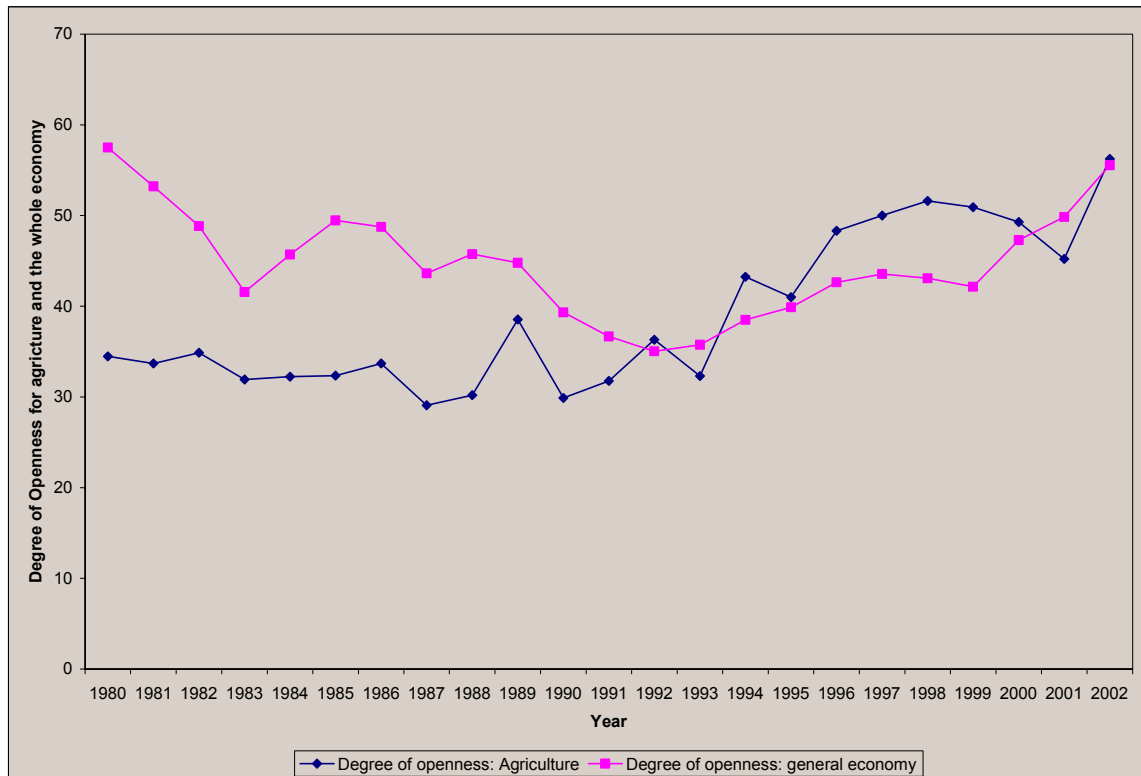


Figure 3.1: Percentage change in degree of openness for agriculture and the general economy

Source: Based on NDA data (2005)

Finally, with regard to the openness of the agricultural sector, Figure 3.2 demonstrates the relationships between agricultural prices and production, and the degree of openness. It is important to illustrate the trend by means of agricultural variables in response to changes in terms of macro-economic development. It is important to note that the agricultural output prices were changing at a rate below the increase in the value of agricultural production and agricultural degree of openness, and that the agricultural prices were positive for the entire period under study, except for 2000. In the 1990s both agricultural prices and the degree of openness increased at a decreasing rate, and both began to increase at a positive rate from 2000 onward. This indicates that the agricultural output prices together with the degree of openness in the agricultural sector increased at the same rate. It also indicates the existence of a positive relationship between output prices and the degree of openness in the agricultural sector.

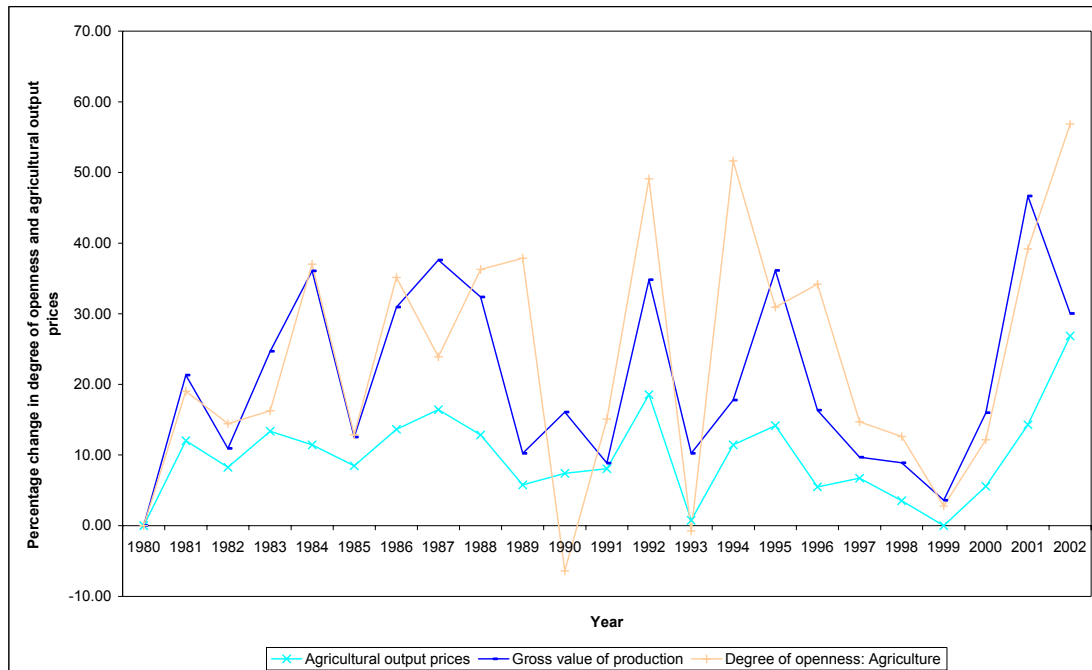


Figure 3.2: Percentage change in degree of openness, agricultural output prices and gross value of production

Source: NDA (2005)

3.2.3 Agricultural employment and capital

Table 3.3 shows the employment and gross capital investment in South African agriculture between 1980 and 2002. Gross capital formation in agriculture increased from R903 million in 1980 to more than R4 500 million in 1996. During the same period, the share of agricultural gross capital formation in the agricultural sector declined from 24.72 percent in 1980 to 14.95 in 2002. In the same period, the share of the agricultural gross capital formation in the South African economy declined from 1.51 percent to 0.58 percent. Also in this period, employment in agriculture declined from 1.24 million jobs in 1980 to 914 000 jobs in 1996. The ratio of capital to labour indicates the value of capital (in R million) for every million of farm employees. In 1980, there was R728 value of capital for every million people employed in the agricultural sector. This number increased to more than R 7000 value of capital for every million of farm employees in 2002. According to Vink and Kirsten (2003a), gross capital formation in agriculture declined during 1997–1999 due to a few poor farming seasons and other factors such as rural emigration. In addition, the extensive liberalisation of agriculture has since 1985 also led to an increase in the number of new agricultural companies registered per annum (Vink and Kirsten, 2003a).

Table 3.3: Agricultural capital formation and employment in South Africa

	Gross capital formation in Agriculture (R million)	Total farm employment (million)	Capital labour ratio
1980	903.2	1.24	728
1990	1 770.6	1.18	1501
1995	3 780.1	0.89	4247
1996	4 589.8	0.92	5016
2002	6 606.5	0.94	7021

Source: NDA (2005)

Table 3.4 below demonstrates the levels of capital and labour intensity in the agricultural sector and the Rands per person worth of capital. The bias in the South African agricultural sector in favour of capital use has been found to be positive between 1980 and 1998 while the bias in land and intermediate goods for that same period was negative. This indicates that agriculture is capital intensive and uses relatively low levels of labour and intermediate input. Van Zyl, Vink and Kirsten (2000) attribute the bias towards capital use to the deregulation of the financial market in the early 1980s, which resulted in the withdrawal of explicit interest rate subsidies from the agricultural sector, which, in turn, resulted in positive real rates of interest. The start of negative real rates of interest in the economy during 1987 led to an increase in the bias toward capital intensity as capital became relatively cheaper. The bias toward capital intensity increased again in the early 1990s when interest rates were targeted to agriculture as part of the drought assistance scheme.

Table 3.4: The bias in technological change in South African agriculture

	Capital	Labour	Land	Intermediate goods
1980	0.1923	-0.0167	-0.0208	-0.1503
1981	0.1891	-0.0166	-0.0215	-0.1513
1982	0.1719	-0.0169	-0.0197	-0.1694
1983	0.1611	-0.0169	-0.0195	-0.1826
1984	0.1856	-0.0149	-0.0191	-0.1690
1985	0.2045	-0.0145	-0.0184	-0.1594
1986	0.1993	-0.0143	-0.0188	-0.1627
1987	0.2017	-0.014	-0.019	-0.1622
1988	0.2134	-0.0139	-0.0181	-0.1587
1989	0.1987	-0.0134	-0.0197	-0.1662
1990	0.1863	-0.0138	-0.0197	-0.1737
1991	0.1811	-0.0139	-0.0200	-0.1762
1992	0.1797	-0.0139	-0.0206	-0.1756
1993	0.2115	-0.0138	-0.0227	-0.1483
1994	0.2174	-0.0137	-0.0229	-0.1454
1995	0.2132	-0.0144	-0.0241	-0.1422
1996	0.2117	-0.0153	-0.0255	-0.1372
1997	0.2086	-0.0161	-0.0261	-0.1344
1998	0.2060	-0.0170	-0.0268	-0.1318
1970-1998	0.1930	-0.0139	-0.0227	-0.1598

Source: Van Zyl *et al* (2000)

3.2.4 Agricultural profitability and net farm debt

Net farm income is a standard measure used to estimate the profitability of an enterprise (Vink and Kirsten, 2003a; Coetzee, Meyer and Adam, 2002). Net farm income in agriculture stood at R1 953 million in 1980 and increased to more than R20 400 million in 2002. In the same period, farm debt increased from R3 838 million to R28 231 million. In other words, for the period under study farm debt was greater than farm income..

By farm profitability ratio is meant the return on every million Rand worth of capital in the agricultural sector. This ratio is calculated as net farm income divided by total capital employed in the agricultural sector multiplied by 100. The farm profitability ratio shows that for R1 million worth of capital employed in the South African agricultural sector in 1980, there is a return of only R216. This amount increased in 2002 to R308 per R1 million worth of capital. This is an indication that farmers are

beginning to realise positive return on their capital investment. It also shows an improvement on the return on capital investment in agriculture.

Table 3.5: Net farm income and total farm debt

	Total farm debt (R million)	Net farm income (R million)	Gross capital formation in Agriculture(R million)	Farm profitability ratio
1980	3838.60	1953.70	903.2	216.31: 1
1990	15973.10	5254.50	1770.6	296.76: 1
2000	29825.90	10947.5	3828.6	285.94: 1
2002	28231.50	20401.9	6606.5	308.82: 1

Source: NDA (2005)

Figure 3.3 (below) illustrates the percentage of total debt and farm income, given the prevailing weighted interest rates paid by farmers. The figure shows that the increase in interest rates was followed by the rise in farm debt, meaning that the farmers could not afford the resulting higher interest repayments. Although farm income and interest rates tended to move in the same direction, income increased at a rate below the interest rate. This shows that interest rates had a negative impact on farm debt and a positive effect on the net farm income.

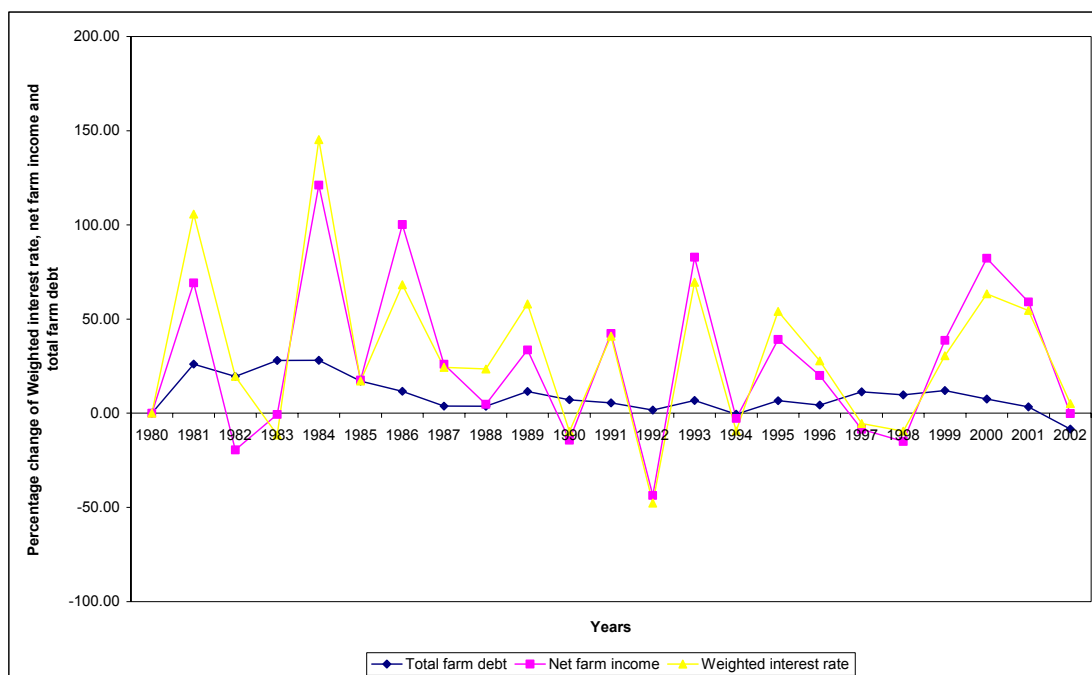


Figure 3.3: The percentage changes in total farm debt, net income and weighted interest rate

Source: NDA (2005)

3.2.5 Agricultural prices and input prices

It is assumed that the indices of agricultural producer prices are equivalent to agricultural output prices, while the price indices of farming requisites are taken as the equivalents of the input prices in the agricultural sector in South Africa. Before 1997 the agricultural sector was characterised by nominally fixed agricultural prices as a result of the agricultural marketing boards, but this changed after the abolishment of marketing boards and deregulation of agriculture in 1997 when the agricultural sector became characterised by more flexible output prices.

Figure 3.4 (below) shows the changes in farm output and input prices between 1980 and 2002. For most of the period under review, agricultural output prices were higher than the input prices. The output and input prices were equal in 2001. From the figure it is quite evident that between 1990 and 1999 agricultural prices increased at a decreasing rate.

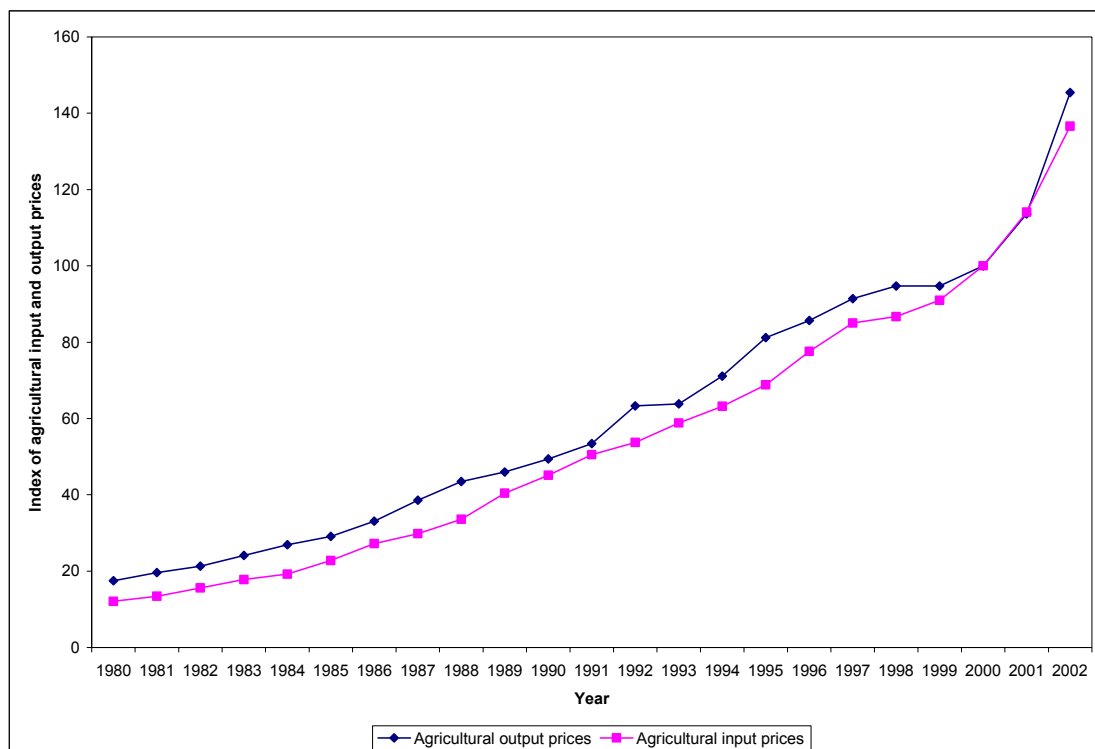


Figure 3.4: Agricultural output and input prices between 1980 and 2002

Source: NDA (2005)

The sections above describe trends and changes in the agricultural sector that took place between 1980 and 2002. The data show that in the last decade agricultural

imports, production levels and degree of openness have increased, which have translated into the integration of the domestic agricultural sector into world markets. This has exposed the domestic agricultural sector to foreign competition and has also created opportunities for new markets. At the same time, agricultural incentives have increased at a decreasing rate, and have fallen more and more under the influence of macro-economic events and policies. The next section attempts to explain macro-economic policies and events critical to these turning points in agricultural transition.

Table 3.6: Relative prices of agriculture and real exchange rate

	Relative prices of agriculture to non-agricultural sector	Real exchange rate
1980	2.00	2.34
1990	1.44	1.63
2000	1.23	1.55
2002	1.55	1.95

Source: Adapted from NDA (2005)

The literature reviewed in Chapter 2, indicates that the relative agricultural prices can be calculated as the ratio between agricultural prices and non-agricultural prices. Table 3.6 shows the prices of agricultural products relative to the prices of non-agricultural products, as well as the real exchange rate, between 1980 and 2002. The prices of agricultural products relative to non-agricultural goods declined from 2 in 1980 to 1.55 in 2002. This implies that the incentives to farmers declined by 23 percent in the period under study. Similarly, the real exchange rate declined from 2.34 in 1980 to 1.95 in 2002. This represents a decrease of 3 percent in the RER over the study period.

3.3 Macro-economic policies and events critical to the evolution and fortunes of agriculture

This Section outlines important macro-economic policies and events, which were critical to the changes in the agricultural sector during the period under study. The Section will focus on the summary of government policy developments between 1980 and 2002. These government policies and decisions include monetary, fiscal and trade policies.

3.3.1 Monetary policies in South Africa

Monetary policies in the 1980s and 1990s were characterised by two governors of the Central Bank with two different objectives in relation to the prevailing macro-economic environment (Mohr, 2003; Schoombee, 2003). The names of the two governors of the Reserve Bank are Chris Stals and Tito Mboweni. The objective of the South African Reserve Bank (SARB) in the 1980's and early 1990s was to protect the domestic and international value of the domestic currency. To achieve this purpose, the SARB used money supply targets. Evidence of this can be seen in the intervention of the SARB when the Rand depreciated in 1996 and 1998 as result of a decline in investor confidence in the changes in the South African government, and as a consequence of the Asian crisis.

The objective of the SARB in the late 1990's was to fight inflation and maintain stability in the South African financial markets. Currently, the value of the Rand is determined by demand and supply, and a range of other international factors. In 2000, the SARB set the inflation targets at 3 – 6 percent in order to control the inflation rate in South Africa. When the Rand sharply depreciated in 2001 the SARB did not intervene to protect the Rand but rather left it to the markets and international events at the time to determine the value of the Rand. The SARB used interest rates as the operational variable to fight inflation. In this study, the effect of monetary policy including the effects of changes in interest rates is captured by changes in money supply. The interest rates as set by the SARB influence the agricultural sector through capital cost, input and output prices.

3.3.2 Fiscal policy in South Africa

During the 1980s, the fiscal policy was generally expansive, for a large part this can be attributed to the cost of maintenance of apartheid structures and policies, and infrastructural development (Dollery, 2003). In addition, the international reaction to apartheid resulted in the imposing of trade and investment sanctions. According to Dollery (2003), investment sanctions appear to have been especially successful, culminating in the 'debt standstill' of August 1985. South Africa became a net

exporter of capital and was obliged to adhere to a strict debt repayment schedule. During this period, government expenditure increased. Evidence of this is found in the rise in the ratio of government debt to GDP early 1993. The reason for this was that the government had to repay the apartheid debt.

