Factors affecting the demand for labour in large-scale sugarcane farming in three

regions of KwaZulu-Natal, 1984-2008

by

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DECLARATION

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ABSTRACT

Many authors have cited the relatively high unemployment rate as the most severe economic problem facing South Africa today. At the same time, government institutions claim that the agricultural sector can help solve the high unemployment rate, as this sector has the potential to create employment for a large number of unemployed South Africans. These institutions do not elaborate on how the sector will provide so many jobs. Published empirical studies on the South African (SA) agricultural sector have recommended ways in which policy-makers may achieve their goals of creating employment. However, most studies on labour considered the entire agricultural sector, whereas this study focuses on a sub-sector, namely the SA sugarcane sector.

The study aims to analyse the potential of the sugarcane SA sector to create employment by estimating long- and short-run price (wage) elasticities of labour demand for large-scale sugarcane farms on the South Coast, in the Midlands and in Tugela/Zululand during 1984/1985-2008/2009. Using panel data, two models are estimated by Ordinary Least Squares (OLS), Model 1 capturing labour use intensity and using "labour units employed per 1000 tonnes of cane cut" as the dependent variable, while Model 2 captures the total labour units demanded by large-scale sugarcane farmers. Only Model 2 is estimated using simultaneous equations as past studies indicate that labour use intensity may be analysed using single-equation models.

For Model 1, the estimates of the long-run wage elasticities compared to the short-run wage elasticities are similar and around -0.5, -0.17 and -0.33 for the South Coast, Midlands and Tugela/Zululand regions, respectively. The wage elasticity estimates for Model 2 in the short-run were -0.34, -0.24 and -0.17 and in the long run -0.61, -0.42 and -0.30 for the South Coast, Midlands and Tugela/Zululand, respectively. The two econometric techniques (OLS and 3SLS) yielded similar wage elasticities. Results suggest that all labour demand estimates were wage inelastic, with the South Coast having a relatively greater response of labour demand to wage rate changes than the other two regions. Inelastic demand estimates for labour in all three regions may be due to the perennial, long-term nature of sugarcane and farmers taking time to decide how to respond to changes (hikes) in the price of labour. The decline in the demand for labour by large-scale sugarcane farmers due to an increase in real wage rates raises questions about the appropriateness of labour laws and minimum wage

legislation that have increased the real cost of farm labour in the large-scale sugarcane sector of KZN.

In order to reverse the rising farm labour unemployment trend in South Africa, the study recommends that policy-makers could rather adopt more flexible labour market regulations (for example, those relating to the hiring and dismissal of workers) that would reduce real labour costs and encourage local farmers to employ more labour on sugarcane farms. Furthermore, the land under sugarcane proved to be an important determinant of the demand for labour by large-scale sugarcane farmers and hence policies regarding land reform need to be revised and implemented more proficiently. Future research could focus on the skill-level of those workers who are affected the most following an increase in minimum wages and possible reasons why the KZN sugar industry is losing land to other land uses.

ACKNOWLEDGEMENTS

ACRONYMS

ANC	-	**African National Congress**
AgriBEE	-	**Agricultural Black Economic Empowerment**
BCEABasic	-	**Conditions of Employment Act**
BFAP	-	**Bureau for Food and Agricultural Policy**
CGE	-	**Computable General Equilibrium**
CPI	-	**Consumer Price Index**
DAFF	-	**Department of Agriculture, Forestry and Fisheries**
DPRU	-	**Development Policy Research Unit**
ECM	-	**Error Components Model**
FEM	-	**Fixed Effects**
HT	-	**Harris and Todaro**
HFCS	-	**High Fructose Corn Syrup**
ICA	-	**Investment Climate Assessment**
ILS	-	**Iterated Least Squares**
KZN	-	**KwaZulu-Natal**
LRA	-	**Labour Relations Act**
LRS	-	**Labour Research Service**
LSDV	-	**Least-Squares Dummy Variable**
NDA	-	**National Department of Agriculture**
NDP	-	**National Development Plan**
OLS	-	**Ordinary Least Squares**
REM	-	**Random Effects Model**

RV - **Recoverable Value**

SAM - **Social Accounting Matrix**

SA - **South Africa**

SACGA - **South African Canegrowers' Association**

SASA - **South African Sugar Association**

SACU - **Southern African Customs Union**

TFP - **Total Factor Productivity**

3SLS - **Three-Stage Least Squares**

2SLS - **Two-Stage Least Squares**

UIA - **Unemployment Insurance Act**

UIF - **Unemployment Insurance Fund**

VMP - **Value Marginal Product**

INTRODUCTION

Employment creation is currently one of the South African (SA) government's most pressing imperatives. Approximately 4.4 million members of the SA workforce of 17.3 million are currently unemployed, according to the official definition of unemployment (Bhorat, 2012). A person is regarded as unemployed (according to the official definition) if he or she did not work in the previous week, wants to work, is available to begin work within a week and has taken active steps to look for employment or self-employment in the previous four weeks (Bhorat, 2012). South Africa's unemployment rate ranks poorly against other (developing) countries (World Bank, 2012). Over the past five years the SA unemployment rate has increased both in absolute terms and relative to other countries (World Bank, 2012). Levels of unemployment vary geographically, with rural unemployment, on average, exceeding urban unemployment (Kingdon & Knight, 2004). High levels of unemployment may have had negative effects on economic welfare, production, erosion of human capital, social exclusion, crime and social instability (Kingdon & Knight, 2001). Employment creation in rural areas, in particular, is necessary to address already high rates of poverty and income inequality in South Africa (Armstrong *et al.*, 2008). The National Development Plan (NDP) (2011) stated that the government's vision for 2030 included an unemployment rate of 6% (as compared to 25% in recent years) and the creation of around 11 million jobs across all sectors of South Africa.

The agricultural sector is one of a few sectors that dominate South Africa's labour market (Fedderke & Mariotti, 2002) and especially its rural labour market. According to the Bureau for Food and Agricultural Policy (BFAP) (2011), the SA agricultural sector has the potential to directly create an additional 190 000 jobs, which will indirectly give rise to a further 97 000 jobs in the sector. BFAP further estimates that the agricultural sector has the potential to create an additional one million jobs in the economy over the next two decades (BFAP, 2011). Vermeulen (2011) contends that agriculture, and in particular irrigation agriculture, can create more jobs per R1 million invested than any other sector. Both BFAP and the NDP agree that these goals are not easy to achieve and will take time. Both entities share highly optimistic beliefs for the future growth of the SA economy, but they do not adequately substantiate how these goals will be met.

Despite the asserted potential of the SA agricultural sector to create new jobs, employment in the sector has declined over the past two decades. According to Statistics South Africa

(2007, 2012), from 1990 to 2012 the number of full-time farm workers (excluding those employed by contractors and casual workers) employed in South Africa declined by more than 37% from 728 414 to 456 958. Agriculture's share of employment declined from 11.3% in 2000 to about 5% in 2010 (Simbi & Aliber, 2000; Stats SA, 2012). In 1992, 1.05 million people were employed on commercial farms, supporting over four million people in rural areas (Newman *et al.*, 1997). In 1998, there were just over 2.3 million jobs in rural areas, accounting for 43.3% of the economically active rural population (Simbi & Aliber, 2000). Evidence by Fedderke & Marrioti (2002) suggests that the relative importance of sectors in the aggregate labour market has been subject to considerable change during 1970-97. According to Murray and Van Walbeek (2007), the sugar growing industry was not immune from this trend of labour shedding as employment decreased at an average annual rate of about one per cent between 1973/74 and 2003/04 (SA Canegrowers, 2003/04, cited by Murray & Van Walbeek, 2007).

Whilst the falling share of agricultural employment is not unusual in the development process, it is so in the context of a large labour surplus (National Development Plan, 2011). Kirsten & Vink (2001) and Aliber *et al.* (2007) attribute the decline in employment in agriculture primarily to changes in labour legislation, amongst other reasons. Higher rates for overtime work, Unemployment Insurance Fund (UIF) contributions, shortened working hours, lengthened periods for maternity leave and higher transaction costs associated with the dismissal and leave benefits for workers have increased the total labour cost and, therefore, it has been more economical for farmers to use casual labour or cheaper sources of labour (Kirsten & Vink, 2001; Aliber *et al.*, 2007; Sparrow *et al.*, 2008).

Bhorat (2002, 2012) contends that SA economists have offered few suggestions for driving employment creation in the economy. He identified six interventions for creating employment in South Africa, namely (a) re-directing investable state funds to companies/industries that directly or indirectly create jobs, (b) a wage subsidy, (c) a transport subsidy for unemployed youth, (d) a change in state procurement rules to grow the informal sector, (e) improve the functioning of public employment services, and (f) changes to labour regulations (Bhorat, 2012). However, he did not discuss the suitability of these interventions for creating employment growth in the SA agricultural sector. BFAP's (2011) study of the employment creation potential of the agricultural sector assumes that all underutilised land is brought into production, but does not identify the policy interventions necessary to achieve this. Gardner (1972), Newman *et al.* (1997) and Sparrow *et al.* (2008), amongst others, have

advocated partially deregulating labour legislation in the agricultural sector. Sparrow *et al.* (2008) speculated that minimum wage legislation and other labour laws that have raised the cost of regular farm labour in South Africa are probably the most important reason for the decrease in the employment of farm labour.

Suggestions for deregulating labour legislation have not been entertained by the African National Congress (ANC) government, which was seeking alternative policy recommendations (Donnelly & Dunn, 2006). The authors state that "It is only too easy to find shortcomings, based on a miscalculation of the damage that had to be repaired post-apartheid, and the consequent enormity of current inequality" (Donnelly & Dunn, 2006: 1-29). Economic stagnation in the two decades before democracy, the extreme economic inequality, and the development of a powerful trade union movement, all continue to have their impact today. Since the advent of democratic governance, the ANC government has had little political and economic room to manoeuvre in its economic policies (Nattrass & Seekings, 2001).

Ortmann (2005) suggests that government should have focused its relatively scarce resources on providing physical infrastructure (especially improved transport and communication infrastructure) and legal infrastructure (secure property rights and contract enforcement). He considers that a focus in this direction will help to reduce transaction costs, including risk; relax restrictive labour laws; reduce uncertainty regarding land claims, AgriBEE and the rural land tax; improve the impact of grants for approved land projects; reduce crime rates; and promote education, agricultural research and development (R&D) and skills training.

This study aims to contribute to the SA farm labour policy debate by estimating the determinants of the demand for labour in sugarcane farming in KwaZulu-Natal (KZN). The main objective of this study is to determine the responsiveness of labour demand and labour use intensity to changes in the wage rate for three sugarcane producing regions – South Coast, Midlands and Tugela/Zululand. Knowledge of the responsiveness of the demand for labour to changes in its determinants may provide an understanding of why employment in the sector has declined and will provide insight into policies for reversing employment loss in the industry. This study also attempts to use two econometric techniques concurrently, which is the use of panel data and simultaneous equations models to estimate total farm labour demanded by large-scale sugarcane farmers in KZN.

This study differs from previous studies of SA farm labour markets, as it focuses on one subsector (sugarcane). Unlike Sparrow *et al.* (2008), who studied the determinants of the aggregate demand for labour in the whole SA agricultural sector, this study focused on employment in the sugarcane industry. The reason is that this industry supports approximately one million people, many of whom are small-scale farmers living in the rural areas of the country (SASA, 2012). Another reason is the availability of data for this industry. The sugarcane industry is cited by BFAP (2011) as the second largest agricultural employer in South Africa after the citrus industry, employing around 80 000 seasonal and permanent workers, annually.

This dissertation is structured into seven sections. Having identified that the SA farm labour market is an important topic for research, the first chapter presents economic theory related to labour employment to establish that an understanding of the economics of farm labour markets can contribute towards understanding past changes in employment in the sector and identifying and evaluating various interventions in farm labour markets to help policy-makers achieve their employment creation objectives. In the second chapter, policies relevant to farm labour in South Africa are reviewed and their likely impact on employment in the agricultural sector is discussed. The third chapter presents a review of local and international economic studies of farm labour markets. The purpose of the third chapter were to (a) identify how research methodologies used for studying farm labour markets have evolved and to identify contemporary methodologies for studying farm labour markets, and (b) to identify what is already known about SA farm labour markets and what gaps exist for future research. An overview of the SA sugar industry is presented in the fourth chapter, to consider the contribution of the industry to farm employment in South Africa and to consider what data are available on employment and wages in the sugar industry. The penultimate chapter presents a methodology for this study and explains how the results will address some of the gaps in existing knowledge of SA labour markets. Chapter six presents the empirical results and discussion of the applied methodology. Finally, conclusions are drawn from the empirical results and the implications for policy recommendations for creating employment growth in SA agriculture are discussed.

CHAPTER 1: ECONOMIC THEORY OF THE SUPPLY OF, AND DEMAND FOR, FARM LABOUR

The objective of this chapter is to demonstrate that an economic study of the SA farm labour market can contribute positively towards the debate on how to create employment growth in the agricultural sector. Firstly, the economic demand for farm labour is explained and defined followed by some of the interventions which shift the demand for labour. The supply of farm labour and the important shifter (the cost of labour) of the farm labour supply curve were described and discussed in this chapter.

1.1 The demand for farm labour

The demand for, and supply of, labour in the agricultural sector are determined in the labour market, with the participants being workers and farmers. Workers supply labour to farms in exchange for wages, and farmers demand labour from workers in exchange for wages (Conradie, 2005). The demand for labour is a derived demand, since it is derived from the demand for the firm's output (in this case sugarcane). *Ceteris paribus*, if demand for the firm's output (sugarcane) increases, the firm will demand more labour and will hire more workers. If demand for the firm's output falls, the firm will demand less labour and will reduce its workforce, *ceteris paribus* (Sinha, 1999). If a firm wants to produce more output in the short run, then it has to employ more labour and in the long run a farm may increase its output by employing more labour but also by using more capital (Parkin *et al*., 2005).

A farm estimates the amount of labour needed according to the amount of output it would like to produce that will maximise profit. A profit-maximising firm would produce the output for which its marginal revenue is equal to its marginal cost (Parkin *et al*., 2005). When the firm knows the level of demand for its output, it determines how much labour to demand by considering the value of the marginal product of labour or (VMP) (Conradie, 2005). The VMP of labour (or any input) is the additional revenue the firm earns by employing one more unit of labour. The VMP of labour is related to the marginal product of labour (Doll & Orazem, 1984).

On the basis of the Law of Diminishing Marginal Returns, the addition to the firm's labour force will, at some point, bring a diminishing return to the firm and, therefore, carry a lower wage rate. As the marginal productivity will be declining, the wages will also have to decline in order to induce the employers to employ more workers (Sinha, 1999).

According to Parkin *et al.* (2005), the demand for labour changes and shifts the labour demand curve when there is a change in any of these factors, namely, the price of the firm's output, factor prices and technology. The market demand for labour in the sugar industry is the total demand for labour by all farms in the market. It is calculated by adding together the quantities of labour demanded by all farms at each wage rate. Since each farm's labour demand curve slopes downwards, so does the market labour demand curve (Doll & Orazem, 1984; Parkin *et al.*, 2005).

From these basic principles of economics, it is evident that when the cost of labour increases (for example, through raising minimum wages to above the market equilibrium wages), employment declines, *ceteris paribus*. What is not known is by how much employment has declined (Bhorat & Hodge, 1999). In other words, how responsive employment is to changes in the wage rate is of interest because if policy-makers have an economic understanding of their decisions, then they can be more cautious in implementing certain policies. This is where the concept of elasticity helps to understand the different responses of the amount of labour demanded to price changes.

The own price elasticity of demand measures the responsiveness of quantity demanded to a change in price. Therefore the own wage elasticity of demand is measured by the percentage change in employment caused by a one percent change in the wage rate (Conradie, 2005). There are many determinants of the own price elasticity of demand of an input, for example, the price of substitutes, the number of uses to which an input can be put and the type of market (Friedman, 1962).

1.2 Interventions that shift the demand for farm labour

Interventions that increase labour demand by the agricultural sector must achieve at least one of the following (Hyami and Ruttan, 1985):

- Promote adoption of more labour-intensive technologies on farms
- Change land-use patterns in favour of more labour-intensive land uses. This idea has been supported by others, for example Lyne & Collins (2008).
- Strengthen the diverse agricultural extension system
- Lower transaction costs in farm labour markets
- Improve average farm worker productivity through improving their health and skills

- Bring more farmland into agricultural production, in particular under-utilised farmland in communal farming areas and in failed land reform projects and collapsed irrigation projects. This idea has been supported by others, for example Lyne & Ferrer (2006).

Labour intensive technology innovation and adoption is driven by lowering the cost of labour relative to the cost of capital (Hyami and Ruttan, 1985). Past policies which favoured under-priced capital relative to labour have set the SA economy on a capital intensive technology expansion path at the expense of employment creation (Black & Hasson, 2012). The evidence presented in a study conducted in South Africa by Fedderke *et al.* (2000) demonstrates that demand-factors, and hence the trade liberalisation of the 1990s, do not serve as a cogent explanation of declining employment generation in South Africa. However, technological change has effectively been capital rather than labour augmenting over time, thus decreasing the capacity of SA industry to expand employment. As human capital becomes increasingly more difficult to acquire (e.g. through high minimum wages demanded by employees), employers may be forced to employ less and mechanise more. In these circumstances, labour market developments which have raised both wage and non-wage costs of labour simply have to lead to the loss in labour competitiveness which must underlie the employment trends that have been observed during the course of the 1990s.

Subsidies and taxes impact on the relative profitability of farm enterprises or farm types and thereby impact on land-use patterns and the intensity of farming in favour of increased labour-use intensity (Beaudry *et al.,* 2009). Subsidisation of capital relative to labour has not only promoted capital intensive technology in agricultural production, but has also created economies of size in farming that favour large farms over small farms. Subsidisation of small-scale sugarcane farming during the 1980s and 1990s resulted in substantial growth in sugarcane production by small-scale farmers (Owens & Eweg, 2003). However, partial withdrawal of these subsidies, since the early 2000s, contributed to the decline in the number of registered small-scale sugarcane farmers and the tonnage of cane produced by small-scale farmers (Armitage *et al.,* 2009).

Newman *et al.* (1997) suggested that labour in agriculture traditionally received a cash wage as well as payments in kind. Costs of labour included not only wages, but also non-cash benefits as well as the implicit costs of management time spent on labour-related matters and the costs of risks associated with the employment of workers. The introduction of, and

changes to, farm labour legislation in South Africa in the 1990s increased costs of farm labour and has consequently has been blamed for the decline in agricultural employment over the past two decades. Calls for more flexible labour legislation for farm workers aimed to lower the implicit costs of farm labour and thus boost growth in agricultural employment (Newman *et al.,* 1997).

Murray and Van Walbeek (2007) surveyed 103 sugarcane farmers on the KwaZulu-Natal coast in order to analyse the impact of the sectoral determination for farm workers in 2002. Their study shows that an increase in the wage and transaction costs of labour encourages growers to employ contract and seasonal labour, in place of permanent labour. Contract labourers are not employed by the grower, but by a labour contractor. The grower, in turn, employs the contractor to supply specific labour services, for example, to harvest his cane at some predetermined rate per ton. The study further indicated that growers who did not use contractors quoted the additional cost and the loss of control of their operations as major restraints. Du Toit and Koekemoer (2003) developed a labour market model of the SA economy. The authors concluded that the main factors which significantly influence the labour market are government interventionist actions, aggressive trade union activities, minimum wage arrangements, excessive social benefit packages of workers, inadequate skills and training of workers, inappropriate production technologies and low productivity.

High transaction costs, including the cost of information and costs associated with the search for trade partners, the distance to formal markets, as well as contract enforcement, are detrimental to the efficient operation of markets for inputs and products (Williamson, 1985, cited by Ortmann and King, 2007). Furthermore, anecdotal information from the SA sugarcane industry indicates that, despite high rates of unemployment, farmers are finding it difficult to find certain categories (skills) of productive farm workers. Interventions that reduce search and discovery costs in farm labour markets will improve the functioning of the market and increase employment in the sector.

Small-scale farmers have limited access to farming inputs, credit and information, and markets are often constrained by inadequate property rights and high transaction costs (Ortmann and King, 2007). Investment in human capital of rural dwellers makes these people more employable, both inside and outside the agricultural sector, and is therefore critical for addressing problems of high rural unemployment in the medium- to long-term.

1.3 The supply of farm labour

In the case of labour supply in the agricultural industry, people may allocate their time to two broad activities - labour supply and leisure. Leisure refers to all activities other than supplying labour and most people see leisure as being more enjoyable (Parkin *et al.*, 2005). According to Parkin *et al.* (2005), the supply of labour will change if any of the following factors change:

- The size of the adult (working age) population who are willing to work.
- Technological change and capital accumulation.

There are many factors which affect a person's willingness to work (e.g. raising the reservation wage). These factors will be discussed at a later stage. Labour scarcities may be related to issues on the supply side. A useful economic model is the model of urbanisation developed by Harris and Todaro (1970). This model was developed in an African context and formalised in the model: high wages in a locality attract more workers to it until unemployment rises sufficiently to equalise the 'expected wage' across localities. This must be combined with an understanding that many rural households who have usufruct rights to land are reluctant to give up those rights; consequently, households may retain their rural base, even if their primary source of income is from urban employment. Usufruct rights to land are linked with the right to food, the right to work and a host of other human rights which are valuable to those living in rural areas.

Labour economists have used the notion of compensating differentials to hypothesise that wages and unemployment are positively correlated across space (Kingdon and Knight, 1999). The authors then contend the perceived notion (that wages and unemployment are positively correlated across space) of these labour economists, by stating that "The Harris-Todaro (H-T) relationship may indeed prevail in the long run but labour may not be sufficiently mobile for H-T to be observed in the short run". The conventional model of the labour market (in which high unemployment regions have higher wages to compensate for search and other costs) seems contradicted by a large volume of recent evidence of a relationship called 'the wage curve'. The wage curve is the negative relationship between the levels of unemployment and wages that arises when these variables are expressed in terms of the locality under study. According to Blanchflower and Oswald (1994), the wage curve summarises the fact that a worker who is employed in an area of high unemployment earns less than an identical individual who works in a region with low unemployment. Kingdon and Knight (1999)

highlight several reasons why an examination of the wage curve in South Africa is of interest, with the main reason being that estimates of the unemployment elasticity for different areas can provide tests of labour immobility based on labour market segmentation - whether, for instance, segmentation is clearer as between rural and urban areas or between former 'homeland' and non-homeland areas. In their analysis of wage curves in the UK and USA, Blanchflower and Oswald (1994) did find that a substantial part of the wage curve slopes upward, and that this might, in principle, reflect Harris-Todaro forces.

Given that the working age population in South Africa is predominantly unskilled, the supply of labour in the agricultural sector is often assumed to be highly wage elastic (e.g. Sparrow *et al.*, 2008; Richardson, 2010). Other factors also play a role on the supply side. Declining health and fitness of the farm worker population (e.g. due to HIV & Aids) may have reduced the supply of workers suitable for cutting cane, as many fit and strong workers are probably absorbed by the mines, where wages are higher (Gladys & Sandkjaer, 2009). Increased social welfare payments may have increased the reservation price at which workers are willing to undertake less attractive, but better-paying, jobs.

1.4 Labour legislation: an intervention that shifts the supply curve of farm labour

According to the Department of Labour (2012), government's primary goal of setting a minimum wage in the agricultural sector is to address income inequalities. For a minimum wage to have the intended effects, it has to be accompanied by laws or basic conditions of employment to protect the interest of women and others who are less likely to be given permanent jobs (Sparrow *et al.,* 2008).

