A Demand Analysis of Farm Labour Employment in the South Coast and Midlands Commercial Sugarcane Farming by Labour Categories: Implications of the Sectoral Determination

By

Tshepo R Pilusa

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College of Agriculture, Engineering and Science

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DEDICATION

To my late mother, Mrs NM Pilusa. This is your return on investment for your support, instilling the spirit of education in me and making me realise how fortunate I am. Your story remains an inspiration and continues to encourage me to achieve my desires.

DECLARATION

I, Tshepo R Pilusa declare that:

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ABSTRACT

The objective of this study is to investigate the impact of changes to the regulatory environment governing farm labour employment since the mid-1990s on wages and employment of farm workers in the South African sugar industry. This study may be differentiated from previous research on the topic, e.g., Conradie (2005), Sparrow *et al.* (2008), Murray and van Walbeek (2008), Bhorat *et al.* (2012), and Stanwix (2013) in so far as the impacts on wages and employment are investigated for four categories of farm workers (namely, drivers, seasonal cane harvesting staff, permanently employed elementary farm workers, and casual labour); whereas previous studies have analysed the impacts on aggregate employment. The distinction is important because not all categories of farm workers historically earned wages less than the real minimum wage rate and because the wage elasticities of demand for labour in sugarcane farming are expected to vary by labour category and by sugarcane producing region. Whilst it is well established that the wage elasticity of demand for farm labour in commercial farming in South Africa is relatively price elastic in the long run (Sparrow *et al.*, 2008; Bhorat *et al.*, 2012), no published research has determined the wage elasticities of demand for farm labour in sugarcane farming in South Africa, *per se*.

The time series data on wages and employment of farm workers in sugarcane production by large scale growers (LSGs) from 1978 to 2012 based on Labour Utilisation and Cost Survey (LUCS) were obtained from the South African Cane Growers Association (SACGA). Analysis of the data verifies expectations that the introduction of regulations on wage structure and computation through the Sectoral Determination (SD) for the Farm Worker Sector in 2003 is associated with an increase in real average cash wages and a reduction in the average real absolute value of non-pecuniary benefits (e.g., on-farm accommodation and rations) received by workers in sugarcane farming. Furthermore, the increase in cash-wages outweighed the

reduction of non-pecuniary benefits, on average composite wages. Implementation of the SD is also associated with an increase in standardisation of wages for relatively unskilled seasonal and permanent farm employees, which is in line with an intended objective of the SD to standardise the farm wage.

Whilst real average wages of workers in sugarcane farming increased by about 70% from 1978 to 2012, employment in sugarcane farming, measured as Full-Time Equivalents (FTEs) Worker, declined by about 36% during the same period, which gives rise to a simple elasticity computation of -0.51 (Δemployment/Δwage = -0.36/0.7), without accounting for changes in factors other than the wage. In order to account for other factors affecting the supply of and demand for the various categories of farm workers in sugarcane production, econometric techniques were used to estimate the relationships between real farm wages and employment in sugarcane farming, and in turn, the wage elasticity of the demand for each category of labour for the industry as a whole and for two particular sugarcane producing regions, the South Coast and Midlands of KwaZulu-Natal (due to the topography of the two regions, sugarcane production on the South Coast is relatively more labour intensive than in the Midlands). High levels of multicollinearity in the data precluded satisfactory estimation of supply and demand functions for farm labour using 2SLS regression techniques. Instead, the Principal Component Analysis (PCA) extraction procedure proposed by Chatterjee and Price (1977) was used to estimate the supply and demand functions separately. Whilst the statistical fit of the estimated farm labour supply (demand) functions was relatively poor and satisfied, respectively, the theoretical fit of the estimated supply of and demand for labour functions was satisfactory.

After accounting for changes in the area under sugarcane, the price per ton of sugarcane, price index of chemicals and labour-related policy implications, estimates of the wage elasticities of demand for the various categories of farm labour, regions and aggregate sugarcane production by LSGs ranged between -0.028 and -0.488 in the short-run, and between -0.041 and -0.647 in the long-run. This finding that the demand for farm labour in sugarcane production is relatively inelastic is consistent with observations that, by and large, sugarcane production methods remained relatively unchanged in the industry and each of the two regions for the 1978-2012 period. The results further indicate that farmers adjust employment in response to a wage change within a period of three years. Over-and-above the impact of changes in the policy on wages, the changes in policy are associated with a further reduction in aggregate employment of an estimated 4119 FTEs and 5768 FTEs in sugarcane production by LSGs in the short- and long-run, respectively. Other things being equal, considering employment levels in 1978 and 1994, LSGs reduced employment in sugarcane farming by 6.82% and 17.1% in the short- and long-run, respectively. This impact may be ascribed to regulation induced changes in non-wage costs of employment, such as transactions costs and perceived risk. The results further verify that chemicals application is a strong substitute for labour in sugarcane production (especially in the Midlands region), and that employment of farm workers in sugarcane production is positively related to the price of sugarcane and the extent of area planted to sugarcane.

Bearing in mind the increases in the real minimum wage of farm workers post 2012, a revision of the current labour legislation to reduce some of the non-wage costs of employing farm workers is recommended to help preserve employment, especially of relatively unskilled workers in sugarcane farming. Activities that increase (reduce) the price received by farmers for sugarcane will have a positive (negative) impact on farm labour employment, both through the price effect, as well as an increase in the area under sugarcane. Finally, considering the trend of declining farm employment, programmes to improve education and training of former farm workers and other people in rural areas are important to improve their prospects of finding employment in non-farm sectors. Furthermore, more research on compliance issues is recommended to improve the effectiveness of compliance on the labour markets that are covered by the SD.

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2SLS	Two Stage Least Squares
AUC	Area Under Sugarcane
BCEA	Basic Conditions of Employment Act
CPI	Consumer Price Index
DoL	Department of Labour
ECC	Employment Conditions Commission
ESTA	Extension of Security of Tenure Act
FTE	Full-Time Equivalent Workers
ICA	Industrial Conciliation Act
ILO	International Labour Organisation
LFS	Labour Force Survey
LMD	Local Market Demand
LRA	Labour Relations Act
LRF	Land Reform Growers
LSG	Large Scale Growers
LUCS	Labour Utilisation and Cost Survey
MCP	Miller Cum Planters
NFG	New Freehold Growers
OHSA	Occupation Health Safety Act
OLS	Ordinary Least Squares
PAM	Partial Adjustment Model
PCA	Principal Component Analysis
PDI	Previously Disadvantaged Individuals

PLAS	Proactive Land Acquisition Strategy
QLFS	Quarterly Labour Force Survey
RV	Recoverable Value
SA	South Africa
SACGA	South African Cane Growers' Association
SACU	South African Customs Union
SASA	South African Sugar Association
SASMA	South African Millers' Association
SD	Sectoral Determination
STATSSA	Statistics South Africa
VMP	Value of Marginal Product

CHAPTER 1: BACKGROUND AND RESEARCH PROBLEM

1.1 Introduction

Minimum wage regulations are a common[1], but often controversial, policy tool used to protect vulnerable or low paid workers in many countries, including South Africa (SA). Although minimum wage policies and their impacts have been widely researched globally, sometimes with conflicting findings, the research has primarily focused on developed countries, and to some extent in Latin America and Asian countries. Despite about 22 African countries having some form of minimum wage legislation (WageIndicator, 2015), economic research on the impacts of minimum wages in Africa is relatively sparse, save for some fairly recent studies by Murray and van Walbeek (2007), Bhorat *et al.* (2012), Bhorat *et al.* (2013), Bhorat and Mayet (2013) and Stanwix (2013) on minimum wages in SA. Given that SA is one of the largest economies on the continent, these studies probably paved the way for the country to be featured in a number of International Labour Organisation (ILO) reports and studies focusing on minimum wages in developing countries, such as ILO (2013), ILO (2015) and Rani *et al.* (2013).

The minimum wage legislation was first introduced in New Zealand in 1894, followed by Australia, the United Kingdom (UK) and United States of America (USA) (Stanwix, 2013). Generally, countries with sectoral or national minimum wage legislation have tended to initially exempt sectors that absorb relatively unskilled labour, such as the agriculture and domestic worker sectors, in an economy. Although minimum wage coverage is usually extended to include farm workers, domestic workers and other vulnerable sectors, minimum wages in these

[1] According to BusinessTech (2015), 155 countries of the 196 United Nations member states have some form of a determined minimum wage legislation at a national, industrial or sectoral level.

sectors tend to be set at lower levels, relative to other sectors. This is evident from studies by Gallasch (1975) and Dickens (1995), respectively, who investigated the impact of extending minimum wage legislation to the farm sectors in the USA and UK.

Amongst the 22 African countries for which WageIndicator (2015) provides details of minimum wage legislation, nine have sectoral minimum wages specific to the agriculture sector and four countries have sectoral minimum wages that are specific to the domestic worker sector. Most other countries have national minimum wages, some of which exclude agriculture and other vulnerable sectors. Despite the extension of coverage to farm and domestic worker sectors in some countries, the minimum wage in these sectors remains low relative to other sectors.

Of the 22 countries, Kenya's minimum wage legislation for its agricultural sector is fairly unique in so far as minimum wages for agriculture in Kenya are differentiated by labour category, with relatively more skilled labour earning higher minimum wages. SA and most other countries may have multiple minimum wages for a sector, but tend not to differentiate minimum wages by skill level. Instead, a minimum wage is typically set to protect the most vulnerable workers in that sector, and then market mechanisms determine wage rates of relatively more skilled workers. Minimum wages may nonetheless vary by the nature of employment, the location (e.g. a municipality) and the size of the establishment. For example, the first sectoral determination for Farm Workers in South Africa (Sectoral Determination 8) set a minimum wage of R800 per month for farm workers working more than 27 hours per week in Area A (relatively more urban municipal areas) and R650 per month for farm workers working more than 27 hours per week in Area B (relatively more rural municipal areas). It further specified that workers working 27 or less ordinary hours of work per week must earn a minimum of R4.10 per hour worked in Area A and R3.33 per hour in Area B (Department of Labour (DoL), 2002).

A brief history of minimum wage legislation in SA and the SA farm sector

South Africa was a founder member of the ILO in 1919 by virtue of its membership of the League of Nations. It withdrew its membership with effect from 11 March 1966 to avoid expulsion, and rejoined the ILO on 26 May 1994. South Africa has ratified 27 ILO Conventions, of which 23 are currently in force. For purposes of this study, it is notable that SA ratified ILO convention No. 26 (Minimum Wage-Fixing Machinery Convention of 1928) on 28 December 1932 and this ratification currently remains in force, however it has not ratified ILO Convention No. 99 (Minimum Wage Fixing Machinery (Agriculture) Convention of 1951) and ILO Convention No. 131 (Minimum Wage Fixing Convention of 1970) (ILO, 2015).

According to ILO (2015), each member of the ILO that ratifies ILO Convention No. 26, undertakes to create or maintain the machinery whereby minimum rates of wages can be fixed for workers employed in certain trades or parts of trades (in particular, in home working trades), where no arrangements exist for the effective regulation of wages, by collective agreement or otherwise, and where wages are exceptionally low. Furthermore, each member that ratifies this Convention is free to decide the nature and form of the minimum wage-fixing machinery, and the methods to be followed in its operation, provided that the minimum rates of wages, which have been fixed, shall be binding on the employers and workers concerned, so as not to be subject to abatement by them and by individual agreement, nor, except with general or particular authorisation of the competent authority, by collective agreement, amongst other provisions.

The SD in South Africa is a system used to protect vulnerable sectors in the instance of failure of collective bargaining via a bargaining council to set minimum wages. It evolved from the Master and Servant Act (1896) (MSA), to the Industrial Conciliation Act (1924) (ICA), the Labour Relations Act of 1956 (LRA) and to the Basic Conditions of Employment Act 1997

(BCEA), which led to the establishment of the first national sectoral minimum wage in 1999, covering the contract cleaning sector since 2001.

Theron (2013) cited by Visser and Ferrer (2015) indicated that the LRA seeks to promote collective bargaining at a sectoral level. The preferred forum for bargaining at a sectoral level is the bargaining council. However, the LRA does not provide for a right to bargain, and a bargaining council could only be established voluntarily, by representative trade union(s) and employer organisations. Currently, there are no bargaining councils in the SA farming sector and there is also little likelihood that one will be established in the foreseeable future. This can be ascribed, not only to trade union weakness in the sector, but also to strong resistance displayed by organized agriculture and individual farmers to the notion of collective bargaining in the sector, due to the diversity of the sector.

The BCEA sets the minimum conditions of work that apply to all workplaces, whether or not there is collective bargaining. The BCEA also empowers the Minister of Labour to make SDs, by way of subordinate legislation. The SDs are made on the advice of the Employment Conditions Commission (ECC), which was established in 1999. The ECC replaced the Wage Board, which fulfilled a similar function in terms of the now-repealed Wage Act (Benjamin and Pretorious, 2011, cited by Visser and Ferrer, 2015). Although this is not explicitly stated in the BCEA, its function is to set minimum wages in sectors in which workers are perceived to be vulnerable, and with limited or no collective bargaining. However, the Wage Board, for reasons already noted, never set minimum wages for farmworkers or the agricultural sector.

The function of the SD is to set minimum wages and basic conditions of employment in sectors in which there is little to no collective bargaining. It is an administrative determination, preceded by an investigation by the ECC. Although, members of the public are entitled to make written representations to the ECC, it does not provide the same platform for an exchange of views as collective bargaining, and the outcome does not necessarily reflect a consensus between worker and employer organisations. Currently, there are eleven SDs in the SA economy, namely, for farmworkers, domestic workers, forestry, private security, contract cleaning, wholesale and retail, taxi, civil engineering, hospitality, and minimum wages for learnerships and children performing advertising, artistic and cultural activities sectors. But according to Bhorat and Mayet (2013), SA has around 167 different individual minimum wage rates in total across the 11 sectoral determinations.

The minimum wage policy in the farm sector through the SD was promulgated in December 2002 and implemented as from the first day of March 2003. It was the fourth sector to have a minimum wage set via the SD, following the contract cleaning sector in 2001, the private security sector in 2001 and the domestic workers' sector in 2002 (DoL, 2015). Before the introduction of the BCEA in 1997, the farm sector in SA was treated as a unique sector that deserved preferential treatment, and it was consequently largely excluded from labour legislation (Visser and Ferrer, 2015). As previously noted, it is not uncommon for farm sectors to receive special dispensations with respect to labour policy. Nonetheless, it is evident that, prior to 1994, the SA farm sector was under-regulated by global standards and that the introduction of regulations governing employment in the sector intended to address a perceived power imbalance between farm workers and farm business owners.

Whereas many provisions of the SD 13 simply recapitulate what is contained in the BCEA, and would in an event apply, the BCEA permits the Minister, in making a determination, to go beyond what is contained in the BCEA. For example, it permits the Minister to prohibit or regulate remuneration in kind, piecework and contract work. It also permits the Minister to set minimum standards for housing and sanitation for employees who reside on their employer's premises. In line with the above provisions, the SD also limits the deductions which may be made from a worker's pay; for example, the supply of food and accommodation is limited to an amount not exceeding 20% in total for farmworkers (DoL, 2013).

Besides the minimum wage, the SD also stipulates that farmers should have a formal employment contract, detailing work responsibilities for their employees and deductions structure from the farm labour wage. Farmers are also required to ensure a safe and friendly working environment for their labour, and the provision of safety training. The employment contract and minimum wage compliance has recently been investigated by Bhorat *et al.* (2012), Stanwix (2013) and Visser and Ferrer (2015) for the SA farming sector and it was also highlighted by Roberts and Antrobus (2013) in the Eastern Cape region. Compliance is crucial to ensure that labour legislation delivers its intended purpose.

Initially, the minimum wage rate application was introduced in two categories that were formed, based on the relative regional economic contribution to the national gross domestic product, where Area A received a higher minimum wage than Area B (DoL, 2002; Murray and van Walbeek, 2007). However, following recommendations by Kassier *et al.* (2003), the minimum wage application changed from a category to a single structure in 2009 to reduce the complexity and remove wage rate inequality amongst employees in the farm sector. The problem with wage zoning as identified by Kassier *et al.* (2003) was the inability to distinguish between farms that can and cannot afford the prescribed minimum wage, e.g. the region's relative economic contribution could be high, however, the majority of farms may be struggling, compared to a number of farms that are doing well economically. (It was noted elsewhere in this section that minimum wages set through the SD do not necessarily reflect a consensus between worker and employer organisations; consequently there is more scope for the minimum wage for farm labour to be set at a level that is not affordable for farm businesses).

Despite minimum wages only being introduced in the farm sector in 2003, in the wake of the political change in SA in the early 1990s, the introduction of this, as well as other changes to labour legislation regulating employment on farms, was probably widely anticipated by stakeholders in the sector. It is, therefore, likely that employment decisions in commercial farming had partly adjusted in response to expectations of the introduction of new labour legislation in the sector before it was promulgated.

From its inception in 2003 until 2012, the minimum wage for farm workers typically increased at a real rate of 1% per annum. The annual changes were predictable and transparent, partly because the planned increases for the following years were published in the Sectoral Determinations and subsequent amendments to those Sectoral Determinations. However, after consultations conducted by the ECC in 2012, the Department of Labour announced an increase in the nominal minimum wage rate of 9.3% and indicated a further increase of CPI plus 1.5% in 2013, citing the increase as an attempt to protect labour from vulnerable sectors from rising food inflation. Despite the increase, farm workers in the Western Cape, in particular, embarked on an industrial action, demanding a further increase in the minimum wage for farm workers to R150 per day. A peculiar aspect of that industrial action is that in 2012 wages of farm workers in the Western Cape were higher, on average, than elsewhere in South Africa (Visser and Ferrer, 2015). Following various consultations conducted by the ECC, the DoL decided to increase the minimum wage in 2013 by about 51% and announced a further increase of CPI plus 1.5% in 2014 (DoL, 2013). From 2003 to 2016, the farm-sector minimum wage increased in nominal terms from R650 to R2606.78 per month in the former predominantly rural areas (referred to as Area B in the Sectoral Determination 8) and increased from R800 to R2606.78 per month in the former relatively urban areas (Area A). In real terms, using 2012 as a base year, the minimum wages in the two area categories increased from R1028.37 to R2201.15 per month and from R1265.69 to R2201.15 per month, respectively.

Economic arguments for and against minimum wage legislation

The Minimum wage policy is contentious and has both proponents and opponents (Donaldo *et al.*, 1996). The basis of arguments made in favour of setting a minimum wage is usually to provide a "living wage" for a targeted group. Olusegun *et al.* (2012) suggested that minimum wages are required to provide wage-earners with necessary social protection. Proponents of minimum wages also argue that they reduce poverty by increasing the wages of those earning less than the minimum wage, and possibly also some of those earning more than the minimum wage. According to Donaldo *et al.* (1996), proponents of the policy argue that it reduces the *strong exploitation of labour in vulnerable sectors* and reduces income inequality amongst the working class. Opponents of minimum wages, on the other hand, argue that minimum wages set at levels above the market wage rate may increase poverty levels by increasing the number of unemployed or disadvantageously employed people, counterbalancing any favourable effect on wages of those remaining in employment (Friedman, 1966).

Measuring the labour market's response to a minimum wage can differ with regard to factors such as country, region, labour type or category and industry or sector, as well as with respect to various attributes, the level at which the minimum wage is set and the methodology used to analyse data. Therefore, a consensus about the economic consequences of the legislation may not necessarily produce complete unanimity about its desirability, for differences may still continue to persist with regard to the political and social consequences. However, given a consensus on the objectives, it may end up resulting in agreement. Hence, a consensus on "accurate" economic policy is regarded as being largely dependent on the progress of positive economics and less dependent on progress in producing conclusions (Friedman, 1966).

Schuh (1962), Gardner (1972) and Friedman (1962), amongst others, argue that unskilled workers in the labour market, such as most farm workers, are more vulnerable than are relatively skilled workers to loss of employment due to the introduction of minimum wages. This is especially true for categories of workers for which the supply and demand for labour are relatively elastic. In general, the demand for labour is more elastic for categories of workers that have close substitutes, and those that account for a relatively high proportion of production costs. If the demand for labour is elastic, an increase in wages will result in a proportionately larger reduction in employment, resulting in a decline in the total wage bill (Friedman, 1962).

The trade-off between providing workers with a living wage and reduced employment is therefore a key consideration for policy makers in setting a minimum wage. Various foreign and local empirical studies on the minimum wage have found that minimum wages have a positive impact on the wage rate, but a negative impact on employment; for example, Fang and Lin (2015) presented evidence of strong adverse impact of minimum wages on employment in the Central and Eastern regions of China, especially for young adults, female and unskilled workers. Nonetheless, the impacts of the minimum wage legislation on wages and employment are primarily determined by the wage elasticities of the demand for and supply of labour, as well as matters of enforcement of and compliance with the minimum wage by employers. Another important consideration for policy makers should include the prevailing rate of rural unemployment and their goals for employment creation in the sector(s) affected by the minimum wage.

1.2 Problem Statement

Statistics on estimated employment in sugarcane farming computed from the South African Cane Growers' Association's (SACGA) annual Labour Utilisation and Cost Survey (LUCS), indicate a trend of decreasing employment in sugarcane production by LSGs from 1978/79 to 1999/2000, but which stabilised at about 67 000 employees from 2000/01 to 2011/12 (SACGA, 2014). In contrast, the recent trends of the Labour Force Survey (LFS) and Quarterly Labour Force Survey (QLFS) suggest a strong decreasing trend in agricultural employment in KZN (STATSSA, 2015). In other words, employment in sugarcane farming may have been relatively more resilient than many other types of farming operations over the past decade.

The change in employment by LSGs in sugarcane farming may be attributed to several contributing factors. On the demand side, the area under sugarcane (AUC) farmed by Large Scale Growers (LSG)[2] may have changed due to changes in the relative profitability of sugarcane farming, transfers of farmland from miller-cum-planters to LSGs, and the establishment of new sugar mills, amongst other reasons. Sugarcane production technologies may have changed on some farms, for example, labour employed in sugarcane production may have been substituted for machinery and chemicals, or *vice versa*, due to changes in the relative cost of labour. On the supply side, growth in the availability of alternative competitive employment opportunities (e.g. in the construction sector), rural emigration, and changes in relative wage rates for relatively unskilled workers across the various sectors in the economy, amongst other factors, may have reduced the supply of some categories of farm workers, resulting in a reduction in the quantity of labour employed.

Researchers, such as Newman *et al.* (1997) and Murray and van Walbeek (2007), have studied the impact of a change in labour legislation on sugarcane farming in the KZN Province. Both studies made use of cross-sectional data of farmers' planned responses to changes in labour legislation (Newman *et al.*, 1997) and farmers' accounts of their actual responses to changes in

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[2] In general, all sugarcane growers are commercial farmers, given the nature of the industry. However, the term LSG, as defined by the SA Sugar Industry, refers to registered sugarcane growers (excluding Miller-cum-Planters) that produce an average of greater and equal to 225 tons of Recoverable Value (RV) for three to four consecutive seasons. For dryland sugarcane production in KwaZulu-Natal, LSGs typically farm a minimum of about 40 hectares of sugarcane. As at 2012, approximately 19% of the area of sugarcane farmed by LSGs was farmed by Previously Disadvantaged Individuals (PDIs) (SASA, 2013).

labour legislation (Murray and van Walbeek, 2007). Neither study provided an estimate of the wage elasticity of demand in sugarcane farming, nor did they investigate the distribution or dispersion of wages between categories of farm workers.