In 1994, the ANC government introduced their macro-economic strategy known as the Reconstruction and Development Programme (RDP). The key programmes of the RDP aimed at meeting basic needs, developing human resources, building the economy, democratising the state and society, and implementing the RDP (<http://www.polity.org.za/html/govdocs/rdp/rdpall.html>). The basic needs of people include providing the following: jobs, land, housing, water, electricity, telecommunications, transport, a clean and healthy environment, nutrition, health care and social welfare. Developing human resources include : education and training. Other programs include: labour law reform, reform of the financial sector, upgrading infrastructures, and financing RDP. After some time the RDP was abandoned, however, and a new macro-economic strategy was unveiled.

In 1996, the government of South Africa introduced its new macro-economic strategy in the Growth, Employment And Redistribution (GEAR) strategy (Calitz and Siebrits, 2003). The introduction of GEAR entailed a switch to a neo-liberal or free-market system and to supply-side economics. The GEAR strategy was more in line with the Washington Consensus type of structural adjustment interventions with their emphasis on fiscal discipline and reduction of the deficit before borrowing (Mohr, 2003). By the end of the last decade government expenditure as a percentage of GDP was declining. The box (below) presents key elements of the GEAR strategy as outlined by Lewis (2001). The key GEAR elements include: fiscal discipline, tariff reduction, stable exchange rates and a consistent monetary policy, restructuring of state assets and an expansionary infrastructure programme.

Lewis (2001) has summarised the key elements of GEAR as follows:

- Faster fiscal reduction program to contain public debt and debt service obligation, counter inflation;
- Renewed focus on budget reform;
- Reduction in tariffs to contain input price;
- Stable effective exchange rate;
- Consistent monetary policy;
- Relaxation of exchange controls;
- Restructuring of state-owned assets;
- Tax incentives to stimulate new investments in competitive and labour absorbing projects;
- Expansionary infrastructural programme to accelerate delivery on the backlog of social infrastructure.

According to Terreblanche (2005), GEAR managed to achieve macro-economic stability in South Africa, which was conducive for considerable economic growth in the "First World" sector of the economy. However, the growth attained did not "trickle down" to the "second economy", the term used to define the poorer sections of South Africa. Terreblanche argues that GEAR resulted in higher levels of unemployment and the privatisation of government assets.

In response to the high rates of unemployment and the increased government revenue, the government of South Africa recently introduced the Expanded Public Works Programme (EPWP). This programme intends expand infrastructure development. Terreblanche argues that the macro-economic stability of the 1990's was achieved by cutting back on expenditure dedicated to infrastructure development. The EPWP is an initiative that aims at reducing infrastructural backlogs, and, through this, at creating an environment conducive for job creation and economic growth (Phillips, 2004). The EPWP is a nation-wide programme, which draws significant numbers of the unemployed into productive work, so that workers can gain skills on-the-job, and so increase their capacity to earn an income (www.epwp.gov.za).

3.3.3 Trade policy in South Africa

As a result of the trade and investment sanctions imposed on South Africa in the early 1980s, the country was forced to become self-sufficient re major products including agricultural products (Griffiths, 2003). According to Lewis (2001), South Africa's trade policy in the pre-democratic era was guided by three interrelated strategies, namely, i) import-substituting industrialisation, ii) the development of "strategic" industries (in coal, arms and oil), and iii) the development of mineral-related exports. This strategy was backed by a highly distorted trade regime that was attained through widespread use of quantitative restrictions (QRs), tariff lines, price controls, import and export permits - through various agricultural marketing schemes (Lewis, 2001; Cassim, 2003). In the 1990s, South Africa also introduced export promotion incentives referred to as the General Export Incentive Scheme (GEIS) (Cassim, 2003; Mohr, 2003).

As mentioned before, in 1995 South Africa signed the Marrakech Agreement of the GATT (Lewis, 2001; Vink *et al*, 2002; Griffiths, 2003), thereby agreeing to liberalise its international trade by lowering import tariffs, eliminating non-tariff barriers to trade, and phasing out the GEIS. Under trade liberalization in South Africa, QRs were replaced by tariffs (Cassim, 2003). According to Cassim, the process of tariffication was completed in 1994, and by 2000 the tariffs had become fairly low..

Table 3.6 (below) shows the tariff reduction structure in South Africa. The number of digits has been rounded-off to the nearest digit. The number of tariff lines was reduced from 12 500 in the 1990s to 8 250 and 7 743 in 1996 and 1999, respectively. This represents a decline in the number of tariff lines of approximately 40 percent from 1990 to 1999. Furthermore, the number of tariff bands declined from 200 in 1990 to only 47 in 1999, which is more than 76 percent reduction in the number of tariff bands.

Table 3.6: The South African tariff reduction structure

	All rates 1990	All rates 1996	All rates 1999	Positive rates 1999
Number of lines	12500	8250	7743	2463
Number of bands	200	49	47	45
Minimum rate (%)	0	0	0	1
Maximum rate (%)	1389	61	55	55
Unweighted mean rate (%)	28	10	7	17
Standard deviation (%)	n/a	n/a	10	9
Coefficient of variation (%)	160	134	140	52

Source: Lewis (2001)

In addition, the maximum tariff rate further fell from 1389 percent in 1990 to just 55 percent in 1999, whilst the mean tariff rate declined from over 27 percent to 7.1 percent in the same period. The unweighted mean tariff rate declined from 27.5 percent in 1990 to a mere 7.1 percent in 1999.

Table 3.7 (below) shows the structure of tariffs by sector in South Africa in 1999. The mining sector (with a maximum rate of 15 %) had the lowest tariff protection in the South African economy, followed by the agricultural sector (35 %), while the manufacturing sector (55 %) had the highest tariff production. In fact, the maximum tariff rate for all sectors in the South African economy was 55 %.

Tariffs in South Africa are generally low with an economy-wide average tariff rate of approximately 4 percent. This is the result of a deep and sustained trade liberalisation that has taken place. Although low, this average figure masks huge distortions and peaks in the system, as shown by the troughs and peaks in Table 3.7. The textile sector, for example, is highly protected with a trade-weighted average tariff rate of 10.4 percent. Wood and wood products are the second most highly protected sector with a tariff rate of 8.1 percent. In contrast, the mining sector receives hardly any protection with a tariff rate of 0.1 percent, while the agricultural sector only receives 1.8 percent. On aggregate, the manufacturing sector receives much more protection than mining and agriculture.

Table 3.7: The structure of tariffs by sector in South Africa in 1999 (%)

Sector	Trade-weighted average rate	Unweighted average rate	Minimum rate	Maximum rate
Mining	0.1	1.4	0	15
Agriculture	1.8	4.6	0	35
Manufacturing	4.4	7.5	0	55
Food, beverages & tobacco	4.2	11.8	0	55
Textiles, apparel & leather	10.4	18.4	0	50
Wood& wood products	8.1	10.3	0	30
Paper & paper products	7.0	7.3	0	22
Chemicals	4.2	5.5	0	40
Non-metallic minerals	6.6	7.4	0	30
Basic metals	4.1	4.5	0	15
Metals products & equipments	3.8	5.1	0	54
Other manufacturing	4.7	8.3	0	30
All sectors	3.9	7.3	0	55

Source: Lewis (2001)

According to Griffiths (2003), the domestic support measured by the producer subsidy equivalent and the aggregate measure of support was 12 percent of the total value of agricultural production in 1995, and 5 % in 2000. Sugar and cotton are the only products that continue to receive price support (Griffiths, 2003).

The 1990s witnessed the fact that the South African economy was in the process of becoming re-integrated into an increasingly globalised world economy. This created many new opportunities for the South African business sector, but at the same times it also increased the vulnerability of the economy to international developments and events such as the Asian crisis (Mohr, 2003). The integration of the agricultural sector into the world markets meant that commodity prices, including agricultural commodity prices were increasingly determined by demand and supply and a range of other international factors.

3.4 Conclusion

This Chapter has reviewed macro-economic and agriculture linkages and the possible impact of macro-economic events and variables on the agricultural sector in South Africa. The agricultural sector's contribution to the GDP declined in the period under study. Both the value of agricultural exports and imports has increased but expressed

as a percentage of the gross value of agricultural production, the agricultural imports increased more than the agricultural exports. The degree of openness in agricultural sector and the economy in general increased between 1988 and 2002, meaning that the South African economy including agriculture has become more integrated in world markets. The agricultural output prices had a positive relationship with the degree of openness. The South African agricultural sector has become more capital intensive, which means that over the period 1980 to 1996, the number of farm workers declined. Also the ratio of total farm debt to net farm income declined, although farm debts still exceeded net farm income. The agricultural output prices increased over period under study.

The macro-economic environment in South Africa in the 1990s changed drastically from the environment that existed in the 1980s. In terms of monetary policies, the objective changed from protecting the value of the Rand in the 1980s and early 1990s, to fighting inflation and maintaining stable domestic financial markets in the late 1990s. This change in monetary policy in the 1990s exposed the Rand to international developments such as the Asian crises and the September 11 attack in the USA. Fiscal policies also changed with a new macro-economic strategy introduced in 1996. The government expenditure as a percentage of GDP declined in 2002 compared to the late 1990s and early 1990s. After the first democratic elections in South Africa in 1994, the government moved towards deeper trade liberalization by signing the Marrakech Agreement and becoming an active member of the WTO. The deregulation of the agricultural sector began in 1997 culminating in the abolishment of the agricultural marketing schemes in 1999/2000.

CHAPTER 4

DEVELOPMENT OF AN ECONOMETRIC MODEL TO ESTIMATE THE EFFECT OF MACRO-ECONOMIC POLICIES ON THE AGRICULTURAL SECTOR

4.1 Introduction

This study applies an Error Correction Model (ECM) to estimate exchange rate misalignment and the impact of macro-economic policies on relative agricultural prices in South Africa. Most analysis on the empirical estimation of the exchange rate and the impact of macro-economic policies on the agricultural sector has been conducted using Vector Autoregressive (VAR) models (Kaabia and Gil, 2000; Townsend, 1996; Taylor and Spriggs, 1989; Penson and Gardner, 1988; In and Mount, 1994; Elbadawi and Soto, 1997; Aron *et al*, 1997; Saghaian, Reed and Marchant, 2002). According to Penson and Gardner (1988), VAR models find empirical regularities that exist in the data.

Saghaian *et al* (2002) employed co-integration tests and Vector Error Correction models (VEC) to investigate whether agricultural prices overshoot in an open economy. According to these authors, VEC is the more appropriate approach to characterise the multivariate relationship among the macro-economic series. Furthermore, VEC is the VAR in first-difference form that has built-in co-integration to capture the information contained in each series' long run stochastic trend. This Chapter outlines the development of the econometric model that is employed to estimate exchange rate misalignment and to examine the impact of selected macro-economic and other trade policies on the economy of South Africa. Furthermore, this Chapter discusses the techniques applied to estimate this ECM model as well as the data and their sources. An error-correction model is a dynamic model in which the movement of the variables in any period is related to the previous period's gap from long-run equilibrium. While a Vector Error Correction Model (VECM) can lead to a better understanding of the nature of any non-stationarity among the different component series, it can also improve longer term forecasting over an unconstrained

model. Finally, the Chapter concludes with a brief discussion of the results that are *a priori* expected from the forthcoming estimation.

4.2 Model development

The framework of the model for this study is based on the traded/non-traded goods model developed by Dornbusch (1974) and the three-sector model by Sadoulet and De Janvry (1995). The purpose of the three-sector model is to explicitly relate the demand for imports and the supply of exports to the production and consumption elasticities of the different commodities in a country (Sadoulet and De Janvry, 1995). Furthermore, Lachaal and Womack (1998) argue that the effect of trade and macro-economic policies on incentives in a predominantly tradable sector such as agriculture could be evaluated through the real exchange rate.

The domestic economy is divided into two sectors, namely, the tradable sector and the non-tradable sector. The tradable sector is further divided into exportables and importables. Together the non-tradable sector, the importables and the exportables make up the three sectors in the economy. The commodities of the tradable sector are perfect substitutes for foreign commodities and their prices are equal to international prices, converted into domestic currency and modified by relevant taxes (Elbadawi and Soto, 1997). The important assumption underlying the model is that South Africa is a small country in terms of world trade so that the relative prices of traded goods in the world markets are taken as given. In this model, income is assumed to equal expenditure, and tariff proceeds are distributed via lump sum subsidies (Lachaal and Womack, 1998). The assumption of South Africa being a small country has been routinely used in modelling the South African economy (Van Schalkwyk, Van Zyl and Jooste, 1997).

Let D_i , S_i and P_i represent the demand, supply and price of commodity i , respectively. Following Sadoulet and De Janvry, the three-sector dependent economy model can be summarised as in Table 4.1:

Table 4.1: Summary of sectors in the three-sector model

	Sectors		
	Importables	Exportables	Non-tradables
Demand	D_M	D_X	D_H
Supply	S_M	S_X	S_H
Price	$P_M = e P_M (1+t_M)$	$P_X = e P_X (1-t_X)$	P_H
Market equilibrium	$M = D_M - S_M$	$E = D_X - S_X$	$S_H = D_H$

Source: Sadoulet and de Janvry (1995)

When there are trade taxes, importers and exporters of different commodities transact the local currency at different prices. An import tariff, t_{Mi} , increases the price of imported good i while an export tax, t_{Xi} , decreases the price received by exporters for the exported good i . The perceived prices of the foreign currency by importers and exporters are $e(1+t_{Mi})$ and $e(1-t_{Xi})$, where e denotes the nominal exchange rate. The effective exchange rate for a specific commodity i , is defined as $e_i^{eff} = e(1+t_{Mi}-t_{Xi})$ or alternatively $e[\frac{1+t_{Mi}}{1-t_{Xi}}]$ where e is the real exchange rate of the Rand/US Dollar (Sadoulet and de Janvry, 1995).

The model's trade components for the two traded goods allow domestic supply and demand for these goods to be different. This is not true for non-tradables for which the market needs to clear domestically in order to meet the equilibrium conditions as a result of demand and supply forces. Elbadawi and Soto (1997) and Aron *et al* (1997) argue that there is causal evidence that consumers and the government have different propensities to spend on tradable and non-tradable goods. The demand for non-tradable goods is disaggregated into two components, namely, private and government expenditure. The proportion of private expenditure allocated to non-tradable goods is denoted by E_H . This depends on the prices of exports, imports and non-traded goods (P_X , P_M , and P_H , respectively), whereas expenditure by government on non-tradables (E_{GH}) is a fixed ratio (g_H) of the total government expenditure. At this early stage it is assumed that the demand for non-tradable goods equals expenditure on non-tradables. Private expenditure on non-tradables is expressed as follows:

$$E_H = E_H\left(\frac{P_X}{P_H}, \frac{P_M}{P_H}\right) \quad (1)$$

and government expenditure on non-tradables, E_{gH} , is expressed as a fixed ratio to total government expenditure, E_g :

$$E_{gH} = gH.g.Y \quad (2)$$

The total demand for non-traded goods is expressed as:

$$E_{PH} = E_H + E_{gH} = E_H\left(\frac{P_X}{P_H}, \frac{P_M}{P_H}, Y\right).[A - gY] + gH.g \quad (3)$$

Where $E_H(\cdot)$ is the proportion of private expenditure (absorption less total government expenditure) devoted to non-tradables, A is absorption, Y is income, and g is the ratio of government expenditure to income. In equation (1), an increase in the prices of exportables and importables will reduce their demand, and will thereby increase the demand for non-tradables. An increase in the price of non-tradables will result in a decline in expenditure on non-tradables (Elbadawi and Soto, 1997).

The aggregate supply of non-tradables, denoted by S_H , is expressed as a function of the relative prices of exportables and importables in terms of non-tradables, and income:

$$S_H = S_H\left(\frac{P_X}{P_H}, \frac{P_M}{P_H}\right)Y \quad (4)$$

S_H is negatively related to the relative prices of tradable goods, that is, both importables and exportables. Higher prices for exportables and importables would shift resources out of the non-tradable sector to the tradable sectors and consequently reduce the production of non-tradables. An increase in the price of non-tradables will result in increases in production of non-tradables.

In equilibrium demand equal supply ($S_H = E_H$):

$$S_H\left(\frac{P_X}{P_H}, \frac{P_M}{P_H}\right)Y = E_H\left(\frac{P_X}{P_H}, \frac{P_M}{P_H}, Y\right).[A - gY] + gH.gY \quad (5)$$

Equation (5) can be solved in order to derive the real exchange rate (Sadoulet and De Janvry, 1995). The real exchange rate has been defined as the relative price of non-tradable to tradable goods:

$$e = \frac{P_H}{E.P_X^\alpha.P_M^{1-\alpha}} = \frac{P_H}{E.P_X^\alpha.P_M^{1-\alpha}(1-t_x)^\alpha(1+t_m)^{1-\alpha}} \quad (6)$$

According to Elbadawi and Soto (1997), equations (5) and (6) can be solved for the level of the RER that ensures instantaneous equilibrium in the non-traded goods market, for given levels of foreign and domestic "fundamentals":

$$e = e\left(\frac{A}{Y}, TOT, t_x, t_m, gN, g\right) \quad (7)$$

where TOT represents the Terms Of Trade (P_x^*/P_m^*). Higher levels of absorption, trade taxes, and public expenditures on non-traded OR NON-TRADABLE goods in equation (7) will result in a more appreciated RER. The effects of TOT and total government expenditures on the RER cannot be determined *a priori*; the empirical evidence shows that improved TOT and higher government expenditure usually lead to a RER appreciation (Elbadawi and Soto, 1997). According to these authors, the ambiguity regarding the effects of TOT arises because of the presence of a wealth effect accompanying an improvement in the TOT – which tends to expand the demand for non-traded goods and thus raises the P_H , which results in appreciation of the RER - and a substitution effect, which works in the opposite direction by lowering the cost of imported inputs in the production of non-traded goods. While government expenditure tends to appreciate the real exchange rate, due to the tendency of governments to spend more on non-traded goods than the private sector.

According to Aron *et al* (1997), the solution given by equation (7) does not account for supply side effects, in particular the Balassa-Samuelson productivity effect (B-S). According to these authors, in equation (7), increasing productivity will have a negative effect on the supply of non-traded goods. They modified equation (7) to include a productivity measure, TECH, where higher productivity operates through shifting the relative schedules of traded and non-traded goods, allowing a higher level of the real exchange rate to be consistent with equilibrium (holding other variables fixed):

$$e = e\left(\frac{A}{Y}, TOT, t_x, t_m, gN, g, TECHN\right) \quad (8)$$

and the above equation can be linearised as follows:

$$\log e = \beta_0 + \beta_1 \log\left(\frac{A}{Y}\right) + \beta_2 \log(TOT) + \beta_3 \log(t_x, t_m) + \beta_4 \log(gN) + \beta_5 \log(g) + \beta_6 (TECHN) \quad (9)$$

where TECH is measured as the ratio of the total factor productivity in traded TRADABLE goods to non-traded goods, relative to trading partners.

Elbadawi and Soto (1997) and Aron *et al.* (1997) further extend the basic model represented by equation (8) by endogenising private absorption as a function of net capital inflows (i.e. the sustainable level of current account deficit) and the real interest rate:

$$\frac{A}{Y} = \delta \left(\frac{NKI}{Y}, \frac{RES}{IMP}, \delta [{}_t e_{t+1} - e_t] \right) \quad (10)$$

and in a linearised format:

$$\log \frac{A}{Y} = LOG \left(\frac{NKI}{Y} \right), \log \left(\frac{RES}{IMP} \right), \delta \cdot [\log {}_t(e) - \log {}_{t+1}(e)] \quad (11)$$

where NKI is a measure of sustainable net capital inflows, δ is the share of non-traded goods in consumption; RES is a measure of Reserve Bank reserves relative to imports and e_{t+1} is the expected real exchange rate. Equation (10) implies that a rise in sustainable capital inflows allows a higher sustainable level of absorption, and that the reserve ratio represents the liquid end of wealth, and that an increase in reserves should promote absorption.

The presence of the expected value of the RER (e_{t+1}) in equation (11) yields a forward-looking expression for the equilibrium RER as a function of the expected path of its fundamentals. Linearising equations (8) and (10), solving for e_t and rearranging, the following reduced-form dynamic equation for the RER can be attained (Elbadawi and Soto, 1997):

$$\log e_t - \lambda \log e_{t+1} = \delta_0 + \delta_1 \log(TOT) + \delta_2 LOG(t_x, t_m) + \delta_3 \log \left(\frac{NKI}{Y} \right) + \delta_4 \log \frac{RES}{GDP} + \delta_5 \log gN + \delta_6 \log g + \delta_7 TECHN \quad (12)$$

where $\lambda = \alpha_3 \beta_3 / (1 + \alpha_3 \beta_3) < 1$, and where the δ 's are corresponding coefficients on the right hand side. The equilibrium RER is the value of the real exchange rate that satisfies equation (10) for sustainable values of the right hand side variables. Equation (12) can be solved forward by recursive substitution (Elbadawi and Soto, 1997). By defining the parameter vector $\delta = (\delta_0, \delta_1, \delta_2, \delta_3, \delta_4, \delta_5, \delta_6, \delta_7)'$ and the vector of fundamentals,

$$F_t [1, \log(TOT), \log(g_t), \log \left(\frac{RES}{IMP} \right), \log(DECOR), \frac{NKI}{GDP}, LOG \left(\frac{PUBGDP}{GDP} \right)] \quad (13)$$

In this particular study, two variables have been included as proxies for fundamentals, namely, GDP, which is defined as the ratio of the value of international trade (exports and imports) and DECON (the degree of openness in the country's economy). DECON is used as a proxy for commercial policy (t_x , t_m) because of the difficulty of obtaining good time-series data on t_x and t_m , and also because the degree of openness accounts for factors such as quotas and exchange controls. Public expenditure (as percentage of the GDP) is used as a proxy for gN , the public sector propensity to spend on non-tradable goods. Note, being the specification relevant for the determination of the long run RER, the short-run capital flow and portfolio investment components of capital flows are expected to have non-significant effects.