Economic theory suggests that the introduction of a minimum wage would decrease employment and increase unemployment (Murray & Van Walbeek, 2007). A binding minimum wage, set above the market clearing wage, increases the cost of labour (Hoddinott, 1996). Firms demand less labour, while more labour is supplied as new entrants want to take advantage of the higher wage. As the marginal cost of labour increases above the marginal productivity (of at least some workers), firms reduce their workforces (Murray & Van Walbeek, 2007). Elementary supply and demand analysis applied to labour markets predicts that minimum wage laws which increase wage rates in the markets will reduce employment in these markets, but increase employment and reduce wages in non-covered markets (Gardner, 1972).

Fields and Kanbur (2006) highlighted three contributions towards the basic theory regarding minimum wages. First, the authors analyse the effects of a higher minimum wage in terms of poverty, rather than in terms of unemployment. Second, they extend the standard textbook model to allow for income sharing between employed and unemployed persons in society. Third, they extend the basic model to deal with income sharing within families. The results of the study show that a higher minimum wage does not necessarily increase poverty because of the unemployment it creates. Conversely, a higher minimum wage does not necessarily reduce poverty simply because it might increase total labour income, and some of this increased income is shared with the unemployed, either through family sharing or through social sharing. The study also showed how the poverty effects of a minimum wage increase depends on four parameters, namely (1) how high the minimum wage is relative to the poverty line (2) how elastic the demand for labour is (3) how much income-sharing takes place and lastly, (4) how sensitive the poverty measure is to the depth of poverty.

Newman *et al.* (1997) state that the increasing cost of labour in South Africa can be explained by changes in the legislative environment for labour. The effect of the Agricultural Labour Act, Act 147 of 1996, was to extend the provisions of the Basic Conditions of Employment Act of 1983, and the Labour Relations Act of 1956, to the agricultural sector. The Unemployment Insurance Act of 1966 had already been extended to the agricultural sector in 1993. The intention of these Acts was to improve working conditions of farm workers, particularly through regulating their working hours. They were also intended to improve farm workers' working wage, probably seen as to occur through collective bargaining (Simbi & Aliber, 2000).

The perceived impact of legislation on the total wage bill, and hence demand for labour, has resulted in fears that extending minimum wage regulations to the agricultural sector will aggravate the employment situation already prevalent in rural areas. The study by Newman *et al.* (1997), suggested that farmers felt that minimum wage legislation would adversely affect employment for both skilled and unskilled labour in rural areas. Bhorat and Hodge (1999) reasoned that a slight increase in the minimum wage would lead to a large fall in the demand for farm labour. There is substantial empirical support, both in the international and SA literature, for the traditional view that the introduction of minimum wages in the agricultural sector reduces employment (Murray & Van Walbeek, 2007).

The objectives of this chapter were to show that an economic study of the SA farm labour market can contribute positively towards the debate on how to create employment growth in the agricultural sector. To demonstrate this, it was imperative to have a basic understanding of the derived demand for, and supply of, labour. The supply of labour and the interventions which shift the labour supply curve were then discussed, with the main intervention being labour legislation. The next chapter reviews labour legislation in South Africa in order to have an idea of which laws affect farm labour.

CHAPTER 2: A REVIEW OF LABOUR LEGISLATION IN SOUTH AFRICA RELEVANT TO FARM LABOUR

The aim of this chapter is to review labour legislation in the agricultural sector of South Africa, on a decade by decade basis starting from the 1970s. The first part of this chapter begins with a brief overview of labour legislation in South Africa as it relates to agriculture. The next part highlights the main changes in labour legislation during each particular decade. The next part provides a basic description of current labour legislation and its effects on the farm labour sector. The chapter ends with an extensive review of minimum wage differentials (mainly between rural and urban sectors) and the move of labour from rural to urban areas in search of higher wages.

2.1 General overview

Kirsten and Vink (2003) suggest that the two most important features of the SA agricultural economy are its dualistic structure and the process of deregulation of commercial agriculture that has taken place over the past two decades. According to Sparrow *et al.* (2008), labour legislation was introduced into agriculture in the early 1990s, with the Basic Conditions of Employment Act (BCEA) being gazetted in 1992. Since the mid-1990s, new labour legislation pertaining to agriculture has been implemented in South Africa. It includes the Basic Conditions of Employment Act 75 of 1997 (amended), the Unemployment Insurance Act (UIA) 63 of 2001 (amended), the Labour Relations Act (LRA) 66 of 1995, the Land Reform (Labour Tenants) Act 3 of 1996, the Extension of Security of Tenure Act 62 of 1997, the Employment Equity Act 55 of 1998, the Skills Development Levies Act 9 of 1999, and the Sectoral Determination (an amendment of the BCEA 75 of 1997), which includes the imposition of minimum wages (Sparrow *et al.,* 2008). The BCEA stipulates minimum conditions governing working hours leave and overtime, while the UIA requires contributions to the Unemployment Insurance Fund. The Agricultural Labour Act (ALA) combines the BCEA (as amended for agriculture) with the agricultural amendments of the LRA 28 of 1956. The LRA deals with labour practices, providing a framework for collective bargaining and dispute settlement (Newman *et al.,* 1997).

Kingdon and Knight (2005) suggest that the system of labour market governance embodied in the various pieces of legislation establish a framework which would be appropriate in a fully employed economy with little labour market segmentation. The authors then reason that this is less appropriate in SA conditions of unemployment and extreme labour market

segmentation. They feel that in protecting the rights of formal sector workers, the legislation and its implementation may harm the interests of those outside the formal sector. Well-intentioned labour laws can have unfortunate unintended labour market consequences. In particular, they may discourage employment and discourage investment. The authors concluded that it is an uncomfortable fact that a government which promotes trade liberalisation must be prepared, when necessary, to also promote a good degree of labour market liberalisation (Kingdon & Knight, 2005).

2.2 Farm policy and legislation on a decade basis

2.2.1 Farm policy and legislation in the 1970s

Agricultural policy in the period up to the late 1970s can be characterised as a combination of segregation of land ownership and a two-track approach of access to support services (Kirsten & Vink, 2003). Kirsten & Vink (2003) highlight six major effects on the farming sector as a whole during this time period. First, it resulted in extraordinary institutional duplication, with attendant high fiscal cost. South Africa ended up with 14 Departments of Agriculture by 1984 and with internal barriers to trade in farm commodities through duplication of control over marketing. Second, it separated the agricultural sector which differed with regards to access to land and support services, productivity, etc. Third, it created the anomaly of a country that regularly exported food 'surpluses', while most of the population lived well below the poverty line. Fourth, there was much evidence of severe environmental damage to fragile land resources in both the commercial farming areas and the homelands. Fifth, the combination of subsidies and distorted prices led to high rates of increases in farmland prices. Sixth, the processes of forced removals and homeland consolidation created a high level of uncertainty among individual farmers, both black and white, as to the protection of existing property rights, with predictable economic consequences in some of the ecologically most vulnerable parts of the country.

2.2.2 Farm policy and legislation in the 1980s

According to Joost and Van Zyl (1998) and Kirsten and Vink (2003), SA farm policy changed dramatically in the period around the 1980s, although some of the policy shifts were initially quite gradual. Vink (1993), cited by Kirsten and Vink (2003), described the effects of policy changes during the 1980s in three steps: First, starting in the late 1970s, the SA financial sector was extensively liberalised. As a result, the exchange rate was weakened and

interest rates increased (Bourdon & Korinek, 2011). As part of the financial sector reforms, the reserve requirements of the banking sector were changed, making it impossible for the Land Bank to continue subsidising farmers' interest rates. The use of interest rate policy by the Reserve Bank saw interest rates rise to very high levels during the widespread drought of 1985/6 (around 15% for land banks) (DAFF, 2012). Second, many of the existing controls over the movement of labour were lifted by the mid-1980s, setting in motion much population movement from the farms and the homelands to the towns and cities (Sandry & Vink, 2008). This was accompanied by migration of people from most parts of southern Africa to the rural and urban areas of South Africa. Third, considerable microeconomic deregulation took place, leading to a significant increase in activity in the informal economy (Jooste & Van Zyl, 1998). One of the most visible effects was the increase in informal marketing of farm products in the urban areas. In summary, the period of the 1980s saw attempts to improve the efficiency and viability of the commercial farming sector, but within the existing framework of support, and largely in the interests of fiscal sustainability (Sandry & Vink, 2008).

2.2.3 Farm policy and legislation in the 1990s

"Until recently, agricultural labour was protected only under common law in South Africa" (Newman *et al.,* 1997: 6). In 1993, the Basic Conditions of Employment Act 3 of 1983 (BCEA) and the Unemployment Insurance Act 30 of 1966 (UIA) were extended to agriculture, with some amendments (Newman *et al.,* 1997). Isolation from the world markets, accompanied by the increased isolation of the country in social, cultural, political and intellectual spheres during the 1980s, meant that the deregulation steps that did take place were aimed at the domestic market. The steps that were taken were, however, characterised by change within an existing institutional structure, as the main role-players involved in the sector remained in place, despite the general relaxation in State intervention (Kirsten & Vink, 2003). This changed with the election of the Government of National Unity in 1994, although in agriculture, at least, some direct policy changes had to wait until 1996, i.e. until after the withdrawal of the National Party from the Government of National Unity and the appointment of an ANC Minister of Agriculture (Kirsten & Vink, 2003 and Sparrow *et al.*, 2008). According to Sandry and Vink (2008), the most important policy initiatives taken subsequent to this time included land reform, institutional restructuring in the public sector, the promulgation of new legislation, including the Marketing of Agricultural Products Act and the Water Act, trade policy and labour market policy reform. The authors suggest that the

purpose of these reforms was to correct the alleged injustices of past policy, to get the agricultural sector on a less capital-intensive growth path and to enhance the international competitiveness of the sector.

2.2.4 Farm policy and legislation in the 2000s

Since 2002, various sectoral determinations have come into force in South Africa (Nganwa *et al.*, 2010). They set general conditions for employment, most important of which are a variety of minimum wage levels for workers in several economic sectors. These include retail and wholesale trade workers, domestic workers, farm workers, forestry workers, taxi operators, security guards, hospitality staff and contract cleaners (Development Policy Research Unit-DPRU, 2008). During this time, South Africa's 1.2 million domestic workers (about one million mostly African and Coloured women who work as housekeepers, cooks and nannies, and another 200 000 men, mostly gardeners) were granted new labour market protections, including the right to a written contract with their employers and the rights to paid leave, severance pay and notice prior to dismissal (Department of Labour, 2012). In November 2002, a schedule of minimum wages, including time-and-a-half provisions for overtime work, came into effect. The minima were set above the median hourly wages that prevailed at the time (repercussions of this kind of law will be discussed later) and so constituted a major intervention in South Africa's lowest-wage labour market (Hertz, 2005). Minimum wage legislation has become central in SA policy discourse, with both strong support and strong opposition (Bhorat *et al.*, 2011).

Whether or not the laws lead to a positive outcome depends crucially on the degree to which they are enforced and on the changes in employment, if any, that they induce (Hertz, 2002). Fields (2011) showed, using the Harris-Todaro model, that a higher minimum wage can improve social welfare or not, depending on parameter values. Taking poverty as the welfare criterion, Fields and Kanbur (2006) showed in a single-sector model with income-sharing that a higher minimum wage could lower poverty or that it could raise poverty, depending on parameter values which might then be estimated empirically. The minimum wage was originally proposed as part of a broad labour market policy aimed at increasing labour productivity and achieving stability. However, in recent times the emphasis has shifted to the use of minimum wages to fight poverty (Vink & Tregurtha, 2003). Many governmental groups make similar claims about the reason for introducing minimum wage laws, but these objectives are very rarely met. Although the government believes that they are reducing

poverty by meeting the wage demands of workers, they are only doing so on short-term bases. In the long run, most workers are going to be economically worse off and inevitably the poverty rate will increase.

2.3 Minimum wages in the different sectors of South Africa

No empirical attempt has been made thus far to investigate the impact of minimum wages on the covered sectors of South Africa (Bhorat *et al*., 2012). This is perhaps due to the complex nature of the minimum wage laws in South Africa, with multiple minimum wages that differ by sector, occupation and often by location of employment that make it difficult to allocate wages to individual workers in the household survey data (DPRU, 2008 and Bhorat *et al*., 2012).

According to the Labour Research Service (LRS) (2011), the average minimum wage across all sectors increased by around 8.9% in 2010. The highest increases were in mining and construction. The lowest increase was in agriculture. When considering minimum wages in each of the main industries, manufacturing and transport emerge as the leaders. Agriculture, construction and finance (business services) return the lowest minimums. The result is unsurprising for agriculture in that it is historically the home of relatively low wages and intensely vulnerable work (LRS, 2011). Dube *et al.* (2007) suggest that average wages in South Africa are high by international standards, quoting the World Bank Investment Climate Assessment (ICA), that labour costs per worker were $7300 in South Africa in 2002, compared to $4000 in Malaysia and Poland, $2700 in Brazil and $2000 per worker in the most productive areas of China. The categories of workers which were used in the study were skilled, unskilled, professionals and managers. They emphasised that the relatively high cost of labour, especially skilled labour, may be responsible for the modest level of private investment and job creation has been modest over the past two decades. From Figure 2.1 it is clear that the agricultural, forestry and fishing minimum wage for 2010 was ranked as the lowest with an amount of around R2250 p/m. Mining, manufacturing and transport & communications were ranked amongst the top-paying minimum wages in South Africa in 2010. There are many reasons why the wage gap between industries exists where trade unions have a great influence on wages paid.
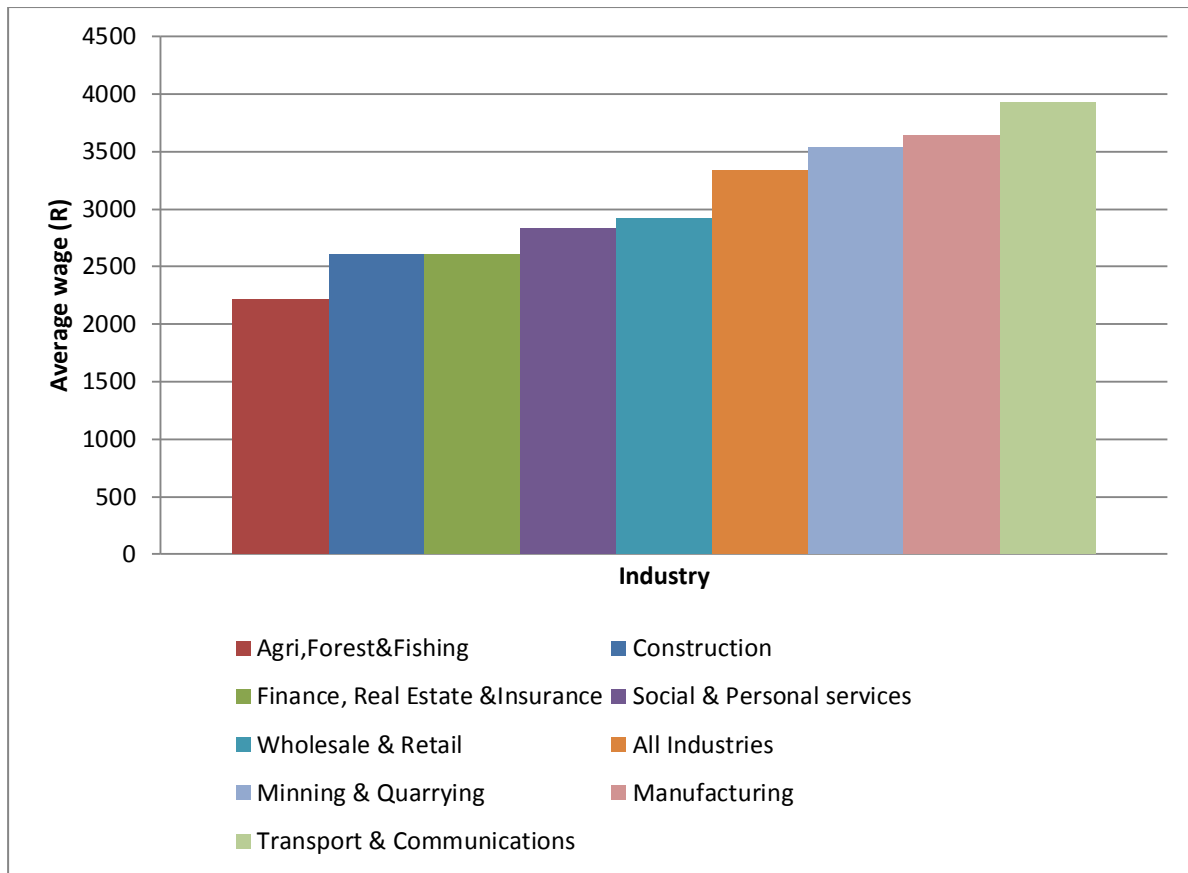
Figure 2.1: Average minimum monthly wage by industry, 2010

Source: LRS (2011)

Bhorat *et al.* (2012) assessed the impact of sectoral wage laws in South Africa. They examined the impact of minimum wage laws transmitted in the retail, domestic work, forestry, security and taxi sectors, using 15 levels of biannual Labour Force Survey data for the 2000-2007 period. In order to assess whether or not the changes experienced by workers in the sectors analysed were unique to those sectors, the authors added an exogenous control group for each sector. The impact on wages, employment and hours of work of affected workers were then considered. The standard competitive model predicts that firms will reduce employment in response to the minimum wage, in turn causing a negative employment effect to be observed for an industry. However, in this study, the effect of the introduction of a minimum wage in a low wage sector shows no clear evidence that the minimum wage laws had a significant impact on employment in the five sectors analysed. The authors also found evidence of a significant increase in real hourly wages in the post-law period as a result of the introduction of a minimum wage in three out of the five sectors examined (notably the retail, domestic worker and security sectors). The total wage bill had

also increased. These results are consistent with other SA studies on the impact of minimum wages in the domestic worker sector that suggest that, while minimum wages did not have a significant impact on employment, they are associated with a significant increase in wages within the sector (Hertz, 2005).

Bhorat *et al.* (2011) provide estimates of minimum wage violation in South Africa. The results of the study show that 44% of workers who are affected by the minimum wage get paid wages below the legislated minimum, whilst the average depth of shortfall is 35% of the minimum wage. The study also showed that the occupations regarded as possibly the two lowest paid in the SA economy, namely farm workers and household domestic workers, yield differential outcomes for compliance with minimum wage laws. In the latter case, the share below the minima, at 39%, is below the national average. In contrast, the estimate for farm workers is significantly higher, as 55% of all these workers earned below the minimum wage.

Lucas (1987), who examined temporary labour migration from five countries to South Africa's mines in search of higher wages, found that emigration to the SA mines has been shown to have reduced crop production in the subsistence sectors of Botswana, Lesotho, Malawi and the SA homelands, in the short run. But the results also suggest that earnings of migrants have enhanced both crop productivity and cattle accumulation in the longer run, except in Lesotho. The study states that whether the mechanism of productivity enhancement is one of physical investment, financing of new techniques, or insurance, permitting experimentation with riskier methods cannot be discerned. Given incomplete insurance markets and segmented capital markets, each of these mechanisms may be important, and may effectively serve to lower the shadow cost of labour withdrawn from agriculture.

It is evident from past studies that many individuals are leaving the low-paying agricultural sector in search of higher paying urban jobs. Harris and Todaro (1970) examine the consequences of this rural-urban migration in which they formulate a two-sector model of rural-urban migration which, among other things, recognises the existence of a politically determined minimum urban wage at levels substantially higher than agricultural earnings (which is evident in SA manufacturing and agricultural sectors, respectively). Despite the existence of positive marginal products in agriculture and significant levels of urban unemployment, rural-urban labour migration not only continues to exist, but, indeed, appears to be accelerating (Harris & Todaro, 1970). The study used this model to show four main points: Firstly, to demonstrate that, given this politically determined high minimum wage, the

existence of rural-urban migration in spite of considerable urban unemployment represents an economically rational choice on the part of the individual migrant; secondly, to show that economists standard policy remedy of generating urban employment opportunities through the use of "shadow prices", implemented by means of wage subsidies or direct government hiring, will not necessarily lead to a welfare improvement and may, in fact, exacerbate the problem of urban unemployment; thirdly, to evaluate the welfare implications of alternative policies associated with various back-to-the-land programmes, when it is recognised that the standard remedy suggested by economic theory, namely full wage flexibility, is, for all practical purposes, politically infeasible and, finally, to argue that in the absence of wage flexibility, an ideal policy is one which includes both partial wage subsidies (or direct government employment) and measures to restrict free migration.

Harris and Todaro's (1970) analysis provides a natural explanation for what is often observed, that is, despite high levels of unemployment in urban areas, large volumes of migration to urban areas still prevail. Their model also predicts that efforts to alleviate unemployment in urban areas involving urban job creation may actually induce migration, since this will increase the probability of employment and thus widen the expected rural-urban wage differential.

The objectives of this chapter were to provide insight on labour legislation in South Africa and the effects of labour legislation on the agricultural farm sector. These aspects were discussed over the period from the 1970s to more recent years. The other objective was to provide an insight into the possible reasons behind decreasing employment in the agricultural sector and the move from rural to urban areas in search of higher paying jobs. The next chapter presents a review of research on the economics of labour markets.

CHAPTER 3: A REVIEW OF RESEARCH ON THE ECONOMICS OF FARM LABOUR MARKETS

A review of past research on economic studies of labour markets and labour productivity is presented in this chapter, with the aim of ascertaining the methodologies that have been used by other studies and the conclusions that have been drawn from those studies. As mentioned in Chapter 2, the Value Marginal Product (VMP) curve of farm labour is the firm's demand curve for labour, so labour productivity is an important determinant of farm businesses willingness to pay for labour. The chapter ends with a review of some SA studies on farm labour productivity.

3.1 International studies on the economics of labour markets

Gardner (1972) studied the effects of minimum wage legislation on farm wage rates and employment in the United States of America (USA). The study used a reduced form supply-demand model of the hired farm labour market to formulate reduced-form equations of the hired farm labour market using aggregate USA data from 1929-1970. The independent variables were: a weighted average of past values as the opportunity wage; an index of product prices received by farmers and an average of past values. An additional shifter was technical change, for which there exists no reliable exogenous measure. It was acknowledged that technical change (as well as other omitted variables) was probably highly correlated with the included independent variables, even the minimum wage variable, since they all have similar trends. To avoid spurious significance of the non-agricultural minimum wage and the minimum wage applicable to hired farm labour, a time variable was introduced as a proxy for omitted shifters of demand or supply that might be correlated with the included variables. Results from the study indicated the extension of minimum wages to some farm labour has significantly increased farm wages and reduced employment, as the marginal productivity theory of factor demand would predict.

Lianos (1972) used time series data to study the effects of minimum wages on agricultural employment in the southern USA in two periods, 1950-1965 and 1966-1969. The study used three labour demand equations, each using a different production function. A different production function was used due to the restrictions of some functions and to avoid difficulty in interpreting wage elasticities. Ordinary Least Squares (OLS) was used to estimate the first two equations, while Two-Stage Least Squares (2SLS) was used to estimate the third equation. The results from the study yielded a wage elasticity of approximately -1.1 for all

three regions. The study concluded that the main burden of the economic adjustments made in response to the imposition of minimum wages had been borne by hired workers.

Swinnen *et al.* (2005) empirically estimated the interaction between institutional reforms and labour use in agriculture, using aggregate data from seven central and eastern European countries (Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia) for which the relevant data were available for the period 1989-1998. The result of the study showed that in general, labour outflow was considerably lower on individual farms than on corporate farms, due to a combination of factors related to human capital, access to finance and physical capital.