According to Friedman (1962), it is expected that the demand for farm labour, in general, is relatively elastic, especially for unskilled farm labour. Although several studies have established that the demand for labour in the farm sector of South Africa is, indeed, relatively elastic in the long-run (e.g., Latt and Nieuwoudt, 1985; Sparrow *et al.*, 2008), and Bhorat *et al.* (2012) and Stanwix (2013) have studied the impact of the SD on employment in the farm sector, no published research to-date has reported on estimates of the wage elasticity of demand for farm workers in sugarcane production in South Africa.

Based on the determinants of the wage elasticity of demand identified by Friedman (1962), it is uncertain whether the wage elasticity of demand is more or less elastic in sugarcane production than for the farm sector as a whole. The reason for this is that although farm staff (wages and expenditure of labour) accounts for a large proportion (about 24%) of production costs in the sugar industry (SACGA, 2014), there are relatively few substitutes for sugarcane harvesting staff, in particular, in sugarcane production on most farmland used for sugarcane production in South Africa. Nonetheless, Newman *et al.* (1997) predicted that because labour accounts for a relatively high proportion of costs in sugarcane farming, employment in sugarcane farming would be relatively more responsive to a change in the cost of labour.

Farm labour employed in sugarcane farming is highly heterogeneous. It ranges from relatively unskilled (e.g., general field staff) to semi-skilled (e.g., drivers and junior managers or *indunas*) occupations, with some farm workers employed on a permanent basis and others on a seasonal basis. Moreover, some jobs (notably cane harvesting) are undertaken predominantly by migrant workers. Furthermore, sugarcane harvesting staff are typically paid on a piecemeal basis rather than at a daily or hourly wage rate. Research on the impact of the minimum wage on employment in South African agriculture, e.g., Sparrow *et al.* (2008), Bhorat *et al.* (2012) and Stanwix (2013), have not investigated the impact by labour category. This study seeks to bridge the gap by employing descriptive statistics and econometric approaches to investigate the impact of the minimum wage on employment, wage structure and redistribution between labour categories in the presence of a minimum wage.

The aim of this research is therefore to investigate how the minimum wage legislation has impacted not only on wages and employment of farm workers in sugarcane production that typically earn minimum wages (e.g., seasonal and permanent field workers), but also how it has impacted on the wage rates and employment of categories of workers that typically earn more than the minimum wage rate (e.g., cane harvesting staff and drivers). Because the demand for and the supply of labour in the various labour categories may vary across sugarcane producing regions, the impact of the minimum wage on employment in sugarcane farming is compared for the South Coast of KwaZulu-Natal region (hereafter referred to as the South Coast - which is relatively more labour intensive) with the KwaZulu-Natal Midlands (hereafter referred to as the Midlands - which is relatively more mechanised.

1.3 Research Objectives

The general objectives of the study are to determine:

- factors affecting farm employment of four selected categories of labour in sugarcane farming in the industry as a whole and in each of the two selected sugarcane producing regions in a minimum wage environment;

- the impact of the minimum wage on the wage structure and wage redistribution between the semi-skilled labour category (Drivers) and other elementary categories (seasonal and permanent field workers) of labour; and
- the impact of the minimum wage on basic wages in the sugarcane farming industry.

The specific research objective is to show how the impact of a change in the minimum wage varies across various farm labour categories, from highly unskilled to semi-skilled workers, and between sugarcane producing regions. This will be achieved by estimating and comparing wage elasticities of the demand for the four categories of farm workers in sugarcane production, and to compare these estimates across the two selected regions and the industry aggregate.

The general objectives will be achieved through:

- the use of relevant data to estimate various demand models;
- trend analysis of the wage components proportion and wage redistribution between labour categories; and
- trend analysis comparing the minimum wage to basic wages in the industry as a whole, selected regions and farm labour categories.

1.4 Structure of the Dissertation

The study is organised as follows: In this chapter, the study was introduced, outlining the specific problem and motivation for undertaking the study. The research objectives are also presented, to give the literature review and analysis direction. Chapter 2 provides a broad literature review, which is important for the development of a theoretical base for the study. Theory is important to assist with the development of an appropriate model through the identification of important variables, to pre-empt possible outcomes from the study, and to set a strong base to guide discussions in Chapter 3. Chapter 3 gives an overview of the farm wage structure and the implications of an effective SD on farm wages and wage structure. The demand for and supply of farm labour is followed by a discussion of the minimum wage implications on employment and wages, as well as the resultant substitution effects.

Having discussed various implications in Chapter 3, Chapter 4 identifies and describes the sugar industry structure, while Chapter 5 justifies and provides a description of each selected region and the availability of suitable data required for descriptive and econometric analysis. The perception of growers about the impact of increasing wages on production systems are also incorporated in the description of selected regions. A description of data availability is important for the development of an appropriate econometric model in Chapter 6, a model that must be suitable for the comparative analysis of selected labour categories in the industry and regions, and be able to deal with expected high collinearity in the data sets. Chapter 7 presents the estimated econometric model results, the wage and cross-elasticity of demand for the price of chemicals on the demand for farm labour.

CHAPTER 2: A REVIEW OF MINIMUM WAGE-RELATED STUDIES

The purpose of this chapter is to present a review of empirical economic research on (a) the supply of and demand for farm labour, and (b) the implications of minimum wages on farm employment and wages. The notion that past studies provide contentious and conflicting evidence about the economic impacts of minimum wages on employment and wages is explored in the review. Considering that Machin *et al.* (2003) and Bhorat *et al.* (2013) drew attention to the importance of methodology in studying the outcomes from the introduction of minimum wage legislation, there is a particular focus in this chapter on which methodologies were adopted in the various studies.

The discussion of these and other aspects of the literature reviewed subsequently guides the development of an appropriate study approach for this study. Both local and foreign peer-reviewed articles are included in the review of literature. South African studies are reviewed in Section 2.1 and studies in other countries are reviewed in Section 2.2. Section 2.1 is sub-divided into studies of the South Africa farm sector, in general, and studies of particular sub-sectors or regions of the farm sector in South Africa. Section 2.2 considers both studies of the farm sector in other countries, as well as some relevant studies of non-farm sectors.

2.1 South African Studies

2.1.1 Studies of Employment in the Farm Sector

Latt and Nieuwoudt (1985) analysed the demand for and supply of farm labour in KZN between 1972 and 1978, to assess the impact of trade unions on wages and employment. A Two-Stage Least Squares (2SLS) log model was used to estimate demand and supply wage elasticities of -1.389 (excluding real expenditure on new equipment) and 5.185, respectively, while the linear

2SLS model presented demand and supply wage elasticities of -1.44 and 5.8, respectively. These estimates and the strong correlation coefficient estimate between the farm and non-farm wage imply strong competition for labour between agriculture and non-farm sectors. This demonstrates the vulnerability of agriculture to losing labour to other sectors due to an increase in off-farm wages relative to on-farm wages for relatively unskilled workers. The coefficient estimate of expenditure on new equipment was positive, suggesting a complementary relationship between labour and investments in new equipment.

Sparrow *et al.* (2008) used OLS and 2SLS to estimate the long and short run supply and demand wage elasticities of regular farm labour for the 1960-1990 and 1991-2002 periods, respectively, to determine structural change in labour demand over time, due to the increase in stringency of labour legislation in agriculture. The results showed low (high) elasticity during the early (later) period, indicating a structural change in the demand for labour as a result of the financial, transaction and risk costs associated with the change in labour-related legislation. The OLS Model gave -0.25 and -1.32 elasticities for the 1960-1990 and 1991-2002 periods, respectively; similarly the 2SLS Model yielded elasticity estimates of -0.23 and -1.34, respectively.

The increase in elasticity between the periods suggest that regular labour has become more wage elastic over time, probably due to more substitutes for labour in many farming operations becoming available over time, due to technological improvements in machinery and agro-chemicals, amongst others. The results further indicate that adjustments to employment level on farms lag change in real wages - approximately 80% of the adjustment is made within three years, whilst the full adjustment is complete in approximately six years. The results also indicate that chemicals are a strong substitute for regular farm labour, compared to casual labour and mechanisation. Importantly, the findings indicate structural changes in the demand for regular farm labour that coincided with the expected and actual change in labour relations.

Bhorat *et al.* (2012) applied the difference-indifference model adopted from Card and Krueger (1994), as well as descriptive statistics on 15 waves of the biannual LFS treated as repeated cross section between September 2000 and September 2007, to investigate the impact of minimum wage on employment, wages and non-wage benefits in South African agriculture. The descriptive statistics analysis indicates a substantial immediate increase in the nominal average wage, with an immediate unrecovered decrease in employment of over 20%, while econometric results suggest an increase in average wages of about 17%. The results also show a significant wage increase in regions, where there was a huge gap between average wages, compared to the sector average wage. The legislation has also improved employment security through contract requirements, which suggests an improvement in farm workers' job security. Nonetheless, employment remains stable as the average number of hours worked has remained stable above 45 hours per week.

The farm labour wage elasticity demand estimate using the 20% decrease in employment and 17% increase in wages, i.e. Δemployment/Δwage = -0.2/0.17 = -1.18, suggests an elastic demand for farm labour in the SA agricultural sector; however, this simple calculation does not account for changes in factors other than the wage. The estimate is nonetheless similar in magnitude to Sparrow *et al.*'s (2008) long-run wage elasticity of demand estimates. The study is important in the sense that it reflects farm labour data variation, since it accounts for factors such as wage rates, hours worked, contracts, etc., whereas Sparrow *et al.* (2008) only used average/aggregate wage and employment statistics. The differentiation makes this study appropriately regarded as a more holistic study of the impacts of the minimum wage, as it considers both employment impact and aspects of working conditions other than wages.

In a similar study, Bhorat *et al.* (2013) studied the impact of minimum wage legislation on employment, wages and hours worked in the retail, domestic worker, forestry, security and taxi sectors in SA during the 2000 to 2007 period. The study provides evidence that the introduction of minimum wages significantly increased hourly wages in districts where the wage rate was previously below the minimum wages in the retail, domestic, taxi and security sectors. The findings did not show clear evidence of a negative impact on employment in these sectors – a very different result to Bhorat *et al.*'s (2012) study of the farm sector. Importantly, higher real hourly wages significantly outweighed the consequent decrease in employment (including cuts in the average number of hours worked per employee), which resulted in a real monthly wage improvement in the retail, domestic and security sectors. No benefit in the real monthly wage was noticed in the forestry and taxi sectors as a result of the legislation. The review of this study is important, as it accounts for other major sectors that are considered vulnerable by the DoL, since they are not covered by any bargaining council. The findings reported in this study presents outcomes that are relevant to the farm labour market.

Stanwix (2013) deduced that, after plotting provincial farm median wages, SD resulted in an increase in wages for permanent labour. He also indicated that there has been an improvement in job security through an increase in employment contract compliance by farmers since 2003. There has also been an improvement in employment conditions for those remaining in employment and new employees that are able to find employment in the sector, and there was the likelihood that more labour understood their employment terms over time. However, he found that the minimum wage had resulted in a 13% decrease in aggregate employment.

2.1.2 Studies of Employment in Sub-Sectors or Regions of the Farm Sector

Newman *et al.* (1997) surveyed a stratified sample of commercial sugarcane, beef and dairy farmers in the KZN Province to elicit their perceptions of and planned responses to anticipated and actual changes in the regulatory framework governing employment of labour on farms post

1994. Although this study pre-dates the introduction of a minimum wage in the farm sector, it provided valuable insights on the likely consequences of changes in labour legislation that were anticipated at that time. The three enterprise studies were selected partially because they vary in capital-use and labour-use intensity: of the three enterprises, dairy farming is most capital intensive, followed by sugarcane farming and then beef production; and wages as a proportion of production costs is highest for sugarcane, followed by dairy and then beef, which is influenced by their respective labour intensity. Sugarcane growers often also have to make incentive payments to induce productivity and to get more work done, as sugarcane requires more hard work, compared to other enterprises.

Their findings suggest that farmers who were paying relatively lower wages tended to provide more rations per labourer and allocated more land use rights for their labour. Responding farmers supported the view that there is some need for labour legislation in agriculture, but most of them lamented that it is time-consuming and costly, and desired a legislation that is less ambiguous, more flexible and less extensive. The study found that the legislation has resulted in an increase in wages and transaction costs, which was anticipated to stimulate substitution of mechanisation and contract labour or contract machinery for labour. Majority of the respondents indicated that if the minimum wage was to be imposed, they will start paying more cash wage, charge for perquisites and start replacing labour with machinery and contractors.

Conradie (2005) conducted the first economic study of the impact of the minimum wage on farm labour in a sub-sector or region of the South African farm sector, namely the wine and table grape industry of the Western Cape Province. She used farm level data collected between 2003 and 2004, such as employment and wages, production, mechanisation and fuel. She used the data to estimate an econometric model (partial derivative of the short-run cost function) specified in double-log form, to compare short-run wage elasticities of farm labour demand for wine and table grape farming operations.

In general, her findings show inelastic wage elasticities of farm labour in grape production. However, it was relatively more inelastic for wine grape farms (-0.33), compared to table grape farms (-0.59). She attributed the difference in the estimates to wine grape farms being 30% more productive than grape farms due to the relatively higher levels of mechanisation on wine grape farms, and because table grape production is four times more labour-intensive than wine grape production. This study is important because it highlights variation in wage elasticities of demand across two relatively similar enterprises. This, in turn, supports the argument that the wage elasticity of demand in sugarcane production may differ significantly from that of the agricultural sector as a whole, and may even vary between sugarcane farming regions because some production practices are not equally well suited to all sugarcane producing regions.

Murray and van Walbeek (2007) analysed descriptive statistics generated from a survey of sugarcane farmers on the South and North Coasts of KwaZulu-Natal to produce a regional comparison of the impacts of the minimum wage on sugarcane farmers across the two regions. They found that wages were, on average, higher on the North Coast, and attributed this to (a) relatively more farmers in their sample on the North Coast were required to pay the higher of the two minimum wages specified in SD8 because they farm in relatively urban municipal areas, (b) a high compliance rate, and (c) the greater availability of alternative employment opportunities for relatively unskilled workers on the North Coast. It is also noted that because sugarcane yields per hectare per year on the North Coast are generally higher than on the South Coast, farms in the former region may be in a stronger financial position to pay the minimum wage. Besides the increase in wages, other positive impacts of the minimum wage identified in their results include that some farmers (especially on the North Coast) planned to invest more in training their labour to improve labour productivity.

Negative impacts of the minimum wage include that surveyed growers in both regions planned to reduce employment on their farms. In the short-run, the farmers proposed to reduce employment via decreasing the number of hours worked per worker per day. Farmers on the North Coast planned to cut working hours to between 27 and 36 per week. Secondly, approximately half of Murray and van Walbeek's (2007) survey respondents planned to substitute casual and seasonal labour for permanent labour and to outsource activities to contractors in response to the minimum wage. Labour contracting was found to be a strong substitute for regular labour, compared to complementary seasonal labour, especially on the North Coast. Thirdly, growers in both regions planned to reduce the perquisites provision, with North Coast growers mainly planning to cut down more on rations and less on accommodation. Finally, surveyed farmers on the North Coast reported that payment of a higher wage had resulted in growers dealing with more alcohol related disciplinary incidents.

Roberts and Antrobus (2013) analysed case studies spanning the past five decades (1957 – 2008) to monitor change in farming practices in the Upper and Lower Albany regions of the Eastern Cape Province as a result of changes in labour legislation. The results show a decreasing trend in employment over the study period, which started to accelerate in 1994, as well as a strong labour casualisation. Farmers also reduced the daily working hours and shortened the length of the working season. The reduction in employment was attributed not only to changes in labour legislation, but also to a general input price squeeze. They found that land use has shifted in favour of relatively less labour-intensive enterprises, e.g. livestock, rather than cash crops, and that this was also associated with an increase in the average farm size. They found that imposition of the SD resulted in an increase in cash wages relative to the value of other non-pecuniary benefits, such as provision of accommodation and rations. Whilst this change is attributed to SD rules, they argued that the Extension of Security of Tenure Act (ESTA) has also contributed to the cut in provision of accommodation. Consequences of farm workers residing off-farm include high transport costs incurred by farmers, and that farm workers are increasingly exposed to more lucrative jobs and lifestyles. Furthermore, it has resulted in an increase in demand for service delivery in towns. They further found that minimum wage legislation caused: (a) increased standardisation of wages (reduced variation in wages), which may have compromised incentives for employees to be relatively more productive, and (b) decreased wage inequality between relatively skilled and unskilled labour.

An important aspect of this study is that it provides empirical evidence that changes in labour-related legislations contributed to a shift in land use from labour-intensive cash crops to extensive livestock farming in the Eastern Cape Province. The consequences of this change in land use patterns included: (a) reduced employment of farm labour, (b) an increase in the casualisation of farm labour in the area, and (c) a decline in the total wage bill as a proportion of farm expenditure. The findings, therefore, reflect that farmers not only change **how they farm**, but that they also adjust **what they farm** in response to a minimum wage induced change in the relative price of unskilled farm labour. In general, an increase in the relative price of unskilled farm labour results in a shift towards relatively less labour intensive farming.

2.1.3 Discussion

Studies reviewed in this section indicate that the SD did impose a minimum wage for farm labour that exceeded the market equilibrium wage rate in the absence of a minimum wage (Bhorat *et al.*, 2012; Stanwix, 2013). There is consensus in the findings of Conradie (2005), Sparrow *et al.* (2008), Murray and van Walbeek (2007), Bhorat *et al.* (2012) and Stanwix (2013) that after accounting for other possible contributing factors, the increase in the wage rate of farm workers due to the SD contributed to labour shedding in the sector.

Sparrow *et al.* (2008) and Bhorat *et al.*'s (2012) findings concur with those of Latt and Nieuwoudt (1985) that for the sector as a whole, the wage elasticity of demand for farm labour exceeds unity in the long-run in absolute terms. However, it may vary across the sector (Conradie, 2005), and none of the studies reviewed considered how it varies across categories of farm labour by skill levels (e.g., "elementary labour" and farms hands vs. machine and vehicle operators). The decline in employment may be attributed not only to how production takes place (e.g., Conradie's (2005) example of labour substitution in wine grape production), but also to changes in land use in favour of less labour intensive land uses (Roberts and Antrobus, 2013).

The findings of Sparrow *et al.* (2008) and Murray and van Walbeek (2007) both indicate that there may be a lengthy period of adjustment to employment on farms following a minimum wage induced hike in the cost of unskilled labour. Murray and van Walbeek's (2007) and Roberts and Antrobus's (2013) finding that farmers reduced employment by reducing workers' working hours may reflect high transactions costs of retrenching permanent workers; thus farmers may be inclined to wait for resignations and retirement of workers to reduce their number of employees. An alternative argument is that farmers avoid labour shedding in order to protect the livelihoods of people with whom they already have a relationship.

There is also clear evidence that because SD8 imposed different regulations on regular labour relative to casual labour, the legislation induced substitution of casual and seasonal labour for permanent labour (Sparrow *et al.*, 2008; Murray and van Walbeek, 2007; Roberts and Antrobus, 2013). Murray and van Walbeek (2007) also noted that farmers planned to increasingly outsource farming activities in response to labour legislation and the minimum wage.

Considering that the minimum wage legislation applies equally to workers directly employed by farms and those employed by contractors and labour brokers, the benefit to farmers of outsourcing labour is not immediately apparent. A possible explanation is that the transaction costs of employment of farm labour as a result of labour legislation may be higher for some farmers than for others, based on their relative skills and abilities. Some farmers may therefore be willing to pay a premium to avoid those costs, whereas others may be willing to specialise in those functions in return for earning a premium (or contractor fee). This argument is supported by Sparrow *et al.*'s (2008) findings.

Besides its impact on employment and cash-wages (including adjustments for changes in working hours), the SD and other changes to the regulatory environment for the employment of farm workers has had other intended and unintended consequences for the living and working conditions of farm workers (Visser and Ferrer, 2015). Some changes identified in the reviewed studies are to the benefit of workers, e.g., the proportion of farm workers with formal employment contracts increased (Bhorat *et al.,* 2012; Roberts and Antrobus, 2013), whilst others are negative, e.g., reduced provision of non-pecuniary benefits such as rations (Murray and van Walbeek, 2007; Roberts and Antrobus, 2013).

2.2 Studies of Minimum Wages in Other Countries

2.2.1 Studies of Minimum Wages in the Farm Sector of Other Countries

The implications of introducing a minimum wage in the agricultural sector have widely been explored in the USA and UK by renowned researchers. Scholars in these countries employ a variety of methodologies, such as descriptive statistics, cross-sections, simple regression and simultaneous models on cross-section and time-series data. Their research approach and key findings are discussed in this section to provide a guide for the development of an appropriate model to study farm labour in sugarcane farming in South Africa.

Schuh (1962) analysed 1929-1957 time series data for hired farm labour in the USA, using a simultaneous model to determine the structural change in aggregate demand and supply over time, while assuming no change in quality of labour and hours worked. Data showed varying employment and composite wage between 1870 and 1960; however, employment (wages) fell and rose by about 44% (236%) between 1929 and 1960, respectively. The supply (demand) indicated a coefficient of adjustments of 0.68 (0.7), which means 32% and 30% of the supply and demand disequilibrium is adjusted in a given period. Estimated supply elasticities in respect of farm and non-farm wages at the mean were 0.25 and 0.36, which suggest a higher labour supply response to non-farm wages, compared to farm wages. Short- and long-run demand elasticity estimates at the mean were -0.12 and -0.4, which suggests a change in the demand for labour over time. Short and long run supply elasticities were also estimated at the mean as 0.25 and 0.78, which show a larger change in the supply of labour over time.

Gardner (1972) applied a reduced-form supply-demand model on the hired labour market to determine the impact of a minimum wage on farm wage and employment between 1929 and 1967 in the USA. The minimum wage was first introduced in non-farming sectors in the USA between 1938 and 1967 and extended to some farm labour in 1967. The results show that the minimum wage coverage extension to some farm labour resulted in a decrease (increase) in aggregate employment (farm wage) of about 18% and 13%, where wages would have only increased by 7% without the minimum wage. The extension of coverage was expected to impact greatly on employment, as the wage demand elasticity for low paid labour is much higher than overall labour elasticity, which makes it important to explore demand elasticity in various labour categories.

Gallasch (1975) investigated the impact of minimum wage extension to cover farm labour in the USA, by applying simultaneous and reduced-form equations on data for covered and unaffected portions of the farm labour market between 1959 and 1971. The findings suggested that the extension of coverage resulted in an increase in wages and a decrease in employment in excess of the labour emigration trend. The mean based demand elasticity estimate suggested that a 10% increase in the real minimum wage resulted in a 2% increase in the real equilibrium wage and a 6% decrease in employment. Whilst the estimated elasticity of the real alternative wage suggested that a 10% increase in non-farm wage lead to a 17% and 5% decrease (increase) in employment and wages, respectively.