Therefore, equation (10) can be rewritten as (Elbadawi and Soto, 1997):

$$\log e_f = \sum_{f=0} N \delta' F_{f+f} \quad (14)$$

where F is the sustainable components of F in equation (11) above. For this study, the fundamentals of RER are terms of trade (TERMSG), degree of openness (DECON), domestic resource balance (RESBAL), ratios of public expenditure to GDP (PUBGDP), government expenditure to GDP (GEXPGDP), and technological and productivity improvement (TECHN). PUBGDP is the expenditure by the public in South Africa on goods and services, while GEXPGDP reflects the expenditure by government on goods and services. Aron *et al* (1997) show that if F is stationary in first differences (i.e. $I(1)$), then the following co-integration relationship exists:

$$\log e_f = \frac{1}{1-\lambda} \delta' F_f + \eta_f \quad (15)$$

where $\delta'/(1-\lambda)$ is the co-integration vector, and η is a stationery disturbance term.

If the co-integration relationship in equation (14) is valid, then the equation cannot only be interpreted as long-run equilibrium, but is also consistent with a dynamic equilibrium correction specification (Aron *et al*, 1997). The equilibrium correction equation consistent with the (assumed) co-integration equation is as follows:

$$\Delta \log e_f = b_0 \left(\frac{1}{1-\lambda} \delta' F_t - \log e_t \right) + b_1 \Delta F_{t+1} - b_2 \Delta \log E_{t+1} + b_3 \Delta \log RESBAL + \varepsilon_{t+1} \quad (16)$$

where E is defined as the nominal exchange rate in terms of domestic currency per unit of the foreign currency, RESBAL is the domestic resource balance used as a

proxy for net capital flow, and the disturbance ε_{t+1} is a stationary random variable composed of the one-step-ahead forecast error in the real exchange rate (i.e. $\Delta \log e_{t+1} - t\Delta \log e_{t+1}$).

The equilibrium correction term $[1/(1-\lambda)] [F_t - \log e_t]$ in equation (16) clearly incorporates the forward-looking sources of real exchange rate dynamics. Starting from an initial condition of real over-valuation (i.e. the equilibrium correction term is negative), the self-correcting mechanism that calls for future depreciation in the actual real exchange rate will be set in motion. This effect is captured by the negative equilibrium correction term and its positive coefficient in the $\Delta \log e_{t+1}$ specification. The speed with which this automatic adjustment operates, depends on the parameter b_0 , which falls in the interval $[0,1]$. The value of b_0 equal to one signifies prompt adjustment over just one period; smaller values signify slower rates of adjustment.

Equation (14) shows that in this framework the equilibrium real exchange rate, in addition to clearing the non-traded market in instant is consistent with the expected long-run evolution of the fundamentals. As discussed in Section 2, however, in order to have an empirical measure of the ERER, it is necessary to estimate the sustainable path of the fundamentals (Elbadawi and Soto, 1997).

The next component of the model defines the mechanism channels through which the impacts of macro-economic policies are transmitted to the agricultural sector (Lachaal and Womack, 1998). Macro-economic policies are linked to both agricultural prices and the production function of the agricultural sector. It is through this production function that the relative prices and, therefore, the macro-economic variables influence agricultural performance. Since the agricultural sector produces products for the exportable, importable, and non-tradable goods market, then an aggregate price index for the agricultural sector, denoted by P_a , would be computed as an average of P_x, P_m, P_h . using the geometric aggregation method:

$$P_a = P_x^{\alpha_1} P_m^{\alpha_2} P_h^{(1-\alpha_1-\alpha_2)} \quad (17)$$

where α_1 and α_2 represent the shares of exportable and importable agricultural products in the total agricultural output. Table 3.2 in Chapter 3 showed that agricultural imports as a percent of total agricultural output increased from 6.2 percent in 1980 to 22 percent in 2002. However, for the purpose of this study, it is assumed

that imported agricultural products represent only a negligible proportion of total agricultural output (i.e. $\alpha_2 = 0$). Hence, agricultural prices can be approximated as follows:

$$\ln\left(\frac{P_a}{P_h}\right) = \alpha_1 \ln\left(\frac{P_x}{P_h}\right) \quad (18)$$

Some macro-variables that were included in equation (18), such as the share of exportable agriculture (α_1), depend on economic variables that determine demand and supply and on the degree of commercial openness (DCO) of the economy. Furthermore, agricultural prices depend on macro-economic policies that affect the demand for non-tradable goods and consequently sectoral output.

Lachaal and Womack (1998) and Saghaian *et al* (2002) specify the relative agricultural prices equation as follows:

$$P_a / P_h = F(P_x / P_h, DCO, Y, M^s) \quad (19)$$

where (P_a/P_H) denotes the prices of agricultural goods relative to non-agricultural goods (RELAT), P_a is agricultural price index (PPIAGRI), P_H is price of non-tradables, actual (or equilibrium) exchange rate (RER), DECON, is the degree of openness of the South African economy, Y , is income (GDP), and M^s is the ratio of money supply to income (M3/GDP). The consumer price index is used as a proxy for the price of non-tradables (CPI), and gross domestic product (GDP) represents income. Lachaal and Womack (1998) in their study on Canadian agriculture also used CPI as a proxy for the price of non-tradables.

4.3 Real exchange rate model specification

This section outlines the possible impacts macro-economic fundamentals have on the exchange rate. Each of the macro-economic fundamentals is explained and illustrated.

4.3.1 External terms of trade

This is defined as the ratio of the world price of the country's exports to the world price of imports. An improvement (deterioration) in Terms of Trade (TOT) leads to

the appreciation (depreciation) of the equilibrium real exchange rate (Asfaha and Huda, 2002; Simwaka, 2004). Aron *et al* (1997) also found that an increase in TOT would have a positive effect on the real exchange rate.

4.3.2 The effects of government expenditure on the real exchange rate

According to Asfaha and Huda (2002), the direction of the movement in the equilibrium real exchange rate (ERER) that is associated with changes in government expenditure, depends on the composition of the expenditure between tradable goods and non-tradable goods. When spending is directed towards the non-traded goods sector, the price of the non-traded goods rises relative to that of traded goods, thereby appreciating the real effective exchange rate. The reverse is true when expenditure is directed to the traded goods sector. The empirical literature, however, seems to suggest that the share of government expenditure towards non-tradables outweighs that on tradables, thereby predicting a positive coefficient. The ratio of total government expenditure to GDP was found by Aron *et al* (1997) to have positive and significant effects on the ERER in South Africa.

4.3.3 Trade restrictions

Trade restrictions refer to a country's trade policy stance, which is mainly reflected in the magnitude and structure of import tariffs and quotas. Trade restrictions, i.e. tariffs and quotas, increase the domestic price of tradables and thus result in both income and substitution effects. Depending on whether the income or substitution effects of trade restrictions dominate, the ERER either depreciates or appreciates. Thus tightening restrictions (i.e. a rise of tariff) leads to a higher relative increase in the price of non-tradables, thereby resulting in real appreciation of the ERER. On the other hand, declines in trade restrictions, i.e. a shift towards trade liberalization, results in real depreciation of the ERER. Aron *et al* (1997) observed that the trade policy in South Africa will have a positive effect on the exchange rate, that is, reforms aimed at reducing tariffs and eliminating trade restrictions are consistent with a more depreciated real exchange rate.

4.3.4 Capital control

Capital control refers to any restriction or control that results in some impediment on free borrowing and lending of capital to and from the rest of the world. Thus, for example, South Africa experienced financial sanctions by the international community in the 1980s. A relaxation of capital controls may affect the long run path of ERER positively or negatively. Edwards (1989) shows that if liberalization of capital controls increases the inflow of capital, it leads to expansion of the monetary base. Chowdhury explains that the expansion of the monetary base “raises current expenditure over income and increases the demand for non-tradables” (Chowdhury, 1999:8). As a result, prices of non-tradables increase in order to maintain the internal balance, resulting in appreciation of the ERER. Therefore, the net effect on ERER of the relaxation of capital controls depends on the net inflow of capital.

4.3.5 Technological and productivity improvements

Technological and productivity improvement (TPI) is a non-policy domestic variable that generally increases productivity efficiency. TPI is a variable that is used to capture the so-called Ricardo-Balassa-Samuelson hypothesis that states that technological and productivity improvements in rapidly growing economies tend to be concentrated in the tradable sector. As a result, the relative price of tradable goods drops, resulting in appreciation of the equilibrium exchange rate path.

4.4 Relative agricultural price model specification

This section outlines the relationship between relative agricultural prices and their determinants. Prices of agricultural goods relative to non-agricultural goods are determined by the relative price of the traded component of the sector and other macro-economic policy indicators that influence the price of the non-tradables.

4.4.1 Real exchange rate

The impact of the exchange rate policy on relative agricultural prices will be estimated through both actual and equilibrium exchange rate. The impact of the exchange rate on the agricultural sector has been discussed in some detail in Chapter 2.

4.4.2 Government expenditure

The impact of the fiscal policy on relative agricultural prices will be estimated through the ratio of government expenditure to GDP. The decline in government expenditure will lead to a decrease in prices of tradables relative to non-tradables (appreciation of exchange rate), and the end result will be an increase in prices of agricultural goods relative to non-agricultural goods (Schiff and Valdes, 2002). This variable was dropped, however, as it consistently failed to provide information beyond the results provided by money supply.

4.4.3 Degree of openness

The impact of the South African trade policy on relative agricultural prices will be estimated through the degree of openness of the South African economy. Trade liberalisation will lead to an increase in the prices of agricultural goods relative to non-agricultural goods through a decline in prices of industrial goods and a decline in the RER (Lachaal and Womack, 1998). Trade liberalisation in the economy can be represented by the degree of openness of the domestic economy.

4.4.4 Money supply

The impact of the monetary policy on relative agricultural prices will be estimated using the ratio of money supply to GDP. An increase in money supply will lead to an increase in commodity prices (Frankel, 1986; Bordo, 1980; Batten and Belongia, 1986). Most researchers have argued that agricultural prices overshoot upward in the short run and downward in the long run because of changes in money supply. One of the reasons why it is expected that agricultural prices are more flexible than industrial

prices is that agricultural prices are usually freer to adjust due to (almost) perfect competition (Ardeni and Freebairn, 2002; Bordo, 1980; Rausser *et al*, 1986).

4.4.5 Income

Income represented by real GDP is expected to have a negative effect on relative agricultural prices. Schiff and Valdes (2002) and Lachaal and Womack (1998) argue that income elasticity for food is generally less than one.

An increase (decrease) in prices of agricultural goods relative to non-agricultural goods, in turn, results in an increase (decline) in their production. According to Saghalian *et al* (2002), changes in US farm policies led to farm income being determined by market prices. Farmers can no longer rely on deficiency payment and price supports to cushion a large variation in farm prices. If money is neutral in the long run, farmers can be assured that there are no long-term effects.

4.5 Analysis of the impact of macro-economic variables on the agricultural sector

This section begins by exploring the actual relationships between the dependent and independent variables discussed above. The analysis is exploratory in nature, focusing on the underlying relationships, trends and causality between macro-economic and agricultural variables.

Figure 4.1 shows the percentage change in money supply and the exchange rate between the US dollar and the South African Rand (ZAR). The increase in money supply is associated with depreciation of the Rand. Money supply increased by 13 percent in 1985 and the Rand per US dollar depreciated by more than 50 percent. The Rand appreciated by 10 percent in 1987 and the money supply increased by 16 percent. In 2001 and 2002, the Rand compared to the US dollar depreciated more than the rise in money supply. In most of the period under study, an increase in money supply was accompanied by depreciation of the Rand against the US dollar.

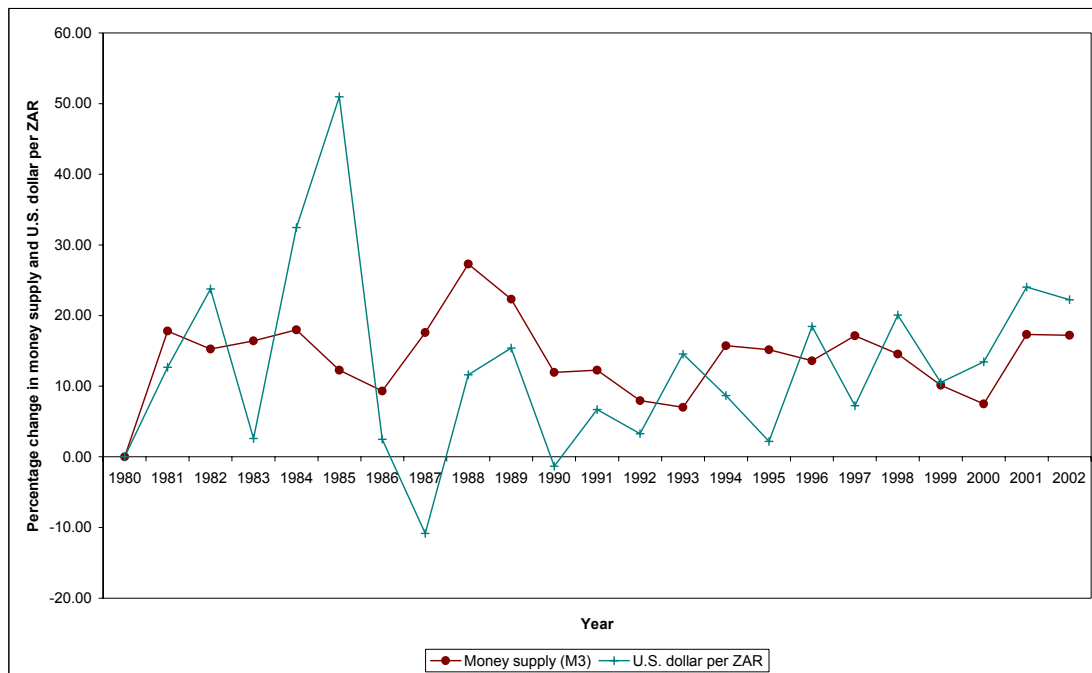


Figure 4.1: Percentage change in money supply and US dollar per ZAR

Source: South Africa Reserve Bank (2004)

4.5.1. The impact of the exchange rate on South African agriculture

This subsection gives a summary of the impact of the exchange rate on the agricultural sector in South Africa. Figure 4.2 shows the US dollar per Rand, and the farm input prices between 1980 and 2002. The base year for agricultural input prices is 2000, and the index for the price of all farm requisites was used as a proxy for agricultural input prices. The appreciation of the exchange rate is associated with a decrease in the price of imported agricultural inputs such as fertilizers, and pesticides. The figure shows that the Rand depreciated heavily from 77 cents per US dollar in 1980 to R1.08/US\$ in 1982. The early 1980's were characterised by the deregulation of the financial sector and removal of explicitly subsidized interest rates in the agricultural sector. This depreciation of the value of the Rand coincided with an increase in the price of agricultural inputs.

The appreciation of the value of the Rand by more than 10 percent in 1987 also coincided with an increase in the price of agricultural inputs by more than 10 percent. The value of the Rand depreciated heavily in 1996 and 1998 when the Rand lost 18 percent and 20 percent of its value, respectively. The Rand again depreciated by more than 24 percent in 2001 after the September 11 attack in the USA. The agricultural

input prices increased by less than 10 percent in 1998 and 1999, and by 20 percent in 2000.

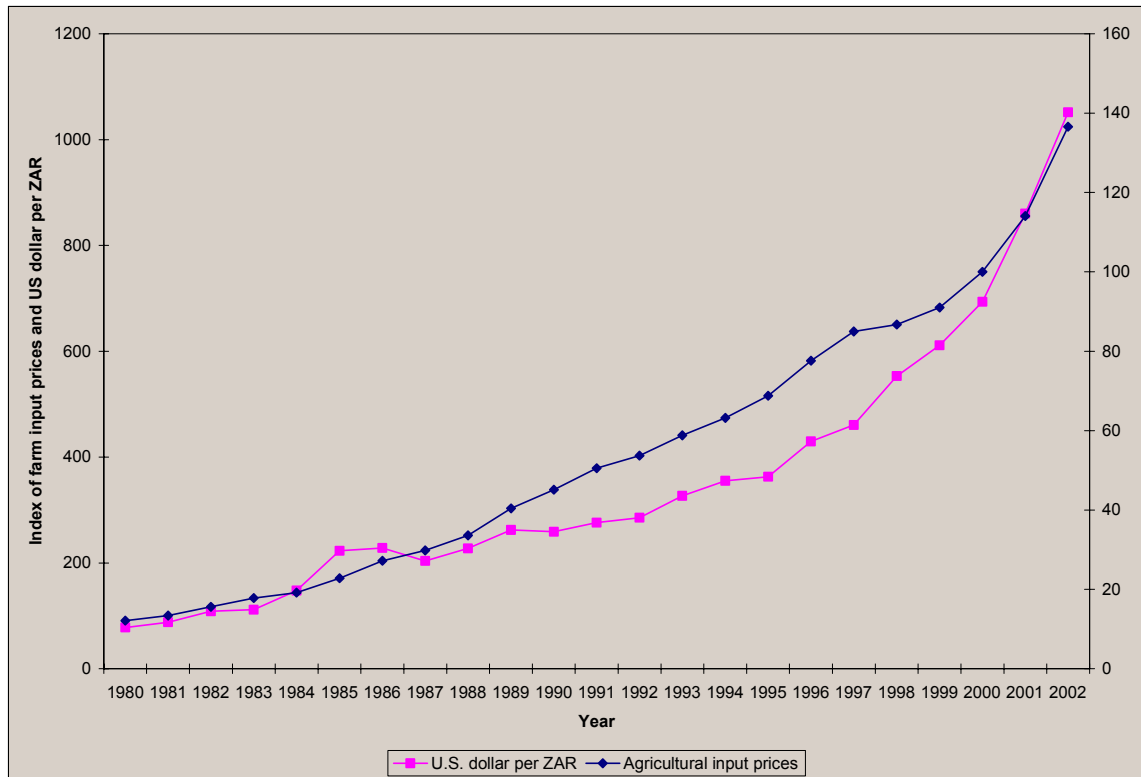


Figure 4.2: The impact of exchange rate on agricultural input prices

Source: South African Reserve Bank (SARB)(2004); National Department of Agriculture (NDA) (2005).

This study merely investigates the trends between the value of the Rand and agricultural output prices. The agricultural sector is one of the major tradable sectors in the South African economy. Hence, movement in the value of the exchange rate affects the agricultural prices. Figure 4.3 depicts the relationship between the exchange rate and agricultural output prices. The depreciation of the Rand coincided with increases in output prices at a decreasing rate, and the appreciation of the Rand coincided with an increase of agricultural commodity prices. For example, the depreciation of the Rand by more than 50 percent in 1985 coincided with an increase in farm output prices of only 8 percent, and the appreciation of the Rand by 10 percent in 1987 led to an increase in output prices of more than 16 percent. Between 1996 and 2001, output prices increased at a rate below the depreciation of the Rand. The discussion shows that there is a significant relationship between agricultural prices

and changes in the value of the exchange rate, but there is a need to quantify the empirical relationships (Grennes *et al*, 1980).