Nkamleu and Kielland (2006) used a multinomial logit model to capture choice probabilities across work and/or school options in the Ivory Coast. The results revealed that child labour on cocoa farms and no schooling were significant variables in determining the amount of child labour used. Moreover, many children were involved in potentially dangerous and/or harmful tasks. Results highlighted gender and age dimensions in the participation of children in tasks and the way labour was allocated. From this study it was learned that, had the study used cross-sectional data and dealt with probabilities, the multinomial logit technique would have been one to consider for the analysis of labour demand used in the present study.

For India, Kanwar (2008) used OLS and 2SLS to present more reliable estimates of the wage responsiveness to the supply and demand for labour from farmers and landless households. The aggregate panel data off-farm labour supplied and demanded were derived by aggregating across all the households in a given village in a given year. The results of the study show that variables which yielded counter-intuitive signs and are significant are very few. This demonstrates that the aggregate off-farm labour supply of farm households is positively and significantly related to the real wage rate.

Mitra and Shin (2012) empirically examined the impact of trade on labour demand elasticities using Korean firm level data. A simple framework was developed, in which an industry has several existing firms and each firm faces a finitely elastic product demand curve. Firms take the aggregate industry price level as given and do not interact with each other strategically. The basic assumption of the study was that each firm produces output using capital, labour and materials under constant returns to scale. Output in the firm was represented by qij, as a constant-returns-to-scale Cobb–Douglas function of capital, labour and materials used by that firm. The results of the study show that Korea's own tariffs do not have any statistically

significant effects on labour-demand elasticities at the firm level, but find some evidence of the impact of imports on labour-demand elasticities when they replace tariffs with import penetration ratios. It was also found that exports increase labour-demand elasticities (in absolute value).

3.2 South African studies on the economics of labour markets

Newman *et al.* (1997) conducted a study similar to that of Murray and Van Walbeek (2007). The study analysed labour remuneration and farmers perceptions on the impact of labour legislation, which at that time had recently been extended to agriculture. Data for this study were obtained in 1995, using a questionnaire posted to a random sample of 450 commercial farmers in KwaZulu-Natal, including 150 sugarcane, 150 dairy and 150 beef farmers. Of the 450 questionnaires sent out, 152 were returned, of which 135 were usable. The results of the study revealed that, all things being equal, farmers who pay relatively lower cash wages tend to provide more rations per worker and allocate more land use rights. Most respondents agreed that there is some need for labour legislation in agriculture, but the majority perceived the present legislation to be time-consuming and costly, and wanted the legislation to be less ambiguous, more flexible and less extensive.

Chant *et al.* (2001) assessed the impact of productivity growth in agriculture during a period of agricultural trade liberalisation (both domestic and global) on welfare and employment in the SA economy. The analyses were carried out using a Computable General Equilibrium (CGE) model, calibrated to a Social Accounting Matrix (SAM) for South Africa. This class of model, which captured the functioning of an economy at a point in time and through the specification of behavioural relationships, can be used for comparative static analysis of the effects of shocks on the economy. The results indicated that agricultural trade liberalisation will have positive impacts on the economy, but that the extent of the benefits is dependent on whether agriculture can remain competitive by improving productivity. There is a downside to increasing agricultural productivity; employment levels will fall unless there are other changes that stimulate employment.

Thirtle *et al.* (2005) conducted a study on agricultural technology, productivity and employment in South Africa. The study used a Ricardian model of dualistic agriculture to explain the historical development of dualism in agriculture, especially how the native farmers were disadvantaged by the colonists. This model is adapted to resemble the Harris-Todaro model of urban unemployment in order to represent the present dual agricultural

sector. Using firm-level manufacturing data, supplemented with wages from household survey data, Behar (2004) estimated a translog cost function to estimate labour demand elasticities and Allen elasticities of substitution between capital and four occupation types. The study found that own-price labour demand elasticities ranged from -0.56 to -0.8, and that capital and all occupation types are substitutes and that most occupation types are themselves complements.

Conradie (2005) conducted a survey on wine and table grape farms in the Western Cape, South Africa. Using data from a two-wave panel of 80 wine farmers surveyed in August 2003 and resurveyed in August 2004, the average monthly wage for farm labour was found to be R928 in 2003 and R1123 in 2004. The study showed that in a single-equation, short-run Hicksian demand function, wage, output, capital levels and mechanisation intensities are highly significant determinants of employment. It was made clear that economic theory usually assumes that prices (wages) and quantity (employment levels) are endogenous in competitive markets, but in the presence of minimum wages this may not be the case.

Murray and Van Walbeek (2007) studied the impact of the sectoral determination for farm workers in the SA sugar industry. In order to determine this impact, a series of semi-structured interviews were conducted between January and March 2005, using a questionnaire developed by Conradie (2003). The initial aim was to select approximately half the respondents from higher-wage Area A and the other half from lower-wage Area B, to establish the different reactions to the sectoral determination in the two areas. This approach was thwarted, as a sizeable number of Area A growers (29 of 54) had successfully applied for dispensation to pay the Area B wage. As a result, only 25 growers in the sample paid the Area A wage, while 78 growers paid the Area B wage. The result of the study showed that the impact of the legislation was similar in each region. No respondent reported mass retrenchment, but job shedding is disguised by not replacing workers (especially unskilled workers) that leave the farm. A sizeable number of growers (17 % on the South Coast and 44 % on the North Coast of KZN) had reduced the working week to 27 hours (or 36 hours in the Felixton Mill Group Area), enabling them to pay wages on an hourly, rather than on a weekly, basis.

Sparrow et al. (2008) estimated the long-run price (wage) elasticity of demand for regular farm labour in South Africa, using both OLS regression and a 2SLS simultaneous-equation model for the period 1960-2002. The long-run price (wage) elasticity of demand for regular

farm labour in South Africa during 1960-1990 was estimated as -0.25 for OLS and -0.23 for 2SLS regression, respectively. For the period 1991-2002, this elasticity estimate rose to -1.32 and -1.34 for OLS and 2SLS regression, respectively. The study points out that the demand for regular farm labour has become markedly more price elastic since the implementation of new labour legislation that has applied to SA commercial farms from the early 1990s onwards. The study concludes by stating that, in order to reverse the rising regular farm labour unemployment trend in South Africa, the government could adopt more flexible labour market regulations (for example, those relating to hiring and dismissal procedures) that would reduce real labour costs and encourage farmers to employ more regular labour.

Conradie *et al.* (2009) attempted to examine the appropriate level of aggregation for the construction of Total Factor Productivity (TFP) indices. Indices of TFP in agriculture measure aggregate output per unit of aggregate input, providing a guide to the efficiency of agricultural production. The dataset covered the magisterial districts and statistical regions of the Western Cape for the years 1952 to 2002. Over those five decades, agricultural production in the Western Cape grew twice as fast as in the country as a whole, but this average masks substantial regional variation. The results show that it is possible, at those lower levels of aggregation, to see the impact of important changes like the introduction of irrigation and rural electrification. In aggregate statistics, those local events were not noticed, as they were continuous over time and space.

Liebenberg and Pardey (2011) documented and discussed developments regarding aggregate input, output and productivity developments within South Africa. The study draws on an entirely new set of production data stretching back to 1910/11, as well as related evidence reported by other studies for South Africa and other countries within sub-Saharan Africa. The study found that SA agriculture had sustained a competitive edge during the decades prior to the late 1980s, with strong growth in agricultural exports and more muted, but still pronounced, growth in net agricultural trade surplus. However, the country's agricultural exports and net trade balances have declined much quicker in more recent years. Rankin and Roberts (2011) studied the link between youth unemployment, firm size and reservation wages in South Africa. Unlike previous studies on the relationship between reservation wages and unemployment the study differentiates between wages in different sizes of firms. The study uses two estimation techniques (ordinary least squares (OLS) and a Heckman two-stage procedure) and three ways of predicting wages to ascertain the robustness of the results. The study concludes that larger firms pay more and thus, even if reservation wages are similar to

average predicted wages, they may be above the wages that young people could expect to earn in smaller firms.

Chapter 3 reviewed farm labour markets in and out of South Africa and, besides studies done on the demand and supply of labour, this chapter reviewed labour productivity in the farming sector of South Africa. It is clear that many different methodologies and approaches can be used to analyse labour demand and productivity. It also helps to identify a suitable methodology for the type of research done for this particular study. The next chapter provides an overview of the sugar industry in South Africa and in other countries since the study was conducted on this sector. The chapter also gets an idea of sugarcane production in other countries in order to boost the efficiency of sugarcane production in South Africa.

CHAPTER 4: AN OVERVIEW OF THE SOUTH AFRICAN SUGAR INDUSTRY

The purpose of this chapter is to offer an explanation why the SA sugar industry is a suitable industry for this study. Important considerations discussed include levels of employment in the industry and labour data availability for the industry. The review of past economic research pointed towards a need for time-series data on employment levels and average wages paid to workers. The chapter begins with a brief overview of the industry and where sugarcane is grown and milled in South Africa. Thereafter there is a brief discussion on the productivity of each mill, followed by a review of employment in the large-scale sugarcane sector. The chapter ends with a brief description of sugarcane production on an international level and how labour employment can be created from other uses of sugarcane, such as bio-ethanol production.

4.1 Size and location of the sugar industry

South Africa is one of the world's leading cost competitive producers of sugar (SACGA, 2012). The industry produces around 2.2 million tonnes of sugar per season, of which 1.32 million tonnes are marketed in the Southern African Customs Union (SACU) and the remainder is exported to markets in Africa, Asia and the Middle East (Funke, 2011). Sugar is a consumer product sold directly to the public, a raw material for the food and beverage industry and for the production of industrial ethanol, mainly used as a gasoline substitute (Tyler, 2010). The SA sugar industry provides substantial employment, offering jobs (directly and indirectly) to many people (Owens & Eweg, 2003). According to SASA (2012), approximately one million people, about 2% of South Africa's population, depend on the sugar industry for a living. Direct employment within the sugar industry is approximately 79 000 jobs, which represents a significant percentage of the total agricultural workforce in South Africa. Indirect employment is estimated at 350 000 (SASA, 2012).

The sugarcane-growing sector consists of approximately 29 130 registered sugarcane growers, farming mainly in KZN (SASA, 2012). Sugar is manufactured by six milling companies, with 14 sugar mills, operating mainly in KZN. There are currently 12 sugar mills in KZN, located at Pongola, Umfolozi, Amatikulu, Felixton, Darnall, Gledhow, Maidstone, Umzimkulu, Sezela, Eston, Noodsberg and Dalton. These locations can be separated into five regions, namely North Coast, South Coast, Midlands, Tugela and Zululand. There are currently two sugar mills in Mpumalanga, in the Nelspruit and Komatipoort region (SACGA, 2012). Sugarcane provides approximately 82 per cent of the income from field crops in KZN.

Therefore, any factor affecting the productivity of the sugar industry in South Africa has an impact on the total GDP of the South African economy (Mac Nicol *et al.*, 2007).

4.2 Size and location of mills in South Africa

Figure 4.1 highlights all the sugarcane growing and milling areas in South Africa, distinguishing between rain-fed and irrigated land. The Eston, Noordsberg and Dalton (UCL) mills are located in the Midlands region of KZN. This region has a lower annual rainfall compared to the North Coast, South Coast and Tugela regions. Land is generally flatter in this region and is also used for timber and livestock production (Lyne & Meyer, 2008). The flat land in the Midlands region makes it easier to mechanise than the regions with rocky slopes. An annual average of 3.1 million tonnes of sugarcane is produced in the Midlands, which results in a seasonal average of 340 000 tonnes of sugar and 151 000 tonnes of molasses. About 260 000 tonnes of sugar are transported by road to Durban, with the remainder transported by rail to Germiston, Gauteng. Growers are located up to 85 kilometres from each mill (Department of Transport, 2010).
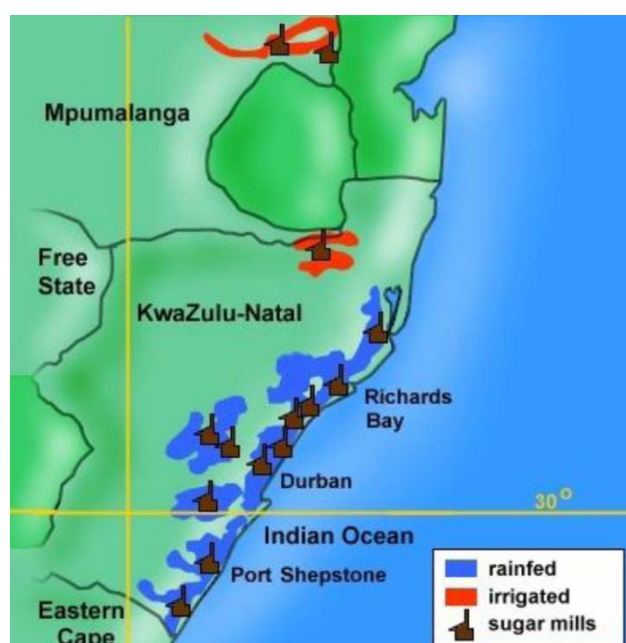
Figure 4.1: Areas of land in South Africa where sugarcane milling and growing occur

Source: SASA (2012)

The Sezela and Umzimkulu mills are located in the South Coast region of KZN. There is generally a higher rainfall in this region. The land in the South Coast is hilly and not suited for mechanisation (Mcelligott, 2013). However, experts in the field of mechanisation for the

sugarcane industry have indicated that the South Coast region has been using non-mechanised manual labour in the past two decades due to rising labour costs (Bezuidenhout, 2013 and Mcelligott, 2013). For example, instead of employing 50 workers with hoes to remove weeds, 20 workers with knap-sacks and boom-sprayers are used to spray chemicals. An annual average of 3.24 million tonnes of sugarcane is produced, which results in a seasonal average of 320 000 tonnes of sugar and 127 000 tonnes of molasses. Growers are located up to 135 kilometres from each mill. All output from mills is transported by road to Durban (Department of Transport, 2010).

The Darnall, Gledhow and Maidstone mills are located in the North Coast region of KZN. An annual average of 3.74 million tonnes of sugarcane is produced, which results in a seasonal average of 355 000 tonnes of sugar. Growers are located up to 76 kilometres from each mill. The Gledhow Mill has its own packing operation and delivers bagged sugar directly to customers in the Durban area. The Darnall and Maidstone mills transport their yield by road to Durban (Department of Transport, 2010). The Amatikulu mill is located in the Tugela region of KZN. There was an additional mill, Entumeni, but it closed down after the 2003/04 season. About 1.5 million tonnes of cane is produced, on average, per annum. Growers are located within a radius of up to 80 kilometres from the mill. An annual average of 150 000 tonnes of sugar and 60 000 tonnes of molasses are produced and transported by rail to Durban (Department of Transport, 2010).

The Felixton, Umfolozi and Pongola mills are located in the North Coast region of KZN. This is a drier region, with irrigation of sugarcane being practised by growers. An annual average of 4.6 million tonnes of sugarcane is produced, which results in a seasonal average of 492 000 tonnes of sugar and 184 000 tonnes of molasses. Deliveries to the Felixton mill are done by rail. Rail is also used by this mill to transport all sugar and half of the molasses produced to Durban. The remaining 50 percent of molasses is transported by road to Durban. The Umfolozi and Pongola mills rely on road for transportation. Some of the Pongola mill's production is transported to Gauteng, with the remainder sent to Durban (Department of Transport, 2010).

From Figure 4.2 it is clear that the Komati mill crushed the most cane during the 2010/2011 season while the Darnall mill crushed the least amount of cane.
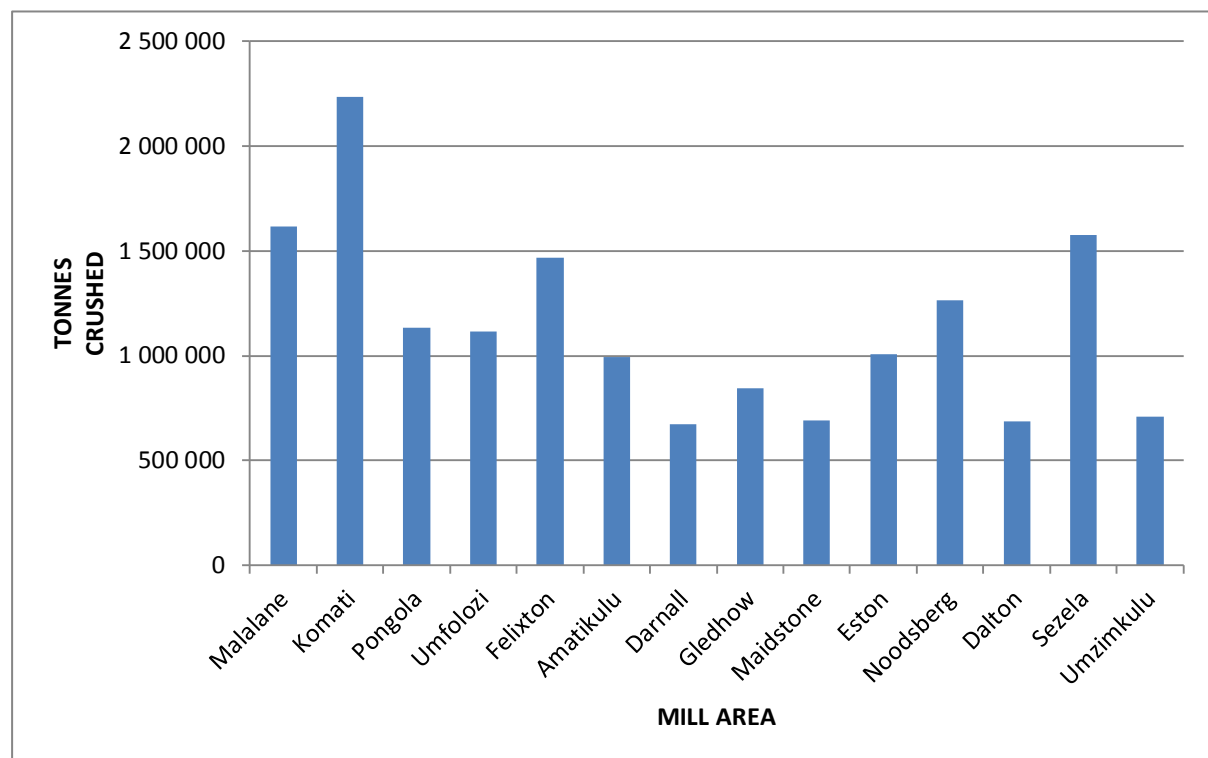
Figure 4.2 Amount of sugarcane crushed by each mill in South Africa, 2010/2011

Source: SASA (2012)

4.3 Number of sugarcane growers in South Africa

There are about 27 580 small-scale farmers and 1550 large-scale farmers in the industry. Although their numbers are high, small-scale cane growers generally do not provide a stable supply of cane to mills. Figure 4.3 depicts the share which each producer type produces (SASA, 2012). About 85 per cent of sugarcane is grown by large-scale growers, 9 per cent by small-scale growers and the remaining 7 per cent is grown by millers (SACGA, 2012). The amount of sugarcane produced by large-scale growers and the availability of data for these farmers is one of the main reasons for including only large-scale sugarcane growers in this study.
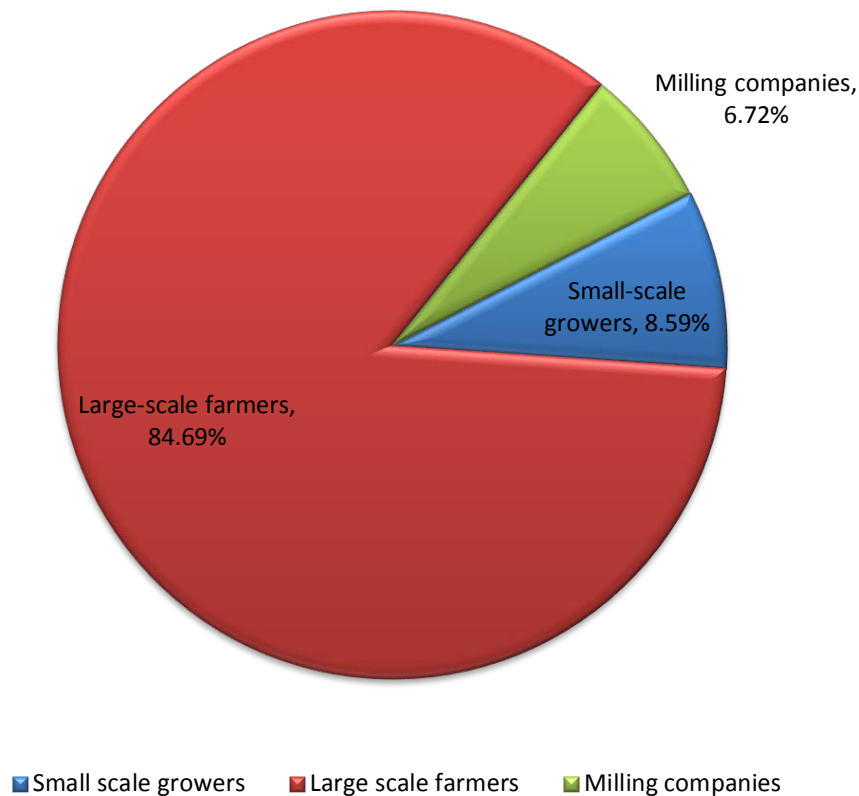
Figure 4.3: Distribution of sugarcane production in South Africa

Source: SASA (2012)

4.4 Employment in the sugarcane sector

Large-scale operations were defined by SACGA (2012) as those responsible for annual sugarcane deliveries exceeding 10 000 tonnes. The decision to focus this study on large-scale producers is due to the relatively large production share (85%) contributed by larger growers, considering that small-scale growers account for only 9% of total cane production (SACGA, 2012). Large-scale farmers usually have a broader range of options available to manage and control labour issues and are better suited to the objectives of this study (Nicol *et al.*, 2007). Figure 4.4 shows that employment in the large-scale sugar industry has been decreasing over the years, from around 87 000 labourers in 1990/1991 to just under 70 000 in 2009/2010. The decrease in employment may be partly due to the change in the area under cane for large-scale sugarcane farmers during this time. However, minimum wage laws prove to be one of the most debated reasons for the decrease in farm labour employment.
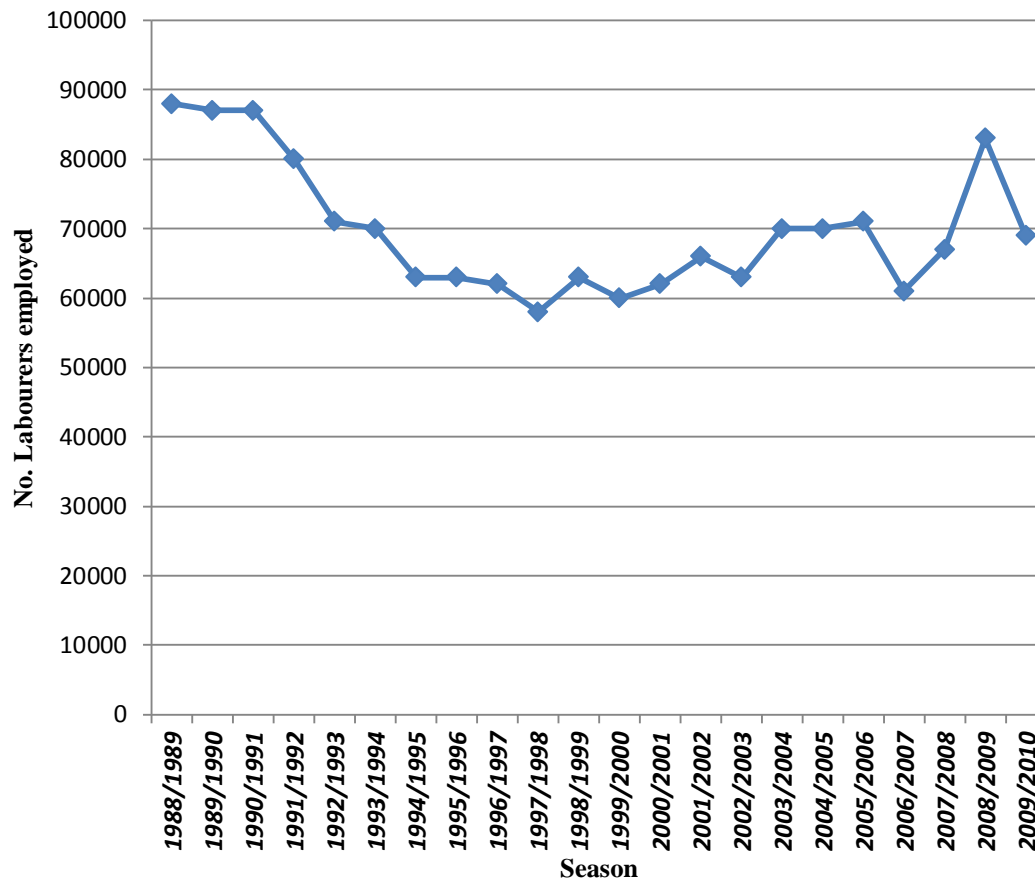
Figure 4.4: Farm workers in the large-scale sugarcane industry, South Africa (1988/89 – 2009/10)

Source: Adapted from (SACGA, 2012)

With the high number of unskilled workers, other challenges that SA farmers are continue to face include land reform, AgriBEE (Agricultural Black Economic Empowerment in Agriculture), new labour legislation and minimum wages, property taxes, skills levies, uncertain water rights, HIV/Aids, a volatile exchange rate and high transport and communication costs (Ortmann, 2005). European Union sugar policy reforms are a major market driver and are expected to continue to reduce world exports and contribute to strengthening prices, together with demand growth in China and India. For this reason, SA sugarcane farmers had to deal with highly variable sugar prices in recent years (Illovo Sugar, 2006, cited by Mac Nicol *et al.*, 2007; SASA, 2012).