Gallasch and Gardner (1978) studied the impact of minimum wage extension, years of schooling and the interaction of the two factors on employment and average farm wage in the USA, using econometric modelling. The model consists of four equations, namely, demand, supply, excess supply and market equilibrium interacting, to determine the quantity demanded and supplied, the wage rate and excess supply. The reduced form equations were estimated and empirical findings demonstrated that higher schooling (higher productivity) or minimum wage introduction and/or increase resulted in a decrease (increase) in employment and average wages, respectively. The minimum wage attracted labour to the limited availability of jobs, while an improvement in schooling redirected farm labour to non-farm sectors. The mean based elasticity estimates showed that the legislation increased (decreased) average wage (employment) by about 5% (42%). On the other hand, an increase in the alternative wage would increase (decrease) average farm wages and employment by attracting labour with high schooling to non-farm sectors with good economic performance. The removal of the minimum wage from the economic model showed that a 10% increase in schooling raised (reduced) the average farm wage (employment) by 3% (8%) to non-farm sectors, respectively.

Machin *et al.* (2003) examined the impact of minimum wage coverage extension from the agricultural sector to other vulnerable sectors of the economy in April 1999 in the UK using descriptive statistics and cross-sectional modelling. The earmarked minimum wage introduction was £3.6 per hour for the 22 years and above age group and £3 per hour for the age group between 18 to 21 years. The main focus was on the residential home care industry, the labour market believed to cater for relatively low income employees, with vulnerable employment and wages to the minimum wage. Initially wages were about 33% below the minimum wage and they subsequently rose by 30% in response to minimum wage introduction. The findings showed wage redistribution with little evidence of non-compliance, as a large number of low paid workers received wage increases, which resulted in wage standardisation at the lower end of the distribution and a reduction in wage inequality. To some extent, the results also showed a decrease in employment and the number of hours worked. Although the study focused on a non-farm sector, its review is important since it covers a low income sector that is also considered vulnerable, which has direct expectation of results from this study.

2.2.2 Studies of Minimum Wages in Non-Farm Sectors of Other Countries

Card (1992) used descriptive statistics and the difference in difference cross-section model to determine the impact of a minimum wage increase of 26.87% in California State in July 1988, using data from between 1985 and 1990. The adjustment was in response to a decline in the real federal minimum wage, due to infrequent adjustments in nominal terms, which made its impact less noticeable on the labour market. The impact on the State's general, teenage and retail labour markets (trade and restaurant) were determined through comparison with control states (the group of states without a minimum wage increase). In general, the results demonstrated that a minimum wage increase raised earnings for the low base employees with low employment loss, while hourly and weekly wages (employment) in the teenage labour market increased by 10% and 4%, which contradicts the competitive labour market conventional theory. Hence, it was suggested that more research into the impact of the minimum wage and an exploration of alternative models, such as the monopsonistic model in the California State, are needed to determine if labour has market power.

Card and Krueger (1994) studied the impact of a minimum wage increase by 18.82% per hour in the restaurant industry, by comparing employment, wages and prices at stores in New Jersey and eastern Pennsylvania (where minimum wages did not change) before and after the rise, using descriptive statistics and the difference in difference model on cross-section data. The results were inconsistent with the general theory of the competitive labour market, as employment in New Jersey increased and product price did not rise. Alternative models based on the monopsony theory showed an increase in employment, no impact on the number of outlets opened and at least a rise in product price.

Machin and Manning (1994) investigated the impact of the minimum wage on the adult labour market, as well as wage dispersion in the UK, using the descriptive statistics and simple regression model to determine if abolishing the Wage Council would increase employment. Empirical findings showed that a decline in the strength of regulations imposed by the Council in the 1980s contributed to wage inequality and resulted in a decrease in employment in covered industries. It was also established that the Council did not impact negatively on employment and its absence would result in huge wage disparity. An unfavourable employment effect was noticed as a result of a minimum wage, while the Council showed a positive employment effect. A relatively more theoretical explanation for these findings was outlined, which suggests that monopsony power may account for some observed positive relationships between the minimum wage and the employment of the low wage based labour market, such as the Wage Council sector. A modern version of the monopsony model was suggested for the high income labour market, in which market frictions make the supply of labour to individual firms inelastic.

Rama (2001) examined the impact of tripling (doubling) the nominal and real minimum wage, respectively, on wage earnings and employment in Indonesia during the first half of the 1990s, by applying simple statistical tools and a regression model on both individual and aggregate data. The increase in wages was intended to safeguard labour, as it was not the case for almost two decades. In general, the results showed a moderate minimum wage impact in the country. Wage distribution analysis only presented minor clusters at or around the minimum wage, which were hardly visible for some provinces and groups of workers. Regression results showed poor statistically significant coefficient estimates with smaller elasticities, which may suggest less compliance, due to a lack of stringent compliance with an enforcement mechanism. However, the results suggested that doubling the minimum wage increased the average wage by five to 15% and led to a less than 5% decrease in urban wage employment. Arguably, the low magnitude of the decrease in aggregate urban wage employment conceals the disproportion across firms, which suggests that employment in small firms would have probably fallen significantly, while large firms would have noticed an increase in employment.

Neumark *et al.* (2002) applied the descriptive statistics and regression model on time series data spanning between 1979 and 1997, to examine the impact of the minimum wage increase on wages, hours worked, employment and labour income at different wage distribution points, but with main focus on the low end of the distribution. It was shown that workers initially earning near the minimum wage experienced wage gains with a decrease in working hours and employment, but the net effect suggested unfavourable outcomes for the low wage workers. Empirical findings also presented an instant increase in the magnitude of wage gains, the reduction in working hours and income loss. The average income of low wage workers declined in response to the rise in minimum wage, due to an increase in the number of relatively poor families. The conclusion is that the minimum wage rise leads to a lower immediate increase in wages than the minimum wage rise, the decline in working hours and employment, which leads to a higher unemployment and a reduction in wellbeing of workers due to a loss in income.

Maloney and Mendez (2004) investigated the impact of the minimum wage on wage distribution and the unregulated/informal sector in Latin America (Argentina, Bolivia, Chile, Colombia, Honduras, Mexico and Uruguay) using numerical, kernel density plots and econometric analysis. These countries were compared and the conclusion focused on Colombia, since the minimum wage in the country was relatively higher and binding. The results show that the minimum wage also impacted on wage distribution in the vicinity, through its potential to resonate wages. Labour market inflexibility was noticed with poverty or flexibility dependent on the attributes of the labour market. The impact on the informal sector for salaried workers, revealed that, on aggregate, the impact was large. Therefore, the legislation impacted on both the formal and informal high level workers, which shows that distortions on the labour market are much larger than anticipated. The probability of losing a job decreases with an increase in the position on the wage distribution. The impacts were not immediate; however, the simultaneous effect was almost double, relative to findings in developed economies.

Fang and Lin (2015) used country-level minimum wage data combined with urban household survey micro-dataset from 16 representative provinces as a merged country-level panel data to estimate the impact of changes in China's minimum wage regulations over the 2002 – 2009 period on employment. The change in the regulation involved extension of coverage to state owned, private enterprises, private non-enterprise units, and employees in self-employed businesses. Particularly, it introduced two types of minimum wages, i.e. a monthly minimum wage applied to fulltime workers and an hourly minimum wage applied to no-fulltime workers.

Descriptive statistics and econometric modelling were used and the findings presented evidence of a sizeable adverse impact on employment in the Eastern and Central regions, resulted in loss of employment for female, young adults and low skilled workers.

2.3 Conclusion

In Section 1.2 it is noted that Machin *et al.* (2003) attributed disagreement in empirical research on the economic outcomes from the introduction of minimum wage legislation to a methodological divide between economists. Section 2.1 presented a broad literature review, while Section 2.2 discussed the methodologies adopted in those studies and to consider the relationship, if any, between the research methods used and the results. The research methods used in those studies involve the use of descriptive statistics and econometric modelling, or the application of both, to analyse the minimum wage implications on employment and wages in a given labour market in SA and markets for farm labour in other countries.

Most of the research was conducted assuming a competitive labour market. However, findings from some studies provide a theoretical base to explore the application of the monopsony model to explain unusual relationships, which suggests the need for more research to focus on the monopsony approach on labour markets initially presumed to be competitive. Machin and Manning (1994), for example, found that under monopsony conditions a minimum wage may have no unfavourable impact on employment and may reduce wage disparity between employees. The low availability of research using this approach may be due to the limited availability of markets with such characteristics and such markets also tend to be sophisticated.

Nonetheless, considering low levels of unionisation in the South African Farm Sector and the large number of employers, the assumption of a competitive labour market is probably reasonable in this study. The application of a simultaneous estimation of the aggregate supply of and demand for farm labour by Schuh (1962), Gardner (1972), Gallasch (1975), Latt and Nieuwoudt (1985) and Sparrow *et al.* (2008), amongst others, fits the conventional assumption of a competitive market. Findings of these studies concur that an increase (decrease) in wages due to minimum wage legislation impacts negatively (positively) on employment. Neumark *et al.* (2004) compared the impact of the introduction of a minimum wage on low and high income earners, and showed that there is a relatively strong (weak) employment effect on low (high) income workers. This suggests that in a competitive labour market the brunt of the impact of minimum wage legislation is borne by relatively less skilled workers, which is in line with the aim of this study as it aims to brig such gap in the context of SA Agricultural Sector.

The SA studies review suggests a diverse coverage of the minimum wage impact, simultaneously with other labour-related legislation on unskilled labour markets, to capture a holistic view. The studies from other countries, however, have largely focused on minimum wage implications only. Studies in SA have mostly utilised either case study analyses (e.g., Roberts and Antrobus, 2013), case studies with descriptive statistics analysis (e.g., Newman *et al.*, 1997; and Murray and van Walbeek, 2007), econometric analyses of cross-sectional data from a survey of farmers (e.g., Conradie, 2005), or econometric approaches to study farm labour markets using secondary data (e.g., Latt and Nieuwoudt, 1985; Sparrow *et al.*, 2008; Bhorat *et al.*, 2012). These studies mainly focused on aggregate employment, i.e. sector, industry etc., which does not compare the impact between various categories of farm labour. Hence, the aim of this study is to compare the impact of the SD between farm labour categories and regions in the sugar industry using descriptive statistics analysis and an econometric model, since a simultaneous model is relatively appropriate to study the impact of SD on the demand for labour dynamics using time-series.

CHAPTER 3: THE ECONOMICS OF MINIMUM WAGE LEGISLATION IN THE MARKET FOR FARM LABOUR

This chapter provides a theoretical framework for studying farm labour wage structure, sectoral determination compliance, demand for and supply of farm labour, supposition of the implications of the minimum wage on wages and employment, as well as the resulting substitution effect from minimum wage introduction and increases. This theoretical framework provides a foundation for the research methodology detailed in the next chapter.

The components of the costs of farm labour, and the farm wage structure for farm workers in sugarcane production are discussed in the first section, followed by a consideration of factors that affect the demand for and supply of farm labour in the next two sections. This is followed by a supply and demand analysis of the theoretical impact of the minimum wage on wages and employment in sugarcane farming, assuming that employers of farm workers comply with the minimum wage. In the final section the assumption that farmers always comply with stipulated minimum wages is relaxed and the matters of enforcement and compliance are discussed.

3.1 The Costs of Farm Labour and Structure of Farm Workers' Wages

As indicated in the introduction and the literature review chapter, the introduction of the SD and ESTA has resulted in a change in the economic costs of hiring farm labour, since it has impacted on cash wages, non-pecuniary benefits, transaction costs and risk. The composite wage has increased to relatively high levels, where cash wages rose at the expense of non-pecuniary benefits as a result of a change in wage computation, and it has become difficult for farmers to adjust their labour due to the legislation.

It is important to start with the farm wage structure section to highlight the impact of the rules governing wage computation, for the purpose of compliance with the impact of the minimum wage legislation on the farm labour wage structure and associated complications. The SD compliance follows, discussing the challenges and compliance associated with the legislation, as the impact of the legislation is only realisable when there is compliance. A discussion of the demand for and supply of farm labour hypothesises the impact of the legislation on the compliance of farmers with regard to the demand for and supply of labour. Lastly, the consequences of the minimum wage introduction are highlighted and hypothesised, on the impact of relevant legislation, and substitution and output effect sections.

The estimated farm labour wage in the industry is made up of basic or cash, a monthly and an annual bonus, and other benefits (an estimated value of all non-pecuniary payments as a form of payment). These non-pecuniary wage components are comprised, amongst others, of accommodation, food rations, other hand-outs, etc., which are often difficult to estimate their true value and their estimated values often vary by enterprise type (Newman *et al.*, 1997). Hence, most of them are often left unaccounted for or are subjectively estimated in calculations of workers' wages.

Post introduction of the farm sector SD, not only has the minimum wage regulated, but also the proportion of the composite wage cash and non-cash. In particular, the provision of accommodation (provided that it satisfies stipulated guidelines) and rations may each be limited to an estimated maximum value of 10% of a worker's composite wage, regardless of the actual costs to company of their provision. All other forms of non-pecuniary benefits are not covered in the computation of a workers' wage, and growers will be providing them on a free-will basis (DoL, 2006). As a result, growers have an incentive to (a) reduce provisions of accommodation and rations if the cost to company of those provisions exceeds the deductions from wages permitted in the SD, and (b) to charge labour for all other provisions on a user basis.

There is a school of thought that holds the view that provision of most non-cash benefits by farmers to their workers reflects "*a paternalistic relationship between the farmer and labour*", and that one objective of the SD was probably to make labour more independent. The consumer choice theory presented in Perloff (2012) and Mankiw (2009), amongst others, also indicates that employees would be better off with more cash relative to more non-cash benefits in the form of food rations (or food stamps), various hand-outs and accommodation-related benefits, because provision of non-cash benefits may compromise the utility attainable by each employee relative to a cash-only wage at the same composite wage. A farmer does not know each worker's preferences with certainty, and consequently cannot determine the best affordable bundle of cash wages and non-cash benefits for each employee. Therefore, by encouraging farmers to provide more cash and fewer rations to workers, the SD relaxes limitations on farm labour choices to select products and services (relatively controlled consumption) based on their preferences and enable them to change their consumption bundles with time.

Considering the remote location of many farms to shops and residential areas, as well as challenges of storing perishable food faced by many workers (and especially migrant workers), it is likely that some farm businesses can provide some non-pecuniary benefits to workers at a cost lower than a similar benefit could be directly procured by its farm workers, after accounting for all transaction costs. Visser and Ferrer (2015) argued that for this reason, stipulations in the SD that discourage provision of non-pecuniary benefits to farm workers may have had a negative impact on the wellbeing of some farmworkers. Murray and van Walbeek (2007) further raise concerns that cash wages intended for food consumption may be used *irresponsibly* by workers for other purposes, such as to increase their consumption of alcoholic products.

Provisions of rations to workers also help protect them against food price inflation (Murray and van Walbeek, 2007; Roberts and Antrobus, 2013).

On the other hand, findings of Roberts and Antrobus (2013) suggest that aspects of farm workers' wellbeing has improved following minimum wage introduction. Their findings indicate that labour now buy a wider variety of goods and services than before, including various appliances and gadgets. Some growers also noted that some workers tend to purchase relatively more luxurious foodstuffs than before. General consumption levels were, however, related to labour type, which is closely associated with wages. For example, relatively high income labours, such as drivers, tend to buy more sophisticated and expensive items. These findings reflect that real wages increased due to the minimum wage, and are not conclusively related to farmers reducing the proportion of non-cash benefits in the wages of farm workers.

The purpose of this section was to assist with identification of (a) the theoretically correct price of labour to specify the demand for farm labour model, and (b) the appropriate wage rate to specify in the supply of labour. In both instances, the cash wage must be adjusted. It was indicated that some of the costs to farmers (e.g., transaction costs of hiring and managing workers) and benefits to workers (e.g., the transaction costs of procuring, storing and preparing food, vs. provision of rations) value cannot be easily observed. However, a dummy variable can be used to capture the impact of transaction and risk costs of hiring labour since the year of anticipated change in labour policy, e.g. putting 0 and 1 for the years before and after 1994, respectively. This observation also has a bearing on the discussion of matters of compliance and enforcement in Section 3.5. The discussion of transaction costs as a cost of hiring labour leads to a conclusion that the SD must be considered together with all legislations relevant to farm labour conditions.

3.2 The Demand for Farm Labour in the SA Sugar Industry

The law of demand indicates that the quantity demanded of a factor in production (in this case farm labour) will decrease as its price (wages) increases, *ceteris paribus*. The opposite is expected when the price of that production factor decreases. In a perfectly competitive market for farm labour, growers (and other employers of farm workers) are price takers in the sense that they are unable to individually influence the price of inputs (the grower is a buyer) or the price received for sugarcane deliveries (the grower is a seller).

Growers do not necessarily compete to sell their sugarcane to millers; their sugarcane, when delivered to a mill, is guaranteed crushing as long as it meets the crushing quality standard. They accept the price of nondiscretionary inputs as given, e.g. the price of fertiliser relative to the price of labour and can adjust their labour requirements in line with its prices (real wage) and the availability of technology. Sugarcane as a product determines the type of inputs demanded and their level of importance. The industry has a relatively low availability of appropriate high labour saving technologies and it is even worse in the South Coast region, due to the steep terrain. Therefore, the demand for farm labour can be expressed as a function of the real price of sugarcane, the real wage for farm labour, the real price of other important inputs and a measure of technology (Schuh, 1962; Friedman, 1962).

The real price of sugarcane determines the strength of the derived demand for labour in the industry from an increase in the demand for sugarcane (derived from an increase in demand for sugar) and/or the sugarcane price, which stimulates sugarcane production and labour requirements. To support the latter, Conradie (2005) found that the labour demand increased with an increase in grape output, given that a production function represents the relationship between inputs and output. Hence, in order for growers to maximise profit in a perfectly competitive market, they must produce the quantity of sugarcane at a point where the marginal cost equals marginal revenue or sugarcane price. Using production economics concepts, it can be established that this point is where the value of the marginal product of an input (VMP_L) equals the price of the input (real wage). Therefore, a rational grower will employ labour until a point where the real farm wage equals the VMP_L of labour (Doll and Orazem, 1984).

If the minimum wage is set higher than the market wage, raising the wage more, relative to prices of other inputs and their VMPs, growers will start substituting other inputs for labour and reduce their demand for labour. When the real wage rises faster than the VMP, labour will reach diminishing returns quickly. Hence, the VMP represents the demand for labour curve, where the slope and elasticity are largely dependent on the proportion of labour from total production costs, availability of substitutes and complements, as well as the importance of labour (Friedman, 1962). The importance of labour may be relatively strong in sugarcane farming in the short-term; however, it is expected to decrease over time, with the improvement in technology, and become less essential in the long run. It is expected that the labour requirements per hectare in sugarcane farming have decreased over time (SACGA, 2014).

This is due to the fact that the price of sugarcane is a determinant of the demand for labour in sugarcane farming. When control of the price of cane is taken away through legislation causing the price of cane to decline, employment in sugarcane farming is therefore expected to decrease. Goedecke and Ortmann (1993), Newman *et al.* (1997), Conradie (2005) and Sparrow *et al.* (2008) all hypothesised that, as the relative costs of labour increase, growers are likely to substitute machinery, casual labour, labour contract service and capital for labour. The supposition is largely dependent on instantaneous reactions by all growers to input price changes (Friedman, 1962). Bhorat and Hodge (1999) also indicated that an increase in the rate of capital-intensive production practices, in general, will lead to a low (high) demand for unskilled (skilled) labour to meet the growth in capital requirements in the SA economy. This could be dire for labour, as it is predominantly unskilled and unemployable, and agriculture is usually a step-up employment provider for unskilled labour.

3.3 The Supply of Farm Labour in the SA Sugar Industry

The law of supply states that there is a positive relationship between the quantity supplied of an input (in this case, labour in sugarcane farming) and its price (the wage rate), *ceteris paribus*. The concept of labour supply suggests that individuals have to make a choice between leisure and employment. Individuals choosing employment become economically active and make use of sector/industry relative earnings/wages as a guide for selecting a sector/industry as an employment choice. If an individual chooses leisure, the opportunity cost of leisure is the real wage (Latt and Nieuwoudt, 1985).

An individual will only decide to work when perceived benefits (monetary and non-monetary) from work are greater than not working. Hence, an individual's choice to be economically active by working in any sector (especially in the farming sector) depends on expected wages, the availability of alternative non-farm labour opportunities and the attributes of the labour force. Given the average unemployment rate in SA of over 20%, it can be argued that the unemployment of unskilled labour is likely going to be higher than of skilled labour. The increase in capital intensity suggested by Bhorat and Hodge (1999) is expected to worsen the unavailability of jobs, especially for unskilled labour.

Therefore, the supply of labour in the industry can be expressed as a function of the real wage rate, the average non-farm labour wage, and a measure of unemployment rate (preferably in KZN Province to determine the availability of non-farm employment opportunities). In general, the supply of labour is still rurally based, with low levels of education, given the level of economic development, the location and nature of farm inputs and the requirements in farming. However, over the years, due to an improvement in economic development (urbanisation) and, to some extent, the end of apartheid government policies that restricted free movement in the country, the urban population has increased at the expense of the rural population in certain instances. Nonetheless, this movement does not guarantee employment in the cities, given low levels of education of migrants.

President Jacob Zuma, in his 2014 State of the Nation address, indicated that since 2011 the proportion of the SA population residing in urban areas has been approximately 63%, and the urbanised proportion of the population is expected to increase in the near future (Presidency, 2014). These developments have the potential of threatening the supply of labour in the farming sector. To support the latter, data from the World Bank obtained in 2014, show that the rural population in SA has been growing at between 1% and 2% before the year 2001, but since then the rate increase has been below 1% and is continuing to decrease. The rural population, as a proportion of the total population, has also decreased from over 50% to about 38% between 1960 and 2012.

3.4 The Impact of Labour Legislation Relevant to the SA Farm Sector

Conventional neoclassical economic theory on the competitive labour market suggests that, *ceteris paribus*, the introduction of a binding minimum wage set above the market equilibrium wage (wage floor) in the farm sector would result in job shedding and a decrease in the availability of new job opportunities, unless the demand for farm labour is perfectly inelastic. Although the number of workers willing to work on farms would increase if wages in the farm sector increased relative to wages for relatively unskilled workers in other sectors, because the imposition of the minimum wage makes labour relatively more expensive, less labour is employed on aggregate (Friedman, 1962).

Ippolito (2003) illustrated a model resembling that of Friedman (1962), to suggest the intolerance of a strong perfectly competitive labour market towards the introduction of an effective minimum wage. Such labour markets usually resemble a relatively elastic supply and demand for labour, mostly predominant to relatively unskilled labour. Growers will tend to retain hardworking labour and ensure a strong separation from poor performing labour. The determination of the strength of labour performance and selective hiring will ensure that growers eventually reach an optimal allocation of labour on various farm tasks.

The repetition of this exercise is necessary for growers to minimise the cost implication of the minimum wage through increased productivity and profit. Initially, it may look like rent is transferrable from higher wage earners to relatively low skilled labour; however, rent gets eroded as the competition for a limited availability of the number of jobs increases. In the end, labour that is able to maintain employment and labour from non-agricultural sectors that is convinced that the agricultural sector is paying a higher wage rate and is able to find employment, will earn a higher wage rate, but with less rent. These resulting effects of a wage floor introduction can be referred to as market failure to efficiently allocate and remunerate labour, as well as other factors of production.

A freely-operating, strong and perfectly competitive labour market in the industry would employ an equilibrium L_0 amount of farm labour at W_0 wage rate in Figure 1. At this point, labour earns area BDF rent, while other factors of production, mainly entrepreneurship/growers, earn ACE rent. Labour that is able to maintain employment over time and those able to find employment in the industry, earn the most rent, with those on the bottom of the supply curve (probably first entrants labour) earning higher rent, which decreases with the movement up the supply curve. The immediate impact of the minimum wage introduction will result in a hypothetical decrease in employment from L_0 to L_2 quantity of labour and the difference between the points represents employment loss. The minimum wage raises the wage rate from W_0 to W_1, where the gap between the points indicate minimum wage portion from total wage rate.