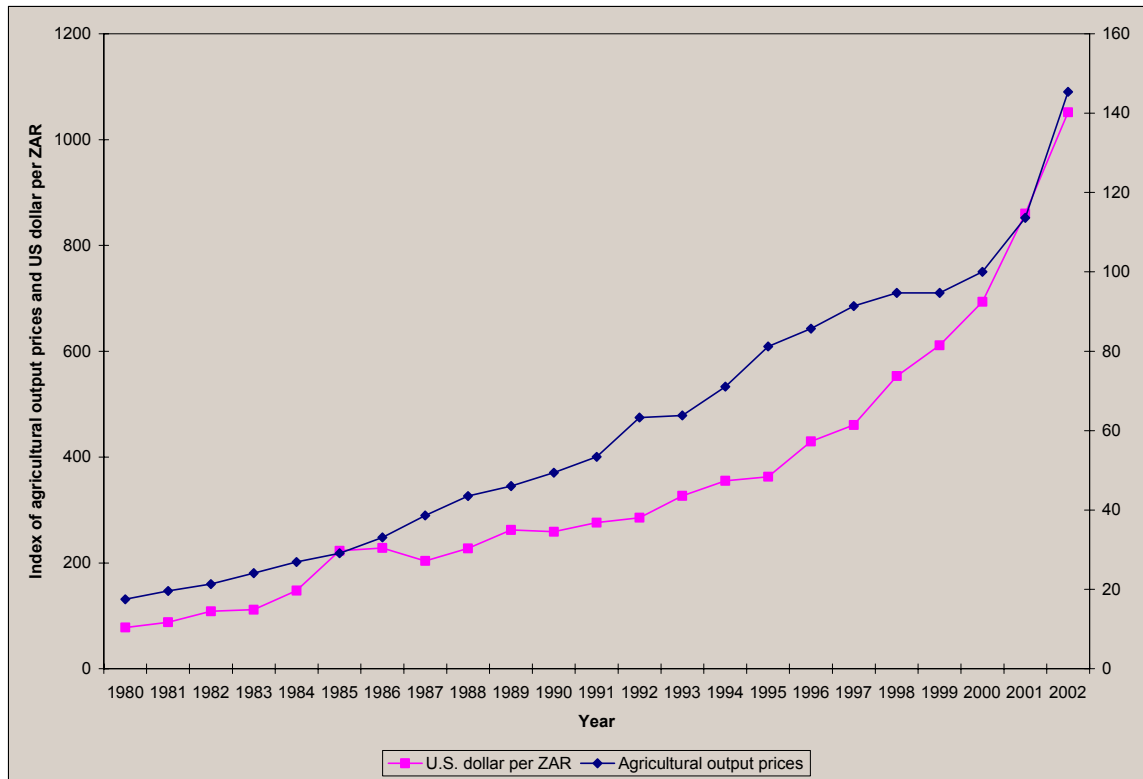


Figure 4.3: Relationship between agricultural output prices and U.S. dollar per ZAR

Source: SARB (2004); NDA (2005)

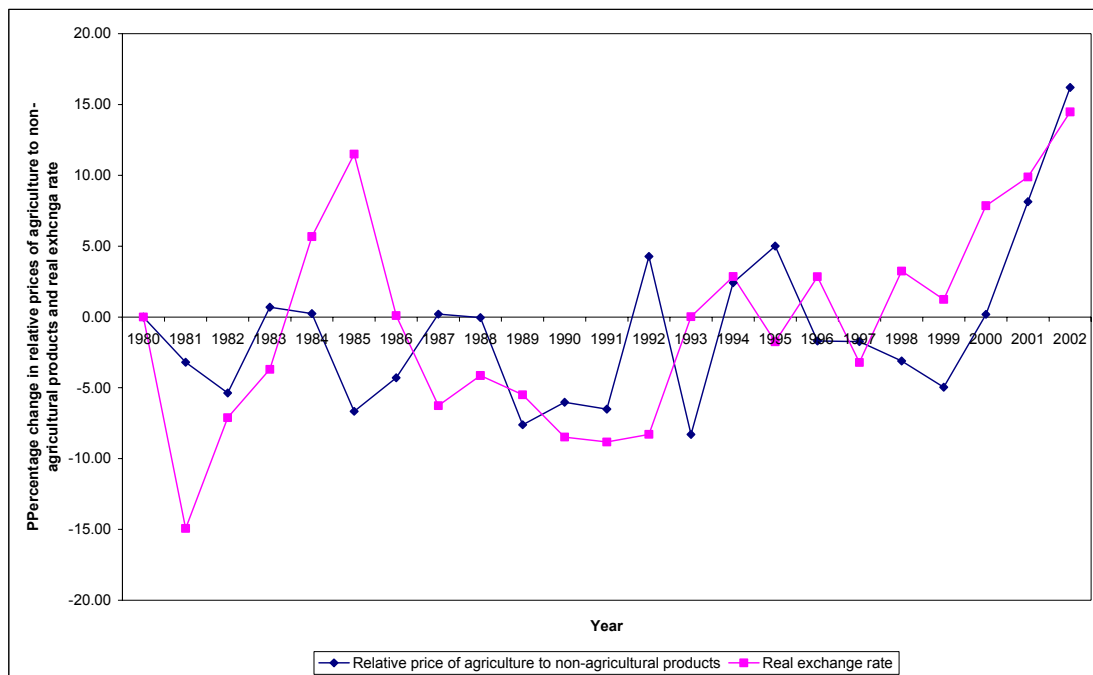


Figure 4.4: Percentage change in relative agricultural prices and real exchange rate

Source: SARB (2004); NDA (2005)

Figure 4.4 represents the percentage changes in the prices of agricultural products relative to non-agricultural products as well as the real exchange rate between 1980 and 2002. There was a sharp decline in the real exchange rate (appreciation) of 15 percent coinciding with decreases in the relative agricultural prices by 3.20 percent.

Table 4.3 shows that the real exchange rate and the relative agricultural prices are positively correlated. Table 4.2 (below) indicates that real exchange rate does Granger-cause changes in the relative agricultural prices. An increase of 11.50 percent in the real exchange rate led to a decrease in the relative prices of agriculture to agricultural products by 0.666 percent. During 1999, the increase in the real exchange rate (depreciation) or 2.84 percent led to a decline in the relative prices of agriculture to agricultural products by 2 percent. Similarly, an increase in the real exchange rate of 3.23 percent was associated with a decrease in the relative prices of agriculture to agricultural products by 3 percent. Finally, the rise in the real exchange rate by 10 percent led to 8.13 percent increase in relative prices of agriculture. These data indicate that the changes in the real exchange rate do, indeed, impact on the relative prices of agriculture.

Figure 4.5 shows the relationship between the exchange rate and the gross value of agricultural production in South Africa. The 50 percent depreciation in the Rand coincided with an increase in the value of agricultural production by just over 4 percent. It is important to note that a depreciation of the exchange rate is associated with an increase in exports (which are derived from domestic production). The appreciation of the Rand in 1987 also coincided with an increase in agricultural output of more than 20 percent. Most notably, the agricultural value of production increased by more than 32 percent when the Rand depreciated by just over 24 percent in 2001.

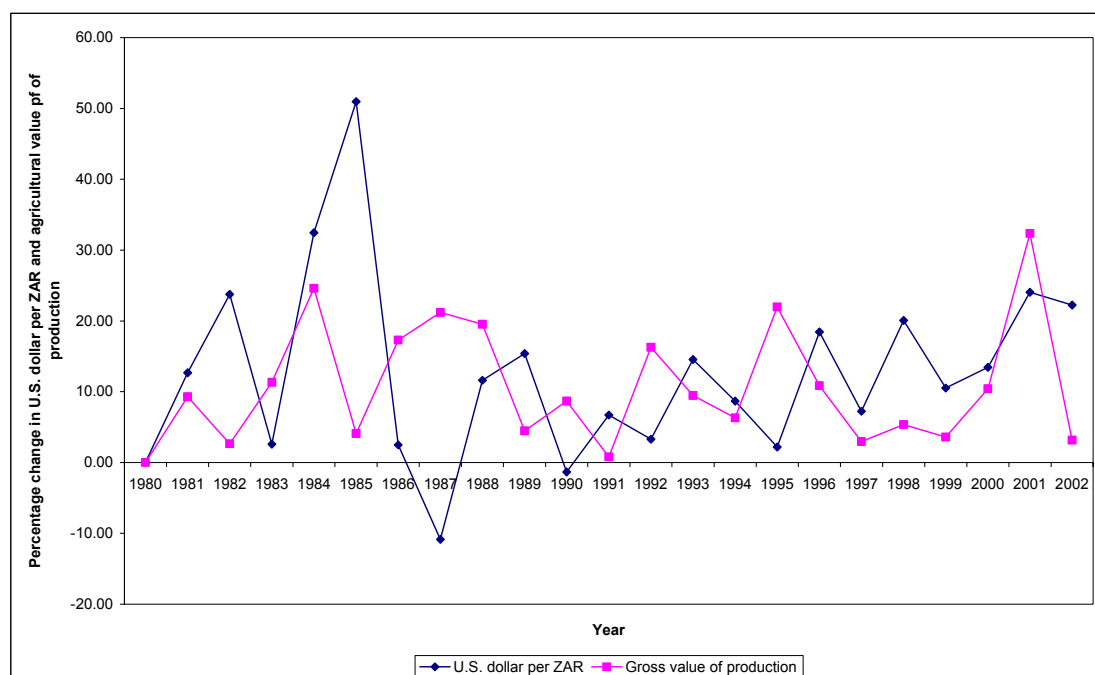


Figure 4.5: Percentage change in US dollar per ZAR and agricultural production
 Source: SARB (2004); NDA (2005)

The literature review in Chapter 2 indicated that an increase in money supply should lead to increases in agricultural prices. This is quite evident in South Africa, as agricultural prices have followed the same trend as the changes in money supply, as illustrated by Figure 4.6. An increase in money supply by 17 percent in 1981 led to an increase in agricultural prices by 12 percent. Agricultural output prices increased by more than 12 percent when the money supply rose by 27 percent. Even more interesting is that the agricultural commodity prices increased by more than 18

percent in 1992 when the money supply rose by just less than 8 percent. In 2000, the money supply rose by 7 percent and the agricultural output by 5 percent.

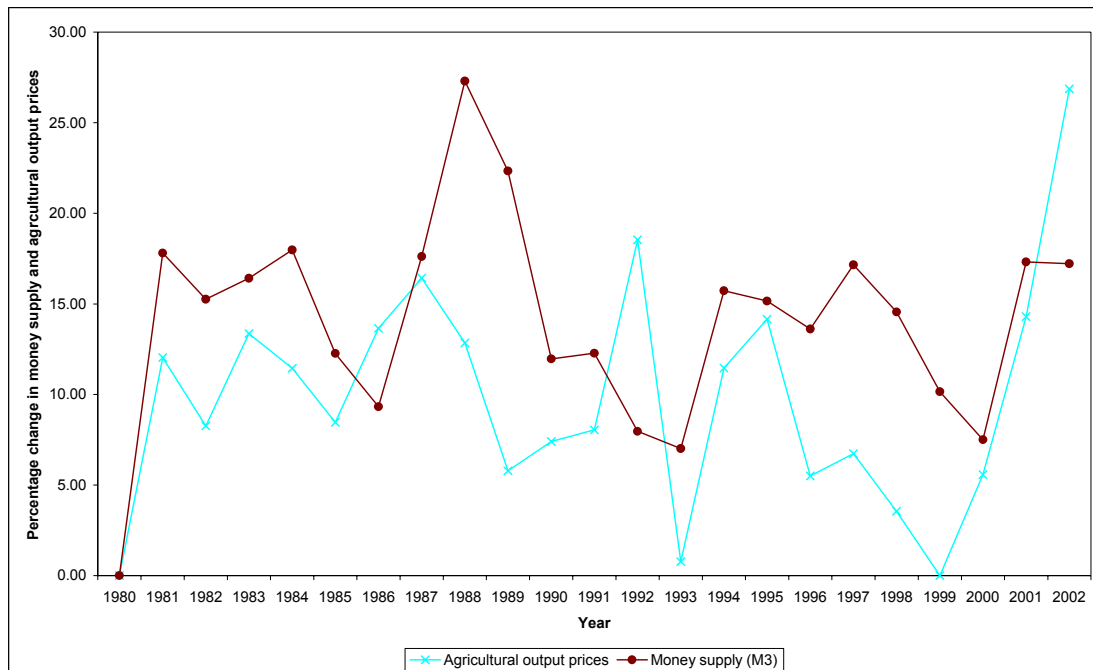


Figure 4.6: Percentage change in agricultural output prices and money supply
 Source: SARB (2004); NDA (2005)

Similarly, an increase in money supply will lead to an increase in agricultural input prices. Figure 4.7 shows that an increase in money supply coincides with an increase in agricultural input prices. However, in most cases farm input prices increased at a rate below the increase in money supply. In 1988 the money supply increased by 27 percent, and the farm input prices rose by just 12 percent. Agricultural input prices rose at a rate above the money supply in 2000 and 2002. The data show that there is a positive relationship between money supply and farm input prices in South Africa, but, also, that the magnitude of this correlation still needs to be quantified.

Table 4.3 shows the correlation between macro-economic variables and agricultural variables. The data show that the aggregate money supply and the index of farm input prices are positively correlated. Table 4.2 also shows, however, that the money supply does not Granger-cause changes in farm input prices.

Table 4.2: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Probability
INTA does not Granger Cause AGRICP	13	0.05848	0.94359
AGRICP does not Granger Cause INTA		0.48331	0.63365
M3 does not Granger Cause AGRICP	13	3.04094	0.10416
AGRICP does not Granger Cause M3		0.36463	0.70543
PINPUT does not Granger Cause AGRICP	13	2.21989	0.17104
AGRICP does not Granger Cause PINPUT		0.96092	0.42266
PPIA does not Granger Cause AGRICP	13	3.82356	0.06833
AGRICP does not Granger Cause PPIA		3.84779	0.06749
RANDUS does not Granger Cause AGRICP	13	2.75831	0.12271
AGRICP does not Granger Cause RANDUS		0.90852	0.44100
RELAT does not Granger Cause AGRICP	13	0.15860	0.85596
AGRICP does not Granger Cause RELAT		2.05129	0.19092
RER does not Granger Cause AGRICP	13	1.26479	0.33321
AGRICP does not Granger Cause RER		2.79166	0.12032
RANDUS does not Granger Cause EXPORT	13	4.58612	0.04710
EXPORT does not Granger Cause RANDUS		1.20027	0.35005
RELAT does not Granger Cause EXPORT	13	0.47754	0.63691
EXPORT does not Granger Cause RELAT		1.37678	0.30630
RER does not Granger Cause EXPORT	13	0.36170	0.70732
EXPORT does not Granger Cause RER		4.32836	0.05321
GDP does not Granger Cause GCONS	13	2.57239	0.13720
GCONS does not Granger Cause GDP		0.02677	0.97367
GVAGRIC does not Granger Cause GCONS	13	4.65684	0.04558
GCONS does not Granger Cause GVAGRIC		0.18466	0.83483
PINPUT does not Granger Cause GCONS	13	2.88662	0.11382
GCONS does not Granger Cause PINPUT		0.31481	0.73857
PPIA does not Granger Cause GCONS	13	1.47032	0.28588
GCONS does not Granger Cause PPIA		2.10814	0.18391
RELAT does not Granger Cause GCONS	13	0.36232	0.70692
GCONS does not Granger Cause RELAT		1.72233	0.23875
GVAGRIC does not Granger Cause GDP	13	3.45195	0.08302
GDP does not Granger Cause GVAGRIC		35.3157	0.00011
PINPUT does not Granger Cause GDP	13	2.61595	0.13362
GDP does not Granger Cause PINPUT		2.50481	0.14299
PPIA does not Granger Cause GDP	13	2.06549	0.18914
GDP does not Granger Cause PPIA		5.12564	0.03691
RELAT does not Granger Cause GDP	13	0.32670	0.73049
GDP does not Granger Cause RELAT		1.50141	0.27948
INTA does not Granger Cause GVAGRIC	13	3.99108	0.06278
GVAGRIC does not Granger Cause INTA		0.79823	0.48297
M3 does not Granger Cause GVAGRIC	13	3.09150	0.10123

GVAGRIC does not Granger Cause M3		3.59645	0.07688
PINPUT does not Granger Cause GVAGRIC	13	1.98330	0.19975
GVAGRIC does not Granger Cause PINPUT		4.12357	0.05878
PPIA does not Granger Cause GVAGRIC	13	0.39687	0.68496
GVAGRIC does not Granger Cause PPIA		8.37022	0.01093
RANDUS does not Granger Cause GVAGRIC	13	2.53454	0.14040
GVAGRIC does not Granger Cause RANDUS		2.96445	0.10882
RELAT does not Granger Cause GVAGRIC	13	0.86719	0.45617
GVAGRIC does not Granger Cause RELAT		4.81861	0.04233
RER does not Granger Cause GVAGRIC	13	0.75839	0.49934
GVAGRIC does not Granger Cause RER		5.33087	0.03377
PINPUT does not Granger Cause INTA	13	0.18074	0.83797
INTA does not Granger Cause PINPUT		1.18379	0.35453
PPIA does not Granger Cause INTA	13	0.06801	0.93478
INTA does not Granger Cause PPIA		2.66300	0.12989
PINPUT does not Granger Cause M3	13	10.5072	0.00578
M3 does not Granger Cause PINPUT		1.58605	0.26292
PPIA does not Granger Cause M3	13	0.70113	0.52412
M3 does not Granger Cause PPIA		3.00957	0.10604
RELAT does not Granger Cause M3	13	0.33844	0.72261
M3 does not Granger Cause RELAT		0.83525	0.46834
RANDUS does not Granger Cause PINPUT	13	3.79027	0.06951
PINPUT does not Granger Cause RANDUS		2.02393	0.19441
RER does not Granger Cause PINPUT	13	1.39930	0.30122
PINPUT does not Granger Cause RER		3.29371	0.09046
RANDUS does not Granger Cause PPIA	13	7.27663	0.01583
PPIA does not Granger Cause RANDUS		2.38497	0.15403
RER does not Granger Cause PPIA	13	4.22732	0.05587
PPIA does not Granger Cause RER		2.84658	0.11651
RELAT does not Granger Cause RANDUS	13	1.12956	0.36976
RANDUS does not Granger Cause RELAT		1.92972	0.20706
RER does not Granger Cause RELAT	13	3.84074	0.06773
RELAT does not Granger Cause RER		3.29443	0.09042

Table 4.3: Correlation between macro-economic policy variables and agricultural variables

	Index of agricultural production	Government expenditure	Gross value of agricultural production	Weighted interest rate	Index of prices of agricultural inputs	Aggregate money supply	Real exchange rate	Index of agricultural products	Relative agricultural prices	Rand per US dollar
Index of agricultural production	1.00	0.70	0.77	0.09	0.79	0.79	-0.32	0.76	-0.64	0.76
Government expenditure	0.70	1.00	0.84	0.23	0.88	0.81	-0.61	0.88	-0.89	0.79
Gross value of agricultural production	0.77	0.84	1.00	0.05	0.99	0.99	-0.41	0.99	-0.69	0.98
Weighted interest rate	0.09	0.23	0.05	1.00	0.10	0.07	-0.48	0.10	-0.33	-0.01
Index of prices of agricultural inputs	0.79	0.88	0.99	0.10	1.00	0.99	-0.47	1.00	-0.74	0.97
Aggregate money supply	0.79	0.81	0.99	0.07	0.99	1.00	-0.39	0.98	-0.67	0.98
Real exchange rate	-0.32	-0.61	-0.41	-0.48	-0.47	-0.39	1.00	-0.48	0.81	-0.25
Index of agricultural products	0.76	0.88	0.99	0.10	1.00	0.98	-0.48	1.00	-0.73	0.96
Relative agricultural prices	-0.64	-0.89	-0.69	-0.33	-0.74	-0.67	0.81	-0.73	1.00	-0.60
Rand per US dollar	0.76	0.79	0.98	-0.01	0.97	0.98	-0.25	0.96	-0.60	1.00

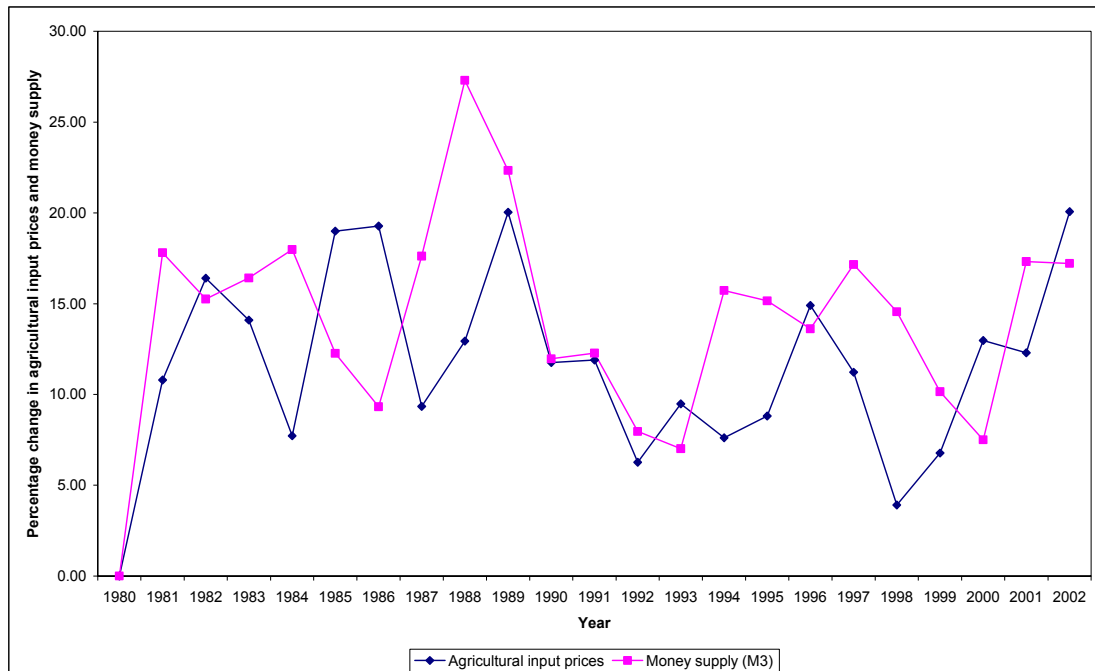


Figure 4.7: Percentage change in agricultural input prices and money supply
Source: SARB (2004); NDA (2005)

Figure 4.8 shows the percentage change in money supply, US dollar per South African Rand, and agricultural exports. Money supply is measured using the aggregate M3. Lachaal and Womack (1998) also measured money supply using the aggregate measure in M3, while Saghaian *et al* (2002) used M1. This study will use M3 to take into account all the interest rates related information contained in the money supply. Theory stipulates that appreciation of the exchange rate results in a decline in exports. Agricultural exports have only declined in 1983 and 1990, while in this same period the Rand only appreciated in 1990. The appreciation of the Rand by over 1 percent and the increase in money supply by 11 percent led to a decline in agricultural exports by approximately 19 percent in 1990. Depreciation of the Rand by 24 percent in 2001 led to an increase in agricultural exports by 27 percent. This confirms the negative relationship between exchange rate and exports. This also implies that the depreciation of the Rand means good news for domestic agricultural exporters, while the reverse is true with an appreciation of the Rand. As with other macro-economic variables, the magnitude of these impacts has to be quantified.