The SA sugar industry is a major contributor to rural development, an area often neglected in an urbanising society (SASA, 2012). Industry focus includes the promotion of economic transformation, social investment and sustainable environmental practices. The sugar industry

also makes an important contribution to the national economy, given its agricultural and industrial investments, foreign exchange earnings, high employment and its linkages with major suppliers, support industries and customers (SASA, 2012). Policy-makers claim that the SA agricultural sector has the potential of creating many jobs and thereby reducing the unemployment rate of the country (BFAP, 2011). The variety of quality data available on the sugar industry is another reason for studying this particular industry. Before deciding whether or not this sector can provide additional employment, it is necessary to determine if there is a need or increased demand for labour in the South African sugar industry. It is important to identify the determinants of the demand for labour in the sector to guide policy recommendations for increasing labour absorption in the sector.

4.5 International sugar trade

Most major developed countries (USA, EU, Japan) protect a high-cost, domestic cane and/or beet industry with high tariff barriers and import quotas, as an extreme example of their more general policy of protecting their agricultural industries (Tyler, 2010). In the USA, for example, the sugar price has been so high that it has artificially stimulated the formation of an alternative sweetener industry known as High Fructose Corn Syrup (HFCS), derived from maize starch. South Africa had been overly ambitious when setting its tariff rates in 1994 and its tariff rates fell well below the bound levels of the World Trade Organisation (WTO) (NDA, 2011). In the EU, the domestic market price has also been very high, causing effective bans on the establishment of a large-scale HFCS industry. However, an initial absence of effective controls on beet growing meant that a very large surplus of beet sugar developed, which could only be disposed of by exporting with the help of subsidies, to cover the difference between the EU and world market prices (Tyler, 2010).

The world's largest consumers of sugar, China and India, have moderately high-cost, protected sugar industries (Tyler, 2010). With world market prices normally lower than the domestic price, they have not sought to be consistent exporters and have hovered between being net importers and net exporters. The size of their potential imports or residual exports are, however, so large and unpredictable that they can have a major impact on world markets. With regards to South Africa, Mac Nicol *et al.* (2007) indicated that, in addition to dealing with the deregulation of domestic agricultural markets in the 1990s and thus more variable product prices, SA farmers also have to adapt to a dynamic global economic and trade environment and a dynamic political environment.

World sugar prices on the residual, free market have normally been so low that even the world's lowest cost major exporters like Brazil, Australia, Thailand and Guatemala have all found ways to subsidise their exports (Tyler, 2010). One of the ways includes blending higher prices achieved in protected domestic markets with those available through exports. Brazil, the world's largest producer of sugar cane and exporter of sugar, has been able to support its industry by creating a large sugar cane for gasohol programme, as a substitute for petrol in car engines (Tyler, 2010).

4.6 Sugarcane in renewable energy production

Investment in renewable energy and energy efficiency is important to reduce the negative economic, social and environmental impacts of energy production and consumption in South Africa (Sparks *et al.,* 2011). Parker (2009) suggests that if South Africa's sugar industry is to grow, it has to keep an eye on new markets and opportunities, one of which may, once current restrictions are overcome, manifest in sugar cane-based energy. In South Africa, the opportunity for bioenergy production from sugarcane is becoming increasingly realistic (Botha & Van Den Berg, 2009). The study highlights that although this commodity seems realistic to produce, many questions remain regarding the extent to which agronomic practices need to be adapted, and the related economic impacts and trade-offs, bearing in mind that future economic conditions are highly uncertain. Mac Nicol *et al*. (2007) conducted a survey among large-scale sugarcane producers in South Africa and concluded that the perceived key risks faced by sugarcane producers were land reform, minimum wage legislation and volatility of the sugar price.

A study by Richardson (2010), to determine how investment in large-scale sugarcane production has contributed, and will contribute, to rural development in southern Africa, highlights three mechanisms by which sugar/ethanol exports could facilitate rural development: First, it has been argued that the increased export of sugar and ethanol that results from foreign investment can lead to business growth. Macro-economic stability is enhanced as the balance of payments improves and export diversification reduces currency volatility. Secondly, the regulatory environment is made more conducive, as governments become more proficient at managing border controls, enforcing contracts and reducing constraints acutely felt in sub-Saharan Africa. Thirdly, government revenue in the form of corporate tax, income tax and tariffs levied on industry imports all increase, thereby allowing further state investment in public goods such as transport infrastructure or education.

Richardson (2010) suggests that by bringing with them managerial and technical expertise, foreign investors can help to increase labour productivity and lower the cost of agricultural products. This is another problem with particular relevance to sub-Saharan Africa, since agronomists frequently point out that much higher yields are possible in the continent.

Chetty (2006) states that job creation is cited as one of the most obvious economic and social benefits of ethanol production. In 2004, Brazil exported 2.4 billion litres of ethanol and the sector employs 500 000 people in sugarcane production and a further 500 000 in ethanol production (Flavin & Aeck, 2005, cited by Chetty, 2006). Parker (2009) estimated that up to 4% of South Africa's liquid fuel pool, about 500-million litres, could potentially be supplied from ethanol manufactured from sugar currently exported to world markets. The multibillion-rand ethanol project being planned for Makhathini, in northern KZN, will be using sugar cane from new and additional planting areas and has promised to create about 1 800 jobs (Chetty, 2006).

Hendricks (2006), cited by Chetty (2006), stated that a task team consisting of various departments has been established to promote the production of biofuels in South Africa. According to Chetty (2006), the strategy is intended to reduce unemployment in the underdeveloped economy significantly, with the expectation to halve unemployment by 2014. These aims and objectives seem very optimistic, given the current inability of the agricultural sector to create jobs and the time allocated to achieve them. Many government authorities speak of these kinds of objectives, but very few outline how they can be achieved with the resources available.

This chapter outlined where sugarcane is grown in South Africa and provided a description of the different mills. It revealed that employment in the large-scale sugarcane sector has declined over the past two decades. The chapter ended with a discussion of sugarcane at an international level and other uses of sugarcane which could create jobs. Chapter 5 covers the research methodology of the study. The data is then described and the properties of some of the econometric techniques used in the study are discussed.

CHAPTER 5: **RESEARCH METHODOLOGY**

The previous chapter introduced the South African (SA) sugar industry and reasons for studying labour employment in this industry. The aim of chapter 5 is to develop a suitable methodology for this study, after reviewing past methodologies used to analyse farm labour. Following the research problem and main objective stated in the introductory chapter, this chapter begins by building on these areas. This is followed by a discussion on the data obtained and the categories of labour used in the study. Thereafter, a brief description of the properties of different econometric methods is presented. After that, an econometric model is specified for estimating the price elasticity of demand for labour in three sugar growing regions of KZN. Lastly, descriptive statistics are presented on each of the study regions.

5.1 Research problem

Figure 5.1 illustrates that employment in large-scale sugarcane farming for the three study regions (South Coast, Midlands and Tugela/Zululand) has declined, over the period 1984/85 to 2007/08. The South Coast region shows a more distinct decrease in labour units employed, compared to the other two regions. The question is, to what extent was this due to a shift in the real cost of labour (including wages and non-wage costs) and to what extent was it attributable to other factors? It can be inferred that governmental institutions like the National Development Plan (NDP) (2011) and the Department of Labour (2012) set goals regarding agricultural employment. They indicate that the SA agricultural sector has the potential to create many jobs and possibly reverse the unemployment trend in the country. However, they do not specify how these goals may be achieved. It may, therefore, be useful for policy-makers to understand the own-price elasticity of demand for agricultural labour, in order to understand the long- and short term effects of their policies. Estimates of the wage elasticity of labour in the sugarcane industry over the past two decades could provide a basis from which to predict the responsiveness of employment to changes in wages in the sugarcane industry.
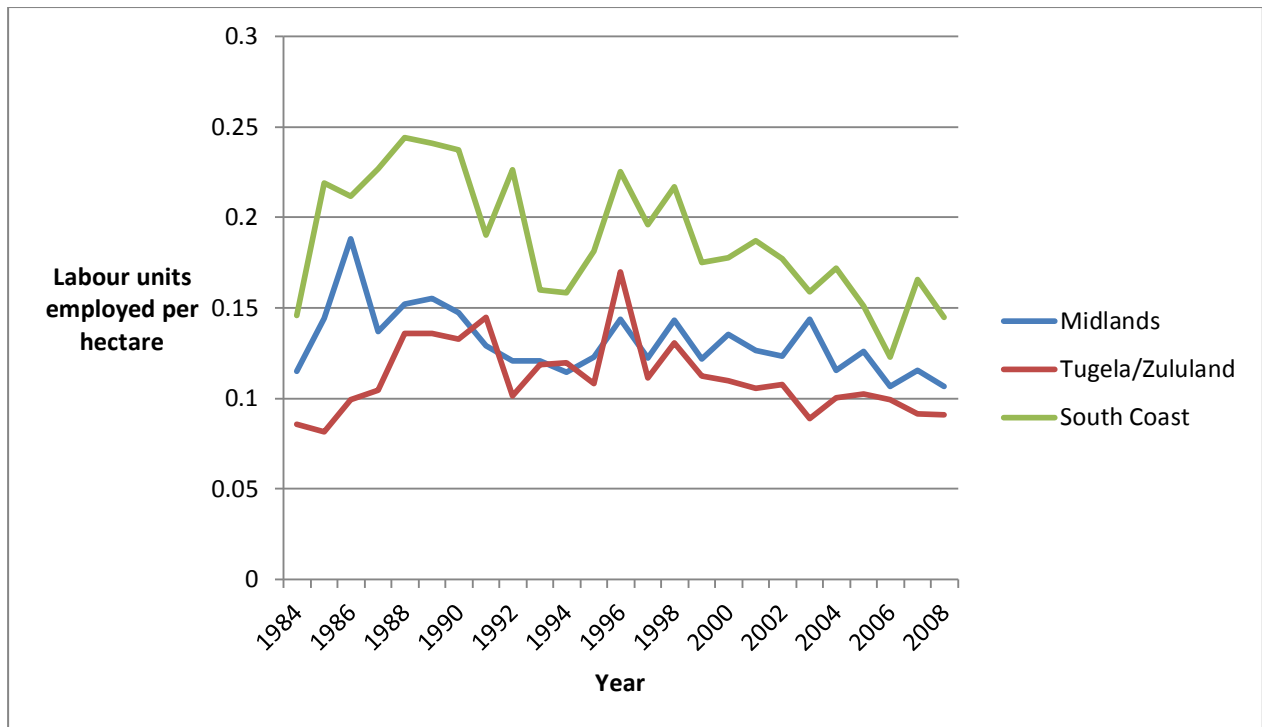
Figure 5.1: Number of labour units employed per hectare by large-scale sugarcane farmers in the three study regions: South Coast, Midlands, Tugela/Zululand (1984-2008)

Source: Adapted from SACGA, (2012)

5.2 Objectives of the study

Considering that the SA working age population in agriculture is predominantly unskilled, their supply of labour is probably highly wage elastic (Sparrow *et al.*, 2008; Richardson, 2010). The main objective of this study is to estimate wage elasticities of demand for three sugar-growing regions in KZN. By knowing the responsiveness of employment to changes in the wage rate, one can:

- Establish some of the factors (variables) affecting the demand for farm labour in the sugar industry,
- Determine the labour use intensity in the three study regions,
- Establish the rate at which minimum wage laws and other forms of wage increases have impacted the demand for farm labour in the three study regions (price elasticity of demand).

5.3 Source of data

Most of the data on the SA sugar industry, including farm labour employment and wage levels, were obtained from the SA Cane Growers' Association (SACGA), the national organisation which represents South Africa's approximately 30 000 small- and large-scale sugarcane growers. This organisation has an economic research department, which allocates individuals who oversee the collection of data. Each year a sample is drawn from farmers in their respective regions and response rates are monitored on an annual basis, to ensure that high-quality and trustworthy data is being captured. The study used data collected over 25 years for three regions of KZN. The data available for the Mpumalanga region are probably distorted, due to the high proportion of labour contractors used (hence employment in sugarcane farming is probably under-stated). The North Coast region was also excluded from the study, due to a low survey response rate by farmers in some years, resulting in concerns about the reliability of SACGA's estimate of employment in that region in those years. The data is analysed as panel data, separating the three regions and equalling a total of 75 observations. In defining the regions used in the study there had been a change in names and areas of the Tugela region. According to SACGA there was a reclassification of the sugarcane growing regions from the 1996/97 season. Before that there were the Pongola, Komati and Malelane regions. Then around the mid-1980s the regions Pongola and Malelane were designated as one region.

To remedy this, from the 1984/85 season until the 1996/97 season, the Zululand and Pongola regions were added together to make up the Tugela region. After this period the Tugela and Zululand regions were combined to make up the Tugela region. In this way, the data flow in a sequential manner, with no major deviations. Remedies to all data are discussed later in the "Treatments to data" section, 5.8.2.

Indices of machinery, chemical and other costs were obtained from the Department of Agriculture, Forestry and Fisheries' Abstract of Agricultural Statistics (2012). The SA Consumer Price Index (CPI), with a base year of 2005, was used to deflate annual nominal values to annual real values, where necessary.

5.4 Category of labour used for this study

SACGA (2012) captures their employment data as "the number of workers employed by large-scale growers", which does not take into account that some workers are employed on a

seasonal basis, and as "the number of labour units employed by large-scale growers". While the former provides details of the total number of workers employed, it is necessary for comparative purposes to make certain adjustments to the data. Owing to the turnover of labour during the year, and the seasonality of certain categories, SACGA finds it necessary to express the labour force in terms of labour units before efficiency of utilisation can be assessed. Therefore, in this study, "the number of labour units employed by large-scale growers" was used. A labour unit is defined by SACGA as "A worker employed for 12 months, or approximately 300 working days, including annual and sick leave". This definition covers both seasonal and permanent workers and consists of general staff, tractor drivers, cutters and stackers, other harvesting staff, harvesting staff out of season and other staff.

5.5 Properties of the different econometric methods used for the study

5.5.1 The use of panel data

Unlike time-series data (where the values of one or more variables over a period of time are observed) or cross-section data (where values of one or more variables are collected for several sample units, or entities, at the same point in time), in panel data the same cross-sectional unit is surveyed over time. In short, panel data have space as well as time dimensions (Gujarati & Porter, 2009). However, in this study, although the respondents to the surveys were not the same, SACGA provided time-series data estimates of employment in sugarcane farming for each region, based on their analysis of their annual Cane Productivity Surveys. Therefore the data used has both time and space dimensions and is suitable for analysis as panel data.

Baltagi (2008) lists six advantages of panel data over cross-section or time series data:

- Since panel data relate to individuals, firms, states, countries, etc., over time, there is bound to be heterogeneity in these units. The technique of panel data estimation can take such heterogeneity explicitly into account, by allowing for individual-specific variables.
- By combining time-series of cross-section observations, panel data give "more informative data, more variability, less collinearity among variables, more degrees of freedom and more efficiency."

- By studying the repeated cross-section of observations, panel data are better suited to study the dynamics of change. Like this study, studies of unemployment, job turnover, and labour mobility are better studied with panel data.

- Panel data can better detect and measure effects that simply cannot be observed in pure cross-section or pure time-series data. For example, the effects of minimum wage laws on employment and earnings can be better studied if researchers include successive panels of minimum wage values.

- Panel data enable the researcher to study more complicated behavioural models. For example, phenomena such as economies of scale and technological change can be better handled by panel data than by pure cross-section or pure time-series data.

- By making data available for many units, panel data can minimise the bias that might result if individuals or firms are aggregated into broad aggregates.

5.5.2 Types of panel data models

There are two types of panel data models, namely:

- The Fixed Effects or Least-Squares Dummy Variable (FEM/LSDV) Regression Model: One way to take into account the "individuality" (heterogeneity) of each cross-sectional unit is to let the intercept vary for each cross-sectional unit, but still assume that the slope coefficients are constant across firms and this is what the fixed effects regression does (Gujarati & Porter, 2009).

- The Random Effects or Error Components model (REM/ECM): In the REM it is assumed that the intercept of an individual's unit is a random drawing from a much larger population with a constant mean value. The individual intercept is expressed as a deviation from this constant mean value.

5.5.3 The choice of the appropriate model to use

Judge *et al.* (1985) suggested four ways to help choose between the two models:

- If T (the number of time-series data) is large and N (the number of cross-sectional units) is small, there is likely to be little difference in the values of the parameters estimated by FEM and ECM. Hence, the choice here is based on computational convenience. On this score, FEM may be preferable.

- When *N* is large and *T* is small, the estimates obtained by the two methods can differ significantly. In the Error Correction Method (ECM) β1i = β1 + εi , where εi is the cross-sectional random component, whereas in Fixed Effects Method (FEM) β1i is treated as fixed and not random. In the latter case, statistical inference is conditional on the observed cross-sectional units in the sample. This is appropriate if it is strongly believed that the individual, or cross-sectional, units in our sample are not random drawings from a larger sample. In that case, FEM is appropriate. However, if the cross-sectional units in the sample are regarded as random drawings, then ECM is appropriate, for in that case statistical inference is unconditional.

- If the individual error component εi and one or more regressors are correlated, then the ECM estimators are biased, whereas those obtained from FEM are unbiased.

- If *N* is large and *T* is small, and if the assumptions underlying ECM hold, ECM estimators are more efficient than FEM estimators. There is a formal test that will help researchers to choose between FEM and ECM, known as the Hausman test. The null hypothesis underlying the Hausman test is that the FEM and ECM estimators do not differ substantially. The test statistic developed by Hausman has an asymptotic χ2 distribution. If the null hypothesis is rejected, the conclusion is that ECM is not appropriate and that it may be better to use FEM, in which case statistical inferences will be conditional on the εi in the sample.

5.6 Simultaneous equations

5.6.1 Two-Stage Least Squares (2SLS)

Single equation models are those in which there is a single dependent variable *Y* and one or more explanatory variables, the *X's*. In such models, the emphasis is on estimating and/or predicting the average value of *Y,* conditional upon the fixed values of the *X* variables (Gujarati & Porter, 2009). The cause-and-effect relationship, if any, in such models, therefore, runs from the *X's* to the *Y*. But in many situations such a one-way or unidirectional cause-and-effect relationship is not meaningful. This occurs if *Y* is determined by the *X's*, and some of the *X's* are, in turn, determined by *Y*. In short, there is a two-way, or simultaneous, relationship between *Y* and (some of) the *X's*, which makes the distinction between dependent and explanatory variables of dubious value. It is better to lump together a set of variables that can be determined simultaneously by the remaining set of variables (precisely what is done in simultaneous-equation models). In such models there is more than one equation (one for each

of the mutually, or jointly, dependent or endogenous variables)**.** As a consequence, an endogenous explanatory variable becomes stochastic and is usually correlated with the disturbance term of the equation, in which it appears as an explanatory variable (Gujarati & Porter, 2009).

One of the crucial assumptions of OLS is that the explanatory X variables are either nonstochastic or, if stochastic (random), are distributed independently of the stochastic disturbance term. If neither of these conditions is met, the least-squares estimators are not only biased, but also inconsistent; that is, as the sample size increases indefinitely, the estimators do not converge to their true (population) values (Gujarati & Porter, 2009). This phenomenon gives rise to the use of Simultaneous Equation Models.

5.6.2 The identification problem

The identification problem arises when numerical estimates of the parameters for a structural equation can be obtained from the estimated reduced-form coefficients, or not. If this can be done, then that particular equation is identified. If this cannot be done, then the equation under consideration is unidentified, or underidentified. An identified equation may be either exactly (or fully or just) identified or overidentified (Gujarati & Porter, 2009). It is said to be exactly identified if unique numerical values of the structural parameters can be obtained. It is said to be overidentified if more than one numerical value can be obtained for some of the parameters of the structural equations. The identification problem arises when different sets of structural coefficients may be compatible with the same set of data. Gujarati and Porter (2009) highlight two ways of analysing the identity of an equation:

- **The Order Condition of identifiability**

In order to understand the order and rank conditions, the following notations are introduced:

M = number of endogenous variables in the model

m = number of endogenous variables in a given equation

K = number of predetermined variables in the model, including the intercept

k = number of predetermined variables in a given equation

A necessary (but not sufficient) condition of identification, known as the order condition, may be stated in two different but equivalent ways:

"In a model of M simultaneous equations, in order for an equation to be identified, the number of predetermined variables excluded from the equation must not be less than the number of endogenous variables included in that equation less 1" (Gujarati & Porter, 2009), that is,

$$K - k \geq m - 1$$

If $K - k = m - 1$, the equation is just identified, but if $K - k > m - 1$, it is overidentified.

- **The Rank Condition of identifiability**

The order condition discussed previously is a necessary, but not sufficient, condition for identification; that is, even if it is satisfied, it may happen that an equation is not identified (Gujarati & Porter, 2009). Therefore, both a necessary and sufficient condition for identification is needed. This is provided by the rank condition of identification, which may be stated as follows:

"In a model containing M equations in M endogenous variables, an equation is identified if and only if at least one nonzero determinant of order $(M - 1)(M - 1)$ can be constructed from the coefficients of the variables (both endogenous and predetermined) excluded from that particular equation but included in the other equations of the model" (Gujarati & Porter, 2009).