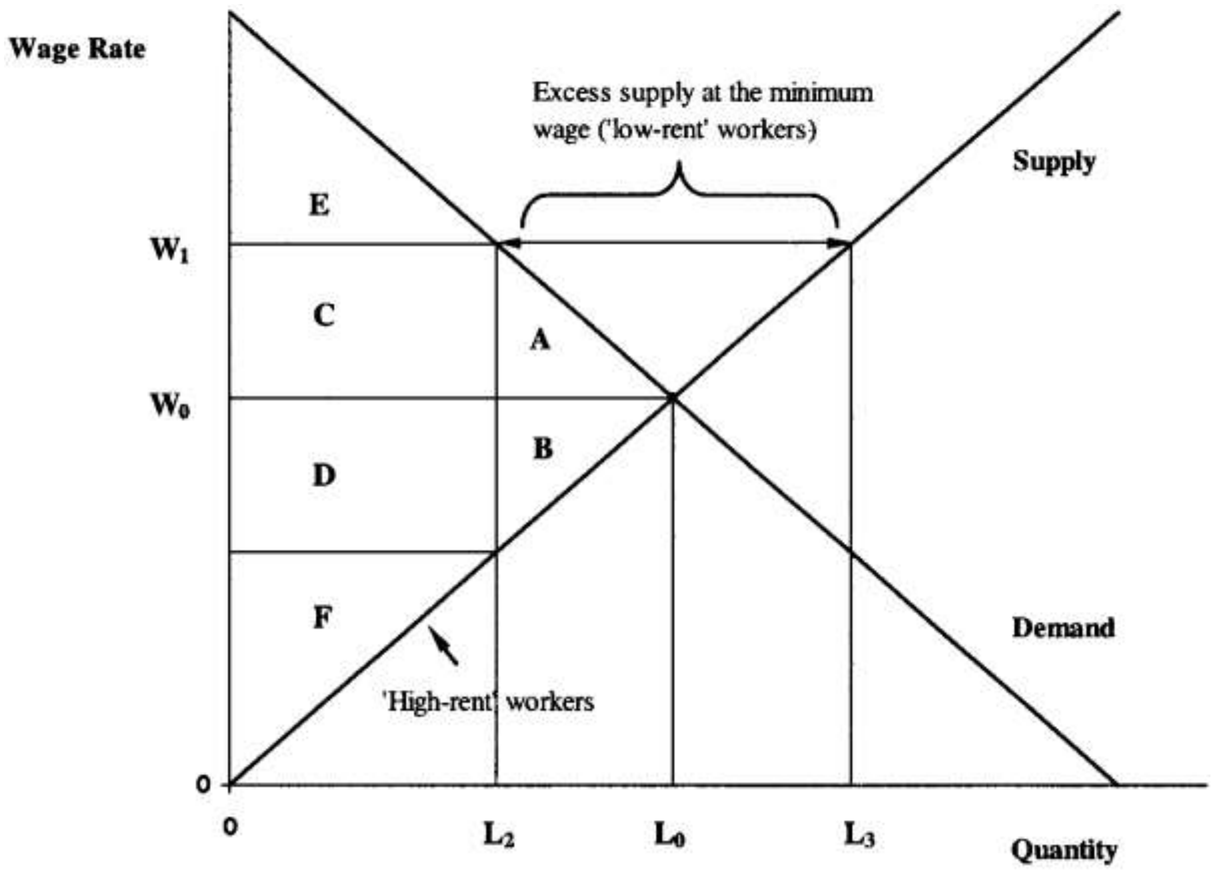

Figure 1: The Impact of Minimum Wage Introduction (Ippolito, 2003)

As a result, the rent to all factors of production decreases by area A and B, the measure of dead weight loss. The intermediate and long-run effects are that the higher wage rate is expected to attract more labour from competing sectors/industries, if the wage in the industry/farm sector is believed to be relatively higher. The increase in the supply of labour for limited number of jobs is indicated by the L_3 quantity of labour. The difference between L_3 and L_2 represents the amount of labour in search of employment and associated searching costs in the form of time and monetary terms. Even if farm labour in search of employment does get employed at a higher wage rate, they will be employed at a relatively lower rent. Growers will also incur searching costs in the form of time spent evaluating suitable candidates and monetary costs related to the recruitment process. This labour will also be willing to take employment at wage rates below W_1. Given the poor unionisation influence in agriculture, the SD is the only factor preventing this adjustment from occurring, enforcing a long-run and stable equilibrium position at less than "full" employment. Anecdotal information provided by growers generally confirmed this impact, and indicated that job seekers often indicate their willingness to work at a wage rate below the minimum wage rate. An effective SD through voluntary compliance and inspection will result in the supply curve starting at point W_1 relative to 0.

However, the industry and study coverage comprise elementary and semi-skilled farm labour. Hence, it is also important to discuss the implications of the minimum wage introduction on semi-skilled labour. Assuming that the two labour categories are substitutes for one another in production, and pre-minimum wage semi-skilled workers earned a wage premium and the minimum wage is set between the wage rates. The imposition of the minimum wage lowers the wage premium attached to the skills possession of the semi-skilled workers, reducing the incentive for workers to invest in obtaining those skills, and therefore reducing the supply of semi-skilled workers. However, because the imposition of the minimum wage causes semi-skilled workers to be less expensive relative to unskilled workers, the demand for semi-skilled workers is likely to increase. Consequently, the wage rate of semi-skilled workers will eventually increase over time. Therefore, it can be concluded that all unskilled and semi-skilled workers who retain their jobs and new entrants (mostly semi-skilled workers) will experience a wage benefit. However, it is expected that the shift in employment composition in the sector is likely favour semi-skilled workers over unskilled workers, since farmers require semi-skilled labour to facilitate the use of capital to replace unskilled labour to reduce the costs of labour.

Substitution and Output Effects of a Wage Increase

Figure 2 was adopted from Griffiths and Jones (1980), it hypothesises the impact of a unit change in the composite wage rate on farm output and the resultant substitution effect between labour and capital.

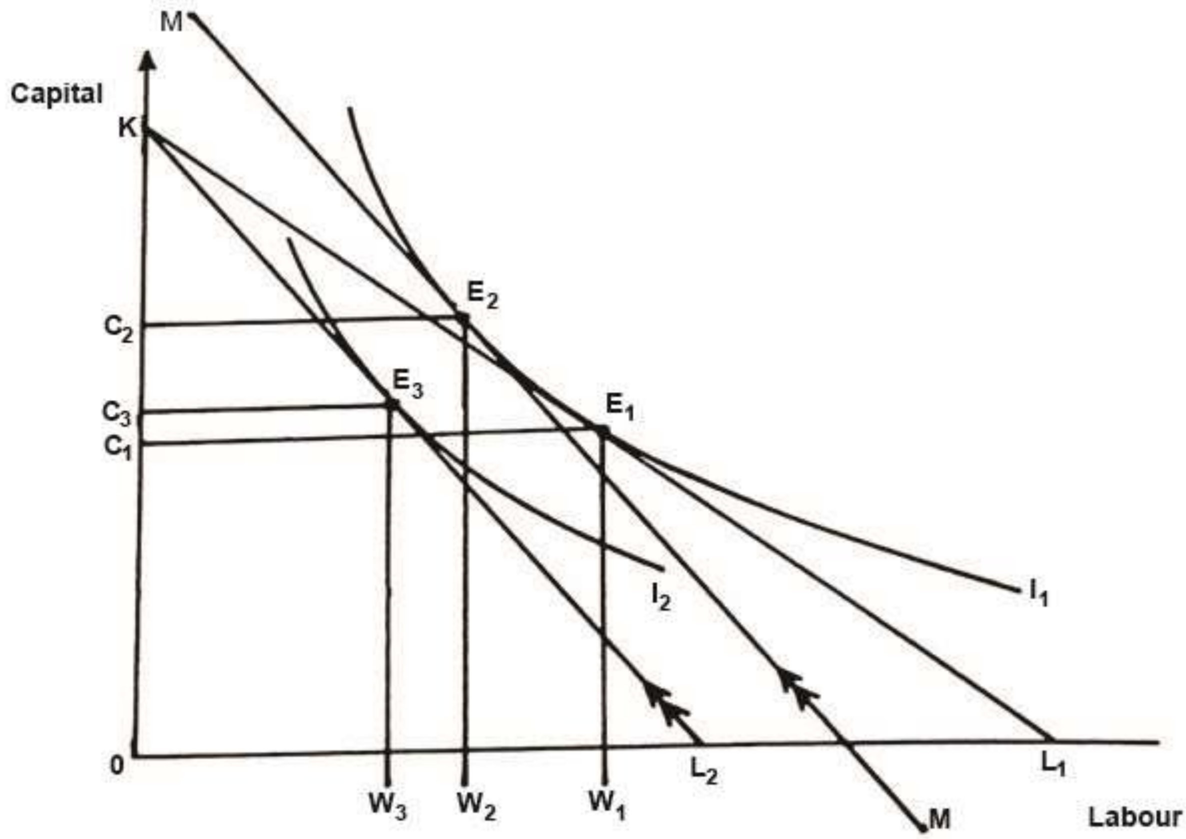

Figure 2: The Impact of a Change in Composite Farm Labour Wage Rate on Output and Substitution Effect (Griffiths and Jones, 1980)

The tangency points (E_1, E_2 and E_3) show different combinations of the wage rate and quantity of labour demanded. Point E_1 is the initial equilibrium combination, the tangency point between isoquant I_2 and isocost KL_1. Hypothetically, an increase in composite wage rate from OK/OL_1 to OK/OL_2 units, provided that the price of capital remains the same, will result in a decrease in the quantity of farm labour demanded and output from OW_1 to OW_3 units and I_1 to I_2 units, respectively, and an increase in the quantity of capital demanded from OC_1 to OC_3.

Since it is rather impractical, from an efficiency point of view, for growers to decrease sugarcane output by working a smaller area from the total AUC, as a result of a decrease in their purchasing power, they are likely going to make use of relative price adjustments to find an affordable inputs combination, in order to remain on the same isoquant I_1 with relatively low operating costs *ceteris paribus*. This compensation for a loss of affordability through input combination adjustment is indicated by drawing a "fictional" iso-cost line (MM) with the E_2 tangency point on isoquant I_1. If growers manage to maintain production on the same isoquant I_1, the quantity of labour demanded will only decrease from OW_1 to OW_2 units, while capital utilisation will increase from OC_1 to OC_2 units. The latter change is referred to as the substitution effect. The substitution effect entails, amongst other things, a reduction in the quantity of labour demanded at the extensive (head count reduction) and intensive (decreasing number of hours and days worked) margin, etc.

Similarly to the partial equilibrium discussion, the implication of capital as a substitute for labour between unskilled and semi-skilled labour is highlighted, as minimum wage introduction is likely to result in different capital replacement for different labour categories. Assuming that the two labour categories are substitutes for one another, and before the minimum wage semi-skilled workers earned a wage premium and that the minimum wage is set between wage rates of the two labour categories. The minimum wage is expected to lower the wage premium attached to the skills possession of semi-skilled workers, reducing the incentive for workers to invest in skills development, and therefore reducing the supply of semi-skilled workers.

However, labour replacement by capital to reduce the wage bill is dependent on semi-skilled and skilled labour (complimentary relationship). Hence, the wage rate and demand for semi-skilled labour is expected to increase at the expense of unskilled labour to facilitate the replacement of unskilled labour with capital. Consequently, the shift in employment composition will likely favour semi-skilled over unskilled workers in the long-run.

3.5 Sectoral Determination Compliance in the Farm Sector

It is widely acknowledged that, in order for the minimum wage to effectively impact on median wage rates in the farm labour market, it must be set above the perfect competition market equilibrium wage rate of relatively unskilled workers and the compliance of farmers must be effectively enforced. Young (1979) defined compliance as the actual behaviour that conforms to proposed behaviour, and non-compliance as the behaviour that deviates noticeably from proposed behaviour. It is believed that compliance may sometimes not always happen voluntarily, especially when farmers are not prepared and offered some form of assistance or incentives (Newman, 1997).

Benassi (2011) presented a theoretical framework indicating the basis of compliance that suggests an argument for an effective system for implementation of the minimum wage to comprise soft (e.g. persuasion and capacity building) and hard (sanctioning) mechanisms, as well as measures to empower workers. In realisation of expected poor compliance, the focus is often placed on imposition of penalties (hard mechanism), in order to enforce compliance to relevant legislations, and less on persuasion (soft mechanism).

Compliance is commonly measured by researchers through the determination of a proportion of workers that are paid less than the minimum wage. Bhorat *et al.* (2012) and Stanwix (2013) used the method to measure the level of contravention in agriculture and noticed an improvement in compliance over time. Rani *et al.* (2013) suggested another compliance measure based on a number of complaints made by workers to enforcement bodies. This approach receives less attention, yet it may be useful, especially given the inability of the DoL to inspect all employers at once. If implemented well and labour is educated and encouraged to report such cases anonymously, it can be used to guide the planning of blitz inspections by the DoL.

Visser and Ferrer (2015) highlighted certain areas of non-compliance with SD and attributed it to the weakness of the unions in agriculture, as well as the relatively inconspicuous role played by civil society in farm employment matters in many rural areas. However, they suggested that the emergence of private sector codes of conduct or ethical standards in agriculture are likely to impact positively on compliance, especially in the LSG commercial farming, as it creates an incentive through access to lucrative markets, that are willing to pay a premium for the assurance that a product conforms to a recognised ethical standard (Barrientos and Visser, 2012, cited by Visser and Ferrer, 2015).

The system is relatively decentralised and effective, and the government may only need to provide incentives for farmers to comply, since these standards tend to include compliance with national labour legislation and even International Labour Organisation (ILO), in the case of more progressive codes (Barrientos, 2002:39, cited by Visser and Ferrer, 2015). Rani *et al.* (2013) suggested that countries with a national minimum wage, set at a meaningful level, tend to realize higher compliance rates relative to countries with job-related or industry-specific minimum wage systems, such as SD. Similar to Visser and Ferrer (2015), Rani *et al.* (2013) argued that compliance is also dependent on, amongst other factors, appropriate comprehensive minimum wage policies, in combination with union/employer involvement, awareness-raising and credible enforcement.

The DoL's compliance system is currently centralised and costly to implement and monitor, as it attempts to enforce and monitor compliance through the inspection of employers in sectors covered by the SD. In this case, the compliance rate is measured by determining the proportion of complying employers relative to those that are non-compliant. According to a provincial staff member from the DoL, non-compliant employers are issued with a contravention notice, followed by an inspection after 14 days, and if there is no change, a compliance court order is issued, where a judge in a court of law will make a ruling, stipulating appropriate penalties in line with the legislation. If the employer contravened the minimum wage legislation, a court judgement may rule that a back-payment be made to labour, however taking into account any plea for leniency made by the employer.

Stanwix (2013) also listed a number of fines that may be applied against non-compliant farmers. The staff members indicated that employers do not usually come out voluntarily to inform the DoL about their inability to meet the minimum wage, until they are found contravening the legislation, which makes things difficult for them. Stanwix (2013) highlighted the low number of inspectors as one of the major reasons for the lacklustre compliance performance. The staff member concurred with the challenge, however, he also mentioned that the Department has made a good effort to increase the number of inspectors over time. He also indicated that, although there is non-cooperation by some employers during inspections, this problem has improved over time. Nonetheless, anecdotal comments from some union officials indicate that the improvement may not be celebrated, since some employers offer bribes to inspectors. Relatively speaking, the staff member indicated that compliance is still problematic in agriculture, compared to the domestic sector, but is worse in the security and construction sectors.

Stanwix (2013) demonstrated the low probability of an employer being inspected and attributed it to the low availability of resources (including inspectors, as indicated) at the disposal of the Department. This is not surprising, as the staff member indicated that there is no structured sampling methodology, e.g. stratified random sampling, when conducting inspections. Inspectors only use a list of employers available from the database of employers at the Department to identify employers to visit, which is mainly a first to last approach. Once an employer is inspected, the same employer may not be inspected within a space of four months, due to complaints often made by employers to the Department, saying they feel targeted. This approach reduces the probability of an employer from being inspected, and the waiting period probably gives some employers a compliance break. Newman *et al.* (1997) and Stanwix (2013) argue that a relatively decentralised and incentive-based compliance system can yield a higher compliance rate, if implemented appropriately.

The economic theory of the farm or unskilled labour market and the implication of the minimum wage on the market discussed in Chapter 2 and this chapter are useful to assist with identification of a model suitable: (a) for the analysis of a single industry, rather than the agricultural sector as a whole, and (b) to be conducted for various categories of farm labour, in order to compare the implications of the legislation in the industry and different farm labour levels. From Section 3.2, the demand for farm labour can be expressed as a function of the real price of sugarcane, farm labour wage and price of other inputs (substitutes, e.g. the price of farm labour contractors), and a measure of technology (Schuh, 1962; Friedman, 1962). From Section 3.2, the supply of farm labour can be expressed as a function of the real wage farm labour and average non-farm labour wage, and a measure of the unemployment rate.

3.6 Conclusion

The Chapter presents the implications of the SD and to some extent ESTA on employment and wages using similar preceding studies and relevant legislation documents. Based on the discussion it is prevalent that the SD has impacted on employment, wages, wage distribution (wage gap between semi-skilled and unskilled labour) and wage structure (basic and non-cash) of farm labour, and increased the cost and risk of utilising labour. However, the implications have never been differentiated between labour categories, regions and industries in the SA Agricultural Sector, which is the aim of the research study. The demand for and supply of farm labour were also presented in the context of the sugar industry in line with the expected impacts of the SD on the demand for and supply of labour to demonstrate expected shifts in curves and substitution effect (to show how labour may be replaced by capital) charts. However, the illustrated impacts are dependent on the compliance rate of farmers with the overall BCEA. Nonetheless, the expected implications of the SD on the demand for farm labour are stronger on unskilled labour, relative to semi-skilled labour. Having considered relevant economic theory on minimum-wage legislation, the next chapter presents an overview of the SA Sugar Industry in the context of this study.

CHAPTER 4: THE SA SUGAR INDUSTRY PROFILE

This chapter presents an overview of the SA Sugar Industry structure and the functions of the major stakeholders, i.e., the organisations representing sugarcane growers and sugarcane millers. It then discusses sugarcane price determination, the distribution of proceeds and protection of the industry through the Sugar Act, notional price and tariff protection; the contribution of the industry to the national economy and the location of the industry.

4.1 The Structure and Functions of the SA Sugar Industry

The SA Sugar Industry comprises a symbiotic partnership between sugarcane growers, represented by SACGA, and sugarcane millers', who are represented by the South African Sugar Millers' Association (SASMA) Non-Profit Company (NPC). Their mutual dependent relationship is managed by the South African Sugar Association (SASA) that represents the interest of both parties at an industry and agricultural sector level. The organisation provides the partnership with specialised independent services in administration, marketing, logistics and research in terms of Section 2 of the Sugar Act. The industry is governed by the sugar agreement and the Act the review of which was finalised in 2014.

The operations of SASA are managed by the SASA Council, where the chairpersonship of the council alternates between representatives of the growers and millers every two years (SASA, 2014). Based on the 2013 production statistics, the industry has an estimated 22 955 registered private individual/natural growers, where 1 383 are LSG, inclusive of 367 PDI or land reform growers (SACGA, 2014). Most of the growers predominantly farm in KZN on 264 763 hectares (89% of LSG land), with increasing operations in Mpumalanga utilising 34 132 hectares (11% of LSG land) and some farming operations being revitalised in the Eastern Cape. Sugarcane is crushed by six milling companies that own 14 sugar mills currently operating in cane-growing regions. However, the sustainability of the sugarcane milling operation in the Umzimkulu Mill region has been doubtful, as the mill did not crush sugarcane in the 2011 and 2015 seasons due to a drought-related decline in yields on the South Coast, resulting in Illovo deciding to divert cane from Umzimkulu to the Sezela Mill.

The SACGA was formed in August 1927 as an association incorporated, not for gain in terms of Section 21 of the Companies Act, but to unify growers and strengthen their voice power. After a robust consultative process, the organisation structures of the KwaZulu Cane Growers Association, Natal Cane Growers' Association and the Mangete Cane Growers' Association were incorporated within the SACGA in 1992, to represent the interests of all growers in SA. Today the Association prides itself as a non-racial and apolitical organisation representing all cane growers in SA. Individual growers are not direct members of the organisation, but are members through 26 member organisations and they can freely join any member organisation operating in their cane supply area. The executive director, management team and staff administer the day-to-day business affairs of the SACGA. The organisation provides growers directly with various services, such as financial and economic advice through its regional services division. Other divisions provide growers with financial and economic information dissemination (survey results and adjusted secondary data to suit a sugarcane farming operation), industry negotiations and the organisation of training for growers, to ensure the sustainability of sugarcane farming and the industry (SACGA, 2014).

The SASMA's NPC represents the interests of millers and refiners in SA. The association is responsible for the administration of matters pertaining to the partnership with growers in the industry, legislative matters affecting the industry, training and scientific support, as well as technological support through the services of the Sugar Milling Research Institute (SMRI). The

SMRI is the institution funded by a determined levy per ton of sugar produced from 14 SA sugarcane mills and affiliated mills from other countries, such as Swaziland, Malawi, Tanzania, Mozambique, Zimbabwe and Zambia. The institution conducts research and compile milling statistics to improve milling efficiency and stimulate technological adoption (SASMA, 2014).

4.2 Sugar Industry Proceeds and Price System

The industry is regarded as one of the world's leading cost-competitive producers of high quality sugar and during a "normal" season produces about 2.2 million tons of sugar from about 20 million tons of sugarcane. About 60% of the sugar is sold within the South African Customs Union (SACU), known as the Local Market Demand (LMD), and 40% is sold to other parts of Africa, Asia and the Middle East (SASA, 2014). The LMD market consists of SA, Lesotho, Botswana and Namibia, i.e., those countries in the SACU bloc that do not produce sugar. The industry earns revenue from selling refined and brown sugar, molasses (mainly utilised by sugar millers) and raw sugar exports in the LMD market.

The proceeds for each season are shared between millers and growers, based on a predetermined formula (taking into account the performance of growers) after covering operating costs of the SASA and other industrial costs. Seasonal sugar sales between the LMD and export markets depend on production and imports, as they have a potential to distort sales performance on the LMD market. The LMD market usually takes first preference, given its relative lucrative and stable price. This is as a result of the export market being subjected to price and exchange rate volatility. The price of sugar in the LMD is determined in a regulated environment through use of a dollar-based reference price system established by the Department of Trade and Industry (DTI) to compute the level of import duty (SASA, 2014).

The reference price is based on a long-term average global price of sugar adjusted for distortions and it only triggers protection when the global price drops below it. The DTI also participates in the determination of the notional price, an artificial price used for the purpose of distributing proceeds between millers and growers. Protection and the notional price provide growers with a relatively downside price risk protection level, compared to other commodities, e.g. maize. The protection provides some level of competitiveness of the industry, as it only takes effect when global prices of sugar drop below the reference price and it does not apply when the LMD market price is above the reference price. Therefore, the Recoverable Value (RV) price depends on the production level, LMD market, global sugar prices and exchange rate performance. Figure 3 represents the division of proceeds process leading to the calculation of the RV price.