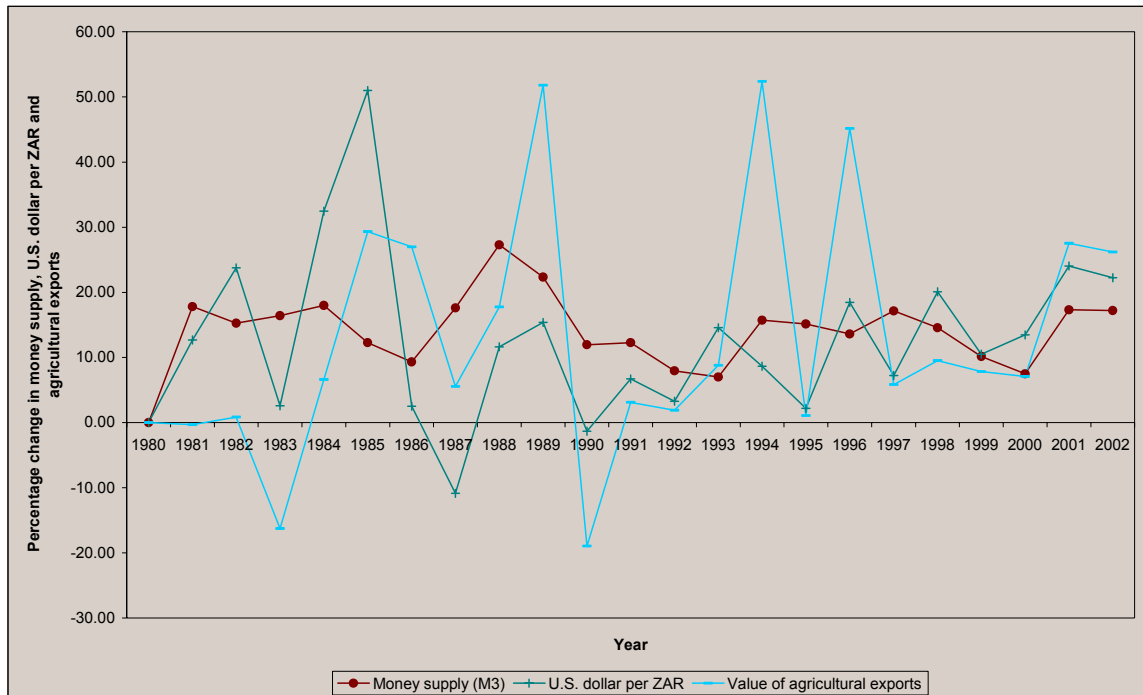


Figure 4.8: Percentage change in money supply and U.S. dollar per ZAR and agricultural exports

Source: SARB (2004); NDA (2005).

4.5.2 The effects of fiscal policy on the agricultural sector

This subsection summarises the impact of fiscal policies on the agricultural sector. Figure 4.9 shows the ratio of government expenditure and government debt to GDP between 1980 and 2002. The ratio of government debt to GDP increased significantly between 1991 and 1995. In this period, the ratio increased from 37 percent to 50 percent. But the implementation of the government strategy, GEAR, saw the government debt as a ratio to GDP decline to a mere 40 percent in 2002. In the same way, the government expenditure ratio to GDP increased from 14 percent in 1980 to 20 percent in 1994. Again, this ratio declined to only 18 percent in 2002.

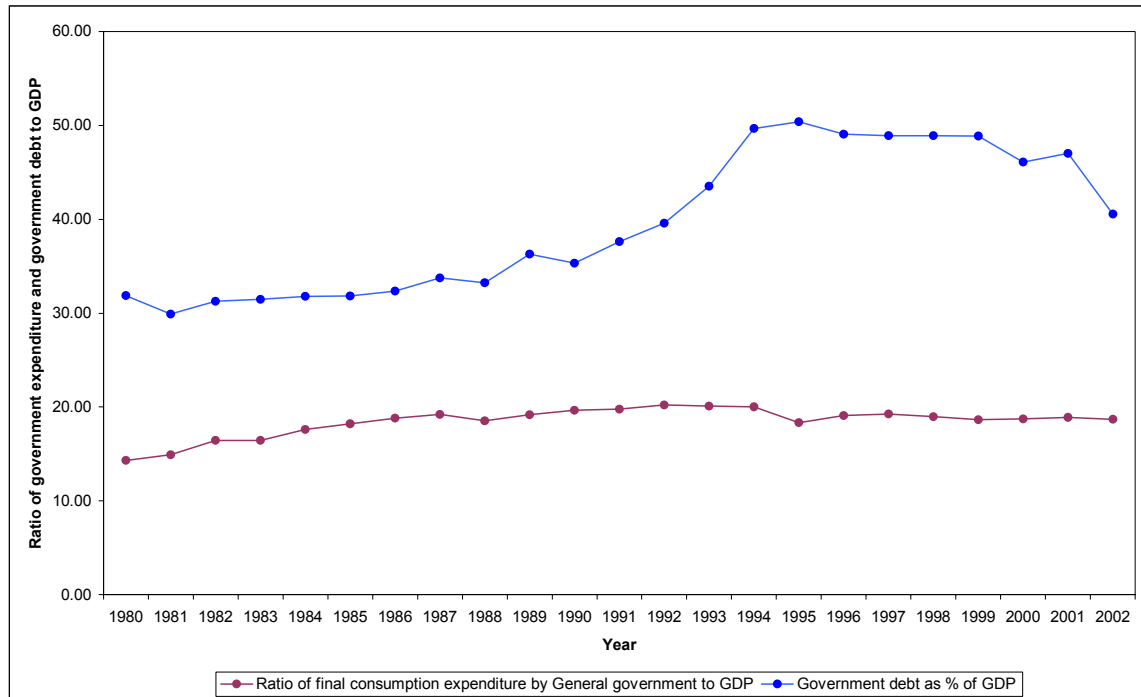


Figure 4.9: Ratio of government expenditure and government debt to GDP
Source: SARB (2004)

As was mentioned in the literature review in Chapter 2, an increase in government expenditure leads to an increase in agricultural output prices.. Figure 4.10 shows the percentage change in government expenditure and agricultural output prices. In the period under study, an increase in government expenditure was associated with an increase in agricultural output prices, with the exception of 2000. Most importantly, agricultural prices increased at a rate higher than the changes in government expenditure. In 1981, government expenditure increased by approximately 2 percent while agricultural prices increased by over 12 percent. Again, in 1992, government expenditure increased by 2 percent and farm commodity prices rose by more than 18 percent. A year after the first democratic elections in South Africa there was a 6 percent decline in government expenditure while farm output prices rose again by 14 percent. The highest ever increase in agricultural output prices, in the study period, was recorded in 2000 with an increase of 26 percent, which coincided with only 3.73 percent increase in government expenditure. Table 4.3 shows that government expenditure and the index of agricultural output prices are positively correlated. Table 4.2 shows that changes in government expenditure affect the index of agricultural output prices in a unidirectional manner.

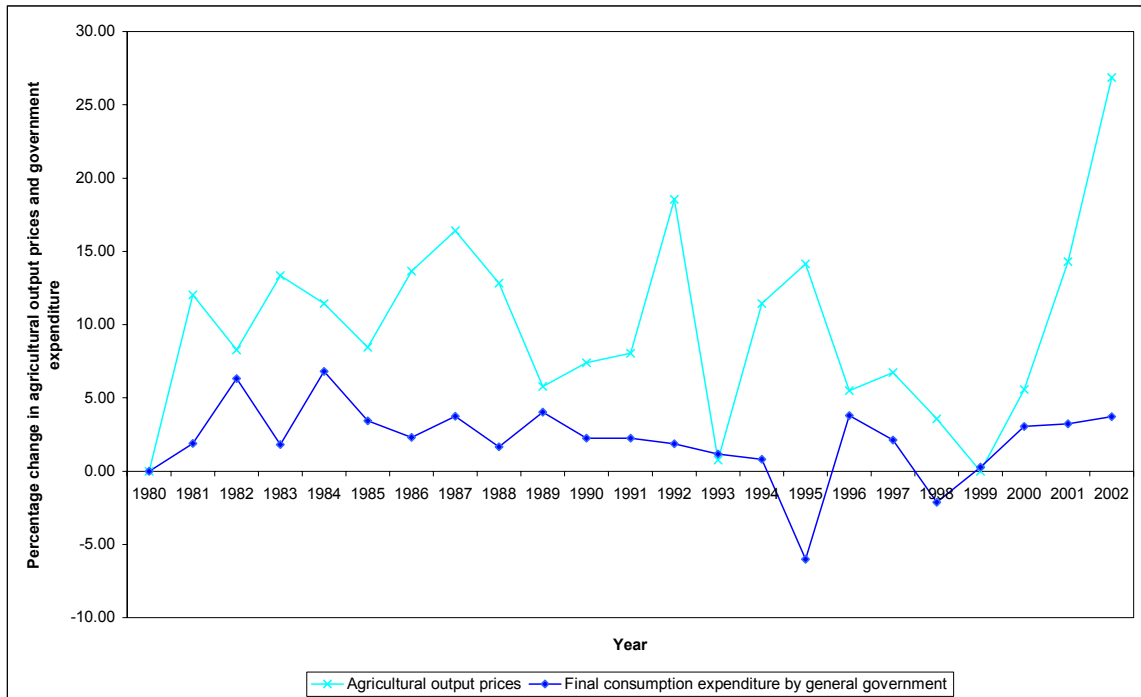


Figure 4.10: Percentage change in government expenditure and farm output prices

Source: SARB (2004); NDA (2005)

The change in agricultural production follows the changes in agricultural incentives. Figure 4.11 illustrates the percentage change in gross value of agricultural production and government expenditure. Similarly to agricultural output prices, the agricultural value of production increased at a rate higher than changes in government expenditure. In 1984, the value of the agricultural production increased by 24.62 percent while government expenditure only rose by 6.81 percent. The government expenditure declined by 6 percent while the value of the agricultural production increased by 21 percent. Table 4.3 shows that the gross value of agricultural production and government expenditure are positively correlated. Again, Table 4.2 shows that government expenditure affects the gross value of the agricultural production in a unidirectional manner.

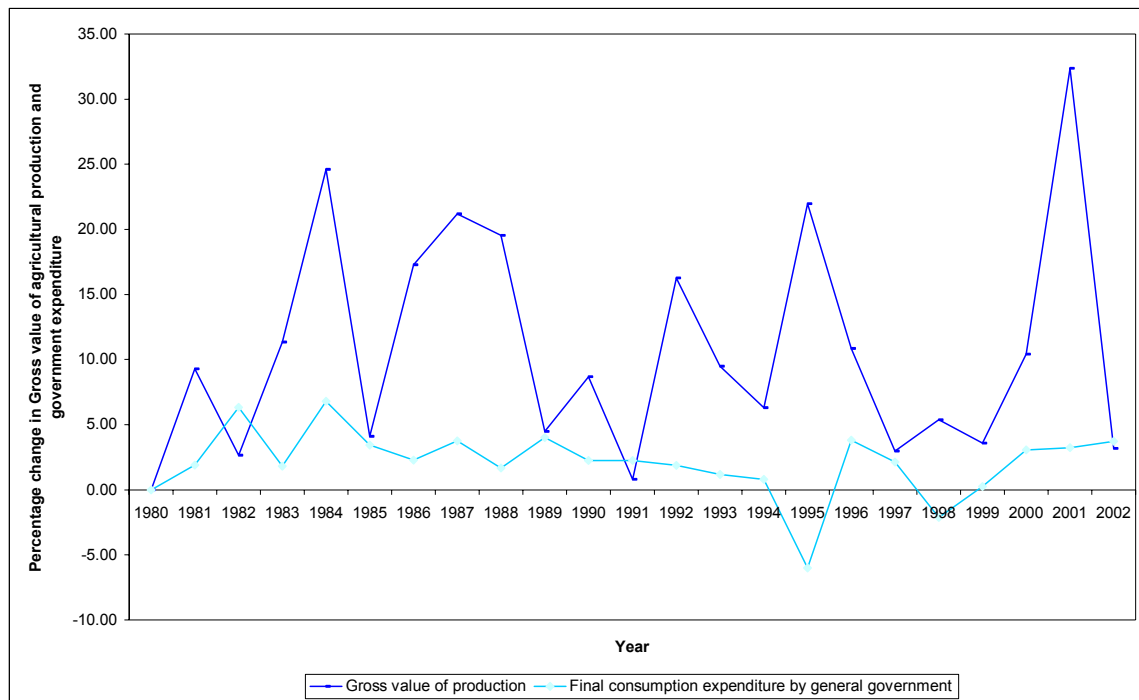


Figure 4.11: Percentage change in gross value of agricultural production and government expenditure

Source: SARB (2004)

Figure 4.12 shows the percentage change in agricultural exports and in government expenditure between 1980 and 2002. According to macro-economic theory, an increase in government expenditure leads to an appreciation of the exchange rate, which, in turn, results in a decline in exports. This indicates that there is a relationship between government expenditure and exports through the resulting appreciation. Having said this, in 1983, however, the decline in government expenditure led to the decrease in agricultural exports by more 16 percent. Again, in 1995, the decrease in government expenditure of 6 percent led to an increase in agricultural exports by just over 1 percent (this is reasonable, though). These data show quite clearly that there is a positive relationship between government expenditure and agricultural exports. Table 4.2 shows that government expenditure does not Granger-cause changes in agricultural exports.

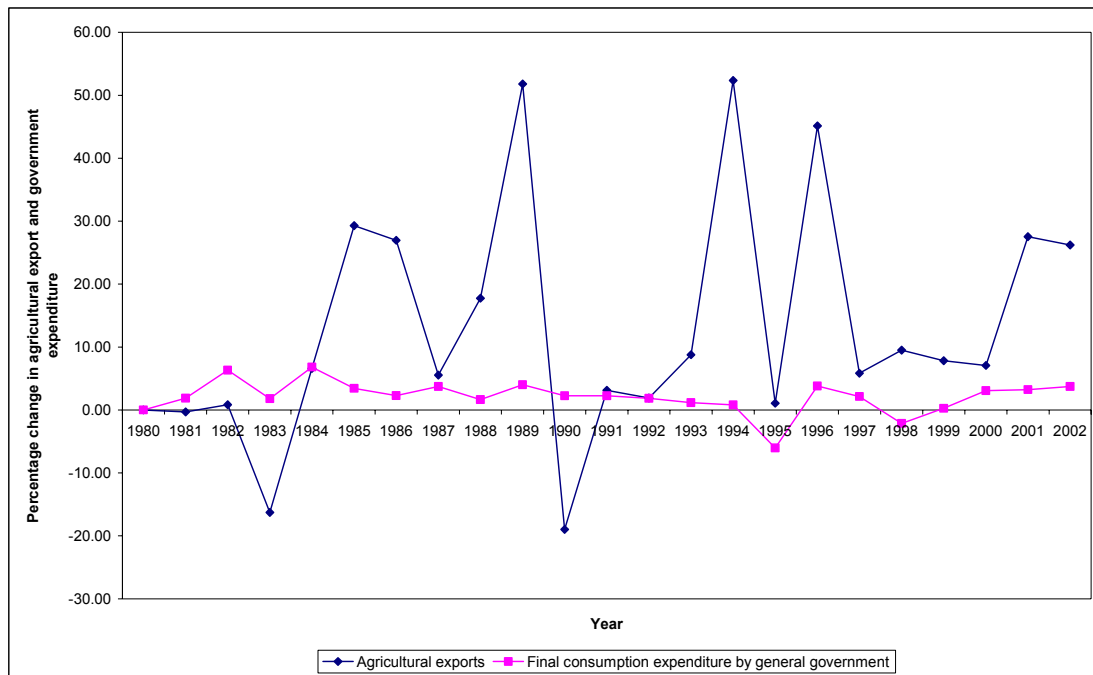


Figure 4.12: Relationship between agricultural exports and government expenditure

Source: SARB (2004); NDA (2005).

4.6 Data Description

This study used quarterly data over a period of fourteen years, commencing in the first quarter of 1988 and ending in the fourth quarter of 2002. All variables except the TECHN are estimated in logarithms. The data were readily available for terms of trade, ratios of government expenditure and public expenditure to GDP, since the South African Reserve Bank (SARB) publishes these data. The data for real exchange rate were not available. Hence the data for real effective exchange rate were used as suggested by Asfaha and Huda (2002), that is, proxies were constructed for capital controls, trade restrictions, technological and productivity growth. Agricultural statistics were collated from the Abstract of Agricultural Statistics published by the National Department of Agriculture (NDA, 2005).

Domestic resource balance was used as a proxy for capital controls, openness of the economy, for trade restrictions. The rate of growth of real output (TECHN) was used for the technological and productivity growth variables. The domestic resource balance is calculated as: $RESBAL = (\text{export} * \text{TOT} - \text{import}) / \text{GDP}$, with all the variables

at a constant 1995 price. Degree of openness (OPEN) is calculated as the sum of exports and imports divided by GDP at a constant 1995 price.

Elbadawi and Khan (1997) suggested using moving averages of government expenditure as a proxy for government consumption, which measures government expenditure on non-tradables. However, the proxy for government consumption performed poorly in the model by Elbadawi and Khan and they decided to omit this variable as it fails to provide any further information beyond that contained in government expenditure. Therefore, the ratio of government expenditure to GDP was used instead as a proxy for government consumption on non-tradable goods.

4.7 Testing for unit root tests

Variables are integrated of order zero, denoted as $I(0)$, if these variables are stationary in level. And if variables need to be differenced once to become stationary, it is taken to be integrated of order one denoted as $I(1)$. The order of integration is checked to avoid a spurious regression result (Engle and Granger, 1987; Banerjee, Dolado, Galbraith and Hendry, 1993). The most widely used tests for unit root are the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The PP test is considered to be more powerful than the ADF, but the ADF test appears to outperform PP even in small samples (Elbadawi and Soto, 1996). The null hypothesis of a unit root is tested against the alternative hypothesis of stationary data. If the test statistic is less than the critical value (in absolute terms), the null hypothesis is rejected, and we, then, conclude that the data has no unit root. If, on the other hand, the test statistic is greater than the critical value, we fail to reject the null hypothesis, and the inference is that there is a unit root (Simwaka, 2004).

Appendix 1 presents the test results of the null hypothesis of the presence of a unit root. Appendix 2 shows the critical values for level variables and first difference variables. The test results for the variables in the levels indicate that the null hypothesis cannot be rejected at the 5% significance level for all variables (LNRER, LNTERMSG, LNGEXPGDP, LNPUBGDP, LNDECON, LNRESBAL) except the rate of growth of real output (TECHN). Appendix 1 also includes the test results for the first difference variables, which indicate that the null hypothesis is rejected at the

5% significance level for all variables. Therefore, all variables in the model, except TECHN, are integrated of order one, denoted as I(1).

4.8 Co-integration tests

The co-integration test helps reveal the exact number of co-integrating relationships present between variables in the model (Solomon, 2003). Furthermore, after carrying out the co-integration test, unit root tests are carried out on the error correction term in order to establish whether variables are in fact co-integrated. Simwaka (2004) outlined the two main reasons for co-integration tests. Firstly, there is the need to identify the plausibility of estimating an error correction model that incorporates the long run information lost by differencing the variables. Secondly, the error correction term assists with the estimation of the speed of adjustment of the ERES to the long run equilibrium level. Co-integration implies the presence of long run equilibrium relationship among the non-stationary variables (Asfaha and Huda, 2002). Therefore, a co-integrated group of variables is stationary despite it being a linear combination of individually non-stationary variables. The Johansen co-integration test is used to test the number of co-integrating relationships between the variables in the model, as well as the nature of the relationships. The greater the number of co-integrating vectors, the more stable is the relationship amongst variables in the system. The Johansen co-integration test shows that there are two integrating equations. The ADF statistic is -4.999 and that of Phillips Perron (PP) is -7.822. The critical values for the ADF and PP at the 5% level of significance are -2.9127 and -2.9118, respectively.