5.6.3 A test of simultaneity

If there is no simultaneous equation, or a simultaneity problem, the OLS estimators produce consistent and efficient estimators. On the other hand, if there is simultaneity, OLS estimators are not consistent (Gujarati & Porter, 2009). In the presence of simultaneity, the methods of two-stage least squares (2SLS) and instrumental variables will give estimators that are consistent and efficient. However, if these alternative methods are applied when there is no simultaneity, these methods yield estimators that are consistent but not efficient (i.e. with smaller variance). The simultaneity problem arises because some of the regressors are endogenous and are therefore likely to be correlated with the disturbance, or error, term. Therefore a test of simultaneity is essentially a test of whether an endogenous regressor is correlated with the error term. If it is, the simultaneity problem exists, in which case alternatives to OLS must be found; if it is not, the OLS may be used. To discover which is the case in a concrete situation, we can use Hausman's specification error test.

5.6.4 Features of 2SLS

- It can be applied to an individual equation in the system without directly taking into account any other equation(s) in the system. Hence, for solving econometric models involving a large number of equations, 2SLS offers an economical method. For this reason the method has been used extensively in practice (Gujarati & Porter, 2009).

- Unlike Iterated Least Squares (ILS), which provides multiple estimates of parameters in the overidentified equations, 2SLS provide only one estimate per parameter (Gujarati & Porter, 2009).

- It is easy to apply, because all that needs to be known is the total number of exogenous or predetermined variables in the system, without knowing any other variables in the system (Gujarati & Porter, 2009).

- Although specially designed to handle overidentified equations, the method can also be applied to exactly identified equations. But then ILS and 2SLS will give identical estimates (Gujarati & Porter, 2009).

- If the R^2 (r-squared) values in the reduced-form regressions (that is, Stage 1 regressions) are very high, say, in excess of 0.8, the classical OLS estimates and 2SLS estimates will be very close. But this result should not be surprising, because if the R^2 value in the first stage is very high, it means that the estimated values of the endogenous variables are very close to their actual values, and the latter are less likely to be correlated with the stochastic disturbances in the original structural equations. If, however, the R^2 values in the first-stage regressions are very low, the 2SLS estimates will be practically meaningless, because the original Ys will be replaced in the second-stage regression by the estimated $\hat{Y}$ from the first-stage regressions, which will essentially represent the disturbances in the first-stage regressions. In other words, in this case, the $\hat{Y}$ will be very poor proxies for the original Ys (Gujarati & Porter, 2009).

5.7 Empirical methodology

This study attempts to combine two econometric techniques, namely the use of panel data in simultaneous equation models. Studies of this kind are very rarely used in estimating labour demand functions, due to the data requirements to utilise these techniques concurrently. Baltagi (2008) shows that an estimation of this nature is possible and highly useful. Although

studies of this type are rare in analysing agricultural labour markets; there are many well documented studies of these combined techniques used to analyse other sectors and markets. For example, Anderson and Hsiao (1981) specified Dynamic Simultaneous Equation Error Models with panel data for the estimation of economic systems, such as empirical application to the analysis of direct and indirect effects of regional equalisation policy instruments on regional output (growth) and factor inputs. The aim of the paper was to put forward the methodological discussion about appropriate dynamic panel data estimators in the context of growth regressions with non-standard (large N, small T) panel data assumptions. Since frequently used dynamic models have generally shown a poor empircal performance in these circumstances, special emphasis is on appropriate estimators which merely use levels of variables instead of first differences. This is done using straightforward generalisations of familiar static panel data models with strictly exogenous variables.

In another study, Vella and Verbeek (1999) use two-step estimators for a wide range of parametric panel data models with censored endogenous variables and sample selection bias. The authors derive estimates of the unobserved heterogeneity responsible for the endogeneity/selection bias to include as additional explanatory variables in the primary equation. These are obtained through a decomposition of the reduced form residuals.

Economic theory suggests that labour prices (wages) and labour quantity (employment levels) are endogenous in competitive markets, but in the presence of minimum wages this may not be the case (Conradie, 2005). The choice of model critically depends on the presence of simultaneity. If there is simultaneity, 2SLS estimation is consistent and efficient, while OLS is inconsistent. If there is no simultaneity, OLS is consistent and efficient, while 2SLS is consistent but inefficient (Bhorat & Lundall, 2004).

5.8 Model specifications

5.8.1 Single equation fixed effects models (OLS)

Two models with different dependant variables, (1) labour units employed per 1000 tonnes of cane cut, and (2) total labour units demanded by large-scale sugarcane farmers, are both estimated using OLS. Thereafter, Model 2 is estimated using 2SLS in order to estimate annual farm labour demand by large-scale sugarcane farmers as a function of the annual real farm wage ($RWAGE_{jt}$) and other explanatory variables.

- **Labour use intensity (Model 1)**

$$Y^D_{1jt} = \beta 0 + \beta_1 RWAGE_{jt} + \beta_2 RPRICE_{jt} + \beta_3 RINT_t + \beta_4 RCHEM_t + \beta_5 Y^D_{1jt}\text{-}1 + \beta_6 YIELD/HA_{jt} + \beta_7 TREND_t + \beta_8 POLICY_t + \beta_9 DRWAGEMID_{jt} + \beta_{10} DRWAGETUG_{jt} + \beta_{11} DUMMID_{jt} + \beta_{12} DUMTUG_{jt} + \mu_{1jt} \dots\dots\dots\dots\dots\dots\dots\dots\ (1)$$

- **Total labour demand (Model 2)**

$$Y^D_{2jt} = \beta 0 + \beta_1 RWAGE_{jt} + \beta_2 RPRICE_{jt} + \beta_3 RINT_t + \beta_4 RCHEM_t + \beta_5 Y^D_{2jt}\text{-}1 + \beta_6 YIELD/HA_{jt} + \beta_7 TREND_{jt} + \beta_8 POLICY_t + \beta_9 AUC_{jt} + \beta_{10} DRWAGEMID_{jt} + \beta_{11} DRWAGETUG_{jt} + \beta_{12} DUMMID_{jt} + \beta_{13} DUMTUG_{jt} + \mu_{2jt} \dots\dots\dots\dots\dots\dots\dots\dots\ (2)$$

j= region = 1….3 (1=South Coast; 2=Midlands; 3=Tugela/Zululand)

t = time (1, 2, 3……..25years)

where:

Y^D_{1jt} = Annual quantity of farm labour units employed by large-scale sugarcane farmers per 1000 tonnes of cane harvested (Model 1)

Y^D_{2jt} = Annual quantity of farm labour units demanded by large-scale sugarcane farmers (Model 2)

$RWAGE_{jt}$ = Real annual wage of regular farm labour (rand),

$RPRICE_{jt}$ = Real price of sugarcane (rand),

$RINT_{jt}$ = Real annual interest rate (proxy for the cost of capital) (%),

$RCHEM_{jt}$ = Real annual price of farm chemicals

$Y^D_{t\text{-}1}$ = Lagged quantity of farm labour units per annum

AUC_{jt} = Area under cane (ha)

$TREND_{jt}$ = Trend variable

$YIELD/HA_{jt}$= Yield per hectare variable (tonnes)

$POLICY_{jt}$ = Dummy variable (1 for 1991-2002 and 0 otherwise),

DRWAGEMID$_{jt}$= Dummy variable representing the Midlands region interacted with the real wage rate of the Midlands (1 if Midlands and 0 otherwise)

DRWAGETUG$_{jt}$= Dummy variable representing the Tugela region interacted with the real wage rate of the Tugela (1 if Tugela and 0 otherwise)

DUMMID$_{jt}$ = Regional intercept dummy for Midlands

DUMTUG$_{jt}$ = Regional intercept dummy for Tugela

5.8.2 Treatments to data

(i) Area under sugarcane

The time-series data of this study run from 1984 through to 2008. However, during this time-period considerable changes have been made regarding mill areas and regions where sugarcane is planted. As explained in section 5.3, data for the Tugela region only started being captured by SACGA (2012) from the 1996/97 season. Therefore the area under cane (AUC) for Zululand and Pongola were combined from 1987 to 1995 to make up the values used for the Tugela region. From 1996 to 2008 the Tugela and Zululand regions were combined to make up the total area under cane for Tugela. Before 1987, the data were captured at mill level and not by region. The regions were defined using data from the 1987/88 season to allocate the mills to their respective regions and come up with a figure for these years. The regions were defined as follows, utilising the following milling regions of KZN:

North Coast- Darnall, Glendale, Gledhow, Shakaskraal, Maidstone

South Coast- Sezela, Umzimkulu

Midlands- Mt Edgecombe, Noodsberg, UCL

Tugela- Pongola, Entumeni

(ii) Real wage earnings for various categories of labour

Due to the definitions of the milling regions explained above, a weighted average for the Tugela region had to be computed. The equation below was used to calculate a weighted average for the average wage earnings variable.

$$\overline{W} = W1X1 + W2X2 \,/\, X1+X2$$

where:

$\overline{W}$- The average wage earnings for various categories of labour, including the bonus in the Tugela/Zululand region.

W1 - Average wage earnings in Zululand

W2 - Average wage earnings in Pongola

X1 - Quantity of farm labour units employed in Zululand

X2 - Quantity of farm labour units employed in Pongola

After the values were calculated for all four regions they were converted into real terms, using a Consumer Price Index (CPI) with 2005 as the base year, which was obtained from the Abstract of Agricultural Statistics (DAFF, 2012).

(iii) Price of sugarcane in a particular region

There is one Recoverable Value (RV) price given for the entire sugar industry each season. The price of sugarcane is different for each region, because each region produces a different amount of sugarcane, the qualities of cane differ and each region has different costs to produce the sugarcane. SACGA (2012) did not supply a list of each region and the sugarcane price per season, but they had supplied enough information to calculate these figures. The equations below were used to calculate the average price of sugarcane for a particular region.

RV price × total tonnes of sugarcane delivered from that region = TR

TR ÷ total tonnes of sugarcane delivered from that region = price of cane per ton

OR

Average RV/SUC price from that region × % RV/SUC from that region = price of cane

where:

TR – Total Revenue

%RV/SUC – Percentage of recoverable per sucrose content

Both these equations yielded the same result; thus the second equation was used for computational convenience. Once the average price of sugarcane for a particular region was calculated, a CPI was used to deflate the values into real terms.

(iv) The real annual interest rate

Nominal interest rates were obtained from the SA Reserve Bank (2012) and converted into real terms using the following formula (Watts & Helmers, 1979):

r" = {(1 + r) / (1 + f)} – 1

Where:

r" = real interest rate

r = nominal interest rate

f = inflation rate

5.8.3 Choice of variables and expected outcomes for the above labour equations

(a) Annual quantity of farm labour units employed per 1000 tonnes of cane delivered (Y^D1_{jt}) and total labour units demanded by large-scale sugarcane farmers (Y^D2_{jt})

Two dependent variables are specified for two different models. The reason for using two different dependent variables is to identify the change (if any) in the estimated wage elasticities of demand in the selected regions. Labour units employed per 1000 tonnes of cane (Y^D1_{jt}) only captures the employment for 1000 tonnes of cane harvested; this dependent variable does not entirely take into account the amount of land used to produce the sugarcane. The total labour units demanded dependent variable (Y^D2_{jt}) however, does capture this effects since it is for the entire number of tonnes harvested for all large-scale sugarcane growers in the three study regions. If the result shows a statistically significant difference in the estimates between the two models then it can be identified that land has been moving into and out of sugarcane over the study period.

(b) The real annual average wage rate ($RWAGE_{jt}$)

According to the law of demand, if the price of labour (average wage rate) increases the quantity of labour demanded declines, *ceteris paribus* (Gujarati & Porter, 2009). Interaction dummy variables for the Midlands and Tugela/Zululand regions were interacted with the real

wage rate of their respective regions and reported relative to the base region which is the South Coast. It is expected that $RWAGE_{jt}$ should be negatively related to both Y^D1_{jt} and Y^D2_{jt}. These dummy variables were created in order to calculate the wage elasticities for each region, as it is expected that each region will differ with regards to amount of labour demanded and, hence, yield different wage elasticities of demand.

(c) The real annual price of sugarcane ($RPRICE_{jt}$)

Since the demand for labour is a derived demand, it is important to take into account the price of the product from labour (sugarcane) (Friedman, 1962). An expected increase in the producer price of sugarcane is expected to increase the demand for labour in the SA sugarcane industry, *ceteris paribus*. Therefore, the sign on the estimated coefficient of sugar price is expected to be positive for Model 2 but negative for Model 1. If the producer receives a higher price he would want to expand his production (by increasing land size or cane per hectare) and therefore require more labour (Model 2). However, holding the number of hectares of land under cane constant, if the price of sugarcane increases, labour employed per 1000 tonnes of cane will decrease, as farmers need not employ more workers when their current stock of workers is sufficient (Model 1).

(d) Real annual interest rate ($RINT_{jt}$)

The real prime overdraft interest rate was used as a proxy for the cost of capital, including machinery and new equipment technologies. Sparrow *et al.* (2008) used the real prime overdraft interest rate as a proxy for the cost of capital. An increase in the real interest rate is expected to decrease investment in machinery and equipment, thus causing an increase in the demand for large-scale sugarcane labour, *ceteris paribus*. Therefore the estimated coefficient ($RINT_{jt}$) is expected to be positive.

(e) Real annual price of farm chemicals ($RCHEM_{jt}$)

Pesticides and herbicides for crops can be considered as labour-saving technologies (Doll & Orazem, 1984:109). Chemical prices were based on the price index for chemicals in the Abstract of Agricultural Statistics (DAFF, 2012). The index values were converted into real terms by dividing by the relevant SA Consumer Price Index (CPI) figures (2005 = 100). If chemicals are a substitute for labour, a decrease (increase) in price of chemicals is expected to result in an increase (decrease) in the use of chemicals and a decrease (increase) in demand

for labour in the large-scale sugarcane industry, *ceteris paribus*. The estimated coefficient of $(RCHEM_{jt})$ should, therefore, be positive.

(f) Lagged quantity of farm labour units per annum (Y^D_{t-1})

Following Sparrow *et al.* (2008), both regression models are specified, using an autoregressive scheme. They are used to account for time lags in adjustments made by farmers to the size of their annual regular labour force, following a change in the expected cost of farm labour. This involves including the lagged value of the dependent variable (Y^D_{t-1}) as an explanatory variable. Reasons for including a lagged value of the dependent variable include psychological, technological and institutional matters that large-scale sugarcane farmers have to deal with (Gujarati, 2003). According to SACGA (2012), cane grows at an average rate of 5-7 tonnes per month, maturing at approximately 12-14 months on the coast and 20-24 months inland. Sugarcane, being a perennial crop, re-grows and repeats its lifecycle 5-8 times before dwindling yields require re-planting of the crop. This gives a crop a life-cycle of between 8-12 years, on average. It is expected that the perennial nature of the crop will contribute to a slow rate of adjustment of the area planted to cane, and hence the demand for labour on sugarcane farms, in response to changes in the relative profitability of sugarcane farming.

The costs of employing farm labour in South Africa are expected to have increased, as a result of the new labour legislation that was introduced during the study period. Farmers are likely to adjust the size of their annual regular labour force in response to these cost increases, with a lag (Gardner, 1972). For the lag variable (Y^D_{t-1}), the estimated coefficient is expected to be positive and between 0 and 1, thus enabling computation of a coefficient of adjustment. This implies that if the quantity demanded for large-scale sugarcane labour increased last year, it should also increase this year, *ceteris paribus.*

(g) Annual area under sugarcane (AUC_{jt})

The reason for adding this variable is mainly because a higher number of hectares means that a greater area would need to be harvested each season, implying that more labourers would be demanded (Mbatha *et al.*, 2010). This relationship suggests that the estimated coefficient on the area under cane variable would be positive.

(h) Dummy variable for policy changes ($POLICY_t$)

The OLS regression for Model 1 will include a dummy variable ($POLICY_t$) to represent the marked structural decline in the quantity of farm labour demanded by large-scale sugarcane farmers that followed the introduction of new labour legislation from 1991 onwards (Fedderke & Mariotti, 2002). Major labour policy changes that would raise farm labour costs were probably being anticipated by SA commercial farmers from the early 1990s onwards, since some studies (e.g. Sparrow *et al.*, 2008; Fedderke & Mariotti, 2002) suggest that the SA labour market at macroeconomic level was subject to a structural break in 1990 - driven in part by changes in labour market policy that raised both wage and non-wage costs of labour - after which the unemployment rate rose (Sparrow *et al.*, 2008). The dummy used in this study equals 0 up to 1991 and 1 otherwise. It is expected that the dummy variable will have a negative coefficient estimate, as the new labour legislation has raised the cost of regular farm labour and reduced the quantity of regular farm labour demanded.

(i) Trend variable ($TREND_t$)

A trend variable was added to capture the effects of technological advancements in the sugarcane industry over the past 25 years. Past studies have included the trend variable in the supply equation. However, over time, there have been many new varieties of cane, better harvesting methods and more efficient irrigation systems (Bezuidenhout, 2013; Gardner, 1972). Therefore the expected sign of the estimated coefficient on the trend variable is positive.

The trend variable has the greatest potential to be collinear with some of the other variables included in the model. Multicollinearity is a statistical phenomenon whereby the explanatory or independent variables are highly correlated with each other (Gujarati & Porter, 2009). These high correlations between explanatory variables yield results which are not a true representation of the relationship between the explanatory and response variables. The major consequence of multicollinearity is that it causes a model to reflect a high R^2 with many insignificant t statistics (Gujarati, 2003). To detect the problem of multicollinearity a Variance Inflation Factor (VIF) can be used. A VIF value for any independent variable which is greater than 10 can be considered undesirable (Gujarati & Porter, 2009).

(j) Yield per hectare of sugarcane (YIELD/HA$_{jt}$)

The data for YIELD/HA$_{jt}$ were computed from data supplied by SACGA (2012) for 1984 - 2008. The reason for adding this variable is mainly to capture the effects of a "good" or "bad" year. A high yield per hectare would imply a good year and would cause farmers to employ less labour per 1000 tonnes of cane cut, as high yields imply productive workers (Model 1), but demand more labour units when total area of large-scale sugarcane growers are taken into account (Model 2). This means that, for Model 1, a negative relationship is expected, whereas for Model 2 a positive relationship is expected for coefficient estimates of YIELD/HA$_{jt}$.

(k) Regional intercept dummies (DUMMID$_{jt}$) (DUMTUG$_{jt}$)

According to Gujarati and Porter (2006), combining time-series of cross-section observations (panel data) give more informative data, more variability, less collinearity among variables, more degrees of freedom and more efficiency. The fixed effects model takes into account the "individuality" of each region or each cross-sectional unit and allows the intercept to vary for each company, but still assume that the slope coefficients are constant across firms. In order to allow for the (fixed effect) intercept to vary between regions, differential intercept dummies (DUMMID$_{jt}$ and DUMTUG$_{jt}$) are added to the model. These dummies were specified to capture potential differences in general labour demand in the regions, holding all other variables constant. This specification creates the fixed effects models. However, it is expected that these dummies may be highly collinear with some of the other explanatory variables.

(l) Interaction dummies (DRWAGEMID$_{jt}$) (DRWAGETUG$_{jt}$)

The study also uses interaction (interacted with the real wage rate of that specific region) dummies for both models, in order to capture the separate responses by region to a change in wage rates. Since the study deals with three regions, two interaction dummies were included in each model. Both dummies are expected to yield negative coefficient estimates as the wage rate is negatively related to the demand for labour in both models. The first dummy (DRWAGEMID$_{jt}$) represents the real wage in the Midlands, whilst the second dummy (DRWAGETUG$_{jt}$) represents the real wage in the Tugela/Zululand region. The base region chosen was the South Coast.

The dummies were calculated as:

The real wage rate in the Midlands × Dumm2

Where Dumm2 = 1 if Midlands and 0 Otherwise and,

The real wage rate in the Tugela/Zululand region × Dumm3

Where Dumm3 = 1 if Tugela/Zululand and 0 Otherwise

5.8.4 Simultaneous equation fixed effects models

Wages are determined by the intersection of the labour demand and supply curve (McConnell & Bruce, 2002). As explained under the theory related to simultaneous equations, wages are determined endogenously. For this reason, a demand and supply function is specified below. After a review of literature which dealt with labour use intensity, it was decided to estimate only Model 2 (total labour units demanded by large-scale sugarcane farmers), using simultaneous equations. The Hausman error specifications test indicated that simultaneity was not an issue with Model 1, making OLS estimation sufficient. Past studies conducted overseas which have analysed labour-use intensity have used single equations or other methods but not simultaneous equations to estimate labour use intensity. These studies include Paxton *et al.* (2011); Arnim and Rada (2011); Subrahmanya (2006).

Model 2

Demand

$$Y^D_{2jt} = \beta_0 + \beta_1 RWAGE_{jt} + \beta_2 RPRICE_{jt} + \beta_3 INT_t + \beta_4 CHEM_t + \beta_5 YD_{jt}\text{-}1 + \beta_6 YIELD/HA_{jt} + \beta_7 TREND_{jt} + \beta_8 POLICY_t + \beta_9 AUC_{jt} + \beta_{10} DRWAGEMID_{jt} + \beta_{11} DRWAGETUG_{jt} + \beta_{12} DUMMID_{jt} + \beta_{13} DUMTUG_{jt} + \mu_{2jt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Supply

$$Y^S_{2jt} = \beta_0 + \beta_{14} RWAGE_{jt} + \beta_{15} LEXP_t + \beta_{16} RUNEMP_t + \mu_{jt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

where:

j= region = 1….3 (1=South Coast; 2=Midlands; 3=Tugela)

t = time (1, 2, 3……..25years)

Y^S_{1jt} = Annual quantity of farm labour units supplied per 1000 tonnes of cane harvested

(Model 1)

Y^S_{2jt} = Annual quantity of farm labour units supplied on large-scale sugarcane farmers (Model 2)

RWAGEjt = Real annual wage of regular farm labour (rand)

LEXPt = Life expectancy of farm labourers (years)

RUNEMPt = Real annual unemployment rate in South Africa

µjt = Residual error term

5.8.5 Choice of variables and expected outcomes for the above supply equations

(a) Annual quantity of total farm labour units supplied to large-scale sugarcane farmers (Model 2)

These dependent variables are equal to the dependent variables used in the demand equation as these equations are in equilibrium ($Qd = Qs$).

(b) Real annual wage of regular farm labourers ($RWAGE_{jt}$)

This variable has already been explained under the demand equation in the above section

(c) Life expectancy of farm labourers ($LEXP_t$)

Stats SA (2010) estimates that as many as 5 500 people die every week of AIDS and AIDS-related diseases. Since the onset of HIV/AIDS in the 1980s, the epidemic has spread rapidly across South Africa, especially affecting the rural areas, where most of the country's farm labourers come from (Murton & Marzo, 2013). Therefore this variable is included to estimate the potential impact of sickness, which reduces the average life expectancy of labourers working in the SA sugar industry. The expected sign on the estimated coefficient for the $LEXP_t$ variable is negative since, as more labourers die, or are infected by HIV/AIDS, less labour would be supplied to the sugarcane industry.

(d) Real annual unemployment rate in South Africa (RUNEMP$_t$)

A relatively high unemployment rate, such as the current 25,2% in South Africa, suggests that the supply of unskilled labour to agriculture would increase as the availability of jobs nationwide decreases (Stats SA, 2012) An increase in the aggregate rate of unemployment indicates fewer alternative job opportunities and could, therefore, increase the supply of labour to SA sugarcane farms (Sparrow *et al.*, 2008). Therefore, the expected sign on the estimated coefficient for the unemployment rate variable is positive.