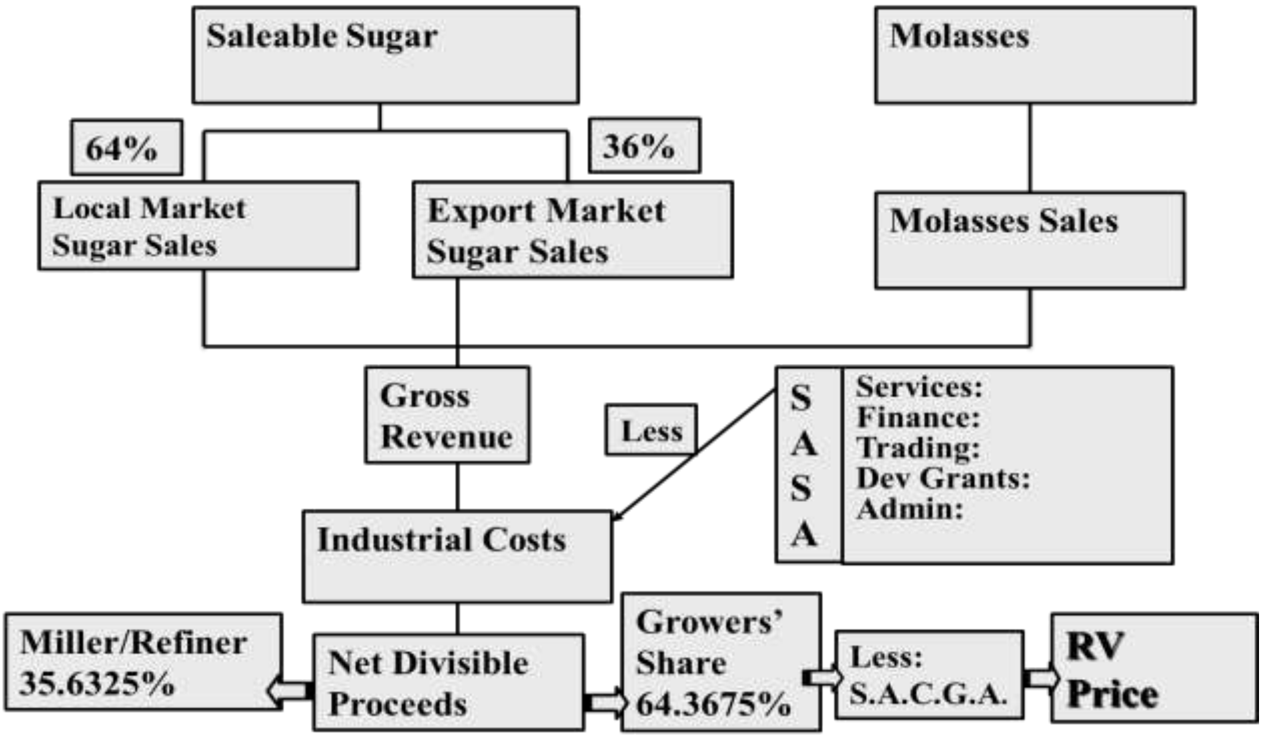

Figure 3: The Division of Proceeds Representation (SACGA, 2014)

Growers are paid based on the RV price system introduced in the 2000/01 season to replace the sucrose payment system. The RV price per ton is determined by the division of grower shares from industry proceeds and the total tons of RV delivered by growers to the mills in a given season, after accounting for operating costs of SACGA. This price system penalises (rewards) growers for producing poor (high) quality sugarcane by subtracting non-sucrose and fibre content from the total sucrose of delivered sugarcane. Growers are paid based on relative RV deliveries, to ensure that they do not only deliver sugarcane when the sucrose content is optimum, e.g. September or October. The relative RV concept adjusts and standardises RV deliveries to ensure fairness between growers, irrespective of the sugarcane delivery month. This concept assumes that the average RV percentage of each grower's delivery is the same as the average for the mill of delivery.

4.3 Economic Contribution of the Sugar Industry in SA

An independent survey of the costs of production of more than 100 global sugar industries consistently ranks the SA sugar industry among the top 15 competitive producers of quality sugar. This makes the industry a critical integral part of the country's economy through its contribution towards foreign exchange earnings, as a net exporter of sugar, agricultural and industrial investments, indirect and higher direct employment and its backward and forward linkages with other industries. Industry operations are diversified, producing sugar and processing various milling by-products (SASA, 2014).

Its monetary inflow contributes significantly to the rural, small- to medium-sized town economies of KZN and Mpumalanga provinces and their development. The industry generates, on average, an annual revenue of R12 billion, constituting R5.1 billion in the value of sugarcane production. It provides approximately 137 000 direct and 110 000 indirect jobs, which represents about 11% of the total agricultural workforce. It is estimated that approximately two percent of SA's population depends on the industry for a living (SASA, 2014).

4.4 Sugar Industry Location and Selected Regions

Figure 4 below presents the commercial sugar industry areas, which stretch from the Northern Pondoland in the Eastern Cape Province through the South and North coastal belt, extending to the inland areas of the Midlands and northern irrigated areas of Zululand and Mpumalanga Province Lowveld. The Illovo and Tongaat milling companies operate the highest number of sugarcane milling operations, where Illovo operates four mills on the South Coast (Sezela, Umzimkulu) and the Midlands (Eston and Noodsberg), and Tongaat operates four mills on the North Coast (Maidstone, Darnal, Amatikulu and Felixton). The TSB milling company owns three sugarcane milling operations that are based in irrigated areas, (Komati and Malelane in Mpumalanga) and (Pongola in KwaZulu-Natal). The Umfolozi, Gledhow and UCL sugarcane milling operations are owned separately by milling companies comprised largely of growers and private investors.

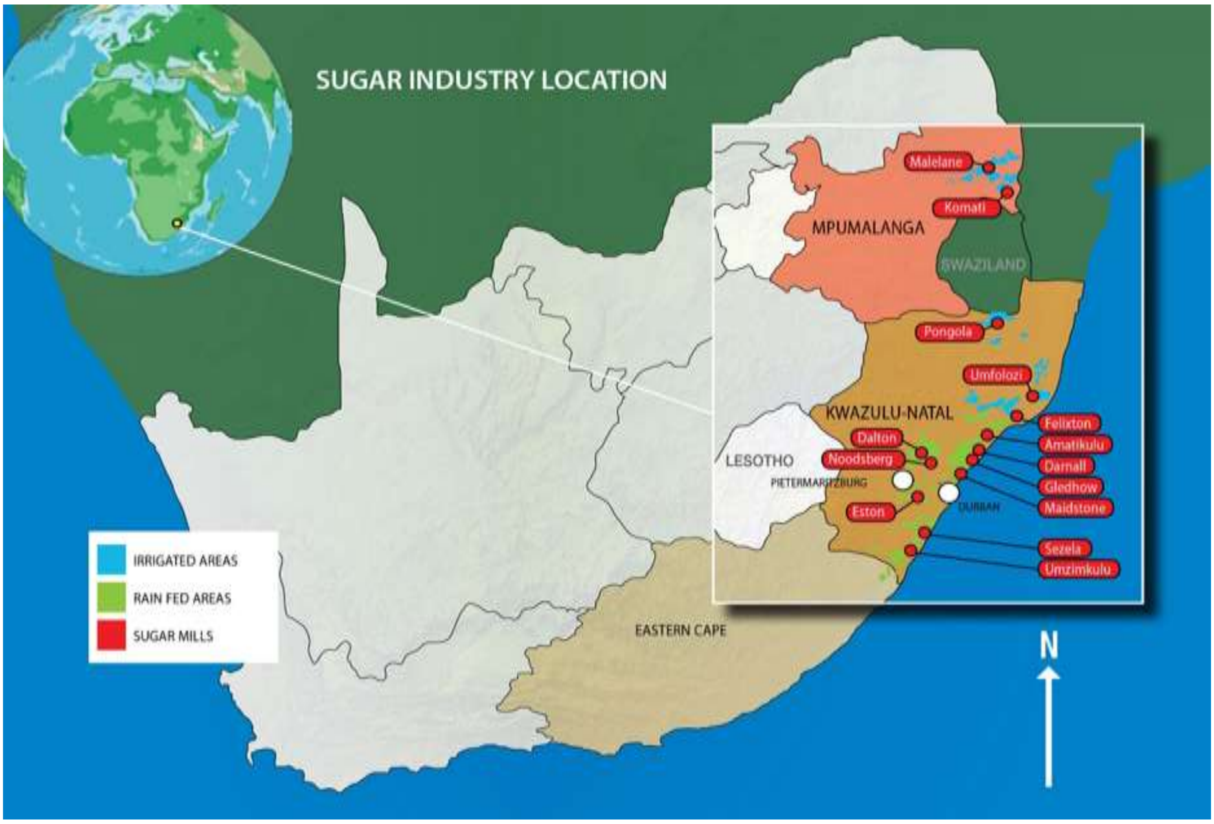

Figure 4: SA Sugar Industry Map (SASA, 2014)

CHAPTER 5: EMPLOYMEMT AND WAGE TRENDS IN SUGARCANE COMMERCIAL FARMING IN SOUTH AFRICA

This chapter outlines the annual Labour Utilisation and Cost Survey (LUCS) of LSG conducted by the SACGA. The SACGA conducts the LUCS by collecting primary data, using a postal survey of a randomly-stratified sample of 320 registered[3] LSGs, i.e. approximately 20% of the LSG population. The purpose of conducting the LUCS on an annual basis is to estimate employment, average wage payment and productivity for the industry, by region and labour category. The findings of the analysis of the LUCS data are reported annually by SACGA in its LUCS Report. This study makes use of estimated results from the LUCS reports from 1978 to 2012, but does not make direct use of the raw data. This chapter presents and analyses descriptive statistics from the findings of those surveys for the industry as a whole, as well as for selected sugarcane producing regions. The purpose of this chapter is to analyse employment and wage trends in sugarcane farming in South Africa.

5.1 An overview of the Labour Utilisation and Cost Survey methodology

The LSG's LUCS estimates farm labour employment, productivity and costs in the industry. The estimates exclude Miller Cum Planters (MCP) (they are not natural growers) and SSG (they have limited employment creation and relatively poor record keeping). LSGs have credible employment records, they employ more labour, and account for over 78% of sugarcane production and more than 73% of the total AUC, relative to other types of sugarcane producers. This section outlines the LUCS procedure, in order to assess the suitability of the data for the purposes of this study. A randomly-stratified sample of 320 LSGs by homogeneous region,

[3] The Sugar Act stipulates that sugarcane producers in South Africa must be registered with SASA.

where some of the regions are also mill areas in the industry, is drawn. The sample represents about 20% of the LSG population in the industry. The key element of the survey is to repeat the sample, in order to produce grower panel data and to control the variability of obtained results, due to high sample inconsistency. This presents a statistical challenge, as the sample of growers may become less representative of the population over time or during seasons of poor participation from growers. New growers are added to the sample over time to replace growers that have not returned a completed the survey form for a period of two to three consecutive seasons. This is necessary to guard against a decline in the survey response rate over time.

Non-responding growers are replaced by a proportional number of growers drawn randomly from the growers' register database maintained by SASA. In some regions with traditionally poor response rates to the postal survey (notably Mpumalanga), the selection of growers for the survey is guided by SACGA's regional staff in order to purposefully select growers that practice labour record keeping and are relatively more likely to respond to the survey. The LSG sample was adjusted during the 2011/12 and 2012/2013 seasons to include PDI growers, who are referred to as New Freehold Growers (NFG) or Land Reform Growers (LRG) in the industry and are part of the replacement process. Growers respond to the survey by completing and returning survey forms to SACGA every season, mostly via postal service.

The basis of conducting the analysis annually, one year in arrears, is predominantly driven by the nature of the data input (AUC, tons of sugarcane and labour records) of the survey, which is usually almost two years old upon finalisation of the estimated results. The fundamental point is that the estimate results are produced by moving from sample to population estimates, using raising factors. The raising factors are computed, using the actual AUC and the sugarcane delivery records of LSGs obtainable from the SASA database. This enables the estimation of statistics for the population, rather than just average statistics for the sample. The AUC survey is conducted one year in arrears, since it also accounts for the actual area harvested. Growers also have to wait until the end of the season to have the necessary information; however, the major delay is mostly due to the area survey.

Despite all the challenges inherent in the estimation process, the findings provide reasonably reliable estimates of employment and wages of farm workers by LSGs over a sufficiently lengthy period of time for the purpose on this study. As far as the author is aware, similar data are not available for employment on farms on a national level or for other agricultural industries in South Africa. The number of growers, AUC and sugarcane production data are reliably known, and the LUCS has employed a fairly consistent methodology over the past four decades, hence its statistics are considered sufficiently reliable for use in this study. The AUC is cross-checked to ensure its accuracy and the data are stored in the same database maintained by SASA. The latter information justifies the reason for choosing the industry for this study, as it allows the SACGA to use farm level labour data with this information, to estimate wage, employment and productivity statistics for homogeneous production areas, regions and the industry for the LUCS Report. Section 5.4 discusses the data contained in the LUCS Reports to enable assessments and the determination of the extent to which it meets the need of the study.

5.2. SA Cane Growers Association Labour Utilisation and Cost Survey and Statistical Book Reports

The importance of this section is to build on Section 5.1 by detailing wage information elicited for the LUCS from the LSGs and the extent to which it is statistically reliable. The question is whether it is possible to fully and accurately measure the non-cash wage? The survey form require growers to supply information on primary employment, basic wages and employment duration in months, productivity (number of months indicated) and annual bonuses, as well as other benefits information from the labour category. The other benefits wage component consists of the provision of rations, pension/provident fund contributions, housing, unemployment insurance fund (UIF), workman's compensation, medical, transport support, etc., as long as the growers are able to provide a realistic estimate value for the non-pecuniary benefits. Hence, some of the benefits are often left unaccounted for, as a result of the difficulty in furnishing realistic values. However, it is not clear if growers do experience such a challenge in line with the stipulated 20% and if SACGA do ensure strong stringency of the prescribed guideline when conducting the survey.

The primary data are analysed to produce secondary data, such as labour units (labour = estimated to have worked for 12 months, or approximately 300 days, inclusive of annual and sick leave per season), aggregate employment, wage (a combination of basic and other payments) and various productivity indicators provided per labour category for the industry and regions. A drawback of the data is that estimated wages between 1978 and 1996 were based on a cost to company or aggregate level; as the wages were not broken down to show all forms of payment. The SACGA started collecting a breakdown of labour wages data in 1997, probably in anticipation of the introduction of farm workers' SD, given that access to the cash component and non-pecuniary benefits data would separately add more meaningful information to the data and probably yield good research outputs.

Since LUCS reports only show the composite wage, raw data was extracted to reproduce the analysis and to enable the separation of all wage component categories. This was only possible for the 16 years between 1997 and 2012, due to the unavailability of raw data for other years on the database. The availability of data over the 1978 to 2012 study period would enable a strong analysis to show any possibility of redistribution between basic, bonus and non-pecuniary benefits, as hypothesised by Newman *et al.* (1997) in KZN, Conradie (2005) in the wine and grape industry of the Western Cape, Murray and van Walbeek (2007) in the South and North Coast of the sugar industry and Roberts and Antrobus (2013) in Eastern Cape regions.

However, the data can enable the use of descriptive statistics and graphical displays to illustrate whether the proportion of non-pecuniary benefits are in line with the 20% (10% for accommodation and the other 10% for food) maximum deduction from the aggregate wage, as stipulated in the SD. Similar to Roberts and Antrobus (2013), the information supplied on the survey forms is neither cross-checked through an employee survey nor verified by SACGA and it is deemed correct. Verification is only done to ascertain the submission of correct season information (e.g. the 2013/14 season, in case of the 2012/13 season), by growers using various screening tactics employed by the Research Economist at SACGA. However, as Roberts and Antrobus (2013) pointed out, it must be acknowledged that some growers may have a concealed incentive to adjust their actual LUCS information in accordance with the SD guidelines, as the survey is in the interest of the industry and conducted by the growers' representative body. This has the potential of making the industry appear to be in compliance with the prescribed regulations and look appealing to government stakeholders.

The attrition problem, or low response rate, could also well be due to the lack of interest from growers who are less compliant with the legislation and who are not in a position to give out labour-related information. Equally so, the majority of responsive growers could be those adhering to the stipulated labour-related legislation and therefore always in a position to share their information. The general complaints by growers regarding legislation must be taken into consideration. Some growers indicate that, in general, there are too many regulations requiring compliance in the agricultural sector, which has increased administration activities, allowing them less time to complete other core business functions. In the end, they have to prioritise the administration activities and surveys, e.g. the STATSSA agricultural survey takes priority over the completion of voluntary survey forms, resulting in SACGA and other stakeholder surveys getting limited, or no, attention.

5.3 Aggregate Employment in Sugarcane Farming: 1978/9 to 2012/13 Season

LUCS results show a decrease trend in the estimated total aggregate farm labour employment in sugarcane farming from 105 758 in 1978/79 to 68 752 employees in the 2012/13 season. Total aggregate labour units (full-time equivalent farm works) also show the similar trend by decreasing from 79 143 to 51 825 units during the same period. Over the study period, aggregate employment and labour units averaged around 77 175 and 59 459, respectively. However, average aggregate employment and labour units are higher and lower over a shorter period, before and after 1994. This is used as a benchmark to measure the impact during a period of poor labour policy and a period of anticipated and eventual policy change. During these periods, the aggregate employment and labour units averaged 91 645 and 69 839 before 1994, and 66 143 and 51 670 post-1994, respectively.

The linear trend line in Figure 6 supports the latter, by showing a significant decrease in total employment, which exemplifies the lack of total employment and the units' resilience over a long period. A number of speculated factors might have contributed to the decrease in farm labour employment, such as vagaries in sugarcane production, loss of land due to development, the production cost squeeze, to some extent a shift in land from sugarcane farming to close substitute enterprises, requiring less labour, an improvement in the availability of labour substitutes and the strength of labour-related legislation, have probably led to the decrease in employment. The long-term implications of the minimum wage have proved to distort resource allocation in sugarcane farming. Growers still prefer the use of labour in most parts of the industry and for most farming activities, due to terrain inconvenience, but the continuous increase in the cost of labour will eventually lead to the usage of labour substitutes at the expense of labour.

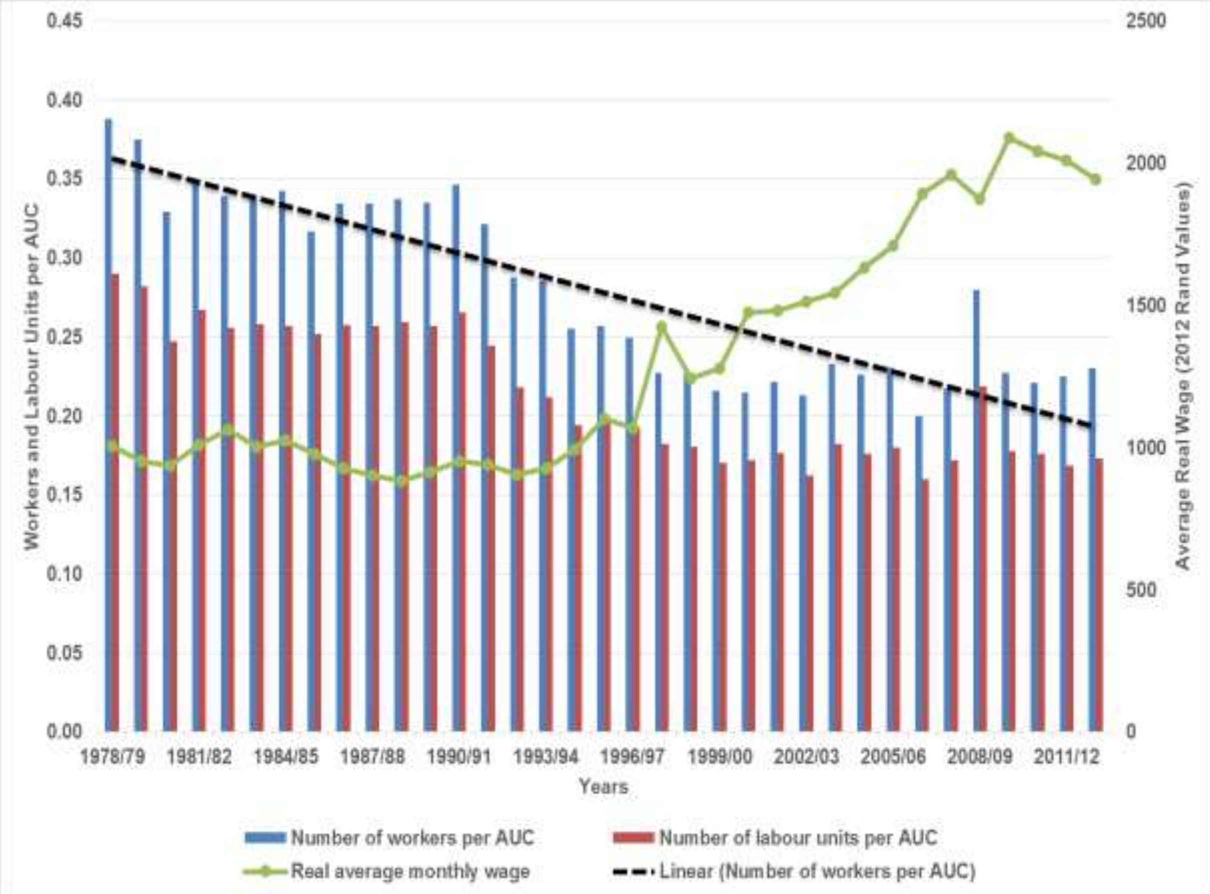

Figure 5: Farm Labour Employment Trend in the Industry (SACGA, 2014)

5.4 Employment in Sugarcane Farming in Selected Regions

The selection of regions for the study was largely informed by the need to compare areas of the industry with different production systems (e.g. coastal vs. inland or dryland vs. irrigated), in line with the need to utilise a sufficiently lengthy time series of data for each region, according to the latter categories. Some regions did not meet the criteria of sufficient time series due to reclassification, e.g. Pongola Mill from the Northern Irrigated to the Zululand North region, and the Felixton Mill from the Zululand region have been combined with the Tugela region, to form the Zululand South region. In the process, the time series for these regions were distorted; for example, the low survey response rates to SACGA's LUCS in the North Coast region over the last decade of the study period. Due to the latter implications on the data, it was decided to compare the industry to the South Coast and Midlands regions. These regions use different production systems due to their inherent differences in climatic and topographical conditions. The purpose of this section is to provide background knowledge about the regions and the perception of farmers about the change in production system over time.

5.4.1 South Coast Region

The region stretches from northern Pondoland in the Eastern Cape Province, sharing a border with the Eston Mill area in the Midlands. It consists of two mills, Umzimkulu and Sezela, and accounts for about 40% and 60% of the area in the region, respectively. These areas also produce about 62% and 38%, respectively, of sugarcane in the region, while the region accounts for 17% and 15% of the AUC and sugarcane production in the industry. The Umzimkulu AUC is about 70% and 30% inland and coastal, respectively, which is the other way round in Sezela. The coastal (inland) part of the region is relatively steeper (flatter), but in general, the South Coast region has an undulating feature that makes the region less conducive for technological adoption. A typically inland area is relatively colder, with an 18- to 24-month cycle, while the coastal area is relatively warmer, with a 12- to 13-month cycle, due to the Eldana problem[4]. In general, the region has an average of 16-month cycle. The region experienced a long-term mean rainfall of 1 023 mm in 2013, which is sufficient for dryland sugarcane growing season water

[4] The current payment system makes farmers on the coast cut their cane early, to avoid Eldana from lowering the RV content of sugarcane.

requirement. A typically coastal (inland) part of the region has relatively marginal (good) soil and, as a result, about 70% of the area has marginal soil. In general, the South Coast region contributes about 27% of farm labour employment in the industry, with the bulk coming from Sezela.