Table 4.4 below shows the Johansen co-integration test for the relative agricultural price model. The co-integration test indicates that there are two co-integrating equations at the 5 percent level of significance.

Table 4.4: Johansen co-integration test

Test assumption: No deterministic trend in the data				
Series: LNRELAT LNRER LNM3GDP LNGDP				
	Likelihood	5 Percent	1 Percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CE(s)
0.412761	56.15979	39.89	45.58	None **
0.207451	25.28499	24.31	29.75	At most 1 *
0.14347	11.79996	12.53	16.31	At most 2
0.04742	2.81773	3.84	6.51	At most 3

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 2 co-integrating equation(s) at 5% significance level

The ADF test is -4.617764 and PP test is -6.935945 at a 5% critical value of -2.9146 and -2.9137, respectively.

4.9 Granger causality test

The Granger causality test is used to test the existence and direction of causality between the real effective exchange rate and its fundamentals. This test is further used to test the direction of causality between relative agricultural prices and their determinants. The results for the exchange rate model and relative agricultural prices are presented in Appendixes 3 and 7, respectively. The results reveal no endogeneity between the vector of equilibrium exchange rate and its fundamentals. Results of the test indicate that the real exchange rate fundamentals Granger-cause changes in the equilibrium real exchange rate represented by the real effective exchange rate in a unidirectional manner. Again, the results of the test indicate that the determinants of the relative agricultural prices Granger-cause changes in the relative agricultural prices in a unidirectional manner. Therefore, the use of Ordinary Least Squares (OLS) in both models is valid since all determinants Granger-cause changes in the dependent variables.

4.10 Methodology of estimating exchange rate misalignment

This study has adopted the model and steps specified by Asfaha and Huda (2002) for estimating real exchange rate misalignment. The estimation model and steps are discussed below.

4.10.1 Estimating the degree of the RER misalignment

The empirical estimation of the real exchange rate misalignment means estimating the equilibrium real exchange rate (ERER) and computing the difference between the actual real exchange rate and the equilibrium exchange rate. The estimation the ERER involves three steps (Asfaha and Huda, 2002). The first step is estimating the long run parameters of the relationship between the RER and its fundamental variables from the static model, [equation 14]. The second step is calculating sustainable components for the fundamental variables by removing temporary components from the time series. The third step is deriving the ERER by combining the long run parameters obtained from step one with the sustainable components of the fundamental variables.

4.10.1.1 Step One: estimating the Error Correction Model

This step was estimated in the previous sections under 4.7 and 4.8, by testing the presence of unit root and co-integration among variables.

4.10.1.2 Step two: Calculating sustainable components of the fundamentals

According to Asfaha and Huda (2002), sustainable components of the equilibrium exchange rate fundamentals can be calculated using the five quarters moving-average technique in order to isolate the permanent components of the exchange rate fundamental variables from their respective transitory components. In order to make sure that no observations from the time series are dropped, the data were smoothed by calculating the five quarters moving-average beginning in the first quarter of 1987 as suggested by Asfaha and Huda (2002) and Elbadawi and Soto (1996).

4.10.1.3 Step three: Calculating sustainable components of the fundamentals

The third step in computing the equilibrium exchange rate is to combine the long run parameters of the ECM, obtained from [equation 16], with the sustainable components of the fundamentals (Asfaha and Huda, 2002). Next, the exchange rate misalignment is computed as the logarithmic difference between the real exchange rate and the

computed equilibrium value (Asfaha and Huda, 2002; Elbadawi and Soto, 1996), i.e. $Exac_t = \log e_t - \log e_t^*$; Where, $Exac_t$ is the exchange rate misalignment index, and e_t is actual equilibrium exchange rate and e_t^* is the equilibrium exchange rate.

4.11 Summary

This Chapter described the development of the econometric model that was used to estimate the impacts of macro-economic policies on the real exchange rate and on relative agricultural prices. The relationship between the dependent variables and the determinants were also specified.

This study used quarterly data from the period 1988 - 2002. All variables except the variable representing productivity (TECHN) are estimated in logarithms. The unit root test indicated that all variables in the model except TECHN are integrated of order one, denoted as I(1). TECHN is integrated in levels denoted as I(0). The Johansen co-integration test indicates that there are only 2 co-integrating equations.

The Granger-Causality test results indicate that the real exchange rate fundamentals Granger-cause changes in the equilibrium real exchange rate represented by real effective exchange rate in a unidirectional manner. Again, the results of the test indicate that the determinants of the relative agricultural prices Granger-cause changes in the relative agricultural prices in a unidirectional manner. Therefore, the use of Ordinary Least Squares (OLS) in both models is valid since all determinants Granger-cause changes in the dependent variables.

CHAPTER 5

ESTIMATION OF EXCHANGE RATE MISALIGNMENT AND THE IMPACT OF SELECTED MACRO-ECONOMIC POLICIES ON AGRICULTURAL PRICES: EMPIRICAL RESULTS

5.1 Introduction

The previous chapter discussed model development, order of integration as well as co-integration of the equations. All variables in the model are integrated of order one, denoted as $I(1)$ except TECHN, which is stationary in levels. The relationship between the real effective exchange rate and its fundamentals was found to be unidirectional. This Chapter presents the results of the error correction model (ECM) and the real effective exchange rate misalignment index. In addition, the Chapter also presents the results of the impacts on relative agricultural prices emanating from macro-economic influences.

Section 5.2 presents the estimation results of the real exchange rate misalignment and Section 5.3 presents the estimation results for relative agricultural prices. Section 5.4 analyses the impacts of macro-economic policy variables on the South African agricultural sector given the empirical results. Section 5.5 provides the summary of this Chapter.

5.2 The estimation results of the real exchange rate model

Table 5.1 below shows the results for the long run parameters of the equilibrium exchange rate. The static long run parameters (the first step of estimation of the two step Engle-Granger Approach) appear significant. Table 5.2 shows the short run model of the equilibrium real exchange rate, and this model is important to derive the speed of adjustment of disequilibria in the exchange rate.

Table 5.1: The long run model of real exchange rate

Variables	Coefficients	t-statistics
LNTERMSG	0.729	(2.11)*
LNPUBGDP	-0.030	(-0.162)
LNGEXPGDP	1.458	(4.209)*
LNDECON	0.555	(1.910)***
LNRESBAL	-0.750	(-2.004)**
TECHN	-0.008	(-1.566)
C	-0.215	(-0.167)
R-squared = 0.52		
DW = 0.74		
F-statistics = 9.712		
Probability = 0.000000		

NB: level of significance: * at 1%; ** at 5%; and *** at 10%

Table 5.3 presents the diagnostic tests. These tests include the Jarque-Bera, Breusch-Godfrey LM test, ARCH test, White test and Ramsey Reset test. The F-statistic is significant, which implies that the model is also significant. The Durbin-Watson statistic test for first order autocorrelation is 2.04 (which is strictly not applicable in the presence of a lagged dependent variable) (Asfaha and Huda, 2002). The Jarque-Bera test tests the null hypothesis of normality of the distribution of the residual term and the test is significant. The Breusch-Godfrey Serial Correlation test tests the null hypothesis of serial autocorrelation, but the test results are not significant, which indicates that there is no serial autocorrelation. The ARCH test is a test for autoregressive conditional heteroscedasticity and was found to be insignificant, indicating homoscedasticity. The last test is the Ramsey RESET Test, which is the general test of mis-specification of the model, and this test was found to be insignificant, indicating that the model is well specified.

Table 5.2: Short run model of real exchange rate

Variables	Coefficients	t-statistics
C	0.011	1.408
ECM_resid	-0.17	(2.301)**
D(LNTERMSG)	-0.038	-0.274
D(LNPUBGDP)	-0.018	-0.259
D(LNGEXPGDP)	0.238	0.938
D(LNDECON)	-0.124	-1.935
D(LNRESBAL)	-0.073	-0.811
TECHN	-0.003	-1.415
Dum01	-0.056	-2.466**
Dum98	-0.044	-1.907***
R-squared = 0.28 AdjustedR-squared = 0.13		
DW = 2.23		
F-statistics = 1.86 Probability = 0.0837		

NB: level of significance: * at 1%; ** at 5% ; and *** at 10%

Table 5.3: Diagnostic tests

Diagnostic tests	Tests Results	Probability
Histogram normality test	Jargue-bera = 11.542	0.003
Breusch-Godfrey Serial Correlation LM Test	Obs*R-squared = 1.472	0.225
ARCH Test	Obs*R-squared = 1.096	0.296
Specification test: Ramsey RESET Test	F-statistic = 0.027	Probability = 0.869

Table 5.2 shows that the speed of adjustment is slow, indicating that 17 percent of the disequilibria in exchange rate is offset by short run adjustments in each period. This coefficient is significant at the 1 percent level and has a negative sign, which indicates that negative short run adjustments correct positive deviations from the equilibrium.

The estimated long run parameters of the model in Table 5.1 agree with the theoretical model. The elasticity of the RER with respect to the terms of trade (TERMSG) is positive (0.729) in the long run showing that a percentage increase in terms of trade appreciates the real effective exchange rate by 0.729 percent. This result is consistent with results found by Asfaha and Huda (2002), Elbadawi and Khan (1997) and Simwaka (2004) for South Africa. Therefore, the increase in competitiveness of the

South African economy correlates positively with the appreciation of the exchange rate.

The ratio of government expenditure to GDP (GEXPGDP) coefficient shows that the real effective exchange rate appreciates by 1.458 percent in response to 1 percent increase in GEXPGDP. The estimated elasticity for the GEXPGDP variable is positive and significant, which indicates that government spends a fairly large share of its income on non-tradable goods. The estimated elasticity for the ratio of public expenditure to GDP (PUBGDP) is negative and insignificant. Although this coefficient is insignificant, the result is consistent with the result found by Asfaha and Huda (2002) for South Africa. This result indicates that expenditure by the South Africans on goods and services does not influence movement or changes in the value of the Rand.

The estimated elasticity for the degree of openness of the South African economy (DECON) is positive and significant at the 10 percent level of significance. The DECON coefficient shows that the real effective exchange rate appreciates by 0.555 percent in response to 1 percent increase in the DECON. The result reflects the fact that trade liberalization and the subsequent re-integration of South Africa to the rest of the world have led to a large net inflow of capital. This result is consistent with the theoretical model which specified that an increase in the DECON will result in an appreciation of the value of the Rand.

The estimated coefficient for the domestic resource balance (RESBAL) is significant at the 5 percent level of significance and shows that the real effective exchange rate depreciates by 0.750 percent in response to a percentage increase in RESBAL. This result is consistent with the findings obtained by Asfaha and Huda (2002) for South Africa, and shows that a decrease in net capital inflows - which induces an increase in resource balance (Asfaha and Huda, 2002) - results in an equilibrium exchange rate depreciation. The technological and productivity improvement variable that is used as a proxy for the Ricardo-Balassa-Samuelson effect is the growth rate of the real output (TECHN). This variable is statistically insignificant. The result indicates that technological and productivity growth in South Africa does not have a dominant effect on both long run and short run movements of the real exchange rate. This result

contrasts with findings by Simwaka (2004) and Asfaha and Huda (2002), who have found that changes in TECHN do have an influence on the value of the Rand. Simwaka, using the industrial production index as a proxy for the technological and productivity improvement variable, found the TECHN to be insignificant in long run. Simwaka also found that the TECHN has negative effect on real exchange rate in the short run. Asfaha and Huda used the growth rate of real output as a proxy for the technological and productivity improvement variable and found that the TECHN has a positive effect on the exchange rate in the long run.

The short run parameters of the model shown in Table 5.2 demonstrate the short run impact of the fundamentals on the RER. According to Asfaha and Huda (2002), the short run parameters in the estimation of the equilibrium exchange rate are not of real interest, but they are included in the model for reasons of measurement precision to obtain the long run parameters. The short run dynamics of the ECM also include two dummy variables that are included based on the graph of the real effective exchange rate. These dummies capture the Asian crisis, which impacted on the Rand (dum 98) and the fall in the Rand towards the end of 2001 (dum01).

5.2.1 Estimating the equilibrium exchange rate

The equilibrium real exchange rate (ERER) is derived by combining the long run parameters of the Error Correction Model (ECM) with the sustainable components of the fundamentals (Asfaha and Huda, 2002). The long run coefficients of the actual real exchange rate are shown in Table 5.1. Sustainable components of the fundamentals are computed by calculating five quarters moving-average. To avoid dropping some observations, moving averages were computed starting in 1987:1. The resulting ERER index can be specified as:

$$\log(ERER) = 0.215 + 0.729 LNTERMSG^* + 1.458 LNGEXPGDP^* - 0.030 LNTPUBGDP^* + 0.555 LNDECON^* - 0.750 LNRESBAL^* - 0.008 LNTECHN^*$$

Where the asterisks over the variables indicate that they are the sustainable components of the fundamentals. Figure 5.1 and Appendix 6 show the logarithm of the actual and equilibrium effective exchange rates for the period 1988:1 to 2002:4.

These results show a good fit between the actual and the equilibrium exchange rates in South Africa.

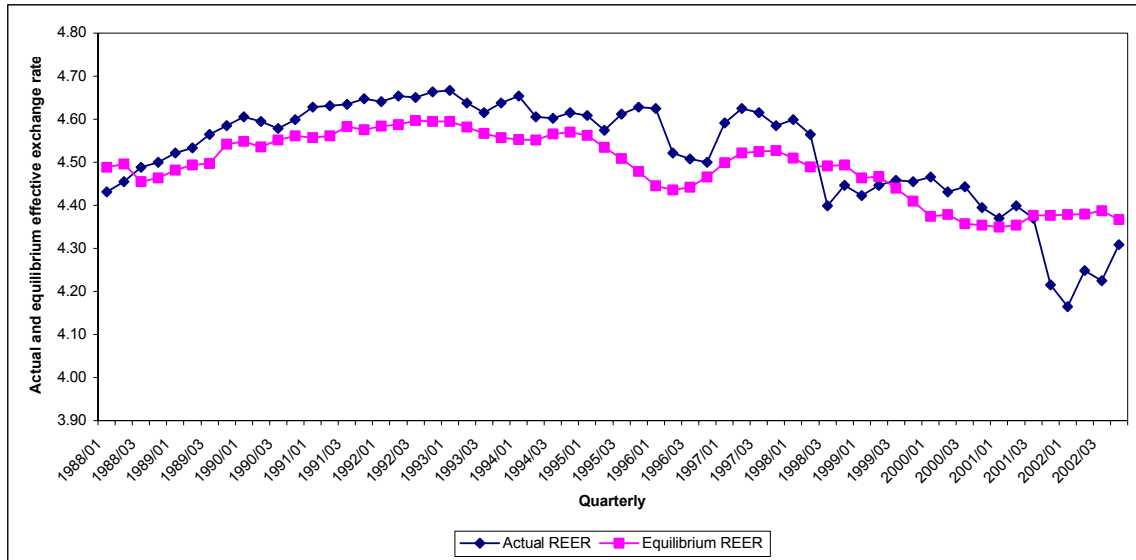


Figure 5.1: The logarithm of actual versus equilibrium effective exchange rate

Figure 5.2 shows the real effective exchange rate misalignment in South Africa between 1988:1 and 2002:4. The data show that the period of undervaluation was between 1988:1 and 1988:2. The period between 1988:3 and 1998:2 experienced overvaluation while the period between 1998:3 and 1999:2 experienced undervaluation. Furthermore, the effective exchange rate was overvalued between 1999:03 and 2001:2, and the period between 2001:3 and 2002:4 experienced undervaluation.

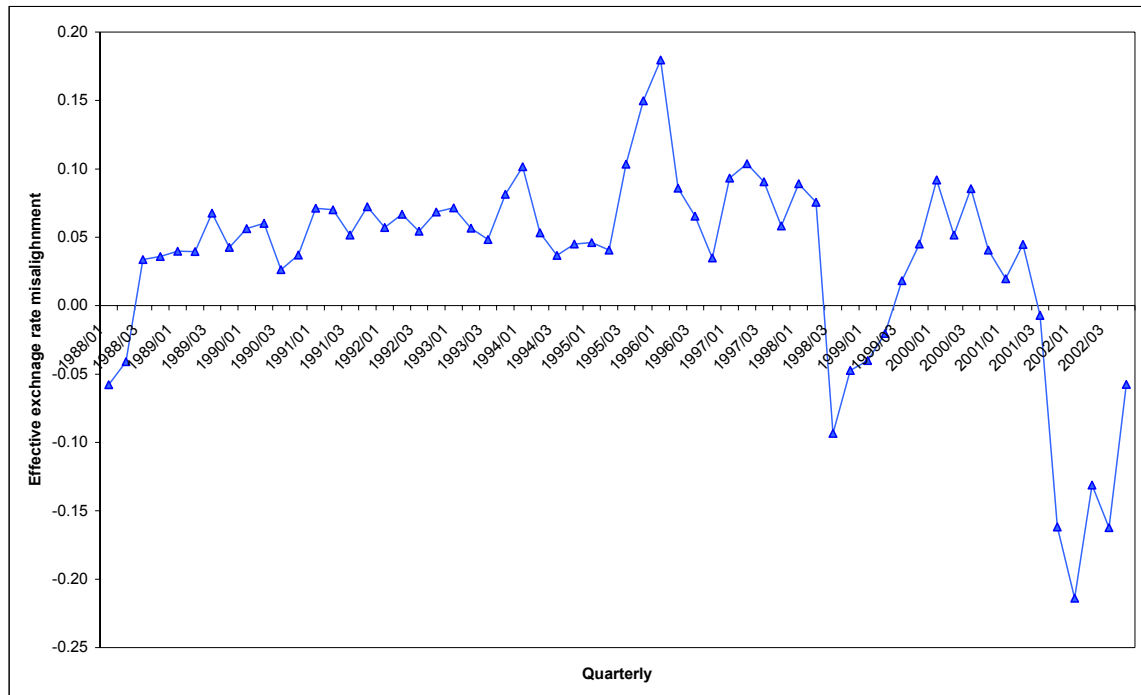


Figure 5.2: Real effective exchange rate misalignment (1988:1 -2002:04)

5.3. The estimation results of the impacts on relative agricultural prices

As a follow-up to the analysis above, this Section discusses the impacts of macro-economic policy variables on the relative agricultural prices in South Africa. The impact of the exchange rate policy on the relative agricultural prices is estimated through both the actual and equilibrium exchange rate (RER or ERER). The impact of trade liberalisation on the relative agricultural prices is estimated through the degree of openness of the South African economy (DECON). The impact of monetary policy on the relative agricultural prices will be estimated using the ratio of money supply to GDP (MSGDP). The fiscal policy variable (government expenditure) was dropped from the equation as it consistently failed to account for the movement in the relative agricultural prices. The results are presented in subsection 5.3.1.

5.3.1 The long-run parameters of relative agricultural prices

The first step of the Engle-Granger two-step estimation is the long run estimation, as discussed earlier. Table 5.4 presents the long run parameters of relative agricultural prices with the exchange rate measured using the actual real effective exchange rate.

Table 5.4: The long-run parameters of relative agricultural prices using LNRER

Explanatory Variables	Coefficient
Intercept	7.816 (1.109569)
LNRER	-0.340 (-3.098)*
LNDECON	0.055 (0.487)
LNGDP	-0.232 (0.909)
LN3M3GDP	-1.189 (-4.060)*
R-square	0.66
Durbin-Watson	0.78

Note: the t-statistics are in parenthesis

* Significant at 1% significance level

The relative prices of agriculture to non-agricultural goods were calculated as agricultural prices divided by the consumer price index (CPI). Appreciation of the effective exchange rate is associated with a decline in the relative prices of agriculture. A one percent increase in the actual real exchange rate leads to a 0.340 percent decline in relative agricultural prices. This result is consistent with results found by Saghaian *et al* (2002) for the US economy and those of Lachal and Womack (1998) for the Canadian agricultural sector. These results indicate that appreciation of the Rand will have a negative effect on the prices received by farmers.

The degree of openness of the South African economy (DECON) and the gross domestic product (GDP) were found to be insignificant. This means that DECON and GDP do not play a dominant role in determining the price of agricultural goods relative to non-agricultural goods. Lachal and Womack (1998) also found the openness variable to be insignificant as a determinant of relative agricultural prices in Canada. The integration of the South African economy including the agricultural sector into world markets will not have a significant effect on prices received by domestic farmers. This implies that trade liberalisation in South Africa does not influence movement or changes in agricultural prices.

An increase in the money supply was found to lead to a decline in relative agricultural prices. A one percent rise in the money supply is associated with a 1.189 percent

decline in prices of agricultural goods relative to non-agricultural goods. This implies that in South Africa, money supply and agricultural price are negatively related. In contrast, the literature review (Chapter 2) indicated that an increase in money supply does not have any effect on agricultural prices in the long run.