5.9 Descriptive statistics

(a) Pairwise correlations for variables used in both models (refer to Appendix 1)

Pairwise correlations show whether two variables are related (or not), how strongly, in what way and have a value between 1 and -1 (Gujarati & Porter, 2009). According to Dancey and Reidy's (2004) categorisation of pairwise correlations, an absolute value of 0.6 and greater is considered strong, while a value between 0.4 and 0.6 is moderate and below 0.4 is considered weak. Under this score the TREND$_t$ variable is strongly correlated with other independent variables (RWAGE$_{jt}$ and POLICY$_t$,). This result is not surprising, as it was expected that the real wage rate, policy and the real unemployment rate have been increasing over time. The relationships of all the other variables where under 0.6, indicating a moderate to weak relationship. It is not surprising that both the interacting wage dummies and regional dummies for the Midlands and Tugela regions are correlated, since the interaction dummies are created from the regional dummies.

Table 5.1 presents the means of the number of labour units employed per 1000 tonnes of sugarcane (Model 1), the total number of labour units demanded by large-scale sugarcane farmers (Model 2) and the real average wages paid to sugarcane farm workers in the three study regions. From Table 5.1 it can be deduced that the Tugela/Zululand region uses the most labour per 1000 tonnes of sugarcane. The South Coast region uses the most labour in terms of total labour units. The real wages paid to farm workers in all three regions are fairly similar.

Table 5.1: Means for the different dependent variables and real wages for each region

Region	Labour per 1000 tonnes	Total labour units	Real average wage (R/month)
South Coast	5.13	9957.5	769.9
Midlands	3.75	9489.2	820.3
Tugela/Zululand	6.80	9577.8	859.6

Source: Adapted from SACGA (2012)

(b) Graphical representation of some of the variables used for the three study regions

(i) Labour use per 1000 tonnes of cane cut

Figure 5.2 shows that the Tugela/Zululand region uses the most labour per 1000 tonnes, while the Midlands use the least. However, all three regions tend to move in a similar direction throughout the study period. Overall, the intensity in labour usage per 1000 tonnes of cane cut has been decreasing. The rise in labour use around 1992-1994 could be due to the fact that sugarcane farmers would increase their stock of labour because they preferred having labour readily available and the cost of labour was relatively low. In the early 1990s, when the relative profitability of sugarcane farming was high, labour had been readily available, hence sugarcane growers had the luxury of having surplus labourer on their farms (McElligott, 2013). However, as time went by, the relative profitability had decreased and the cost of labour had started to rise.
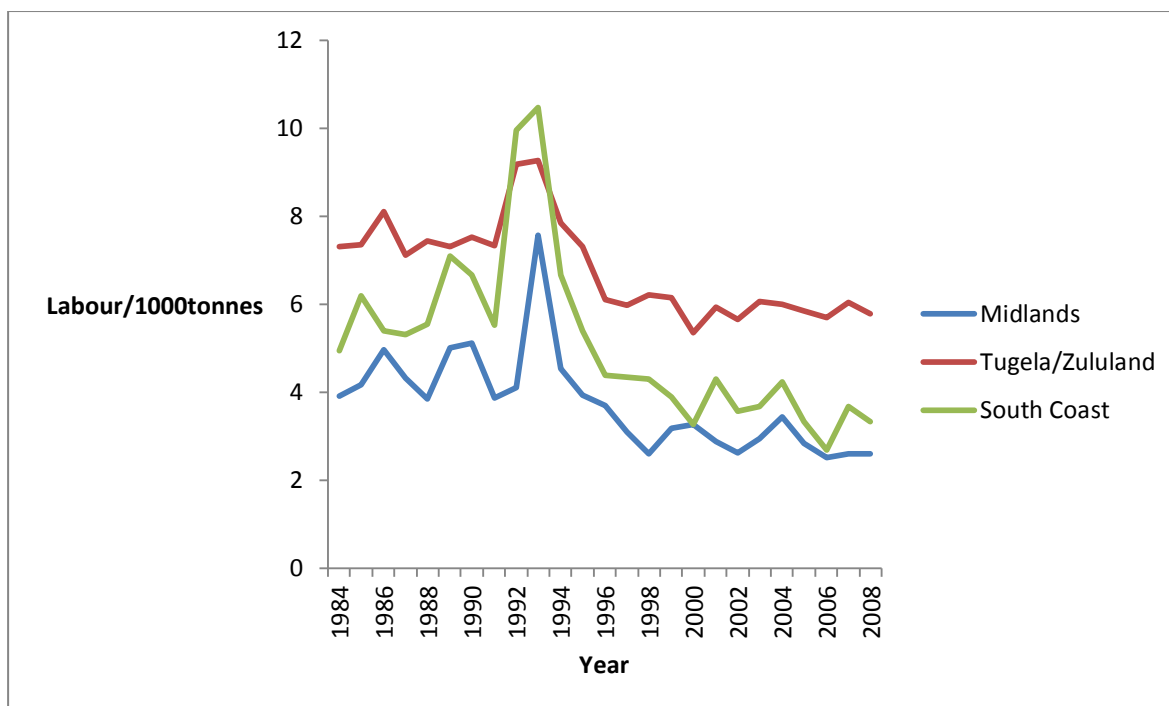
Figure 5.2: Labour employed per 1000 tonnes of cane cut for large-scale sugarcane workers in the three study regions

Source: Adapted from SACGA (2012)

(ii) **The real average monthly wage rate**

Figure 5.3 shows the real wage rate in the three study regions. It can be seen that the real wage rates in all regions were quite similar at the beginning of the study period. However, in the early 1990s there was an increase in the wage rate, which continued to increase throughout the study period. There could be many reasons for the increase in wage rates in the past two decades. Empirical evidence suggests that the introduction of minimum wage legislation could be one of the main reasons for rising wages in the sugarcane growing sector.
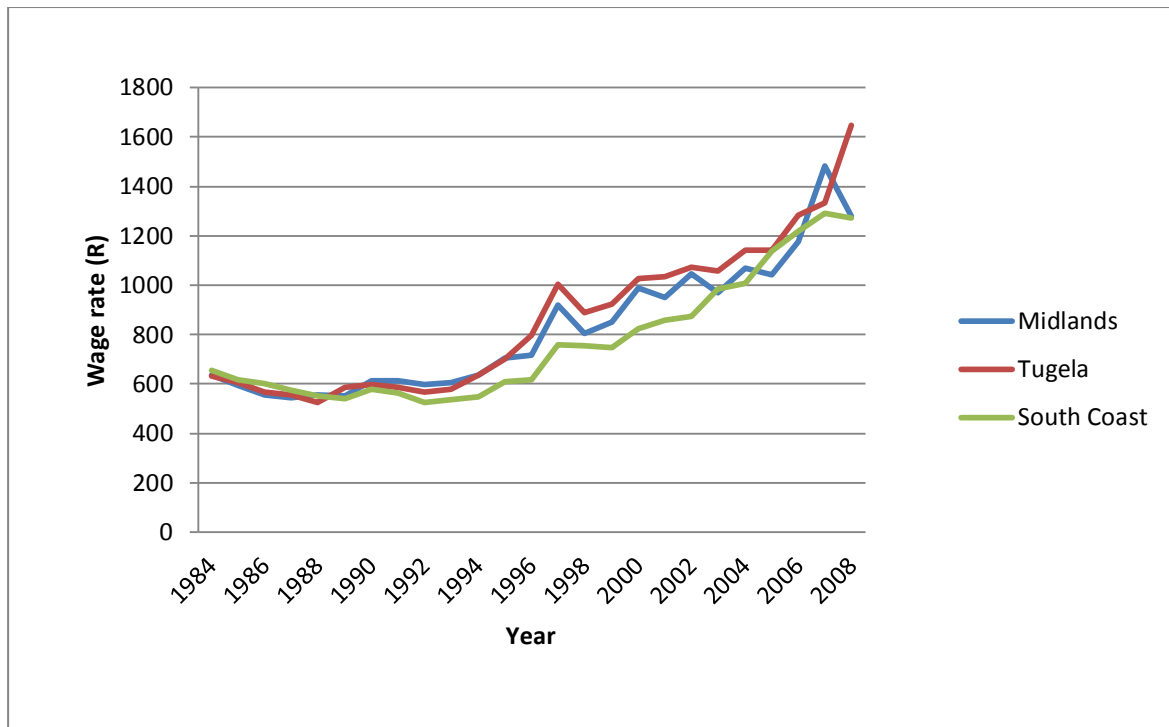
Figure 5.3: Real average monthly wage rate of large-scale sugarcane workers in the three study regions

Source: Adapted from SACGA (2012)

(iii) **Area under cane**

Figure 5.4 shows that the South Coast and Midlands shared a similar number of hectares under sugarcane during the early 1980s. However, after this period the Midlands gained more area and the South Coast reduced in number of hectares under sugarcane. During the mid-1990's, all regions experienced a decrease in the area under sugarcane. Throughout the study be period, it can be seen that the Tugela and South Coast regions have been reducing the number of hectares under sugarcane, while the Midlands region has increased slightly. Anecdotal information from the sugar industry suggests that a drought had occurred around 1994, which caused farmers to cut down on the number of hectares under sugarcane due to the costs of re-planting (McElligott, 2013). The decrease in area under cane occurred around 1996 as farmers took time to decide how to deal with a decrease in relative profitability. Some farmers considered staying in sugarcane production, whilst others considered moving to less labour-intensive crops.
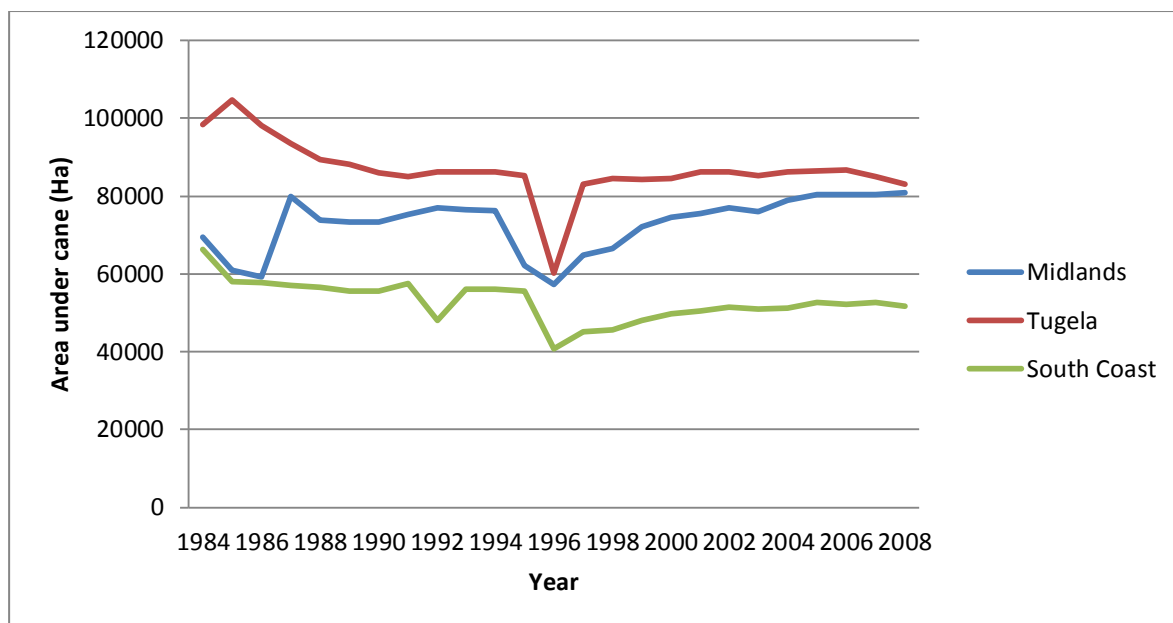
Figure 5.4: Area under sugarcane for large-scale sugarcane farmers in the three study regions

Source: Adapted from SACGA (2012)

(iv) **Yield per hectare**

Figure 5.5 shows the yield per hectare in the three study regions. It is clear that all three regions have variable yields per hectare of sugarcane. This could be due to the different sources (rain-fed or irrigated) and quantities of water received in each region. There are many possible reasons for a fluctuating yield per hectare, including size of farms, production cycles and labour employed per hectare (Mcelligott, 2013). However, there is a distinct decrease in yields in all regions around 1994. As explained above, the sugar industry had experienced a severe drought which affected most aspects of sugarcane growing.
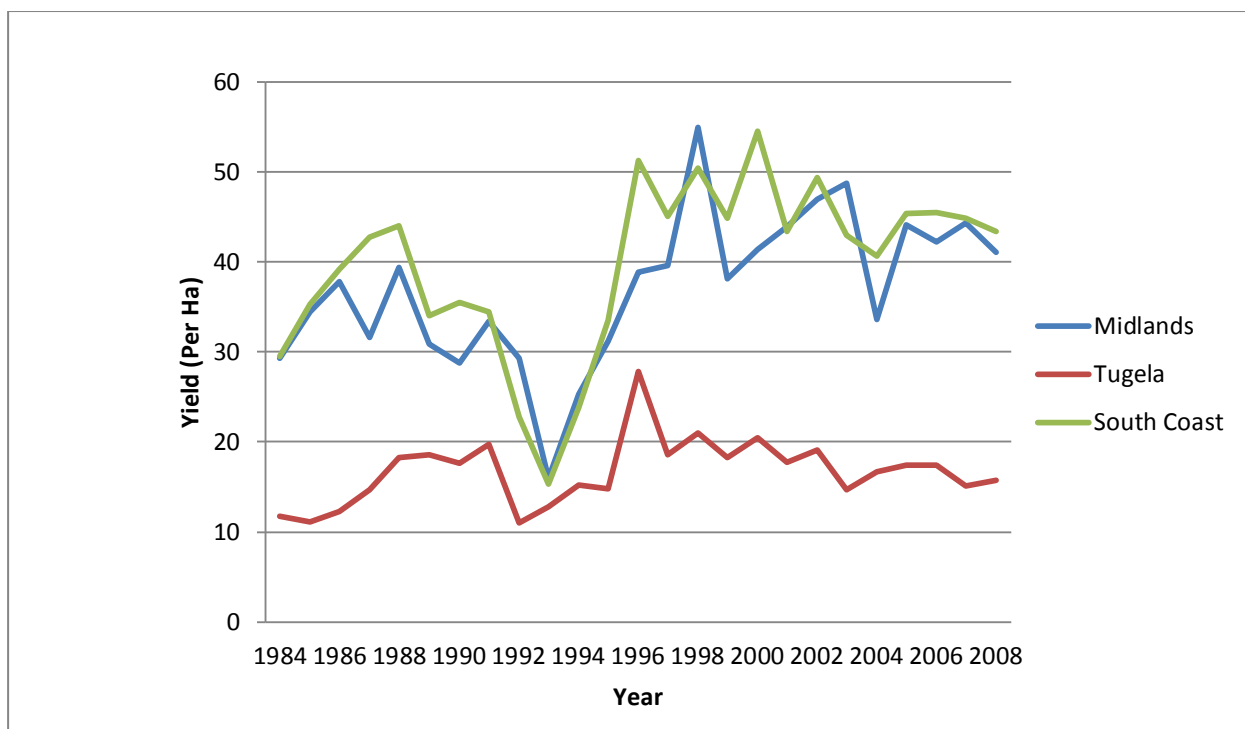
Figure 5.5: Yield per hectare for large-scale sugarcane farmers in the three study regions

Source: Adapted from SACGA (2012)

From the graphical representation of some of the variables used, it is clear that each region differs from the next with regards to the variables plotted. For this reason (as will be seen later), it is better to analyse these regions using panel data, rather that time series or cross-sectional data. Each region is different to the next with regards to yields, labour requirements, etc., and therefore are better analysed separately. These graphical representations indicate that analysing the entire sugarcane or agricultural sector as a whole is different to analysing a sub-sector or region as each region, is different and unique.

Chapter 5 aimed at developing a methodology which fits in with past studies that have analysed labour. The chapter clearly defined the variables chosen to analyse labour in the large-scale sugar industry and discussed the expected outcomes of these variables. The econometric models that were used were discussed and explained in order to have an idea of the benefits of using such techniques. The chapter concluded with a graphical representation of some of the main variables used in the study, in order to add context to some of the findings. The next chapter will present the results from the single equation labour use intensity model, followed by the simultaneous equation total demand model.

CHAPTER 6: **RESULTS AND DISCUSSION**

Statistically significant levels of collinearity between some of the explanatory variables specified in equations (1) and (2) are identified. The approach used to remedy this problem has been discussed in section 6.1, before reporting the results of the econometric analyses of labour use intensity and the demand for, and supply of, labour in large-scale KZN sugarcane farming, in sections 6.2 and 6.3, respectively. Section 6.3 includes a single equation estimation of the demand for labour, using panel data, and 2SLS and 3SLS models of the demand for, and supply of, labour. The discussion of the results focuses on the magnitude of the short-run and long-run wage elasticites that are estimated from the regression equations. Finally, estimated wage elasticities across the three sugarcane-producing regions and for OLS, 2SLS and 3SLS are compared.

6.1. Remedy for the problem of multicollinearity

In the process of estimation and checking for collinearity (Appendix A), a few changes had to be made with regards to the explanatory variables used. The problem of multicollinearity has been discussed in the previous chapter, as it was expected that the $TREND_t$ variable would be highly collinear with other explanatory variables. Therefore, to avoid biased estimated regression coefficients some variables (such as $TREND_t$, $POLICY_t$ and $RCHEM_t$), which were collinear with the $RWAGE_{jt}$ variable, were dropped from the models. Gujarati and Porter (2009) identify seven ways of dealing with the problem of multicollinearity: (1) *A priori* information, (2) combining cross-sectional and time-series data, (3) dropping a variable(s), (4) transformation of variables, (5) additional or new data, (6) reducing collinearity in polynomial regressions and (7) using multivariate statistical techniques.

After attempting options 1, 2 and 7 (Appendix B), it was decided to drop the $TREND_t$, $POLICY_j$, $RPRICE_{jt}$, $RCHEM_t$ and $RINT_t$ variables from both Models 1 and 2. The high Variance Inflation Factors (VIFs), which were well above 10, with the inclusion of these variables suggested a high amount of collinearity between these variables and other explanatory variables. The estimated coefficients for three of these variables ($RPRICE_{jt}$, $RCHEM_t$, $POLICY_t$) were statistically insignificant and were, therefore, dropped from both models. After the models were re-specified, the estimated coefficient on the $RINT_t$ variable was also statistically insignificant and so this variable was also excluded.

6.2 Determinants of labour use intensity for large-scale farmers using a single equation Ordinary Least Squares (OLS) model

The general OLS model is specified as:

$$Y^D_{1jt} = \beta_0 + \beta_1 RWAGE_{jt} + \beta_2 YIELD/HA_{jt} + \beta_3 Y^D_{jt-1} + \beta_4 POLICY_{jt} + \beta_5 DRWAGEMID_{jt} + \beta_6 DRWAGETUG_{jt} + \beta_7 DUMMID_{jt} + \beta_8 DUMTUG_{jt} + \mu_{1jt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The OLS regression of the above equation produced an $\bar{R}^2$ of 0.89, which is considered to be a "good fit" according to Gujarati (2003). An $\bar{R}^2$ of 0.89 indicates that 89% of the variation in the dependent variable (quantity of labour employed per 1000 tonnes) was explained by the independent variables. Given the estimated highly statistically significant F statistic (at the 1% level of probability), the explanatory variables as a group significantly influence farm labour use intensity. A value greater than 10 for the VIFs would suggest multicollinearity. VIF's presented in Table 6.1 show that all estimated values are below 10, suggesting that multicollinearity is not a problem for this model.

Gujarati and Porter (2009) cite the Durbin-Watson d statistic as the most commonly used test for detecting serial correlation. As a rule of thumb, if the Durbin-Watson d statistic is close to 2 in an application, it can be assumed that there is no first-order autocorrelation, either positive or negative. To avoid some of the pitfalls of the Durbin-Watson d test for autocorrelation, Gujarati and Porter (2009) suggested the use of the Breusch-Godfrey test, which is a test of autocorrelation that is general in the sense that it allows for (1) nonstochastic regressors, such as the lagged values of the regressand; (2) higher-order autoregressive schemes (AR), such as AR(1), AR(2), etc.; and (3) simple or higher-order moving averages of white noise error terms. The null hypothesis (H_0) for the Breusch-Godfrey test is that there is no serial correlation of any order (H_0: $\rho_1 = \rho_2 = \cdots = \rho_p = 0$). From the $\chi 2$ statistic of the Breusch-Godfrey test, the null hypothesis cannot be rejected and, therefore, it can be concluded that there is no serial correlation of any order.

Table 6.1: Determinants of labour use intensity on large-scale sugarcane farms in three sugarcane growing regions of KZN, 1984 – 2008

VARIABLE	OLS		
	COEFFICIENT ESTIMATE	t VALUE	VIF
Intercept	13.21***	11.69	-
$RWAGE_{jt}$	-0.0032***	-3.69	6.1
$YIELD/HA_{jt}$	-0.1298***	-9.71	5.5
$Y^{D}1_{t-1}$	-0.0477	-0.55	5.1
$POLICY_{jt}$	-0.0001	-0.16	1.2
$DRWAGEMID_{jt}$ (Midlands)	-0.0007***	3.38	2.1
$DRWAGETUG_{jt}$ (Tugela/Zululand)	-0.0025**	1.01	2.4
$DUMMID_{jt}$	-1.6065***	- 6.07	2.0
$DUMTUG_{jt}$	-1.1473***	-3.27	4.6
$R^2 = 0.91$ $\bar{R}^2 = 0.89$ DW statistic= 1.97 BG statistic= 0.86	F stat = 75.55 F sig = 0.00	Sig level: 1% = *** 5% = ** 10% = *	Mean VIF = 3.4

The estimated coefficient of the yield per hectare variable ($YIELD/HA_{jt}$) is highly statistically significant and negatively related to labour use intensity on large-scale farms. This suggests that if the yield per hectare increases by a tonne, labour employed per 1000 tonnes of cane will decrease by 0.13 units, *ceteris paribus*. Although it may seem counter-intuitive that an increase in yield per hectare requires less labour per 1000 tonnes, an increase in yield per hectare is associated with larger (heavier) sticks of sugarcane. In other words, fewer sticks of cane need to be cut (loaded) to make up a ton of cane. Therefore, higher yields are associated with increased worker productivity.

The coefficient estimate of the lag variable ($Y^{D}1_{t-1}$) is not statistically significant even at the 10 % level, and this result is in line with *a priori* expectation due to the dependent variable

used in this model. This result indicates that farmers respond fairly quickly (within the first year) to changes in all variables which affect the amount of labour employed per 1000 tonnes of cane harvested. The highly statistically significant coefficient estimates for $DUMMID_{jt}$ and $DUMTUG_{jt}$ variables indicate that, holding all explanatory variables constant, the two regions employ statistically significantly different amounts of labour per 1000 tonnes from the base region, which is the South Coast. This result also indicates different labour use intensity between regions, showing the importance of analysing each region separately (using panel data), rather than combining all regions and estimating a wage elasticity for the industry. From Figure 5.2 in the previous chapter this result is clearly depicted, that all three regions differ for labour use intensity.

The coefficient estimate for $RWAGE_{jt}$ (which represents the South Coast region) is statistically significant at the 1% level, which implies that increase in wages paid to workers on the South Coast will lead to a decrease in the number of labour units employed per 1000 tonnes of cane cut, *ceteris paribus*. The magnitude of the decrease in number of labour units employed per 1000 tonnes can be calculated from the wage elasticities presented in Table 6.2. A 10% increase in the real wage paid to farm workers on the South Coast would result in a 4.9% and 5.1% decrease in the number of labour units employed per 1000 tonnes of cane cut in the short-run and long-run, respectively, *ceteris paribus*.