Umzimkulu and the coastal areas in the region are diversified with macadamia nuts, while the inland area in Sezela is diversified with livestock and timber. The region has lost AUC due to development, but there is also evidence of LSG land making way for macadamia, which is less labour-intensive. The willingness to adopt new technology in the region is deterred by the topography and the impact and suitability of technology on operation factors have contributed to the slow adoption rate.

The region is relatively more rural, with low education level of individuals from the surrounding community from which most of the labour is sourced. Cutters are mainly sourced from northern Pondoland in the Eastern Cape Province and Lesotho. In general, the areas surrounding both mills have a limited presence of non-agricultural activities, such as construction, tourism, catering, industrial and retail providing labour with an opportunity cost. Besides the industry, the Eastern Cape is also a source of labour in the mining sector, which to some extent provides competition as a source for cutters. Growers in the region paid Category B (lower wage rate) after the introduction of SD in agriculture and, as a result, the area experienced huge minimum wage increases between 2007 and 2009, leading to a single minimum wage introduction in the sector.

The impact of the minimum wage on employment has been strong on the unskilled compared to semi-skilled labour, as redundant and social responsibility related employment has been reduced significantly. Growers have become strict during recruitment, with more emphasis on expected productivity from the prospective employees. The legislation resulted in an immediate decrease in the wage gap between semi-skilled and unskilled labour, causing an uproar from semi-skilled labour that resulted in the eventual wage increase of semi-skilled labour, to maintain a sizable wage gap. There has not been a strong substitution of casual labour and contractors for permanent labour, apart from the NFGs in Sezela, who rely on contractors, due to limited resources. Growers still prefer their own labour, probably owing to the low availability of quality labour in the region. The preference is, in a way, a retention strategy for quality labour. Labour training is not undertaken by growers to improve productivity and only astute growers are doing so, to improve farming operation efficiency.

A reasonable number of growers are using bonus payment and wage differentiation to induce labour productivity and reward hard work for important activities usually performed by cutters, drivers, etc. The recent large increase in the minimum wage has seen growers cut employment by reducing the working hours from around 8 and 9 hours to around 7 and 6.5 hours. There has not been much use of labour cost saving technologies in the region, except for more usage of knapsack sprayers to do more chemicals spot spraying during weeding, compared to the labour-intensive method of hand hoeing. The method has reduced the head count of field workers, but has not made a significant dent on the costs of labour. The introduction of applicable harvesting technologies would significantly impact on labour costs, as cane cutters account for a larger proportion of the total costs of labour. In some areas, a chopper harvester can be used to harvest cane, but it would require growers to change their farming operation, which takes years to achieve[5] and optimal utilisation can prove to be a challenging factor.

Growers are now making various applicable deductions from labour wages, in line with SD guidelines, which resulted in an increase in cash payments at the expense of non-pecuniary payments. The provision of rations to farm workers by their employers has decreased, with

[5] Unlike many cash crops, sugarcane is a perennial crop and growers tend to replant only 10% of their area under cane on an annual basis.

growers now preferring the establishment of shops on farms, offering basic food stuffs for the convenience of labour and to minimise administration activities associated with monitoring deductions. The general view of the grower is that the minimum wage is set much higher, relative to realisable margins, and they believe they are presented as villains, yet they just do not have enough resources to afford the prescribed wage. They are hoping for a provision of relevant support from the government. As a result of high labour costs, growers are shifting from sugarcane production to less labour-intensive enterprises, such as macadamia. The Introduction of ESTA has discouraged growers to invest in compounds, because of the deterioration of their condition, due to low maintenance. In some instances, the preference has been to destroy compounds and not to establish such structures on their farms, which has resulted in labour staying off-farm. These factors have consequently led to the isolation of labour from the farms and additional labour transport costs.

5.4.2 Midlands Region

The Midlands region shares its borders with the South and North Coast regions. The region consists of three mills, Eston in the south, while Noodsberg and UCL are the neighbouring mills in the north. It accounts for about 21% and 18% of the AUC and sugarcane production in the industry. The south (north) areas account for about 39% and 37% (61% and 63%) of the AUC and sugarcane production in the region. The region is mainly inland, with a 24-months average production cycle due to the low average temperature[6] and rainfall conditions. However, some believe that the actual average cycle is close to 22.5 months long. Consequently, on average about 50% of the AUC is harvested each season. Minimal supplementary irrigation can reduce the production cycle to about 18 months and improve the yield, but may result in two winters

[6] Sugarcane often suffers from frost damage due to very low temperatures.

and a low yield during the third season. The longer cycle gives sugarcane enough time to grow and accumulate a good quantity of sucrose. As a result, yields per AUC are generally lower (43 tonnes) and higher (86 tonnes) per area harvested, with a higher average sugarcane quality (12.6% RV). In general, the Midlands north (south) has a higher (lower) cane yield with lower (higher) quality cane, since the south area is drier, relative to the north. The region contributes about 20% of the total farm labour employment in the industry.

5.4.2.1 Midlands South (Eston)

The sub-region covers, amongst other areas, Umbumbulu, Ixopo and Richmond to Pietermaritzburg and consists mainly of the Eston Mill area. The area experienced a long-term mean rainfall of 820 mm in 2013, which is relatively sufficient for dryland sugarcane growing season water requirement. Despite the area possessing undulating features, with a gradient slope of about 12%, in general most parts are accessible with a tractor and only about 15% to 20% of the area is inaccessible. The area has visible enterprise diversification involving mostly vegetables, livestock, pastures and timber. Over time (about 40 years) there has been a significant move from timber and maize to sugarcane, due to the higher returns from sugarcane in the area, relative to other sugarcane areas.

Growers indicated that, even if there might be movement of land from sugarcane to other enterprises, it is on a small scale and definitely not at the expense of sugarcane production, e.g. around Tala Valley. Vegetables are often used as rotation crops to break monoculture, rather than competing against sugarcane, and timber is typically planted on marginal land for sugarcane production. Growers indicated their preference to rather get rid of other enterprises to make way for sugarcane production. Sugarcane growing conditions are generally good in Mid Illovo, Umbumbulu and Richmond and poor from central Eston to Pietermaritzburg. The area has an average yield per AUC and area harvested of about 41 and 84 tonnes, respectively, with an average quality (RV) of about 13% per season.

The adoption of technology is considered to be in line with its financial implications, ease of use[7] and its impact on labour productivity improvement. Sugarcane farming has gone through technological improvement stages that have been relatively strong on land preparation or planting, weed management, loading and extraction activities, but less on harvesting improvement. Chopper harvesters can be utilised in some terrains, but are expensive and would require growers to restructure some of the fields, by laying them out properly, and over the years growers have preferred to acquire relatively flat land, in order to convenience mechanisation. Negative comments were made about field damage (stool damage), yield and ratoon performance reduction in the long-term, as a result of the use of a Bell loader[8]. Stacking is relatively labour-intensive and expensive, but results in less field damage and cleaner sugarcane[9] delivered to the mill. These side effects have resulted in the retrogression of mechanisation and the preference of cutting and stacking. Growers indicated a strong emphasis on financial viability before they could consider technological adoption relative to other factors.

The region paid the lower minimum wage (Category B) and experienced high wage increases before introduction of the single minimum wage in 2009. The area is still predominantly rural, with an improvement in the education level of young labour from the surrounding community, where most labour is sourced. Cutters/stackers are mainly sourced from Port St Johns to Northern Pondoland in the Eastern Cape Province and Lesotho, where development and education levels are still very low, the areas that traditionally supplied labour to mining and

[7] Sloppiness, technological complexity and whether the fields will need to be restructured to suit the technology. Changing the fields to make them compatible in the Midlands would take a long time, due to a longer cycle (24 months).
[8] Fast, easy to use, more output and can reduce the number of cutters/stackers by half.
[9]The presence of tops in sugarcane sent to the mill is more controlled and sugarcane is also relatively cleaner from unwanted bodies, e.g. soil.

other industrial sectors. The employment of local labour in the region has certainly improved from past levels. In general, the area has limited non-farm employment opportunities, with the exception of areas close to town, but during the infrastructural boom of the 2010 Soccer World Cup, a lot of good labour was lost to the construction industry.

Despite the increase in labour costs due to the minimum wage, growers maintained their labour forces, but they are not replacing lost employment through retirement and dismissal, which eventually decreases the labour force over time, and they have cut down on social responsibility[10] related employment. The impact on employment of unskilled labour has been clear, as replacements have only been prevalent for skilled labour and growers seem more prepared to pay for a skill. Labour recruitment has become stricter, with more emphasis on the perceived productivity of prospective employees. Employment has also been cut at the intensive margin by reducing the number of working hours from 49 to 42 and days from six to five, to improve productivity and this action has been strong in response to the increase in the minimum wage rate. The legislation has resulted in a decrease in wage discrepancy between skilled and unskilled labour, but relatively not in line with probable expectation[11], as it has not narrowed as much as one would have thought.

Anecdotal information provided by growers suggest that there does not seem to be a correlation between the minimum wage and training to improve productivity, rather farm workers are mostly trained to meet the requirements of the Occupation Health and Safety Act (OHSA). Cutters are continuously trained to improve sugarcane topping, while knapsack and mechanisation operators are trained for health and safety reasons; however, the end result does

[10] Now social responsibility employment is not more than five employees, whereas in the past, a grower would look after about 10 employees.

[11] The increase in the minimum wage increased general labour wages very close to drivers' wages, to the extent that there was pressure to also increase the wages of drivers, to maintain a reasonable wage gap between the two labour categories.

impact on labour productivity. Growers are of the view that productivity has more to do with the quality of supervision by supervisors and indunas on the farm. There is limited substitution of casual labour and contractors for regular labour, as growers still prefer regular labour and technological substitution is largely dependent on financial viability. There has been a growing preference of utilising knapsacks to do more spot spray during weeding; however, the phenomenon has not made a material impact on labour costs[12]. Some growers do practise wage differentiation and bonus payments to promote productivity, mostly of cutters and mechanisation operators.

There has been a change in consumption from the more staple to the more luxurious food items by labour, due to the SD, and contrary to Murray and van Walbeek (2007) and Roberts and Antrobus (2013), growers cited less unruly labour behaviour due to high consumption of alcohol, as a result of a minimum wage driven by higher buying power. The establishment of farm shops is more preferred to the provision of rations to labour, to reduce administrative duties associated with the SD guidelines on deductions. Growers still meet sometimes, but mainly for transparency and to standardise labour conditions, rather than as collusive behaviour to control wages. In the past, most growers would eventually match wages, not because of strong ties, but to preserve the movement of labour to other growers. After introduction of the minimum wage, growers' discussions now revolve around labour working hours, conditions and payments in kind. The provision of residential employment is structured as a form of work accommodation, to prevent permanent settlement, hence, the limited impact of ESTA in the area.

[12] It has reduced the amount of farm labour but not the wage bill since it has increased considerably.

5.4.2.2 Midlands North (Noodsberg and UCL)

The area consists of Noodsberg and UCL mill areas, with a long-term mean rainfall of 878 mm in 2013, which is sufficient for dryland sugarcane growing season water requirement. There are three main enterprises in the area, where sugarcane is more prevalent, followed by wattle and pine enterprises. Maize and livestock (mainly beef) are visible, and some growers have recently been establishing macadamia. Similar to the Midlands South, macadamia is usually established on relatively less productive soil, so it is not taking away land from sugarcane production. Sugarcane is still regarded as the most profitable enterprise, compared to macadamia nuts, unlike on the South Coast region, due to the conducive conditions. However, wattle production is currently viewed as relatively competitive, given that it is relative closer to the mill, compared to the Midlands South growers. Despite the latter, growers prefer wattle, mainly to supplement sugarcane, especially in summer, as there is no cash flow from sugarcane. It is possible for afforestation permits to act as a protection for sugarcane from wattle; however, the general view is that wattle is not affecting sugarcane, but rather that sugarcane has been taking land from wattle over time. Despite the latter, there has been no recent major sugarcane expansion in the area.

The area is very convenient for mechanisation, with less than 1% of the fields inaccessible to tractors, and about 40% to 50% of the area can easily be harvested with a chopper harvester. The financial implications determine technological adoption, but with consideration of the side effects, e.g. field damage. Stool damage has been the most discouraging factor for the utilisation of Bell loaders and chopper harvesters. The practicality of technology (hidden costs or risk) is important, as some growers tend to adopt technology on the basis of the visible costs. Adoption is often based on the friendly complementary use of existing technology, as it may require a complete system change to accommodate new technology and this can be very costly.

Sometimes the adoption of technology is based on the expected user-friendly with current systems in both sugarcane and diversified enterprises, in order to spread fixed costs. In general, there is scepticism regarding the use of new chemicals, due to the unexpected damage on sugarcane[13] when dealing with weeds. A chopper harvester is a lot more accurate in separating tops from sugarcane, compared to a Bell loader, as it blows away sugarcane tops during harvesting. However, anecdotal information provided by growers suggest that the most limiting factor about adopting a chopper harvester is its relative cost to labour, as it is relatively more expensive than labour, and it is mostly competitive with very large farming operation or contract business.

Despite its proximity to urban areas, the farming area is still predominantly rural, but there has been an improvement in education level of recent young labour coming through. As a result, some growers in the past paid the higher minimum wage (Category A) before the conversion to a single minimum wage in 2009. Besides sugarcane farming, labour can work in five factories (two sugarcane mills and three forestry related factories, which are mainly industrial jobs), farm labour contractors, some tourism and construction. Labour contracting is said to be increasing in the area, mainly due to the increase in demand from farmers as labour legislation strengthens. Most of the farm labour is sourced locally (about 70%) and the other portion, which consists mainly of cutters/stackers, is sourced from the Eastern Cape, Lesotho, Mozambique and, recently, to some extent Zimbabwe.

The introduction of the minimum wage and the recent (2012 and 2013) unanticipated substantial increases have impacted on farming operations through the reduction of spare labour who assisted during emergencies, e.g. backlogs after rain, labour strikes, etc., especially on growers without diversified farm operations. In the long run, when growers have enough time

[13] There's a chemical that works well on weeds and growers only have to spray once and do not have to clean up, but it also causes damage to sugarcane.

to adjust their farming operations, indunas and relatively skilled labour are likely going to be retained and menial labour is likely to be replaced by labour contractors and the use of more chemicals, rather than hand hoeing. The minimum wage is not the only problem, because other labour related legislations are also exerting pressure to change farming operations.

Growers prefer own labour as it gives them control over their farming operations. However, the increase in the number of contractors that keep their charges relatively low will eventually compel growers to employ less labour, as they would still be able to maintain a level of control over their operation by choosing a good contractor to absorb most costs. Growers did not indicate any secular employment reduction, but are no longer replacing retiring and absconding labour. The impact of the legislation on employment affects unskilled labour relative to semi-skilled labour, as farmers have mainly been replacing unskilled labour. To some extent, unskilled labour has been replaced by an increase in spot spraying. The legislation has impacted the way growers pay labour, as it has compelled them to increase wages of semi-skilled labour, in order to maintain a reasonable wage gap between the labour categories. Nonetheless, the wage gap has narrowed by a reasonable distance between the wages of the latter labour categories.

The legislation has stabilised labour movement between farms, owing to wage standardisation and non-pecuniary benefits, especially for unskilled labour, and the movement, if any, is largely dependent on the way growers treat labour. Growers have also become more stringent about the labour recruitment process, with more emphasis on expected productivity, and have significantly reduced social responsibility related employment. Some activities are better done using labour, e.g. appropriate removal of noxious weeds, cleaning river areas, etc., but they are no longer completed appropriately due to employment reduction of menial labour, which has significant cost implications in the long-run.

Although mechanisation has been adopted, it was indicated that labour is still efficient relative to current planters and chopper harvesters. Sometimes technology is made available for risk management during labour strikes and labour contractors have mostly affected casual labour relative to regular labour. The relative flatness of the area has been conducive for Bell loader utilisation relative to cutting and stacking. Labour training is mainly linked to the OHSA and, to some extent, to SASFARMS regulations, which eventually impact on labour productivity. The legislation has led to a reduction in the labour force, working days and hours, with an attempt to minimise rising labour costs and maintain expected increase in labour costs. Wage differentiation to penalise under-productivity has decreased significantly, due to the tightness of the legislation over the years, and it is mainly practiced through productivity bonus payments, especially to cutters/ stackers and drivers.

There has been a significant shift from the provision of rations and accommodation to shopping transport assistance. Labour evictions are generally not happening, growers rather wait for labour to retire, to find alternative accommodation somewhere else or they allocate a small portion of land on their farms for settlement, before they can convert or demolish compounds. Growers now prefer the daily collection of labour from communities, compared to on-farm living, which has resulted in the separation of labour from farms and additional labour transport costs, which growers say they would rather experience. Credit acquisition has increased over the years due to income improvement, especially for high income labour relative to low income labour.

Growers still meet for discussions about issues affecting agriculture to moderate their approach to farming activities and the frequency of meetings is dependent on the importance of the farming issues, e.g. huge increases in the minimum wage. As the wage rate is now set outside the labour market, growers are now mainly discussing moderation of their labour force, working days and hours. No unruly behaviour related to alcohol abuse was cited due to the minimum wage increase. A backward bending supply curve is probably being experienced, as some labour are now opting to work less hours in some instances, because they are able to earn their ideal wage with less effort.

5.5 Graphical Presentation of Data

Various charts are plotted, showing the proportion of basic wage, bonuses (monthly, which are mainly based on productivity, and annual, which mostly applies to some permanent, semi-skilled and skilled labour), as well as other benefits from the composite wage, using data from the 1997 to 2012 period. Figures 6 to 8 and Figures 11 to14 each contain five charts showing the proportionate comparison between the industry and selected regions for both the aggregate and selected farm labour categories. Figure 9 and Figure 10 show the proportion of Drivers composite and basic wage above cutters, permanent and seasonal labour. Another set of charts in Figure 11 compares the real minimum wage with the real aggregate basic wage and real basic wages, whilst charts in figure 12 to 13 show the relationship between employment and wages for selected farm labour categories in the industry and selected regions. Aggregate employment and wage data were computed, using only the data for selected farm labour categories (drivers, cutters, permanent and seasonal labour), rather than using all types of farm labour in the industry. The approach prevents an account of relatively less important farm labour categories, such as clerks, cooks, general staff and security, etc., which would distort the analysis.

Five charts for the industry and selected regions show the relationship between the real wage and employment during the study period. Both the minimum wage and wage data were presented in 2012 Rands, to deflate the data from nominal to real terms. Plotting proportions separately and the relationship between real basic wage and the minimum wage is due to the fact that other benefits and various monthly and annual bonuses are not directly linked to the minimum wage, rather to the basic wage level.

It would therefore not be ideal for farmers to directly link bonuses and other benefits to a formal wage, since monthly bonuses are usually performance-based, which is not always guaranteed and is independent of the minimum wage level, while other benefits are capped at 20%. It would not also be ideal in terms of the legislation stipulation for farmers to use annual bonuses to make up for paying less than the minimum wage during the year. The year 1997, in some charts, seems like an outlier, especially the proportion of other benefits from the composite wage. This is probably due to the fact that farmers did not appropriately account for non-pecuniary benefits or the research team at SACGA was probably still getting familiar with changes in the analysis. It would have been useful to have the data starting from at least 1994, to allow observations over a longer time series.

5.5.1 Proportion of Basic Wage, Bonuses and Other Benefits from the Composite Wage

Chart A in Figure 6 shows an increase in the proportions of the real average basic wage in the industry and selected regions over time. However, the increase in the industry real average basic wage fluctuated between 70% and 80% since 2002, while it has fluctuated around 90% in both selected regions since 2003. The latter suggests that the basic wage is, on average, less than the 80% stipulated in the SD in the industry, relative to the two regions, which is probably influenced by the wages of drivers and cutters at that level. Chart B shows that the basic wage proportions for drivers have been between 60% and 70% in the industry and on the South Coast, and for some levels it has been around 80% in the Midlands since 2003. The finding may not be surprising, since the composite wage for drivers is relatively higher, which provides room for a higher proportion of other forms of payment.

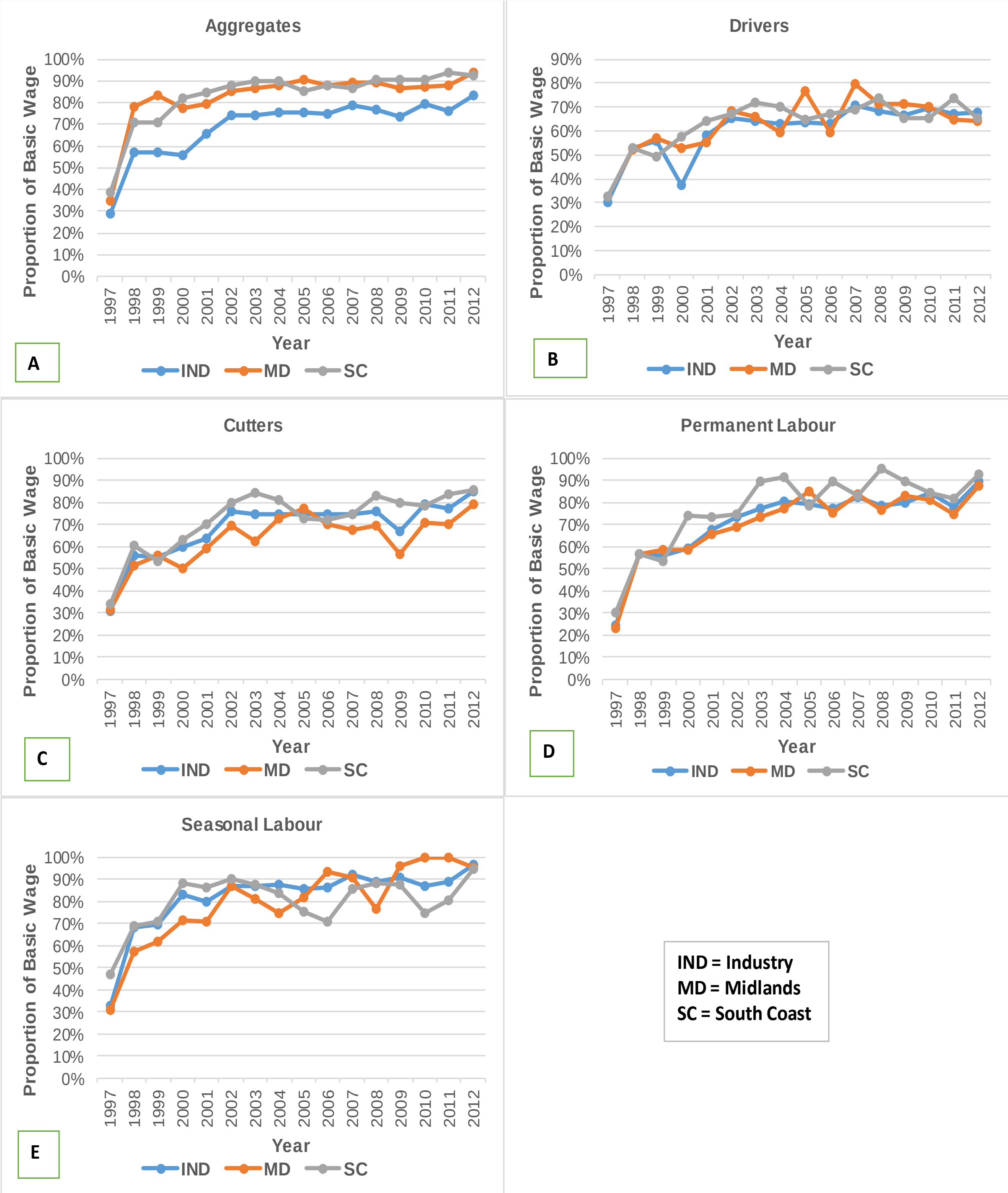

Figure 6: The Basic Wage as a proportion of the Composite Wage for Selected Labour Categories in the Industry and Selected Regions (SACGA, 2014)

Cutters in Chart C also present a similar trend, showing a basic wage proportion of less than 80%; however, the South Coast has some movement around 80%. The trend is not unusual, since cutters are usually paid more productivity bonuses monthly, as well as other forms of payment, which also pushes their composite wage higher. The proportion for permanent labour in Chart D has fluctuated above and around 80% since 2004. Seasonal labour proportions in the industry on Chart E show fluctuations well above 80% and around 100% since 2000, while it fluctuated above 80% and 100% with some spell below 70% in the two regions. The trends in the charts present findings in line with the expectations. It would be possible to find that basic wage proportions for permanent and seasonal labour fluctuate mostly around 80%, compared to those for cutters and drivers, as a result of the SD.