Table 5.5: The long-run parameters of relative agricultural prices using LNERER

Explanatory Variables	Coefficient
Intercept	-2.075 (-0.212)
LNERER	-0.340 (-0.139)
LNDECON	-0.071 (-0.616)
LNGDP	0.108 (0.309)
LN3M3GDP	-0.158 (-2.898)*
R-square	0.55
Durbin-Watson	0.67

Note: the t-statistics are in parenthesis

* Significant at 1% significance level

Table 5.5 (above) shows the results estimated using the equilibrium real effective exchange rate (not the actual REER as discussed above). However, the results were insignificant except for the results for money supply, which were consistently negative.

5.3.2 The short run parameters of relative agricultural prices

The short-run estimation of relative prices of agriculture and their determinants, namely money supply (M3GDP), income (GDP), exchange rate (RER), and degree of openness (DECON), can be modelled as follows:

$$LNRELAT = \beta_0 + \beta_1 LNRER + \beta_2 LNDECON + \beta_3 LNGDP + \beta_4 LNM3GDP \quad (18)$$

Where β_s are coefficients. Since all variables are stationary in first difference form, the model can now be specified as follows:

$$\Delta LNRELAT = \beta_0 + \beta_1 \Delta LNRER + \beta_2 \Delta LNDECON + \beta_3 \Delta LNGDP + \beta_4 \Delta LNM3GDP \quad (19)$$

To incorporate the short run requires that the error correction model (ECM) be introduced. The ECM is the second step of Engle-Granger estimation model. ECM contains the short and long run effects, because all the regressed variables are co-integrated. Therefore the ECM is specified as follows:

$$\Delta LNRELAT = \beta_0 + \beta_1 \Delta LNRER + \beta_2 \Delta LNDECON + \beta_3 \Delta LNGDP + \beta_4 \Delta LNM3GDP + \beta_4 \Delta ecm_relat_{t-1} \quad (20)$$

In the ECM, the long-run equilibrium is incorporated by its lagged form:

$$\Delta ecm_relat_{t-1} = \Delta LNRELAT - \beta_0 + \beta_1 \Delta LNRER + \beta_2 \Delta LNDECON + \beta_3 \Delta LNGDP + \beta_4 \Delta LNM3GDP \quad (21)$$

where *ecm_rel* indicates the speed of adjustment towards the long run equilibrium situation and its values are between -1 and 0. The larger the *ecm_rel*, the faster the speed of adjustment. The opposite is true with lower absolute values of *ecm_rel*.

Table 5.6: The short run parameters of relative agricultural prices using LNRER

Explanatory Variables	Coefficient
Intercept	
LNRER	-0.067 (-0.522)
LNDECON	-0.076 (-0.618)
LNGDP	0.156 (0.410)
LNM3GDP	0.248 (0.778)
Ecm_rel	-0.374 (-3.466)*
R-square	0.21
Durbin-Watson	1.85

Note: the t-statistics are in parenthesis

* Significant at 1% significance level

Tables 5.6 and 5.7 indicate the short-run parameters of the ECM for relative agricultural prices using the actual and the equilibrium real effective exchange rates, respectively. As argued earlier, the short run parameters in the estimation are not of interest but they are included in the model for measurement precision in obtaining the long run parameters. The absolute value of *ecm_rel* is 0.37 and 0.36 for both the actual and the equilibrium real effective exchange rate, respectively, which indicates that the speed of adjustment towards equilibrium per period is fast.

Table 5.7: Short-run parameters of relative agricultural prices using LNERER

Explanatory Variables	Coefficient
Intercept	0.011 (-0.907)
LNERER	0.027 (0.082)
LNDECON	-0.111 (0.884)
LNGDP	0.214 (0.510)
LN3GDP	0.252 (0.721)
Ecm_rel(-1)	-0.361 (-3.430)*
R-square	0.21
Durbin-Watson	0.85

Note: the t-statistics are in parenthesis

* Significant at 1% significance level

5.5 Summary of the results

The aim of this chapter was to present the results of the study. The results include the impacts of macro-economic fundamentals on the real exchange rate and the impacts of macro-economic variables on the relative agricultural prices. The results were estimated using the error correction model.

The speed of adjustment of the exchange rate model is slow showing that 17 percent of the disequilibria in the exchange rate is offset by short run adjustments in each period. The elasticity of the RER with respect to the terms of trade (TERMSG) is positive in the long run showing that a one percentage increase in the terms of trade appreciates the real effective exchange rate by 0.729 percent. The estimated elasticity for the ratio of government expenditure to GDP variable is positive and significant, which indicates that the larger share of government expenditure is on non-tradable goods and tends to appreciate the exchange rate. GEXPGDP coefficient shows that the real effective exchange rate appreciates by 1.458 in response to a 1 percent increase in GEXPGDP. The estimated elasticity for the degree of openness of the economy (DECON) is positive and significant at 10 percent. The DECON coefficient shows that the real effective exchange rate appreciates by 0.555 percent in response to

1 percent increase in the DECON. The technological and productivity improvement variable that is used to proxy the Ricardo-Balassa-Samuelson effect is statistically insignificant. The result indicates that technological and productivity growth in South Africa does not have a dominant effect on both long run and short run movements of the real exchange rate.

The impact of exchange rate policies on relative agricultural prices is estimated through both the actual and the equilibrium exchange rate. A one percent increase in the actual real exchange rate leads to a 0.340 percent decline in relative agricultural prices. The degree of openness of the South African economy was used to estimate the impact of trade liberalisation on relative agricultural prices. The degree of openness of the South African economy (DECON) and the GDP were found to be insignificant. The impact of monetary policy on the relative agricultural prices was estimated using the money supply to GDP ratio. A one percent rise in money supply is associated with a 1.189 percent decline in relative prices of agriculture. The speed of adjustment towards equilibrium is fairly fast at more than 0.36.

The results indicate that the appreciation of the Rand did have a negative effect on the prices received by farmers. The degree of openness of the South African economy and the gross domestic product do not have a significant effect on the prices of agricultural goods relative to non-agricultural goods. The integration of the South African economy, including the agricultural sector, into world markets will not have a significant effect on the prices received by domestic farmers. Furthermore, money supply and agricultural price are negatively related, thus an increase in money supply will reduce the prices received by farmers.

CHAPTER 6

SUMMARY AND CONCLUSION

Chapter 1 of this study provided the background of the study, the objectives, hypothesis and the justification of the study. Chapter 2 presented the literature review related to the relationship between the agricultural sector and macro-economic policies and variables. Chapter 3 presented an overview of the macro-economic environment in South Africa and the statistics related to the contribution of agriculture to the economy, and the relationship between various macro-economic variables and the agricultural sector. Chapter 4 presented the development of the empirical model for the study. It also presented the estimation techniques applied to achieve the objectives of the study. Also the data sources and the description of the data were discussed in this Chapter. Chapter 5 presented the empirical results as well as a discussion of the results.

The major objective of this Chapter is to present the summary and conclusions of the study. Section 6.1 of this chapter will focus on summarising the study, and Section 6.2 will discuss the findings of the study. Section 6.3 points to areas for possible future research.

6.1. Summary of the study

The main objective of the study was to determine the impact of macro-economic policies on South African agricultural performance, given the change in the political environment, trade liberalisation, and the deregulation of the agricultural sector. These changes in the macro-economic environment imply that farmers are facing a greater price uncertainty since prices have come to be determined in the international markets, where South Africa is a relatively small player. In the absence of government interventions, such as subsidies and guaranteed prices, farmers' incomes depend entirely on world market prices they receive for their output. Thus, changes in output prices will directly affect the profitability of the agricultural sector. This Chapter also provided the theoretical and empirical models used for the analysis of the impact of macro-economic policies in developing countries.

Chapter 2 presented a review of the literature related to the feed-back and feed-forward linkages between government policies and the agricultural sector. In this sense, macro-economic policies such as monetary and fiscal policies, exchange rate and trade policies were also referred to as government policies.

There are real and monetary links originating from the agricultural sector that contribute to the economic performance of the general economy, such as employment, fiscal revenues, expenditures and foreign exchange earnings. Government decisions can affect agriculture directly through sector-specific measures including tariffs, input and credit subsidies, price controls, quantitative restrictions and government expenditures and taxes. Indirectly, agriculture incentives are affected by policies such as industrial protection, exchange rates, interest rates and other fiscal and monetary policies.

The impact of macro-economic policies on the agricultural sector was estimated using prices of agriculture relative to non-agricultural prices. In low-income countries, high exchange rates tend to adversely affect agricultural exports and agriculture, generally. The variable commonly used to capture the impact of the exchange rate on agriculture is the real exchange rate (RER), which is the ratio of prices of tradables to non-tradables. An increase in the RER can be interpreted as a relative increase in the prices of tradables, while a decline in the RER implies a relative increase in prices of non-tradables. The agricultural sector has been found to be highly tradable.

Expansionary fiscal policies usually aim to stimulate output in agriculture, but the agricultural sector has low income elasticity and a rigid short run supply response, so that these policies will only increase the agriculture output prices in the short run (via overshooting model), while tight fiscal policies will have a reverse effect. Higher interest rates in agriculture remain largely responsible for the lack of access to commercial finance by farmers, and these constraints condition the response of farmers to available opportunities. Expansionary monetary policies also lead to increases in output prices.

Between 1980 and 2002, the contribution of the agricultural sector to the GDP declined in South Africa.. The share of agriculture in the GDP declined from 6.1 percent in 1980 to 4.1 in 2002. Both the value of agricultural exports and imports increased, but the agricultural exports were relatively higher (37%) than agricultural imports (21%) as a percent of the gross value of agricultural production. Between 1980 and 2002, the degree of openness in the agricultural sector and the South African economy in general increased. This means that the South African economy, including agriculture, has become more integrated in world markets. The degrees of openness in both the agricultural sector and the general economy were approximately 60 percent in 2002. The South African agricultural sector has become more capital than labour intensive. Thus, comparing the number of farm workers in 1980 with that of 1996, the number has declined. The ratio of total farm debt to net farm income has declined, with farm debts still exceeding net farm income. Overall, the agricultural output prices increased over the study period.

Compared to the environment that existed in the 1980s, the macro-economic environment in South Africa in the 1990s changed drastically. . Monetary policies changed their objective from protecting the value of the Rand in the 1980s and early 1990s to fighting inflation and maintaining stable domestic financial markets in the late 1990s. These changes in monetary policies exposed the Rand to international shocks such as the Asian crisis and the September 11 attack in the USA. Fiscal policies also changed with the new macro-economic strategy introduced in 1996. Government expenditure as a percentage of the GDP declined in 2002 to levels comparable to those of the early and late 1990s. After the first democratic elections in South Africa in 1994, the government moved towards trade liberalization by signing the Marrakech Agreement and becoming an active member of the World Trade Organisation.

The data show that the depreciation of the Rand coincided with increases in agricultural commodity prices. Similarly, an increase in government expenditure and money supply coincided with an increase in the agricultural output prices, but the magnitudes of these correlations still have to be quantified. In addition, there is a positive relationship between the real effective exchange rate (REER), and agricultural prices and value of production, but the REER changes by a lower

magnitude than the agricultural prices and the value of production do. The data for the empirical real exchange rate (prices of tradables relative to non-tradables) show that RER had an ambiguous effect on the relative prices of agriculture.

An empirical and theoretical model was developed in Chapter 4 to attempt to empirically estimate the equilibrium real exchange rate (ERER), the exchange rate misalignment and the impact of these macro-economic variables on the South African relative prices of agriculture. The exchange rate model pioneered by Dornbosch (1974) was later on used and modified by others (Elbadawi and Soto, 1996; Aron *et al*, 1997; Asfaha and Huda, 2002). The model was modified following the previously applied model by Lachaal and Womack (1998) for the Canadian agricultural sector, and that of Saghaian *et al* (2002). This study applied a Vector error correction model, and after validating the necessary diagnostic tests, ordinary least squares (OLS) was applied. The results of the study are discussed below in Section 6.2.

6.2 Summary of results

The purpose of this Section is to summarise the empirical results of the analysis of the exchange rate misalignment and the impact of macro-economic policies on the relative prices of agriculture in South Africa. Because of limitations in data capturing, the study period was chosen to be between 1988:01 and 2002:04. This period captures the more significant fluctuations in the exchange rate as well as the important changes in the agricultural policies

The results show that the terms of trade are positively related to the real exchange rate (RER). A one percent increase in the terms of trade will lead to 0.729 percent appreciation in the exchange rate in the long run. In addition, the ratio of government expenditure to the GDP will have a positive effect on the RER. The degree of openness of the economy (DECON) is also positively related to the RER, and the RER appreciates by 0.555 percent in response to a 1 percent increase in the DECON. The technological and productivity improvement variable that is used to proxy the Ricardo-Balassa-Samuelson effect was found to be statistically insignificant. The speed of adjustment is slow showing that 17 percent of the disequilibria in the exchange rate is offset by short run adjustments in each period. The exchange rate was

overvalued between 1989 and 1998, while it was most likely undervalued between 2001 and 2002.

The result for prices of agriculture relative to non-agricultural goods (RELAT) has shown that the RELAT is negatively affected by appreciation of the effective exchange rate. A one percent increase in the actual real exchange rate leads to 0.340 percent decline in the relative agricultural prices. The DECON and the GDP were found to be insignificant, implying that the DECON and the GDP do not play a dominant role in determining the relative agricultural prices. Most importantly, the results indicate that a one percent rise in money supply is associated with a 1.189 percent decline in relative agricultural prices in the long run. This implies that an increase in the RER and money supply leads to reduction in the RELAT. The speed of adjustment of the RELAT towards equilibrium is fairly fast at more than 0.36 percent.

6.3 Areas for future study

Future work on this topic should include long time series and an attempt to investigate the impacts of trade and macro-economic policies on specific sectors of agriculture. The maize industry is currently debating the possible impacts of foreign subsidies and low tariffs for South Africa. To guide this debate, future studies could concentrate on the possible impacts of degree of openness and the exchange rate on the maize industry.

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Appendix 1: Root test results

Diagnostic	lnpubgdp	Lndecon	lngexpdp	lnopen	lnrer	Internsg	lnresbal	techn	Lnrelat	Lnm3	Lngdp
Tests for variable in level variables											
ADF	-2.482	-1.551	-0.074	-1.7	-0.426	-0.705	0.298	-2.449754	-3.009256	-1.44222	0.087793
DW	1.973	2.108	2.1	2.094	1.93	2.156	2.201	2.048633	2.042199	2.022894	2.17354
PP	-4.441	-1.918	-0.346	-1.954	-0.398	-0.788	0.407	-2.550846	-2.627975	-1.881252	0.739462
DW	2.349	2.815	2.299	2.894	1.863	2.365	2.792	2.062086	2.116713	2.072728	2.522046
Tests for variable in first difference variables											
ADF	-6.984	-7.06	-7.217	-7.091	-5.682	-8.95	-8.664		-5.956797	-7.475488	-8.83103
DW	2.066	2.07	1.94	2.039	1.939	2.075	2.203		2.007648	2.059501	2.446286
PP	-17.44	-12.8	-9.583	-13.41	-7.006	-10.525	-15.032		-8.477989	-7.85017	-13.21989
DW	2.087	2.07	2.101	2.042	1.932	2.142	2.196		2.009023	2.006828	2.169552

Appendix 2: Critical values for unit root tests

Critical values in levels			
	ADF	1% Critical Value*	-2.6026
		5% Critical Value	-1.9462
		10% Critical Value	-1.6187
	PP	1% Critical Value*	-2.6019
		5% Critical Value	-1.946
		10% Critical Value	-1.6187
Critical values in first difference			
	ADF	1% Critical Value*	-2.6033
		5% Critical Value	-1.9463
		10% Critical Value	-1.6188
	PP	1% Critical Value*	-2.6026
		5% Critical Value	-1.9462
		10% Critical Value	-1.6187

Appendix 3: Pairwise Granger Causality test for RER

Pairwise Granger Causality Tests

Date: 01/23/05 Time: 12:59

Sample: 1988:1 2002:4

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LNRESBAL does not Granger Cause LNRER	58	2.25119	0.11525
LNRER does not Granger Cause LNRESBAL		0.24615	0.78269
LNPNBGP does not Granger Cause LNRER	58	2.04294	0.13973
LNRER does not Granger Cause LNPNBGP		0.97587	0.38353
LNDECON does not Granger Cause LNRER	58	2.22829	0.11771
LNRER does not Granger Cause LNDECON		1.20193	0.30867
LNGEXPGBP does not Granger Cause LNRER	58	1.62769	0.20605
LNRER does not Granger Cause LNGEXPGBP		2.17117	0.12408
LNTERMSG does not Granger Cause LNRER	58	1.97795	0.14843
LNRER does not Granger Cause LNTERMSG		1.30163	0.28064
TECHN does not Granger Cause LNRER	60	0.40471	0.66914
LNRER does not Granger Cause TECHN		0.67492	0.51336
LNPNBGP does not Granger Cause LNRESBAL	58	1.06314	0.35262
LNRESBAL does not Granger Cause LNPNBGP		1.66163	0.19956
LNDECON does not Granger Cause LNRESBAL	58	10.3754	0.00016
LNRESBAL does not Granger Cause LNDECON		0.86915	0.42520
LNGEXPGBP does not Granger Cause LNRESBAL	58	2.30736	0.10944
LNRESBAL does not Granger Cause LNGEXPGBP		6.10472	0.00411
LNTERMSG does not Granger Cause LNRESBAL	58	5.25890	0.00825
LNRESBAL does not Granger Cause LNTERMSG		4.51818	0.01542
TECHN does not Granger Cause LNRESBAL	58	0.81680	0.44733
LNRESBAL does not Granger Cause TECHN		0.78689	0.46050
LNDECON does not Granger Cause LNPNBGP	58	5.51380	0.00668
LNPNBGP does not Granger Cause LNDECON		0.01669	0.98345
LNGEXPGBP does not Granger Cause LNPNBGP	58	1.88110	0.16246
LNPNBGP does not Granger Cause LNGEXPGBP		1.27378	0.28820
LNTERMSG does not Granger Cause LNPNBGP	58	2.80152	0.06973
LNPNBGP does not Granger Cause LNTERMSG		2.27994	0.11224
TECHN does not Granger Cause LNPNBGP	58	3.68559	0.03172
LNPNBGP does not Granger Cause TECHN		0.94237	0.39613
LNGEXPGBP does not Granger Cause LNDECON	58	1.49144	0.23434
LNDECON does not Granger Cause LNGEXPGBP		4.10902	0.02193
LNTERMSG does not Granger Cause LNDECON	58	0.39159	0.67792
LNDECON does not Granger Cause LNTERMSG		2.66885	0.07864
TECHN does not Granger Cause LNDECON	58	1.47149	0.23881
LNDECON does not Granger Cause TECHN		1.11119	0.33671
LNTERMSG does not Granger Cause LNGEXPGBP	58	5.62911	0.00607

LNGEXPGDP does not Granger Cause LNTERMSG		1.67054	0.19790
TECHN does not Granger Cause LNGEXPGDP	58	0.38721	0.68085
LNGEXPGDP does not Granger Cause TECHN		1.69289	0.19378
TECHN does not Granger Cause LNTERMSG	58	2.04716	0.13919
LNTERMSG does not Granger Cause TECHN		5.30334	0.00795

Appendix 4: The long-run parameters of real effective exchange rate

Dependent Variable: LNRER

Method: Least Squares

Date: 01/23/05 Time: 13:04

Sample: 1988:1 2002:4

Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTERMSG	0.729429	0.346012	2.108102	0.0398
LNGEXPGDP	1.458151	0.346452	4.208806	0.0001
LNPNBGP	-0.030157	0.186089	-0.162058	0.8719
LNDECON	0.555368	0.290851	1.909458	0.0616
LNRESBAL	-0.750222	0.366976	-2.044336	0.0459
TECHN	-0.008074	0.005155	-1.566262	0.1232
C	-0.215440	1.575660	-0.136730	0.8918
R-squared	0.523685	Mean dependent var		4.524247
Adjusted R-squared	0.469762	S.D. dependent var		0.123937
S.E. of regression	0.090247	Akaike info criterion		-1.863242
Sum squared resid	0.431664	Schwarz criterion		-1.618902
Log likelihood	62.89726	F-statistic		9.711814
Durbin-Watson stat	0.744479	Prob(F-statistic)		0.000000

Appendix 5: The Short-run parameters of Error Correction Model

Dependent Variable: D(LNRER)

Method: Least Squares

Date: 01/23/05 Time: 13:23

Sample(adjusted): 1989:3 2002:4

Included observations: 54 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.011104	0.007886	1.408138	0.1661
ECM_RESID(-1)	-0.170800	0.074231	-2.300938	0.0262
D(LNTERMSG)	-0.037808	0.137996	-0.273976	0.7854
D(LNGEXPGDP)	0.237715	0.253488	0.937774	0.3535
D(LNPNBGP)	-0.017641	0.068002	-0.259416	0.7965
D(LNDECON)	-0.124250	0.133215	-0.932698	0.3561
D(LNRESBAL(-5))	-0.072505	0.089457	-0.810505	0.4220
TECHN	-0.003118	0.002204	-1.414857	0.1641
DUM01	-0.056275	0.022821	-2.465907	0.0176
DUM98	-0.043787	0.022962	-1.906889	0.0631
R-squared	0.275741	Mean dependent var		-0.004155
Adjusted R-squared	0.127597	S.D. dependent var		0.045977
S.E. of regression	0.042944	Akaike info criterion		-3.292262
Sum squared resid	0.081144	Schwarz criterion		-2.923932
Log likelihood	98.89109	F-statistic		1.861303
Durbin-Watson stat	2.231783	Prob(F-statistic)		0.083740