The coefficient estimate for $DRWAGEMID_{jt}$ (which represents the Midlands region) is highly statistically significant, at the 1% level. This indicates that an increase in wages for workers in the Midlands region will lead to a decrease in number of labour units demanded per 1000 tonnes of cane relative to the South Coast, *ceteris paribus*. From Table 6.2, this estimate yields a short-run price elasticity of -0.17 and long-run price elasticity of -0.18. This implies that a 10% increase in the real wage paid to farmworkers in the Midlands would result in a 1.7% and 1.8% decrease in the number of labour units employed per 1000 tonnes of cane cut in the short-run and long-run, respectively, *ceteris paribus*. The coefficient estimate on $DRWAGETUG_{jt}$ (which represents the Tugela/Zululand region) is statistically significant, relative to the South Coast. This estimate yields a short-run price elasticity of -0.32 and a long-run price elasticity of -0.34. This means that a 10% increase in the real wage paid to farmworkers in the Tugela/Zululand region would result in a 3.2% and 3.4% decrease in the number of labour units employed per 1000 tonnes of cane cut in the short-run and long-run, respectively, *ceteris paribus*.

Table 6.2: Estimated wage elasticities for labour use intensity in three sugarcane producing regions of KZN, 1984-2008

VARIABLE	MODEL 1	
	SHORT-RUN	LONG-RUN
RWAGE$_{jt}$ (South Coast)	-0.49	-0.51
DRWAGEMID$_{jt}$ (Midlands)	-0.17	-0.18
DRWAGETUG$_{jt}$ (Tugela/Zululand)	-0.32	-0.34

Note: The estimated wage elasticities were calculated as β*(mean real wage/mean labour use intensity)

The estimated elasticities in Table 6.2 suggest that farms in each region respond differently to increases in wages. However, the number of labour units employed per 1000 tonnes of cane in all regions have a negative relationship with the amount of wages paid, *ceteris paribus*. The estimated elasticities for Model 1 suggest that there is not much lag in the response from farmers to a change in the price of labour (most change occurs in the first year). Both long- and short-run price elasticities of labour demand are, therefore, very similar. This result was expected from Model 1 as the dependent variable (labour units per 1000 tonnes of cane cut) does not capture much of the effect of area moving into and out of sugarcane. The magnitude of the short- and long-run wage elasticities suggest that the South Coast region showed the highest response in labour use intensity to changes in the real wage rate. Although the topography of land on the South Coast is not generally suited for mechanisation, the South Coast sugarcane farmers have been reducing their stock of labour and replacing them with more productive workers who use specialised tools and equipment which can produce the same output with fewer labour units (Bezuidenhout, 2013; McElligott, 2013). Figure 5.1 showes that the South Coast had the clearest decline in labour units employed per hectare indicating a greater elasticity estimate, as expected *a priori*.

6.3 Determinants of the total number of labour units demanded by large-scale sugarcane farmers in three sugarcane producing regions of KZN

6.3.1 Single equation OLS results

The general model is:

$$Y^D_{2jt} = \beta_0 + \beta_1 RWAGE_{jt} + \beta_2 YIELD/HA_t + \beta_3 AUC_{jt} + \beta_4 Y^D 2_{jt-1} + \beta5 DRWAGEMID_{jt} + \beta_6 DRWAGETUG_{jt} + \beta_7 DUMMID_{jt} + \beta_8 DUMTUG_{jt} + \mu_{1jt} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

The OLS regression results, presented in Table 6.3, report an $\bar{R}^2$ of 0.61, which means that 61% of the variation in the dependent variable (quantity of labour units demanded) is explained by the estimated relationships in the model. Given the estimated highly statistically significant F-statistic (at the 1% level of probability), the explanatory variables as a group significantly influence annual large-scale farm labour demand. The Durbin-Watson and Breusch-Godfrey statistics shows that there is a high degree of confidence that there is no serial autocorrelation of any order in the model. The VIFs suggest that there is no problem of multicollinearity (Gujarati & Porter, 2009).

The coefficient estimate for yield per hectare (YIELD/HA$_{jt}$) is highly statistically significant and positively related to the number of labour units demanded by large-scale sugarcane farmers. This suggests that if the average yield increases by a tonne per hectare, labour units demanded will increase by 72 units per region in the short run, *ceteris paribus*. This result agrees with *a priori* expectations, since an increase in yield/ha means that there is a greater quantity of cane to cut which requires more labour. However, trends in sugarcane yields impact on the relative profitability of sugarcane production and therefore the area under cane (Bezuidenhout, 2013; McElligott, 2013). This is part of a long-run response and therefore the short-run response is not adequate in explaining the impact of increased yields on labour demand. The long-run coefficient estimate indicates that if the average yield increases by a tonne per hectare, labour units demanded will increase by 129 units per region. The long-run estimates are calculated by dividing the coefficient estimate by the coefficient of adjustment (72/0.56). The coefficient estimate for the lag variable ($Y^D 2_{t-1}$) is highly statistically significant, at the 1% level. This implies that the coefficient of adjustment of farm labour demand over the study period is about 56% (1 - N = 0.44). Large-scale sugarcane farmers in KwaZulu-Natal, therefore, are advised to adjust their labour employment levels by closing the gap between the beginning year actual and their desired level of farm labour by around

56% each year, *ceteris paribus*. The lagged variable also had the expected positive sign on the estimated coefficient.

Table 6.3: Determinants of the total number of labour units demanded by large-scale sugarcane farmers in three sugarcane growing regions of KZN, 1984-2008

MODEL	OLS		
VARIABLE	COEFFICIENT ESTIMATE	t VALUE	VIF
Intercept	3794.06**	1.94	-
$RWAGE_{jt}$	-4.4082***	-4.20	6.2
$YIELD/HA_{jt}$	71.9985***	3.63	4.2
Y^D2_{t-1}	0.4424***	4.38	1.2
AUC_{jt}	0.0429**	1.97	8.3
$DRWAGEMID_{jt}$ (Midlands)	-2.7264**	1.37	2.4
$DRWAGETUG_{jt}$ (Tugela)	-1.8478**	2.22	3
$DUMMID_{jt}$	-645.392	-1.24	4.3
$DUMTUG_{jt}$	439.132	0.58	8.8
$R^2 = 0.64$ $\bar{R}^2 = 0.61$ DW statistic= 2.1 BG statistic= 0.31	F stat = 14.55 F sig = 0.00	Sig level: 1%= *** 5%= ** 10%= *	Mean VIF = 4.8

The coefficient estimate for AUC_{jt} is statistically significant at the 5 % level. This means that if the area under cane for large-scale sugarcane farmers were to increase by one hectare, farmers would demand 0.043 more workers in the short-run, *ceteris paribus*. The long-run response yields a coefficient estimate of 0.077 and shows that if the area under cane for large-scale sugarcane farmers were to increase by one hectare, farmers would demand 0.077 more workers in the long run, *ceteris paribus*. The sign on the estimated coefficient for AUC_{jt} agrees with *a priori* expectations, as it is expected that farmers demand more labour when there are more hectares of land to work with. The long-run response is clearly higher than the

short-run response, indicating that farmers take time to decide whether to increase the area of land under sugarcane and, hence, demand more labour.

Since the South Coast was used as a base/reference region, the coefficient estimate on RWAGE$_{jt}$ represents the South Coast and is highly statistically significant. From Table 6.4, this estimate yields a short-run price (wage) elasticity of -0.34 and a long-run price elasticity of -0.61. These wage elasticities imply that a 10% increase in the real wage paid to farm workers in the South Coast would result in a 3.4% and 6.1% decrease in the total number of labour units demanded in the short run and long run, respectively, *ceteris paribus*. The coefficient estimate on DRWAGEMID$_{jt}$ (which represents the Midlands region) was statistically significantly different to the South Coast. This estimate yields a short-run price elasticity of -0.24 and a long-run price elasticity of -0.42, which implies that a 10% increase in the real wage paid to farmworkers in the Midlands would result in a 2.4% and 4.2% decrease in the total number of labour units demanded in the short run and long run, respectively, *ceteris paribus*. The coefficient estimate on DRWAGETUG$_{jt}$ (which represents the Tugela/Zululand region) was statistically significant at the 5% level, meaning that relationship between employment and wages in the Tugela region is different from that on the South Coast. This estimate yields a short-run price elasticity of -0.17 and a long-run price elasticity of -0.30, which suggests that a 10% increase in the real wage paid to farm workers in the Tugela/Zululand region would result in a 1.7% and 3.0% decrease in the total number of labour units demanded in the short run and long run, respectively, *ceteris paribus*.

From Table 6.4, both models indicate that the South Coast region is relatively more responsive to changes in real wages paid to farm workers. Experts in sugarcane mechanisation have indicated that regions such as the Midlands and part of Zululand have been mechanising from some time (from before the period of this study), due to their relatively flat lands. However, regions such as the South Coast which have steeper slopes are now moving from manual weed control (such as hoeing) to non-mechanised chemical weed control (such as knapsacks) in order to reduce labour requirements. This may be the reason why the South Coast has relatively higher wage elasticities compared to other sugarcane growing regions. There is also a clear distinction between the short- and long-run wage elasticities in Model 1 and Model 2. Model 2 shows a significant difference in the magnitude of wage elasticities when moving from the short to the long run whereas, Model 1 shows very similar wage elasticties between the two time-periods. The reason for this is that Model 1

does not capture much of the land moving into and out of sugarcane. Results thus show that it is part of a short-run response, rather than a long-run response.

Table 6.4: Comparison of wage elasticities between labour use intensity (Model 1) and total number of labour units demanded (Model 2) for labour for large-scale sugarcane farmers in three sugarcane producing regions of KZN, 1984-2008

VARIABLE	MODEL 1		MODEL 2	
	S/R	L/R	S/R	L/R
RWAGEt (South Coast)	-0.49	-0.51	-0.34	-0.61
DRWAGEMID$_{jt}$ (Midlands)	-0.17	-0.18	-0.24	-0.42
DRWAGETUG$_{jt}$ (Tugela/Zululand)	-0.32	-0.34	-0.17	-0.30

Regarding the Midlands region, the wage elasticities for Models 1 and 2 are similar in the short run. However, for Model 2, in the long run, this estimate increases to 0.42. This suggests that it is difficult to mechanise in this region, when the area under cane is fairly constant (Model 1). However, when area can move in and out of cane (Model 2), in the long run there is a possibility of mechanisation because the topography and steepness of slopes favours mechanisation in the Midlands region. For the Tugela/Zululand region the wage elasticities are similar in both models, with the exception of the short-run response in Model 2. This result indicates that mechanisation may be possible in the long run but highly unlikely in the short run.

6.3.2 Simultaneous equation models results

The analysis of labour demand which is represented by Model 2 in section 6.3.1 was extended, using a simultaneous-equation framework to consider both the supply of, and the demand for, labour in large-scale KZN sugarcane production in the three regions. The previous section used a single equation OLS model, which only considered demand because it is hypothesised that the supply of unskilled labour in South Africa is almost perfectly

elastic (due to the high unemployment rate). To test this notion, labour demand and supply are estimated simultaneously.

The demand and supply equations are specified as follows:

Demand

$$Y^D_{2jt} = \beta_1 RWAGE_{jt} + \beta_2 YD_{jt-1} + \beta_3 YIELD/HA_{jt} + \beta_4 AUC_{jt} + \beta_5 DRWAGEMID_{jt} + \beta_6 DRWAGETUG_{jt} + \beta_7 DUMMID_{jt} + \beta_8 DUMTUG_{jt} + \mu_{2jt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

Supply

$$Y^S_{2jt} = \beta_9 + \beta_{10} RWAGE_{jt} + \beta_{11} LEXP_t + \beta_{12} RUNEMP_t + \mu_{jt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8)}$$

According to the rank and order condition of identification discussed in Chapter 5, both equations (demand and supply) are identified, causing the simultaneous-equation model as a whole to be identified. Also mentioned in Chapter 5, under simultaneity, the Hausman's specification error test indicated that the problem of simultaneity does exist and that the above equations (3) and (4) would be estimated more efficiently using simultaneous-equation models. Table 6.5 compares the results of equation (3) estimated by 2SLS and 3SLS. Both techniques yield similar results with regards to the statistical significance and signs of the estimated coefficients. However, these estimates yielded different values on their standard errors and coefficient estimates. As expected, the 3SLS estimation yields lower standard errors.

The R^2 values of 0.61 and 0.63 for 2SLS and 3SLS, respectively, were achieved, which is a good fit, according to Gujarati and Porter (2009). The R^2 value implies that 61% and 63% of the variation in the dependent variable (total labour units demanded by large-scale sugarcane farmers) is explained by the independent variables. Given the highly estimated statistically significant Wald test statistic (at the 1% level of probability), for both 2SLS and 3SLS, the explanatory variables as a group significantly influence total farm labour demand. All the coefficient estimates of the chosen variables were statistically significant.

Table 6.5: Results from simultaneous demand equation estimation of the total number of labour units demanded by large-scale sugarcane farmers in the three regions of KZN.

VARIABLE	2SLS		3SLS		
	COEFFICIENT ESTIMATE	STANDARD ERROR	COEFFICIENT ESTIMATE	STANDARD ERROR	VIF
Intercept	6227.631**	2525.061	3794.064**	1830.292	-
$RWAGE_{jt}$	-7.3812***	2.2373	-4.403009***	0.99026	6.2
$YIELD/HA_{jt}$	92.4467**	24.0276	72.00036***	18.6951	4.2
Y^D2_{t-1}	0.28044**	0.14813	0.44319***	0.0956	1.2
AUC_{jt}	0.05600**	0.02354	0.04280**	0.02059	8.3
$DRWAGEMID_{jt}$ (Midlands)	-3.4096**	1.9533	-2.7243**	1.1554	2.4
$DRWAGETUG_{jt}$ (Tugela)	-2.1996**	2.08966	-1.84685**	1.0888	3
$DUMMID_{jt}$	-4066.234**	1713.334	-2022.397*	987.649	4.3
$DUMTUG_{jt}$	-3797.708**	1822.741	-1758.273	1151.594	8.8
	$R^2 = 0.61$ Sig level: 1%= *** 5%= ** 10% = *	Wald test stat = 111.47 χ2prob= 0.00	$R^2 = 0.63$ Sig level: 1%= *** 5%= ** 10%= *	Wald test stat = 124.16 χ2prob= 0.00	Mean VIF = 4.8

Since the South Coast was used as the reference region, the coefficient estimate $RWAGE_{jt}$ represents the South Coast. The sign on the estimated coefficient on $RWAGE_{jt}$ is negative and highly statistically significant in both models. This suggests that if wages paid to South Coast sugarcane farm workers increases, farmers would demand fewer labour units. This estimate yields wage elasticities for 3SLS in the short and long run of -0.35 and -0.63, respectively. This indicates that a 10% increase in the real wage paid to farmworkers on the

South Coast would result in a 3.5% and 6.3% decrease in the total number of labour units demanded in the short run and long run, respectively, *ceteris paribus*. The coefficient estimate of DRWAGEMID$_{jt}$ (which represents the interaction dummy for the Midlands region) is statistically significantly different to the South Coast. From Table 6.6 this estimate yields a short-run price elasticity of -0.25 and a long-run price elasticity of -0.45 for 3SLS. The result shows that a 10% increase in the real wage paid to farmworkers in the Midlands results in a 2.5% and 4.5% decrease in the total number of labour units demanded in the short run and long run, respectively, *ceteris paribus*. The coefficient estimate on DRWAGETUG$_{jt}$ (which represents the interaction dummy for the Tugela/Zululand region) is statistically significant at the 5% level, meaning that the relationship between employment and wages in the Tugela/Zululand region is different from that on the South Coast. This estimate yields a short-run price elasticity of -0.19 and a long run price elasticity of -0.32 for 3SLS, respectively. Therefore a 10% increase in the real wage paid to sugarcane farm workers in the Tugela/Zululand region results in a 1.9% and 3.2% decrease in the total number of labour units demanded in the short run and long run, respectively, *ceteris paribus*.

The coefficient estimate for yield per hectare (YIELD/HA$_{jt}$) is positive and highly statistically significant at the 1% level. This suggests that in the short run, if the average yield increases by a tonne per hectare, total labour units demanded will increase by 92 and 72 (for 2SLS and 3SLS, respectively) per region, *ceteris paribus*. These estimates rise to 127 and 129 in the long run for 2SLS and 3SLS, respectively. As noted in the previous section, the long-run estimates are calculated by dividing the coefficient estimate by the coefficient of adjustment. The coefficient estimate of the lag variable ($Y^{D}2_{t-1}$) was highly statistically significant, at the 5% level and 1% level, for 2SLS and 3SLS, respectively. This result confirms that large-scale sugarcane farmers in KZN take time to adjust following an increase/decrease in the price of labour. The lagged variable also had the expected positive sign on the estimated coefficient.

Table 6.6: Comparison of the estimated wage elasticities between OLS and 3SLS

VARIABLE	MODEL 2 (OLS)		MODEL 2 (3SLS)	
	S/R	L/R	S/R	L/R
RWAGEt (South Coast)	-0.34	-0.61	-0.35	-0.63
DRWAGEMID$_{jt}$ (Midlands)	-0.24	-0.42	-0.25	-0.45
DRWAGETUG$_{jt}$ (Tugela/Zululand)	-0.17	-0.30	-0.19	-0.32

From the results of the supply equation in Table 6.7, an R^2 of 0.34 and 0.42 (for 2SLS and 3SLS, respectively) means that 34% and 42% of the variation in the dependent variable can be explained by the independent variables. Although the R^2 is relatively low, the Wald test statistics for both 2SLS and 3SLS was statistically significant, at the 1% level. Both 2SLS and 3SLS yielded only one statistically significant coefficient estimate, which is the life expectancy ($LEXP_t$) variable. The sign of the coefficient estimate makes sense as it is reasonable to expect that if people's life expectancy were to rise by one year, due to good health, then the number of total labour units supplied also increases.

Table 6.7: Results of simultaneous supply equation estimation for the total number of labour units supplied to large-scale sugarcane farms in three regions of KZN.

VARIABLE	2SLS		3SLS	
	COEFFICIENT ESTIMATE	STANDARD ERROR	COEFFICIENT ESTIMATE	STANDARD ERROR
Intercept	8164.599	1.3577	6165.164	5931.758
$RWAGE_{jt}$	1.7946	102.3299	2.1737	1.0169
$LEXP_t$	69.1900*	57.0522	87.3303*	81.8215
$UNEMP_t$	-40.4234	7524.59	14.9732	50.4399
$DUMMID_{jt}$	-328.6572	365.212	-367.229	358.126
$DUMTUG_{jt}$	-244.3856	382.641	-199.543	366.644
	$R^2 = 0.34$ Sig level: 10%=*	Wald test stat = 28.66 χ2prob= 0.00	$R^2 = 0.42$ Sig level: 10%=*	Wald test stat = 30.02 χ2prob= 0.00

One of the main reasons for adding the $LEXP_t$ variable was to capture the incidence of the HIV-AIDS virus in rural South Africa, as past studies have indicated that a high proportion of farm workers are affected by the disease (Murton & Marzo, 2013). This result indicates that people who are able and available to work on sugarcane farms consider the impact of their

health on work. The low R^2 values of the supply equation and number of statistically significant coefficient estimates, compared to the high R^2 values and higher number of statistically significant coefficient estimates of the demand equation, make it clear that the impact of labour demand is greater than the impact of labour supply in the three sugarcane production regions. According to this study, the non-statistically significant coefficient estimate on the $RWAGE_{jt}$ variable suggests that real wages do not affect the supply of labour.

6.4 Discussion

Model 2 (total farm labour units demanded by large-scale sugarcane farmers) show that the single equation estimation from section 6.3.1 and the simultaneous-equation estimation yield similar wage elasticities (see Table 6.6). Sparrow *et al.* (2008) estimated the long-run wage elasticity of demand for regular farm labour in South Africa during period 1960-1990 as -0.25 for OLS and -0.23 for 2SLS regression, respectively. For the period 1991-2002, their elasticity estimate rose to -1.32 and -1.34 for OLS and 2SLS regression, respectively. The estimates for the 1960-1990 period are fairly similar to those in this study in the short run. However, their estimates for the 1991-2002 period are higher than those estimated in this study. This result is not surprising as they analysed aggregate agricultural sector labour demand whereas this study deals with a subsector. Like the results of this study, the Sparrow *et al.* (2008) results show that the estimated coefficients on the variables used in the OLS and 2SLS models were not very different. Latt and Nieuwoudt (1985) estimated the long-run wage elasticity for regular farm labour in KZN during 1972-1978 as -1.39. Their result is similar to that of Sparrow *et al.* (2008). Conradie (2005) estimated a price elasticity of demand for farm labour in the Breërivier Valley of the Western Cape of -0.3. The study also focused on a subsector (grapes) but did not allow for a structural change in farm labour demand driven by farmers expectations of higher labour costs associated with implementing the requirements of new labour legislation that have affected SA commercial farms from the early 1990s onwards. However, the estimates for the price elasticity of demand in the present study are similar to those found in Conradie (2005).

Overall, from the above elasticities for Model 2 (OLS and 3SLS) for all the regions, the long-run elasticity estimates are significantly higher than the estimated short-run elasticities. This suggests that sugarcane farmers are more responsive to changes in wage rates in the longer run, as also reported by Sparrow *et al.* (2008). The rationale is that SA sugarcane farmers are hypothesised to have a desired annual number of regular farm workers that they wish to

employ, given the expected farm labour wage rate and other factors affecting the annual demand for labour, but they cannot adjust immediately when regular farm labour wage rates change. According to Sparrow *et al.* (2008:50) "This plausible lag could be due to rigidities such as the time needed to search for and adopt labour-saving technology, machinery or contractors, and other institutional factors such as the transaction costs and time needed to comply with the terms of labour contracts and legislation provisions".

The estimated wage elasticities of labour demand from the study suggest that farms in each region respond differently to increases in real wages. Experts from the local sugarcane industry indicated several reasons for these differences, namely: different labour requirements for each region, different wages paid to workers in each region and widely differing profit margins between regions, amongst other reasons. All of the experts agreed that due to the increase in real wages of farm workers throughout the study period sugarcane farmers have been reducing their stock of labour across the three study regions. The price-cost squeeze forced farmers to reduce costs and labour was targeted because of labour's lower marginal productivity compared with other inputs. For example, a farmer can plant sugarcane without much labour, but not without seed and fertilizer.

The magnitude of the short and long-run wage elasticities for both models suggest that the South Coast region had the highest response in labour to changes in the real wage rate. McElligott (2013) indicated that, although the topography of land in the South Coast is not generally suited for mechanisation, the South Coast sugarcane farmers have been reducing their stock of labour and replacing them with more productive workers. The fact that less productive workers are being replaced by more productive ones could be the reason for the estimated wage elasticities for labour-use intensity for the South Coast being higher than those of the other two regions.

Hurley (2014) confirmed that due to the slopes of the sugarcane farms found in this region, mechanisation is highly unlikely making farming practices more labour intensive than the other two regions. Ducasse (2014) suggested that due to the relatively lower profit margins experienced in the South Coast, farmers cannot afford to increase their stock of labour but may decrease labour employment if real wages increase. He also indicated that the supply of farm labour (mostly cane harvesting staff) is relatively high in this region causing their wages to be lower than the wages paid to farm workers in the other regions. This phenomenon is in-

line with economic theory (Friedman, 1962) since wages paid to farm workers in the South Coast consists of a relatively higher proportion of variable costs than the other two regions.