Figure 7 shows a huge decrease in the proportion of real average of other benefits in the industry and selected regions over time in Chart A. The industry and the Midlands show much lower levels after 2003 (below 10%) than on the South Coast (over 60%). Chart B shows the proportions for drivers since 2003 for the industry and regions to be from around 50%, to around 5% and below. The proportion for cutters in Chart C also presents a similar trend, showing proportions around 10% and below; however, the South Coast show proportions over 10% since 2003. The proportion for permanent labour in Chart D also mostly remained below and around 10% since 2003 and from 60% and above in 1997. The seasonal labour in Chart E fell from around 60% and 50% and has fluctuated below 10% since 2003, reaching a much lower level, close to zero. It was expected that the average proportions for the industry and regions would fall from higher levels, similar to the proportions for the permanent and seasonal labour level, relative to drivers and cutters, given that labour in these categories earn relatively higher wages.

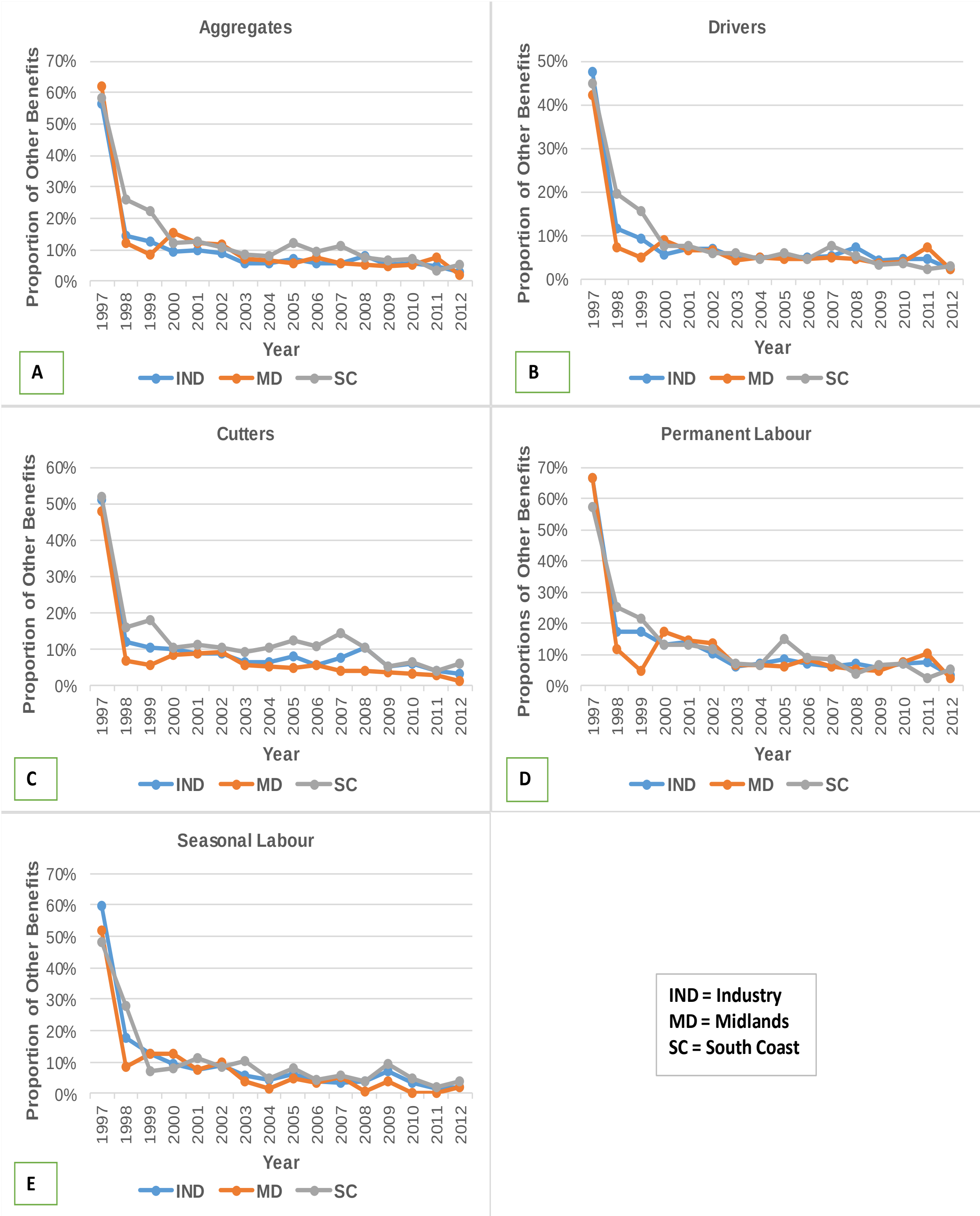

Figure 7: Other Benefits as a proportion of the Composite Wage for Selected Labour Categories in the Industry and Selected Regions (SACGA, 2014)

Figure 8 presents a decrease in the proportion of bonuses in the industry and selected regions over time. After the drop in 2002, the average proportions of bonuses for the industry remain high at between 15% and 20%, compared to the regions which are at around 5% and below, as indicated on Chart A.

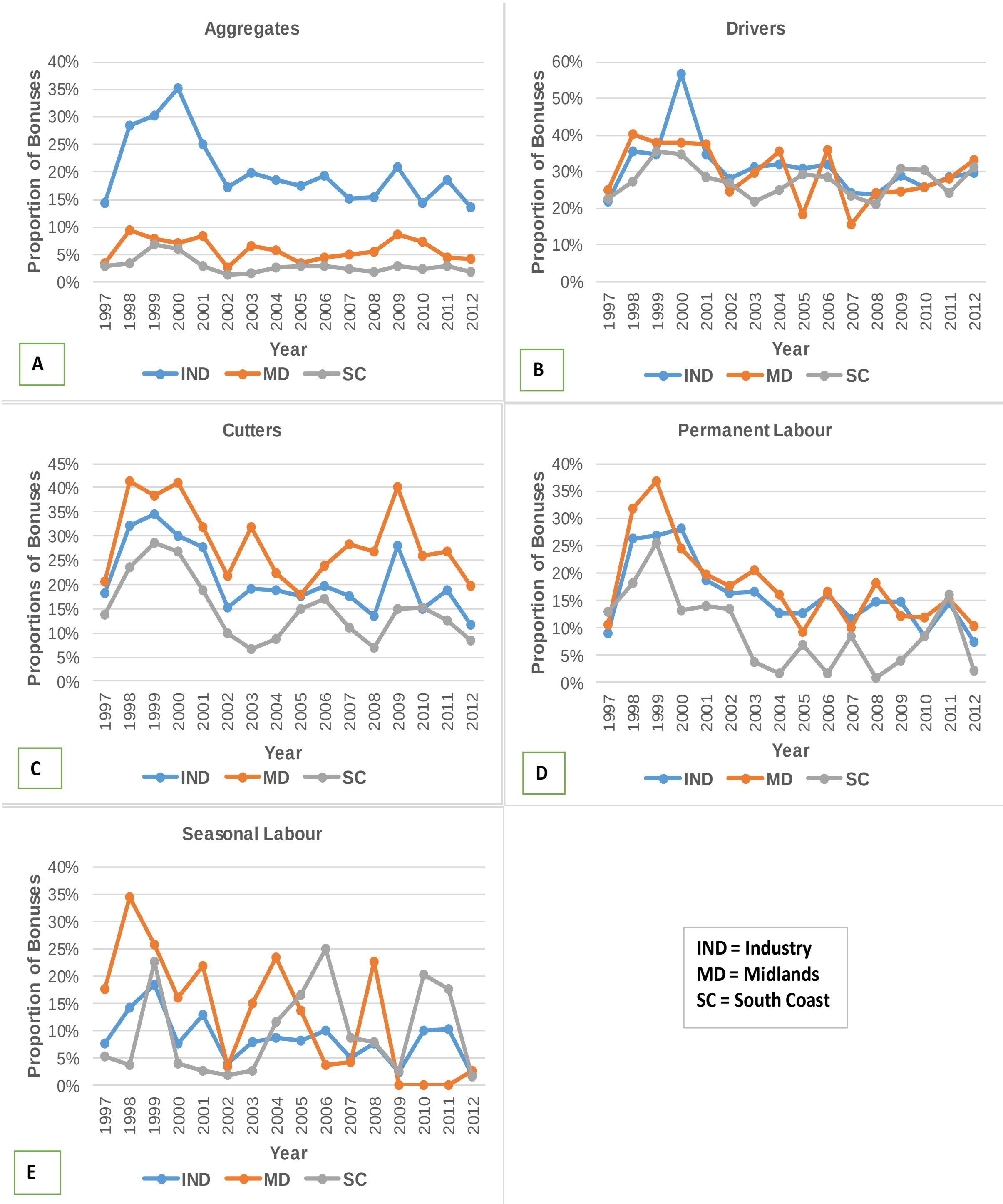

Figure 8: Bonuses as a proportion of the Composite Wage for Selected Labour Categories in the Industry and Selected Regions (SACGA, 2014)

Chart B shows a similar proportion of bonuses for drivers in the industry and regions at around 20% and 30%, with a few outliers since 2002. Cutters in the Midlands, followed by the industry, seem to be receiving more bonuses relative to the South Coast in Chart C. The proportion contribution of bonuses on wages for permanent labour in the industry and the Midlands fluctuated between 10% and 15%, while on the South Coast they fluctuated mostly below 10%, since the marked drop in 2000 on Chart D.

Chart E shows a huge variability for the bonus contribution on total wages of seasonal labour and a clear trend is only noticed for the industry plot. Growers seem to be paying seasonal bonuses to induce strong productivity, which follows seasonal fluctuations. It was expected to see the higher level of bonuses paid to drivers and cutters. Cutters are usually paid more in monthly productivity bonuses, based on the number of rows covered in sugarcane cut, while drivers are paid annual bonuses and monthly productivity bonuses, based on their sugarcane payloads between the field and loading, and from the loading zone to the mill. The higher proportion in the industry and Midlands in most charts suggests a higher payment of bonuses, in general, relative to the South Coast.

5.5.2 Wage Redistribution Analysis between Drivers, Cutters, Permanent and Seasonal Labour

Figures 9 and 10 show percentages by which the drivers' total and basic wages are above the total and basic wages of cutters, as well as permanent and seasonal labour in the industry and selected regions. In Chart B and C of Figure 9 there has been a clear downward trend since the year 2000, relative to Chart A, which shows no clear trend.

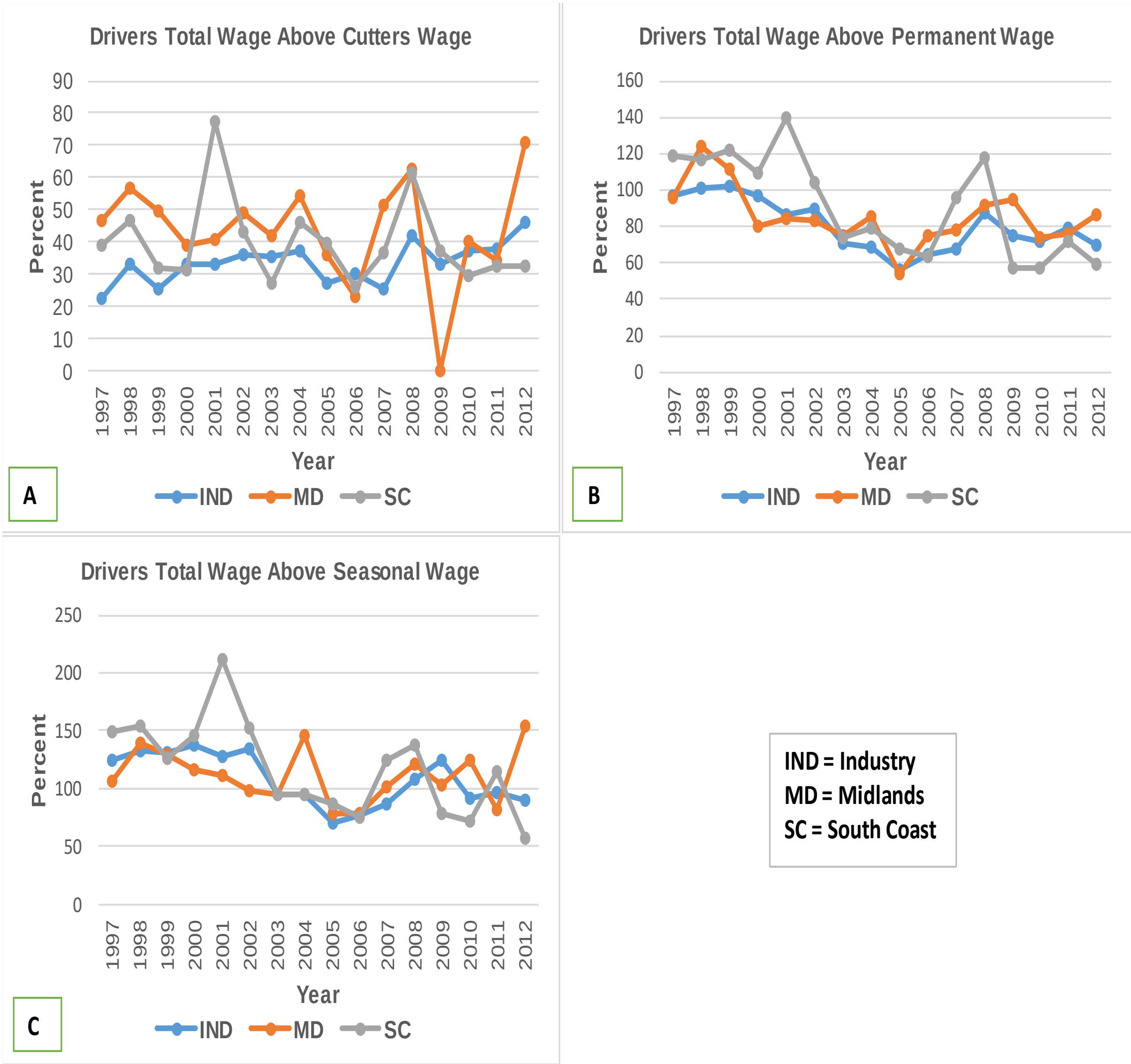

Figure 9: The Percentage of a Driver's Total Wage above a Cutter's, Permanent and Seasonal Labour's Total Wage in the Industry and Selected Regions (SACGA, 2014)

The findings suggest that the drivers' composite wages have become relatively lower than those for permanent and seasonal labour in recent years and that the composite wages for cutters were less affected by the minimum wage, given that they have been earning relatively higher wages, compared to permanent and seasonal labour. Figure 10 shows similar trends, but with a much clearer downward trend in Chart B for permanent labour, compared to Chart C for seasonal labour. This attests to the fact that permanent labour earns more wage benefits than seasonal labour, which means that there is a small difference between the composite and basic wages for seasonal labour.

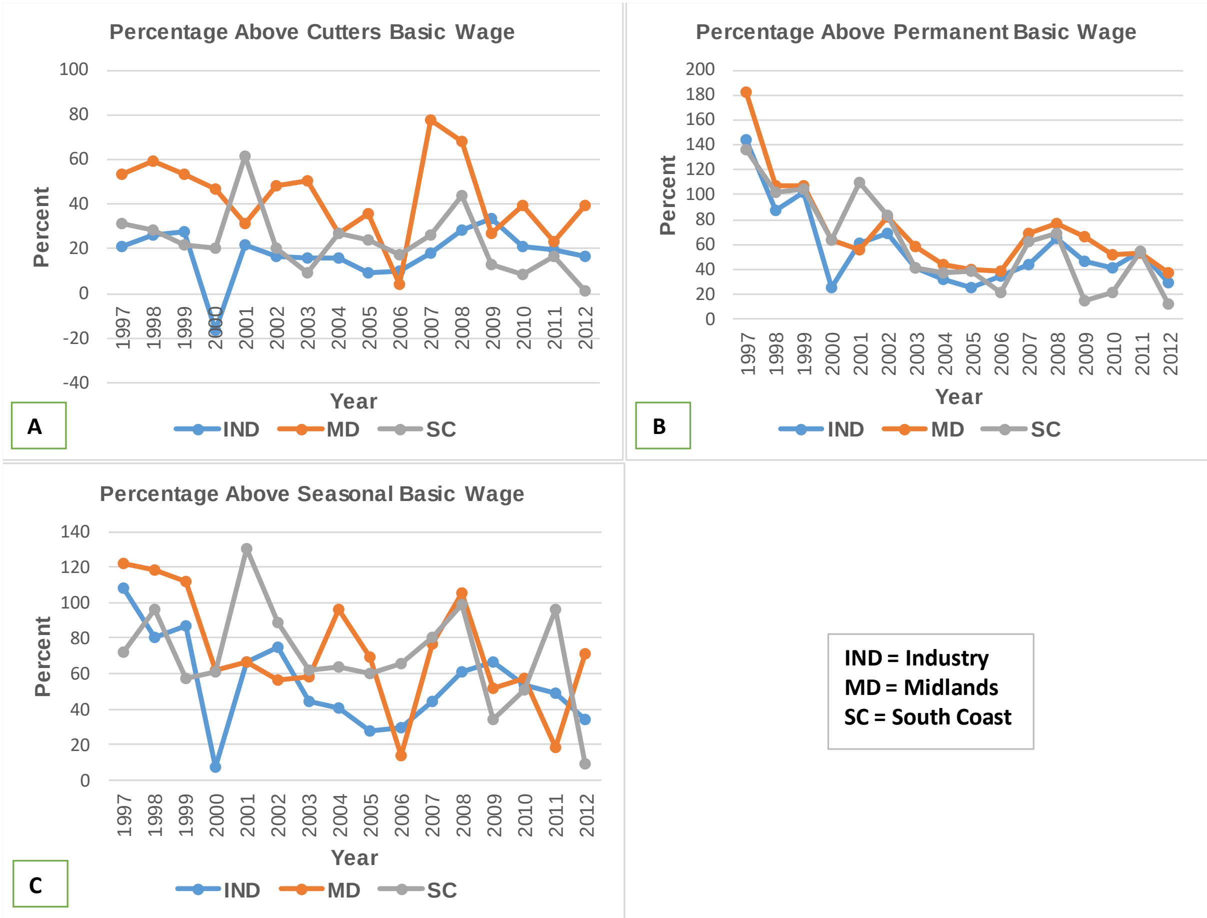

Figure 10: The Percentage of Driver's Basic Wage above Cutter's, Permanent and Seasonal Labour's Basic Wage in the Industry and Selected Regions (SACGA, 2014)

5.5.3 Comparison between the Minimum Wage and Basic Wages

Figure 11 compares the minimum wage to the average basic wage and the basic wage of the different labour categories in the industry and regions. In Chart A, it can be seen that the average wage in the regions was competitive, relative to the minimum wage, between 2003 and 2012, with the industry only catching up and being slightly above, between 2007 and 2012, before the above 50% increase in the minimum wage in 2013. However, the average wage trend is expected to have caught up with the minimum wage in 2015.

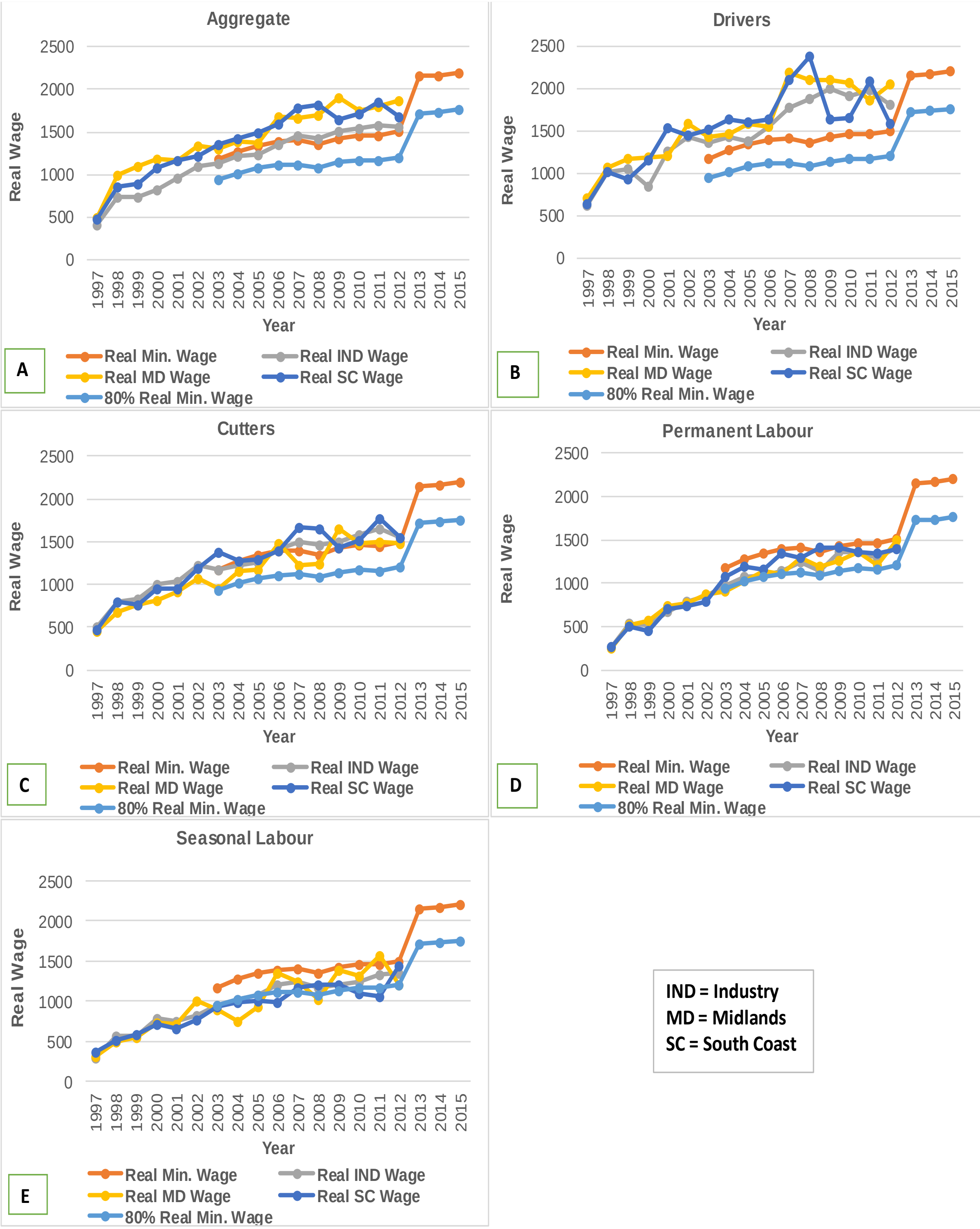

Figure 11: Comparison between the Minimum Wage and Wages of Selected Farm Labour Categories in the Industry and Selected Regions (SACGA, 2014 and ECC, 2013)

Growers are expected to have responded with an average basic wage matching the minimum wage in the industry and South Coast, which can only be confirmed by the SACGA's 2013 to 2015 season analysis results. Chart B shows the above minimum wage basic wage received by drivers in the Midlands, between the years 2003 and 2012, which can be expected remain above the higher minimum wage in 2013 to 2015.