Appendix 6: Actual and equilibrium REER and REER misalignment index

	Actual REER	Equilibrium REER	REER misalignment index
1988/01	4.43	4.54	-0.11
1988/02	4.45	4.55	-0.09
1988/03	4.49	4.50	-0.02
1988/04	4.50	4.50	0.00
1989/01	4.52	4.52	0.01
1989/02	4.53	4.53	0.01
1989/03	4.56	4.52	0.04
1989/04	4.58	4.57	0.02
1990/01	4.61	4.57	0.03
1990/02	4.60	4.56	0.03
1990/03	4.58	4.58	0.00
1990/04	4.60	4.59	0.01
1991/01	4.63	4.59	0.04
1991/02	4.63	4.59	0.04
1991/03	4.63	4.62	0.02
1991/04	4.65	4.61	0.03
1992/01	4.64	4.63	0.01
1992/02	4.65	4.63	0.02
1992/03	4.65	4.64	0.01
1992/04	4.66	4.65	0.02
1993/01	4.67	4.64	0.02
1993/02	4.64	4.63	0.01
1993/03	4.62	4.61	0.00
1993/04	4.64	4.60	0.04
1994/01	4.65	4.59	0.06
1994/02	4.61	4.59	0.01
1994/03	4.60	4.61	-0.01
1994/04	4.62	4.61	0.00
1995/01	4.61	4.60	0.01
1995/02	4.57	4.57	0.00
1995/03	4.61	4.55	0.06
1995/04	4.63	4.52	0.11
1996/01	4.62	4.49	0.14
1996/02	4.52	4.48	0.05
1996/03	4.51	4.48	0.03
1996/04	4.50	4.50	0.00
1997/01	4.59	4.53	0.06
1997/02	4.62	4.55	0.07
1997/03	4.62	4.56	0.06
1997/04	4.58	4.56	0.03
1998/01	4.60	4.54	0.06
1998/02	4.56	4.52	0.04
1998/03	4.40	4.52	-0.13
1998/04	4.45	4.52	-0.08
1999/01	4.42	4.49	-0.07
1999/02	4.45	4.50	-0.05
1999/03	4.46	4.47	-0.01
1999/04	4.45	4.44	0.01
2000/01	4.47	4.41	0.06
2000/02	4.43	4.41	0.02

2000/03	4.44	4.39	0.05
2000/04	4.39	4.39	0.01
2001/01	4.37	4.38	-0.01
2001/02	4.40	4.39	0.01
2001/03	4.37	4.41	-0.04
2001/04	4.21	4.41	-0.20
2002/01	4.16	4.42	-0.25
2002/02	4.25	4.42	-0.17
2002/03	4.22	4.43	-0.20
2002/04	4.31	4.41	-0.10

Appendix 7: Granger causality test for agricultural relative prices equation

Pairwise Granger Causality Tests

Date: 01/23/05 Time: 18:23

Sample: 1988:1 2002:4

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LNRRER does not Granger Cause LNRELAT	58	0.23165	0.79402
LNRELAT does not Granger Cause LNRRER		2.11723	0.13043
LN3GDP does not Granger Cause LNRELAT	58	1.14232	0.32681
LNRELAT does not Granger Cause LN3GDP		1.17740	0.31601
LNGDP does not Granger Cause LNRELAT	58	0.32864	0.72136
LNRELAT does not Granger Cause LNGDP		0.55991	0.57460
LNDECON does not Granger Cause LNRELAT	58	2.88701	0.06455
LNRELAT does not Granger Cause LNDECON		0.35007	0.70626
LN3GDP does not Granger Cause LNRRER	58	3.58157	0.03476
LNRRER does not Granger Cause LN3GDP		1.37605	0.26145
LNGDP does not Granger Cause LNRRER	58	4.58179	0.01461
LNRRER does not Granger Cause LNGDP		1.35978	0.26552
LNDECON does not Granger Cause LNRRER	58	2.22829	0.11771
LNRRER does not Granger Cause LNDECON		1.20193	0.30867
LNGDP does not Granger Cause LN3GDP	58	11.2227	8.6E-05
LN3GDP does not Granger Cause LNGDP		1.77342	0.17968
LNDECON does not Granger Cause LN3GDP	58	2.94342	0.06135
LN3GDP does not Granger Cause LNDECON		0.92120	0.40432
LNDECON does not Granger Cause LNGDP	58	5.31221	0.00789
LNGDP does not Granger Cause LNDECON		1.39731	0.25622

Appendix 8: The long-run parameters of real effective exchange rate using actual effective exchange rate

Dependent Variable: LNRELAT

Method: Least Squares

Date: 01/23/05 Time: 18:20

Sample: 1988:1 2002:4

Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRRER	-0.340179	0.109791	-3.098413	0.0031
LNLM3GDP	-0.189031	0.046561	-4.059833	0.0002
LNGDP	-0.232326	0.255539	-0.909159	0.3672
LNDECON	0.054484	0.111971	0.486589	0.6285
C	7.816124	7.044287	1.109569	0.2720
R-squared	0.668656	Mean dependent var		0.132071
Adjusted R-squared	0.644558	S.D. dependent var		0.095159
S.E. of regression	0.056733	Akaike info criterion		-2.821273
Sum squared resid	0.177024	Schwarz criterion		-2.646745
Log likelihood	89.63820	F-statistic		27.74766
Durbin-Watson stat	0.780608	Prob(F-statistic)		0.000000

Appendix 9: The long-run parameters of real effective exchange rate using equilibrium effective exchange rate

Dependent Variable: LNRELAT

Method: Least Squares

Date: 01/23/05 Time: 21:36

Sample(adjusted): 1988:3 2002:4

Included observations: 58 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRRER	-0.138656	0.247748	-0.559665	0.5781
LNDECON	-0.071235	0.115687	-0.615757	0.5407
LNGDP	0.107979	0.338428	0.319060	0.7509
LNLM3GDP	-0.158327	0.054635	-2.897910	0.0055
C	-2.075378	9.773450	-0.212349	0.8326
R-squared	0.548899	Mean dependent var		0.123935
Adjusted R-squared	0.514854	S.D. dependent var		0.085701
S.E. of regression	0.059693	Akaike info criterion		-2.716953
Sum squared resid	0.188850	Schwarz criterion		-2.539329
Log likelihood	83.79165	F-statistic		16.12260
Durbin-Watson stat	0.669844	Prob(F-statistic)		0.000000

Appendix 10: The short-run parameters of real effective exchange rate using actual effective exchange rate (ECM model)

Dependent Variable: D(LNRELAT)

Method: Least Squares

Date: 01/23/05 Time: 18:27

Sample(adjusted): 1988:2 2002:4

Included observations: 59 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRER)	-0.066667	0.127616	-0.522402	0.6036
D(LNM3GDP)	0.248407	0.319029	0.778634	0.4397
D(LNGDP)	0.155619	0.379257	0.410325	0.6832
D(LNDECON)	-0.075563	0.122294	-0.617883	0.5393
ECM_RELAT(-1)	-0.373514	0.107770	-3.465841	0.0011
C	-0.011827	0.012216	-0.968163	0.3374
R-squared	0.209244	Mean dependent var		-0.003572
Adjusted R-squared	0.134644	S.D. dependent var		0.046105
S.E. of regression	0.042889	Akaike info criterion		-3.364258
Sum squared resid	0.097492	Schwarz criterion		-3.152983
Log likelihood	105.2456	F-statistic		2.804893
Durbin-Watson stat	1.850753	Prob(F-statistic)		0.025488

Appendix 11: The short-run parameters of real effective exchange rate using equilibrium effective exchange rate (ECM model)

Dependent Variable: D(LNRELAT)

Method: Least Squares

Date: 01/23/05 Time: 21:39

Sample(adjusted): 1988:4 2002:4

Included observations: 57 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNERER)	0.026470	0.323629	0.081791	0.9351
D(LNDECON)	-0.110782	0.125307	-0.884085	0.3808
D(LNGDP)	0.213697	0.419186	0.509790	0.6124
D(LNM3GDP)	0.251849	0.349531	0.720534	0.4745
C	-0.011867	0.013078	-0.907387	0.3685
ECM_ERER(-1)	-0.360971	0.105229	-3.430319	0.0012
R-squared	0.209279	Mean dependent var		-0.003808
Adjusted R-squared	0.131758	S.D. dependent var		0.046644
S.E. of regression	0.043463	Akaike info criterion		-3.334511
Sum squared resid	0.096341	Schwarz criterion		-3.119453
Log likelihood	101.0336	F-statistic		2.699625
Durbin-Watson stat	1.855330	Prob(F-statistic)		0.030696

Appendix 12: Data used for estimation

obs	LNRRER	LNRELAT	LNPNBGP	LNRESBAL	LNOPEN	LNMGDP	LNEXPDP
1988/01	4.430817	0.3534335	3.2580965	3.1446809	-0.9817797	-0.637163	2.944439
1988/02	4.454347	0.3826209	3.2188758	3.1034063	-1.0016844	-0.5999581	2.8903718
1988/03	4.488636	0.3597191	3.2188758	3.210776	-0.9341518	-0.5771081	2.8903718
1988/04	4.49981	0.2979536	3.2580965	3.1289271	-0.9888154	-0.5150846	2.944439
1989/01	4.521789	0.3060312	3.3672958	3.0895507	-1.0027144	-0.4329246	2.9957323
1989/02	4.53295	0.2650041	3.2580965	3.1235362	-0.9308798	-0.4100487	2.944439
1989/03	4.564348	0.2241123	3.2958369	3.1550503	-0.9314844	-0.3681678	2.944439
1989/04	4.584967	0.2282587	3.2958369	3.0978928	-0.9988969	-0.3148793	2.9957323
1990/01	4.60517	0.2198378	3.3322045	3.112046	-0.9921957	-0.2412859	2.9957323
1990/02	4.5951199	0.1888861	3.2958369	3.1171281	-0.9930895	-0.2322072	2.944439
1990/03	4.5781415	0.1508229	3.1354942	3.1230919	-0.9333857	-0.2266145	2.9957323
1990/04	4.5984812	0.1252947	3.2188758	3.1183403	-0.9761246	-0.200419	2.9957323
1991/01	4.6282355	0.136663	3.3672958	3.0761429	-0.9694918	-0.10662	2.9957323
1991/02	4.6314875	0.1184082	3.2580965	3.1288564	-0.9243635	-0.08169	2.9957323
1991/03	4.634729	0.1252815	3.2188758	3.0750026	-0.9451472	-0.0823843	2.9957323
1991/04	4.6475909	0.1225529	3.1354942	3.1200655	-0.9827688	-0.0595598	2.9957323
1992/01	4.6411806	0.0908825	3.2580965	3.1549187	-0.9165343	0.0043404	2.9957323
1992/02	4.6539604	0.1432418	3.2188758	3.1144482	-0.9300309	0.0109459	2.9957323
1992/03	4.6507807	0.1958033	3.2580965	3.1509633	-0.8380263	0.0326184	2.9957323
1992/04	4.6634391	0.3733768	3.1780538	3.0993237	-0.9060135	0.0561761	2.9957323
1993/01	4.6665788	0.1585292	3.4339872	3.1137421	-0.9075095	0.0767872	2.9957323
1993/02	4.63796	0.1130321	3.1354942	3.2278982	-0.8409947	0.0443886	2.9957323
1993/03	4.6151205	0.1010011	3.2188758	3.1970824	-0.8119157	0.0388612	2.9957323
1993/04	4.63796	0.0969028	2.944439	3.1440977	-0.860135	0.0774021	2.9957323
1994/01	4.6539604	0.1319223	3.1354942	3.1546978	-0.8177929	0.1597321	2.9957323
1994/02	4.6051702	0.1458155	3.1780538	3.2024438	-0.8430751	0.1357231	2.9957323
1994/03	4.6018313	0.1706554	3.1780538	3.3680962	-0.7527181	0.1492736	2.9957323
1994/04	4.6151205	0.1506299	3.1354942	3.1439773	-0.7953074	0.1820401	2.9957323
1995/01	4.608498	0.1688195	3.1354942	3.1483743	-0.7318338	0.2356337	2.944439
1995/02	4.574711	0.1490249	3.1354942	3.2132426	-0.7300559	0.2738547	2.8903718
1995/03	4.6118147	0.100277	3.1354942	3.2509485	-0.6687683	0.2585774	2.8903718
1995/04	4.6282355	0.1396694	3.0910425	3.2426356	-0.7148282	0.2812563	2.8903718
1996/01	4.6249728	0.1254835	3.1354942	3.2878378	-0.6978228	0.3402178	2.8903718
1996/02	4.5217886	0.0900029	3.1780538	3.2706189	-0.7028707	0.350634	2.944439
1996/03	4.5071898	0.0985886	3.1780538	3.3630843	-0.5996213	0.3613165	2.944439
1996/04	4.4998097	0.1351476	3.1780538	3.3009878	-0.6683321	0.3842184	2.9957323
1997/01	4.5917472	0.1089903	3.1780538	3.2487761	-0.7025989	0.4579092	2.9957323
1997/02	4.6249728	0.1057177	3.1780538	3.2813483	-0.6796154	0.4546401	2.944439
1997/03	4.6151205	0.1006602	3.1780538	3.4478935	-0.5814982	0.4737704	2.944439
1997/04	4.5849675	0.1006931	3.1780538	3.3711261	-0.5959858	0.5280361	2.944439
1998/01	4.5984812	0.0953067	3.1780538	3.4140592	-0.5855618	0.6003889	2.944439
1998/02	4.5643482	0.0804696	3.1780538	3.3704372	-0.6156609	0.6160052	2.944439
1998/03	4.3985559	0.0331759	3.2188758	3.3344478	-0.5818073	0.6378406	2.944439
1998/04	4.4465652	0.0102638	3.2188758	3.290386	-0.6461282	0.6571794	2.944439
1999/01	4.4228486	0.0098384	3.1354942	3.3954062	-0.6340345	0.6828442	2.8903718
1999/02	4.4465652	0.0205546	3.1780538	3.2515518	-0.7161653	0.6627352	2.944439
1999/03	4.4582158	0.0415588	3.1354942	3.2959992	-0.6276043	0.6773614	2.8903718
1999/04	4.4543473	0.02212	3.0910425	3.2766996	-0.6416081	0.7103099	2.8903718
2000/01	4.4659081	0.03015	3.0910425	3.3387148	-0.6047144	0.7549303	2.8903718
2000/02	4.4308168	0.0228492	3.1354942	3.2987526	-0.6536288	0.7239574	2.8903718
2000/03	4.4426513	-0.0222753	3.0910425	3.286652	-0.6356254	0.7021193	2.8903718
2000/04	4.3944492	-0.0253939	3.0910425	3.349288	-0.605122	0.737176	2.8903718
2001/01	4.3694479	-0.00864	3.0910425	3.350112	-0.6199035	0.8177765	2.8903718
2001/02	4.3985559	0.0243242	3.0910425	3.3586686	-0.6173062	0.8113346	2.8903718
2001/03	4.3694479	0.0484295	3.0910425	3.2715839	-0.670267	0.8409375	2.944439
2001/04	4.2145937	0.1041406	3.1354942	3.2893121	-0.6683296	0.8679885	2.8903718

2002/01	4.1640779	0.1316083	3.0910425	3.3334475	-0.6544851	0.981285	2.8903718
2002/02	4.2484952	0.1088662	3.0910425	3.3170565	-0.6599789	0.970147	2.8903718
2002/03	4.2243977	0.1545166	3.0910425	3.2907128	-0.6831618	0.9796039	2.8903718
2002/04	4.3085595	0.1426664	3.0910425	3.290722	-0.6525773	1.0085516	2.8903718

Appendix 13: Data used for estimation (continued)

obs	LNGDP	LNERER	LNDECON	LNCAPGDP	LNTERMSG	TERMS
1988/01	25.92752		-0.9888133	2.944439	4.7706846	107
1988/02	25.942783		-0.9899577	2.944439	4.8121844	108
1988/03	25.988269	4.49	-0.9406193	2.9957323	4.7957905	110
1988/04	25.991072	4.5	-0.9834479	2.9957323	4.804021	111
1989/01	25.961249	4.45	-1.0068523	2.9957323	4.7449321	107
1989/02	25.98186	4.46	-0.9280315	2.9957323	4.7361984	108
1989/03	26.001003	4.48	-0.9438245	2.9957323	4.7184989	106
1989/04	26.001202	4.49	-1.0043998	3.0445224	4.7449321	107
1990/01	25.965949	4.5	-1.0095191	2.9957323	4.7095302	107
1990/02	25.980219	4.54	-1.002462	2.944439	4.7449321	107
1990/03	25.989349	4.55	-0.9339037	2.944439	4.7273878	111
1990/04	25.997337	4.53	-0.9987389	2.8903718	4.6821312	107
1991/01	25.954946	4.55	-0.9845006	2.8903718	4.6634391	103
1991/02	25.969727	4.56	-0.9379461	2.8332133	4.6821312	105
1991/03	25.981063	4.56	-0.9425785	2.8332133	4.7004804	107
1991/04	25.986158	4.56	-1.0001138	2.7725887	4.7095302	108
1992/01	25.948103	4.58	-0.9333787	2.7725887	4.6913479	108
1992/02	25.955288	4.58	-0.9390731	2.7725887	4.6913479	110
1992/03	25.951702	4.58	-0.8434643	2.7725887	4.6539604	105
1992/04	25.950672	4.59	-0.9141675	2.7080502	4.6539604	104
1993/01	25.928179	4.6	-0.9131392	2.7080502	4.6821312	105
1993/02	25.958883	4.59	-0.8566828	2.7080502	4.6913479	106
1993/03	25.979943	4.6	-0.8188731	2.7080502	4.6728288	105
1993/04	25.986774	4.58	-0.8649813	2.7080502	4.6728288	107
1994/01	25.945938	4.57	-0.8227318	2.7080502	4.6443909	109
1994/02	26.000416	4.56	-0.8449888	2.7080502	4.7273878	109
1994/03	26.011664	4.55	-0.744508	2.7725887	4.8441871	106
1994/04	26.022398	4.55	-0.7922254	2.7725887	4.6443909	106
1995/01	25.986402	4.57	-0.7239023	2.7725887	4.6051702	108
1995/02	26.010527	4.57	-0.7206138	2.7725887	4.6728288	106
1995/03	26.048872	4.56	-0.6610926	2.7725887	4.6443909	107
1995/04	26.057404	4.53	-0.7123074	2.7725887	4.6634391	106
1996/01	26.024125	4.51	-0.695499	2.7725887	4.6913479	107
1996/02	26.069649	4.48	-0.6914331	2.7725887	4.7095302	107
1996/03	26.084802	4.45	-0.5907838	2.7725887	4.6913479	104
1996/04	26.093518	4.44	-0.6670661	2.7725887	4.6728288	103
1997/01	26.058069	4.44	-0.6956378	2.8332133	4.6728288	105
1997/02	26.10196	4.47	-0.6728461	2.8332133	4.6821312	107
1997/03	26.107963	4.5	-0.5740666	2.8332133	4.7535902	109
1997/04	26.109145	4.52	-0.5949685	2.7725887	4.6728288	106
1998/01	26.070807	4.52	-0.5929597	2.8332133	4.6821312	106
1998/02	26.103334	4.53	-0.6146172	2.8332133	4.6913479	108
1998/03	26.109466	4.51	-0.5720907	2.8332133	4.6443909	103
1998/04	26.114472	4.49	-0.640984	2.8903718	4.6539604	104
1999/01	26.081219	4.49	-0.6539881	2.7725887	4.6728288	106
1999/02	26.121876	4.49	-0.7183329	2.7725887	4.6634391	105
1999/03	26.136879	4.46	-0.638624	2.7080502	4.5951199	100
1999/04	26.15057	4.47	-0.6506542	2.7080502	4.5951199	98
2000/01	26.116111	4.44	-0.6228984	2.7080502	4.5951199	99
2000/02	26.1551	4.41	-0.6670649	2.7080502	4.6151205	101

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2000/03	26.187598	4.37	-0.6426479	2.7080502	4.6051702	100
2000/04	26.193998	4.38	-0.6235805	2.7080502	4.6051702	100
2001/01	26.15312	4.36	-0.6398324	2.7080502	4.6151205	102
2001/02	26.191651	4.35	-0.6359916	2.7080502	4.6249728	104
2001/03	26.202921	4.35	-0.6800536	2.7080502	4.6151205	100
2001/04	26.213921	4.35	-0.6800168	2.7080502	4.6249728	101
2002/01	26.181723	4.38	-0.6698411	2.7080502	4.6443909	101
2002/02	26.228467	4.38	-0.671733	2.7080502	4.6443909	102
2002/03	26.238536	4.38	-0.6874282	2.7080502	4.6634391	104
2002/04	26.252465	4.38	-0.6630731	2.7080502	4.6151205	101