Pilusa (2014) and McElligott (2013) believe that the 1992/93 drought was especially challenging for most South Coast farmers and many had to take bank loans to replant large areas of their farms. Input costs also escalated to an all-time high in 2008 when both diesel and fertilizer prices reached relatively high levels. With these reduced profit margins experienced over the last two decades, growers have had to either increase technical efficiencies and/or reduce certain inputs (e.g. dismiss any reserved labour or "charity cases").

Differences between the three sugarcane study regions are represented by the different wage elasticity estimates. Experts have indicated that due to the relatively flatter lands in the Midlands and Tugela/Zululand regions, mechanisation (e.g., sugarcane harvesting machines) has been occurring long before the start of this study period (1984) (Stainbank, 2014). Therefore, the estimated wage elasticities of demand for labour are lower in these regions than the South Coast. The substitution of many farm workers for fewer, more productive, workers in the South Coast is a relatively new phenomenon in comparison to mechanisation in the Midlands and Tugela/Zululand regions (Stainbank, 2014).

The intensity of labour use is much less in the Midlands and Tugela/Zululand than the South Coast due to the ability to mechanize (Ducasse, 2014; Pilusa, 2014). Therefore, the responsiveness of labour demand to changes in real wages is lower. Other reasons for lower estimated wage elasticity include the diversity of available jobs for sugarcane farm workers in the Midlands and Tugela/Zululand regions (Ducasse, 2014; Hurley, 2014; Pilusa, 2014). Experts have indicated that many farms in these regions are not exclusive to sugarcane only. Enterprises such as dairy, timber and a variety of vegetables are also farmed in these regions (Ducasse, 2014; Hurley, 2014; Pilusa, 2014). Therefore, land use changes and moves to less labour intensive farm enterprises. Another reason for the relatively low estimated wage elasticities for the Midlands and Tugela/Zululand regions is the relatively high profit margins in comparison to the coastal regions. Farm businesses in the Midlands and Tugela/Zululand can afford to keep workers following a wage increase. However, farmers do not keep excess workers in anticipation of high yields which was the case in the past (pre-1985).

From this chapter the proposed methodology in Chapter 5 is used to estimate the models, obtain results and discuss these results. Most of the results presented were in line with *a priori* expectations. However, some of the estimated models suffered from multicollinearity

which was dealt with accordingly. The chapter ended with a discussion of all the results obtained from the different econometric models. The next section will discuss the conclusions of the study and make recommendations to policy-makers regarding the sugarcane sector of KZN.

CONCLUSIONS AND POLICY RECOMMENDATIONS

A review of the literature shows that most economic sectors in South Africa, including the agricultural sector, shed a significant number of jobs during the study period of 1984 to 2008. High levels of unemployment are a matter of concern in South Africa, as they could have potential negative effects on economic welfare. Much has been said about the potential of the South African agricultural sector to create employment, but to date there has been a dearth of practical commentary on how this can be achieved. In the past 20 years, instead of this sector providing employment, it has been shedding labour. A better understanding of the main factors which affect the demand for farm labour in South Africa could help to identify ways to increase employment in the sector.

Previous studies have analysed the potential of the agricultural sector as a whole to create employment. Unlike those studies, the present study focuses only on the SA sugarcane sector, which is the second highest employer of agricultural labour in the country. Descriptive statistics have indicated that the sugarcane industry has also been shedding labour. This study adds to local literature by estimating wage elasticities of demand for three sugarcane regions in South Africa, the South Coast, Midlands and Tugela/Zululand. This helps to determine the extent to which labour is being shed as a result of increasing real wages and other costs.

It is important to note that the estimated wage elasticities in this study are not constant throughout the study period. Although they are calculated using the mean values for real wages and labour demand, when calculated using the upper bound values of these variables, the estimates are similar. It should also be noted that the study uses interpolation for predicting the value of Y (the dependent variable) at given values of X (the independent variables), within the study range (1984 to 2008). Predicting the outcome of an increase in minimum wages using the estimated results in this study is possible, but risky, as this would require extrapolation, which is beyond the ambit of this study.

The estimated wage elasticities for both models (labour use intensity and total labour demand) in the long or short run were below one and negative, suggesting that the demand for labour in the three regions of the sugarcane sector is wage inelastic. The South Coast, however, seemed to have farmers who were relatively more responsive to changes in the real wage rate. However, the topography of land on the South Coast is not well-suited for mechanisation. Hence, farmers there have been reducing the number of labour units to do a particular job. For example, manual weed control using hoes is substituted with non-

mechanised chemical weed control, such as providing fewer workers with knapsacks. Experts have also indicated that, due to the relatively flat lands in the Midlands and Tugela/Zululand regions, mechanisation was occurring long before the start of this study period (1984). Differences between the three sugarcane regions are represented by the different wage elasticity estimates. Although the estimates of the elasticities were below one in absolute terms, they seemed to be getting closer to one in the long run (becoming more elastic). This implies that further increases in the real cost of farm labour may result in substantial job losses for sugarcane farm workers in South Africa, *ceteris paribus*. Over time, due to higher labour costs, it might become economic for farmers to mechanise.

The OLS, 2SLS and 3SLS results estimated for both models indicate that the real wage rate, lag of the dependent variable, yield per hectare and area under cane had an effect on the demand for labour. This suggests that, when the real price of labour changes, farmers react to it, but with a lapse of time, and do not rapidly shed labour following an increase in the wage rate. Therefore, it is important that policy-makers are aware of these lags to better understand the short- and long-term effects that changes in the real wage rate have on employment levels in the large-scale sugarcane sector of KZN.

Results from both labour models used in this study indicate that the three local sugarcane production regions have different estimated wage elasticities of labour demand. Hence, commercial farmers in each region would reduce quantity of labour demanded by a different amount in response to an increase in minimum (real) wages. Past studies (e.g. Conradie, 2005) which have analysed other sub-sectors of SA agriculture such as grapes have also estimated different wage elasticities to those estimated in this study. It is important that policy-makers are aware of these differences because of the different response from each region, with regard to the reduction in the quantity of labour demanded. Therefore, it is tempting to recommend that current minimum wage laws be implemented taking enterprise type and region into account, simply because of the practicality and monitoring of such laws. However, in order to reverse the rising farm labour unemployment trend in South Africa, the government could rather adopt more flexible labour market regulations (for example, those relating to the hiring and dismissal of workers) that would reduce real labour costs and encourage local farmers to employ more labour on sugarcane farms.

Most labour laws that have been implemented in SA agriculture generally benefit employees. Results of this study show that this has resulted in higher real wages paid to farm workers and

increased transaction costs for employers. Commercial sugarcane farmers have responded by substituting labour with capital, mechanisation and other labour-saving technologies. The results of this study also indicate that the area under sugarcane had a positive effect on labour demand in all three study regions. The descriptive statistics showed a marked decline in the area under sugarcane for all three regions during 1984-2008. The yield of sugarcane per hectare also had a positive effect on labour demand. The relative profitability of sugarcane production is dependent on the yield and the land under sugarcane. This implies that ways of increasing profitability of sugarcane production directly affect the creation of employment in this industry. Profitability of sugarcane may be increased in many different ways, such as the removal of uncertainty with regards to land restitution cases (lower risk), sugarcane being used for the production of bio-fuels, and the generation of electricity from sugarcane production, amongst other things (Ducasse, 2014; Pilusa, 2014).

Programmes regarding land redistribution especially in sugarcane production, such as, Land Redistribution for Agricultural Development (LRAD) and the Proactive Land Acquisition Strategy (PLAS) could be revised by policy-makers (e.g. to increase the pace at which land reform projects are carried out). Experts have indicated that confusing land tenure arrangements whereby sugarcane farmers who face land restitution claims feel like tenants (because of uncertainty about future land rights) does not provide a sense of security and constrains investment. Experts in the sugarcane industry have agreed that continued efforts by government are needed, as a matter of urgency, to resolve the issue of uncertainty about future land rights. Furthermore, insecurity of tenure can be a disincentive to further investment in sugarcane land and other farm practices. Government could play a more facilitating role by promoting tenure security and hence promoting employment in the industry.

The decline in the area under sugarcane in the three regions could be attributed to the decline in relative profitability of sugarcane production for reasons mentioned above. To increase future expected profitability, local sugarcane farmers could also consider decreasing production costs or increasing the price of their sugarcane through value addition. However, the current Cane Purchase Agreements (CPAs) state that growers can only sell sugarcane to sugar mills, and any value addition benefits (e.g. white sugar, bio-fuels and electricity generated from bagasse) accrue to the core estate. The only other benefit for sugarcane farmers provided for in the CPAs is a share of revenue from molasses. Large-scale SA sugarcane farmers could perhaps increase profitability and hence have an incentive to invest

further in land for sugarcane production by negotiating with millers for shares in value addition benefits.

Another way of increasing cane farm profitability could be the production of biofuels using sugarcane. The need for alternative sources of crude oil and fuel has been a persistent issue worldwide and in South Africa. Past studies (Chetty, 2006; Meyer *et al.,* 2008; Sparks & Ortmann, 2011) have indicated that alternative energy technologies in South Africa such as biofuels are not sustainable without government support (e.g. funding the biofuel plant) to be successful. This raises the issue of whether such support can be justified. Another possible way to increase profitability for local sugarcane farmers is the generation of electricity through improved mill steam efficiency and conventional high efficiency condensing generation based on conventional bagasse and additional sugarcane leaves. The use of sugarcane bagasse for the production of electricity does not substitute the end product of sugarcane (sugar) but provides a supplementary product.

The question remains about what can be done to reverse declining employment in the large-scale SA sugarcane sector. The study suggests that the area under cane and yield per hectare of sugarcane are important determinants of the demand for labour in the sugar industry. Perhaps more research is necessary on how to reverse yield decline and better manage factors which have reduced the area used for sugarcane production. For example, issues of land reform and re-distribution and factors affecting the relative profitability of sugarcane farming could be further investigated.

Future research could also focus on determining whether or not other sub-sectors within SA agriculture are able to create employment. By estimating the wage elasticity of labour demand in other agricultural sectors, a comparison between the most and least responsive sectors to wage changes would be possible. Hence, instead of developing policies which apply to the entire agricultural sector, policies may need to be tailored to a particular sub-sector. It is expected that the loss of employment following rising real wages will be experienced predominantly amongst unskilled workers, whereas employment of semi-skilled labour may actually increase. Therefore, future research on the relative skill level of farm labour affected relatively more by changes in real wage rates would be useful.

SUMMARY

In summary, it is evident that there has been a long-term decline in labour employment in the agricultural sector as a whole. The current trends in agricultural employment threaten to deepen the poverty crisis in South Africa's rural areas. There are claims that land reform can contribute significantly to increased labour absorption in agriculture, but the scale of redistributive land reform to date is uncertain and difficult to quantify. Other authors have produced strong evidence of a shift in labour demand towards more skilled labour in South Africa, but the bulk of farm workers are unskilled. Institutional factors, such as the role of trade unions, appear to have played a more important role in driving wage movements than the relative scarcities of workers with different levels of education. However, it is difficult to attribute the decline in agricultural labour demand to any one factor, because each sub-sector of agriculture comes with its own challenges and reasons behind employment/unemployment.

Economic theory suggests that an increase in real wages will result in reduced agricultural employment. Farmers will substitute labour with capital or substitute labour intensive-enterprises with less labour-intensive enterprises. From this theory, the effects of high wages is known, but the extent to which labour demand decreases following an increase in real wages is important. Unless the elasticity of demand for agricultural labour is known, the impact of wage changes on agricultural employment cannot be accurately estimated.

Most studies focus on the entire agricultural sector and its ability to create employment, even though they agree that each sector within agriculture differs with regards to labour use. It is therefore difficult for one policy to positively affect some of the sub-sectors without adversely affecting others. This is one of the main reasons why this study focuses only on the sugarcane growing sector, which is one of the highest employers of agricultural labour in South Africa. Another reason for choosing the sugar industry was the availability of good-quality data.

This dissertation analyses three sugarcane growing regions in KwaZulu-Natal, namely the South Coast, Midlands and Tugela/Zululand. Panel data for two models over 25 years (1984-2008) is analysed, using two different but related econometric procedures, namely single equation (OLS) and simultaneous equation (2SLS/3SLS) estimations. Model 1 captures labour use intensity and uses "labour units demanded per 1000 tonnes of cane cut" as the dependent variable, while Model 2 captures the total labour demanded by large-scale

sugarcane farmers. Only Model 2 is estimated using simultaneous equations, as past studies indicated that labour use intensity may be analysed using single-equation models.

For Model 1 the long- and short-run wage elasticities are very similar and are around -0.5, -0.17 and -0.33 for the South Coast, Midlands and Tugela/Zululand regions, respectively. This result was expected, as the lag variable yielded a coefficient estimate which was not statistically significant. This means that when labour use intensity is considered, farmers respond fairly quickly to changes (within a year). Although the land in South Coast is not suited for mechanisation, it yielded the highest elasticity. Anecdotal information suggests that this may be due to the fact that during the time of the study (the past 25 years) this region has been using more labour efficient methods for example, instead of using 10 workers with hoes to remove weeds, two workers with knapsacks are used to apply chemicals.

The results from the OLS and 2SLS/3SLS were similar for Model 2 and therefore yielded almost identical wage elasticites. The wage elasticities for Model 2 in the short run were -0.34, -0.24 and -0.17, and in the long run -0.61, -0.42 and -0.30 for the South Coast, Midlands and Tugela/Zululand, respectively. For Model 2 the long- and short-run wage elasticities differ quite markedly. Results suggest that all elasticities were negative and inelastic, with the South Coast having a relatively greater response in labour demand, due to wage rate changes, than the other two regions. Although the elasticity estimates were inelastic, for Model 2 the short-run estimates were lower in absolute terms than the long-run estimates. This result shows that, due to the perennial nature of sugarcane and the fact that this is a long term crop, farmers take time to decide whether to mechanise, stay in sugarcane, etc., following a hike in the price of labour. The results also suggest a decline in the demand for labour by large-scale sugarcane farmers, due to an increase in real wage rates, which raises questions about the appropriateness of labour laws and minimum wage legislation that have increased the cost of farm labour in the large-scale sugarcane sector of KZN.

The area under sugarcane proved to be an important determinant of the demand for labour by large-scale sugarcane farmers in the three study regions. Therefore legislation pertaining to land redistribution is of high importance. Policy-makers need to be aware that employment on sugarcane farms may decrease as long as land is moving out of sugarcane and into less labour intensive land uses. It is crucial to pursue a set of policies that encourage employment in the sugarcane and other agricultural industries. The study recommends that policy-makers could play a more facilitating role by promoting tenure security and hence promoting

employment in the industry. The study also recommends that government could rather adopt more flexible labour market regulations (for example, those relating to the hiring and dismissal of workers) that would reduce real labour costs and encourage local farmers to employ more labour on sugarcane farms. Future research is necessary on addressing problems of yield decline and factors which have reduced the area used for sugarcane production, as both these variables proved to be important determinants in the demand for labour in the sugar industry. The skill levels of labourers working on sugarcane farms also need to be analysed in order to recommend policies which will help those categories of workers most affected by labour laws.

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APPENDICES

APPENDIX A: Pairwise correlation matrix with statistical significance levels for all variables for labour use intensity (Model 1)

	lab1000t	realwa~e	realpr~e	intrate	prchemc	laggc	yield_ha
lab1000t	1.0000						
realwagerate	-0.4624	1.0000					
	0.0000						
realprcane	-0.0559	0.1576	1.0000				
	0.6338	0.1770					
intrate	-0.2865	0.2852	0.1425	1.0000			
	0.0127	0.0131	0.2227				
prchemc	-0.2996	0.6368	0.1057	-0.1601	1.0000		
	0.0090	0.0000	0.3668	0.1701			
laggc	0.8318	-0.4502	-0.2044	-0.2109	-0.3542	1.0000	
	0.0000	0.0001	0.0850	0.0754	0.0023		
yield_ha	-0.7991	0.1533	-0.0252	0.2023	0.0995	-0.7290	1.0000
	0.0000	0.1891	0.8303	0.0818	0.3957	0.0000	
trend	-0.4612	0.8957	0.1808	0.4024	0.3900	-0.4480	0.2670
	0.0000	0.0000	0.1205	0.0003	0.0005	0.0001	0.0206
policy	-0.2368	0.5411	0.3125	0.5637	-0.0772	-0.1765	0.1338
	0.0408	0.0000	0.0063	0.0000	0.5103	0.1381	0.2526
drwagemid	-0.6044	0.2038	0.3594	0.0622	0.1200	-0.6036	0.3838
	0.0000	0.0794	0.0015	0.5961	0.3052	0.0000	0.0007
drwagetug	0.4454	0.3540	-0.1138	0.0790	0.1464	0.4452	-0.7272
	0.0001	0.0018	0.3312	0.5006	0.2102	0.0001	0.0000
fdummid	-0.5553	0.0096	0.3628	-0.0000	-0.0000	-0.5584	0.3277
	0.0000	0.9351	0.0014	1.0000	1.0000	0.0000	0.0041
fdumtug	0.5919	0.1131	-0.1740	-0.0000	-0.0000	0.5876	-0.8042
	0.0000	0.3341	0.1355	1.0000	1.0000	0.0000	0.0000

	trend	policy	drwage~d	drwage~g	fdummid	fdumtug
trend	1.0000					
policy	0.7783	1.0000				
	0.0000					
drwagemid	0.1890	0.1211	1.0000			
	0.1043	0.3006				
drwagetug	0.2083	0.1313	-0.4301	1.0000		
	0.0729	0.2613	0.0001			
fdummid	0.0000	-0.0000	0.9345	-0.4602	1.0000	
	1.0000	1.0000	0.0000	0.0000		
fdumtug	0.0000	0.0000	-0.4672	0.9205	-0.5000	1.0000
	1.0000	1.0000	0.0000	0.0000	0.0000	

APPENDIX B: Pairwise correlation matrix with statistical significance levels for all variables for total labour demand by large-scale sugarcane farmers (Model 2)

	total abu	real wa~e	real pr~e	intrate	prchemc	lagg	yield_ha
total abu	1.0000						
real wagerate	-0.5526 0.0000	1.0000					
real prcane	-0.3286 0.0040	0.1576 0.1770	1.0000				
intrate	-0.4190 0.0002	0.2852 0.0131	0.1425 0.2227	1.0000			
prchemc	-0.2829 0.0139	0.6368 0.0000	0.1057 0.3668	-0.1601 0.1701	1.0000		
lagg	0.7041 0.0000	-0.5279 0.0000	-0.2677 0.0230	-0.3372 0.0038	-0.2851 0.0152	1.0000	
yield_ha	0.0263 0.8230	0.1533 0.1891	-0.0252 0.8303	0.2023 0.0818	0.0995 0.3957	-0.1016 0.3960	1.0000
trend	-0.5577 0.0000	0.8957 0.0000	0.1808 0.1205	0.4024 0.0003	0.3900 0.0005	-0.5236 0.0000	0.2670 0.0206
policy	-0.5655 0.0000	0.5411 0.0000	0.3125 0.0063	0.5637 0.0000	-0.0772 0.5103	-0.4537 0.0001	0.1338 0.2526
auc	-0.0305 0.7948	0.1111 0.3427	0.0185 0.8749	-0.1926 0.0979	0.1000 0.3933	-0.0031 0.9791	-0.7112 0.0000
drwagemid	-0.1174 0.3159	0.2038 0.0794	0.3594 0.0015	0.0622 0.5961	0.1200 0.3052	-0.1303 0.2754	0.3838 0.0007
drwagetug	-0.1672 0.1518	0.3540 0.0018	-0.1138 0.3312	0.0790 0.5006	0.1464 0.2102	-0.1460 0.2209	-0.7272 0.0000
fdummid	-0.0860 0.4634	0.0096 0.9351	0.3628 0.0014	-0.0000 1.0000	-0.0000 1.0000	-0.1052 0.3791	0.3277 0.0041
fdumtug	-0.0449 0.7019	0.1131 0.3341	-0.1740 0.1355	-0.0000 1.0000	-0.0000 1.0000	-0.0405 0.7354	-0.8042 0.0000

	trend	policy	auc	drwage~d	drwage~g	fdummid	fdumtug
trend	1.0000						
policy	0.7783 0.0000	1.0000					
auc	-0.0644 0.5830	-0.1300 0.2664	1.0000				
drwagemid	0.1890 0.1043	0.1211 0.3006	0.1302 0.2657	1.0000			
drwagetug	0.2083 0.0729	0.1313 0.2613	0.6406 0.0000	-0.4301 0.0001	1.0000		
fdummid	0.0000 1.0000	-0.0000 1.0000	0.0935 0.4249	0.9345 0.0000	-0.4602 0.0000	1.0000	
fdumtug	0.0000 1.0000	0.0000 1.0000	0.7309 0.0000	-0.4672 0.0000	0.9205 0.0000	-0.5000 0.0000	1.0000

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APPENDIX C:

1.1 Model specification and alteration to deal with alteration

There were a few changes made to the original Fixed Effects Model to achieve a more parsimonious model. The Fixed effects model was transformed into a Within-Group Estimator model to get rid of the regional dummies. The Within-Group Estimator model works in such a way that the regression can be performed in deviations from individual means and thereby producing the same estimates for the beta coefficients.

1.2 Derivation of the Within-Group Estimator

$$\bar{y}i = T^{-1} \sum_{T=1}^{T} yit$$

And

$$\bar{x}i = T^{-1} \sum_{T=1}^{T} xit$$

Define:

X*it = Xit - $\bar{x}i$

And

Y*it = Yit - $\bar{y}i$

Then:

$\bar{y}i$ = αi + $\bar{x}i$β + ūi

Subtracting from the original equation gives us:

Y*it = X*itβ + u*it

1.3 The Within-Group Estimator models which was estimated –

$YD1_{jt} = \beta1RWAGE_{jt} + \beta2YD_{jt}-1 + \beta3YIELD/HA_{jt} + \beta4POLICY_{jt} + \beta5DRWAGEMID_{jt} + \beta6DRWAGETUG_{jt} + \mu1_{jt}$ …………………………(1)

$YD2_{jt} = \beta1RWAGE_{jt} + \beta2YD_{jt}-1 + \beta3YIELD/HA_{jt} + \beta4AUC_{jt} + \beta5DRWAGEMID_{jt} + \beta6DRWAGETUG_{jt} + \mu2_{jt}$ …………………………(2)

Results from the WGE

Table 1: Results from model 1 with "Labour units demanded per 1000 tonnes of cane" as the dependant variable

VARIABLE	t VALUE	COEFFICIENT ESTIMATE
RWAGEt	-3.69***	-0.0032611
YIELD/HAt	-9.71***	-0.1298145
YDt-1	-0.55	-0.047699
POLICYt	-0.16	-0.000132
DRWAGEMIDjt (Midlands)	3.38***	0.002477
DRWAGETUGjt (Tugela)	1.01	0.000697
R-Square= 0.83	F sig= 0.000000	Sig level: 10% = * 5%=** 1% = ***

Table 2: Results from model 2 with "Total labour units demanded for large-scale growers"

VARIABLE	t VALUE	COEFFICIENT ESTIMATE
RWAGEt	-4.20***	-4.408207
YIELD/HAt	3.63***	71.9985
YDt-1	4.38***	0.442438
AUCt	1.97**	0.042934
DRWAGEMIDjt (Midlands)	1.37	1.68173
DRWAGETUGjt (Tugela)	2.22*	2.56035
R-Square= 0.64	F sig= 0.000000	Sig level:1% = *** 5%=** 10%=*

The results are the same as the FEM reported in the paper with the exception of the intercept dummies used in an FEM. However it was decided to stick with the original FEM presented in the study as the simultaneous equation estimation would not flow well if the single equation estimation was done using WGE.