The industry and South Coast only show the minimum wage above the basic wage for drivers between 2003 and 2012. The basic wage of cutters in the industry and regions fluctuated around the minimum wage between 2003 and 2012; however it can be expected to move in line with the minimum wage, even with the huge increase since 2013 that created a new level of the minimum wage. The latter findings to some extent confirm that the total wage for cutters is relatively higher, but with a lower basic wage component. Charts D and E plot a comparison of the minimum wage and basic wages of permanent and seasonal labour, respectively, and show that the results are in line with the expectations. The minimum wage is higher, relative to the basic wage received by permanent and seasonal labour, given that their composite wage is lower than the composite wage of cutters and drivers. After accounting for the deductions, the wage of the two categories becomes much lower than the minimum wage. However, the basic wage trend of permanent labour on the South Coast followed the minimum wage closely between 2003 and 2010. However, the minimum wage less the stipulated 20% deduction is significantly less than the basic wages in Chat A, B and C, slightly less than the basic wage of permanent labour in Chart D and competitive with the basic wage of seasonal labour in Chart E.

5.5.4 The Relationship between Employment and Wages

The industry is presented in Figure 12 and shows a relationship between employment and the composite wages for the industry and regions. Only Chart E for seasonal labour shows a strong negative relationship between employment and wages, while Charts A and D, for aggregate and permanent labour, show a lacklustre negative to relatively flat relationship between wages and employment.

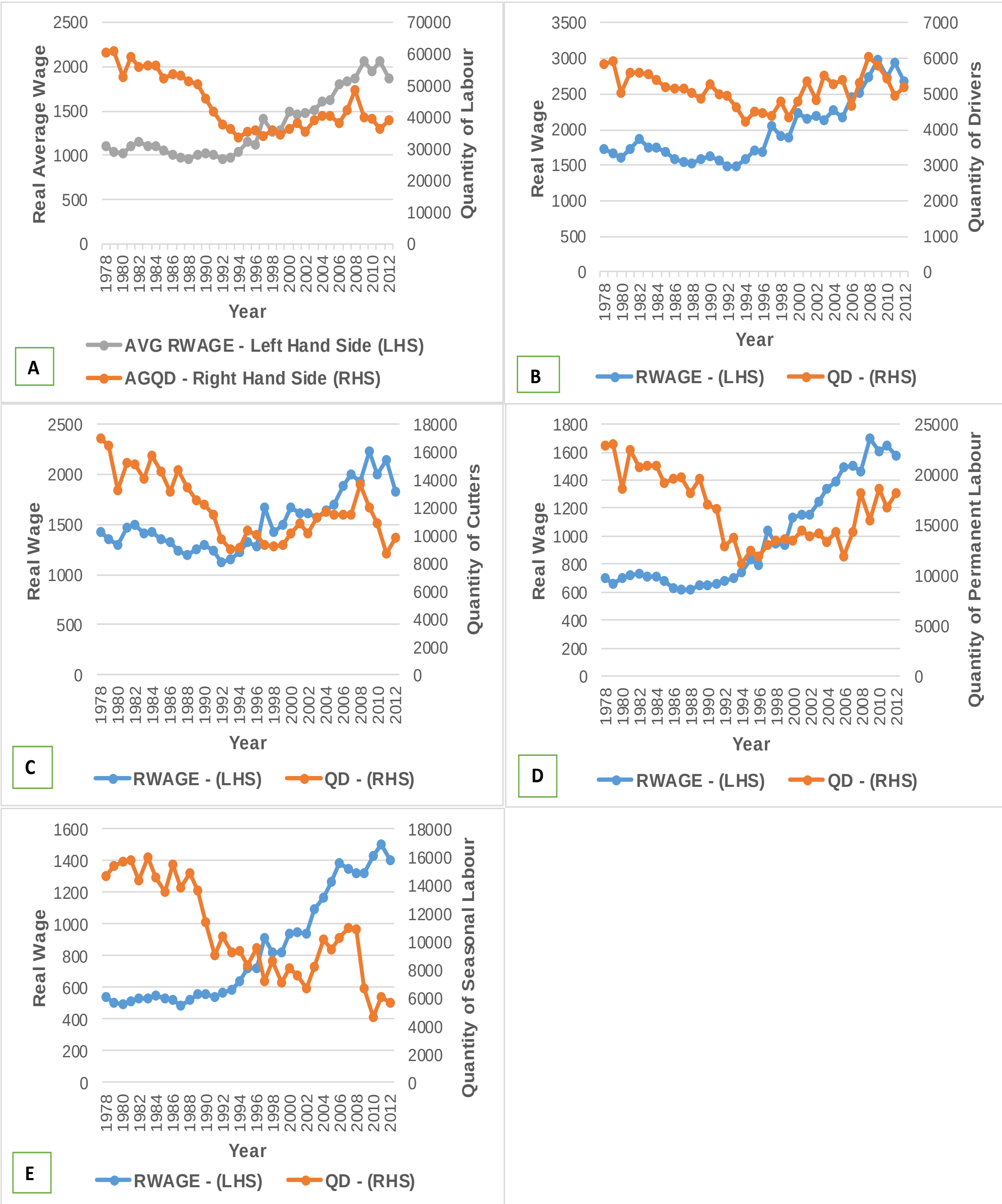

Figure 12: Comparison of the Relationship between Real Wages and Employment for Selected Farm Labour Categories in the Industry (SACGA, 2014)

Charts B (drivers) and C (cutters) show a lacklustre and a strong positive correlation between the level of employment and wages. The finding may suggest that growers probably paid enough wages to retain cutters or, based on the available cutters, paid relatively more for the required number of drivers. Furthermore, the observation may suggest the availability of competitive sectors for drivers in the sugarcane growing areas.

In general, wages remained relatively flat, except for cutters, which decreased until the early 1990s and started to increase considerably, with sharp increases only noticed for seasonal and permanent labour. This indicates that those who were able to get seasonal and permanent employment have gained higher wages from the perceived policy change and the actual change and seasonal employment seems to have been impacted, relative to permanent employment. The decrease in employment corresponds well with the increase in mechanisation, which can be argued to have probably been more labour saving, compared to a complementary relationship. The slight impact on drivers' employment can be due to the introduction of relatively better-performing and multiple-task tractors.

Figure 13 for the Midlands shows a similar presentation to the industry Figure 12 in Chart E for seasonal labour. However, the Midlands Chart E shows a clear negative relationship between employment and wage, relative to the industry. A poor negative relationship between employment and wage is prevalent in Chart D for permanent labour. Chart B and C present a relatively constant trend in the employment of drivers and cutters, but with more variability. The relatively constant employment with an increase in the wage of drivers and cutters, suggests that growers probably paid more for the required employment, which is probably due to the availability of strong competitive sectors in the region. Chart A shows a decrease in average employment until the early part of the 1990s, which then fluctuated to around 8 000 labour employed and a poor negative relationship between wage and employment. In general, wages were flat in the Midlands until the early 1990s and they have shown an increasing trend in all charts since the early 1990s.

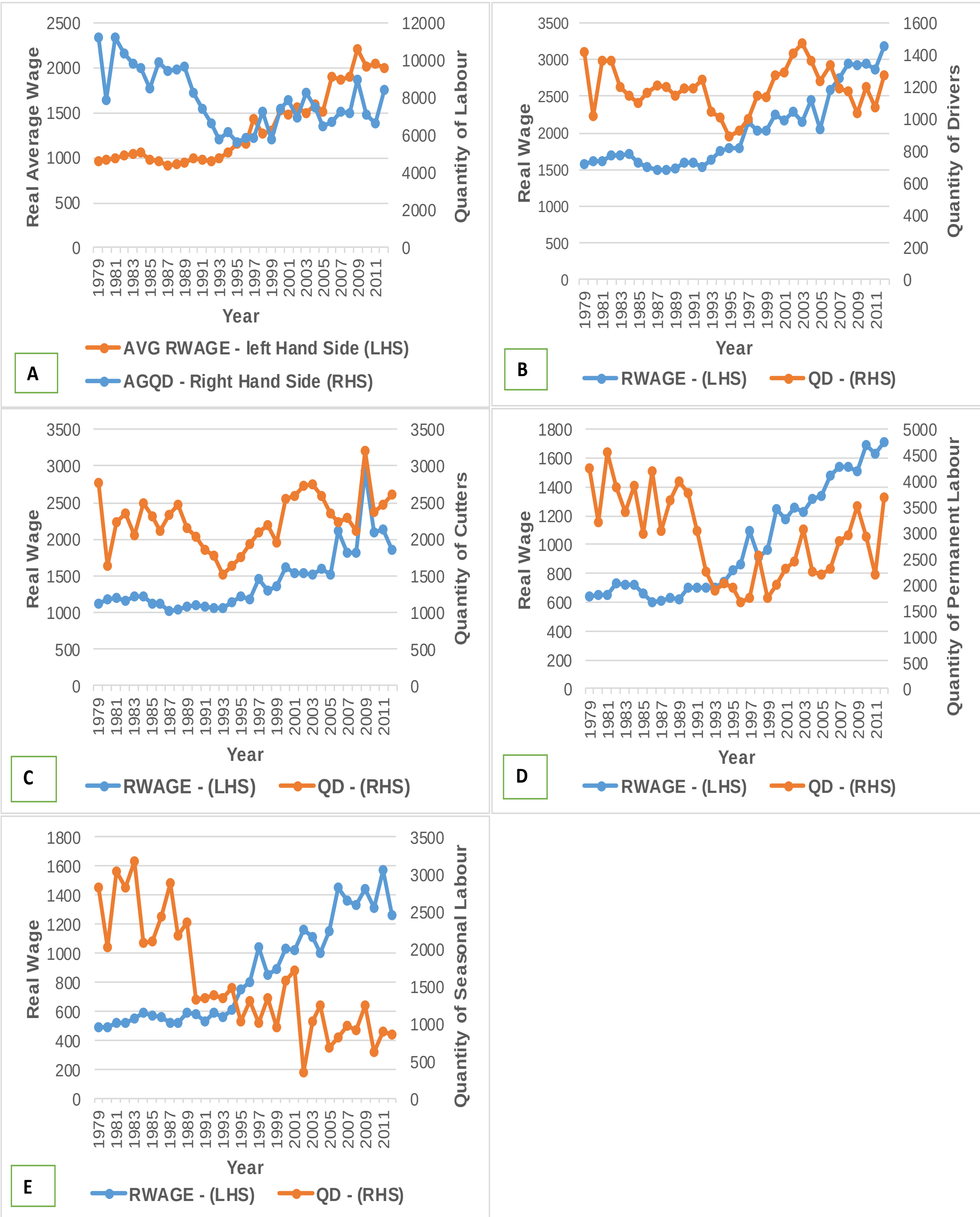

Figure 13: Comparison of the Relationship between Real Wages and Employment for Selected Farm Labour Categories in the Midlands (SACGA, 2014)

Chart B and C in Figure 14 for drivers and cutters on the South Coast show a relatively solid positive correlation between employment and wages, when compared to the industry and the Midlands.

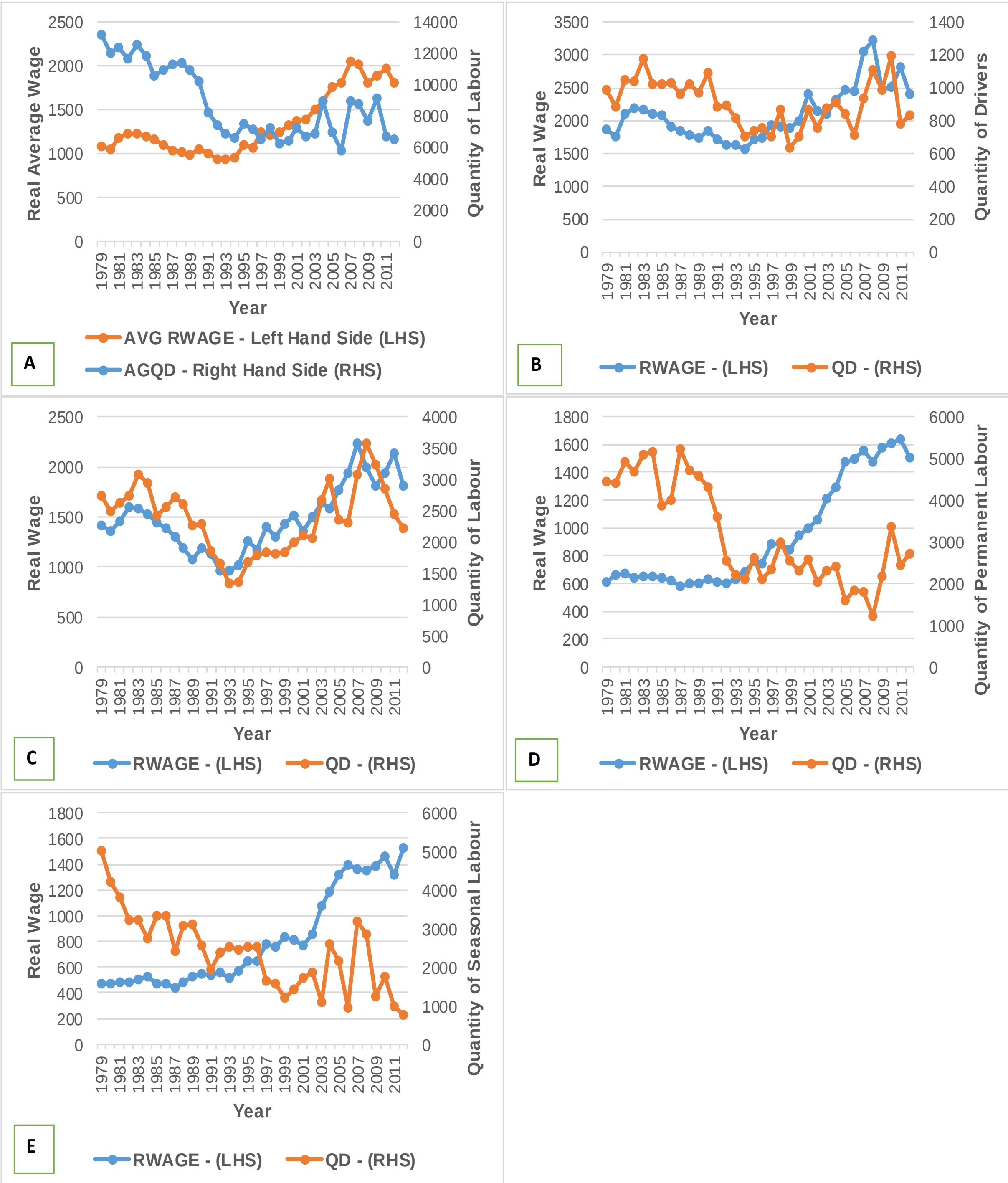

Figure 14: Comparison of the Relationship between Real Wages and Employment for Selected Farm Labour Categories on the South Coast (SACGA, 2014)

The solid correlation between employment and wages for these labour categories on the South Coast suggests that growers paid what is necessary to retain and attract the required amount of labour, which may indicate the limited availability of a competitive sector for these labour categories in the region. While Chart D and E for permanent and seasonal labour show a strong negative relationship between employment and wage, this finding suggests a strong vulnerability of seasonal and permanent employment on the South Coast, in case of development of strong labour-saving technology, relative to the Midlands and the industry, where only seasonal employment is vulnerable. On the other hand, Chart A for aggregate employment presents a lacklustre negative relationship between employment and wages. Only the average wage and the wages of permanent and seasonal labour were flat until the early part of the 1990s and they then started to increase considerably, especially for both permanent and seasonal labour.

5.6 Conclusion

The source (LUCS) of labour data (quantity and wages), its process and associated challenges was explored in detail. Despite the challenges, the data is credible and it seems it is only the sugar industry that possesses such data in the SA Agricultural Sector. The data is suitable for both descriptive and econometric analyses in order to answer the research problem that seeks to determine the impact of the SD on labour categories (high and low income earners) by region with different labour requirements. The South Coast, Midlands South and North show high (low) labour (mechanisation) to low (high) labour (mechanisation) intensity. The descriptive analysis show high (low) impact on employment of unskilled (semi-skilled) labour, low (high) impact on wage distribution of semi-skilled (unskilled) labour and high (low) impact on wage proportions (basic and non-pecuniary) adjustment of unskilled (semi-skilled) labour.

CHAPTER 6: RESEARCH METHODOLOGY

Having provided a background to the South African Sugar Industry in Chapter 4 and a descriptive analysis of employment trends and wages in LSG sugarcane farming in Chapter 5, the purpose of this chapter is to specify an appropriate econometric model to study the impact of the minimum wage legislation on employment in sugarcane farming. The econometric model is based on the conceptual model presented in Chapter 3, with due consideration of the need to address high levels of collinearity in the data sets identified in Chapter 5. The structure of this chapter constitutes the data collection process in Section 6.1; an estimation and specification of an appropriate econometric model, and the empirical specification of the appropriate econometric model in Sections 6.2, 6.3 and 6.4; a discussion of the multicollinearity problem and the description of the appropriate model to deal with multicollinearity in Sections 6.5 and 6.6.

6.1. Data Collection

Wages and employment data, AUC and price per ton of sugarcane for this study were obtained from the SACGA, and as in Chapter 5, the farm labour data are estimated from farm level wages and employment data. A much longer time series of estimated farm labour data would have been more useful to enable a *more sound* analysis; however, only data from 1978 and 1979 were obtainable for the industry and selected regions, respectively. The cap limited the utilisation of a much longer time series which, according to Gujarati and Porter (2010), has a bearing on the estimated econometric results. A future revision of the analysis, with a longer time series of estimated farm labour data in the near future, may be beneficial, as estimated results tend to improve with an increase in the length of the time series data, i.e., the null hypothesis seems more likely to be rejected in survey data involving hundreds of observations (Gujarati and Porter, 2009).

The price index of machinery and equipment, and chemicals data with a base year 2005 were obtained from the 2014 Abstract of Agricultural Statistics report. The supply function data, such as the rural population, life expectancy and CPI were obtained from the World Bank website database by country, while data for the alternative wage proxy were obtained from the Steel and Engineering Industries Federation of Southern Africa (SEIFSA). The CPI with the base year 2012 was used to deflate the nominal values of appropriate explanatory variables to real values. Only data utilised in the industry empirical model are presented in Appendix A, however all the empirical models were estimated using STATA 11.

The literature review suggests that a number of studies applied a simultaneous equation model on time series data to study the aggregate demand and supply functions and estimated the structural change in the labour market overtime, while simple demand models (i.e., those not estimated simultaneously with supply) were mostly used when dealing with cross-section or less time span data, to compare states, industries and sectors in different regions. The simultaneous model enables the determination of different responses of the demand and supply of labour functions at once. The response of each function to respective explanatory variables enables the utilisation of more information and assists with resolving the inter-dependence relationship between the quantity of labour and wage, a problem often encountered when using OLS. The simultaneous-equation and 2SLS techniques are discussed, and an empirical simultaneous model incorporating the demand and supply functions is specified.

6.2. Econometric Estimation of Simultaneous Equations

The Ordinary Least Square (OLS) procedure is usually associated with the simple or multiple regression single equation models, where there is a single dependent variable and more explanatory variables (Gujarati and Porter, 2009). The model emphasises the estimation and prediction of the average value of the response variable in respect of the fixed values of explanatory variables. However, certain relationships in some situations do not follow unidirectional procedure and this usually occurs when there is a multidirectional relationship between the response and some of the explanatory variables.

Multidirectional relationships are mostly inherent in the analysis of the demand for and supply of labour models, where the quantity of labour and wage are mutually dependent variables. Friedman (1962) contends that the analysis of demand is further complicated by the simultaneous reaction of growers to the price, or other resource, change. Hence, a rise in unit price of farm output would induce more production, leading to a change in the quantity of labour needed by farmers and wage, *ceteris paribus*. Parameter estimation involving this model cannot happen without taking into account the full information in both equations and it allows one to estimate structural parameters to induce any changes in a labour market over time.

As a result, parameter estimation, using the OLS model, would violate the assumption of the OLS model and yield inconsistent parameter estimates, as the wage variable would be correlated with the error term. The main assumption in the OLS Model is that all explanatory variables are independently distributed from the stochastic error term. This is based on the fact that the error term on the demand function follows the shift in the demand function and unless the supply function is completely inelastic, the shift in the demand function will change both the quantity of labour and wage. A simultaneous equation procedure also requires the satisfaction of the main critical assumption that exogenous variables are uncorrelated with the error terms of the demand and supply equations (Maddala, 1977).

6.2.1 The 2SLS Technique

A number of methods can be used to estimate simultaneous equation models. They may be classified into single equation (limited information) methods and system or (full information) methods (Maddala, 1977; Gujarati and Porter, 2009). In a single equation method, each equation is estimated separately, using only information about restrictions on parameters of that specific equation, while system methods are based on the joint estimation of all sets of equations, using all restrictions on coefficients of all equations, as well as the variances and covariances of residuals.

One of the system methods commonly used to estimate a simultaneous equation is a 2SLS Model, since it has been designed typically for over-identified equations; however, it can also be used on exactly identified equations. The basis of the 2SLS method is to replace endogenous explanatory variables that are correlated with the error term by a linear combination of all exogenous or predetermined variables by a proxy explanatory variable resembling all endogenous variables and to use it as an explanatory variable during estimation.

The best proxy used should be highly correlated with the endogenous variables that it replaces. The proxy variable is called an instrumental variable and it yields consistent coefficient estimates, as it is uncorrelated with the error term. The application of a 2SLS method is based on a weighted average of multiple solutions and involves two successive applications of the OLS method. Firstly, reduced form equations are estimated by OLS to remove the expected correlation between wage and the error term by the regression of the quantity of labour and wage on exogenous variables.

The actual values of exogenous variables are then substituted into reduced form equations to obtain the proxies for endogenous variables, in order to produce instrumental variables. Secondly, the OLS method is applied on the original structural equations, where the proxies are used to replace endogenous variables to estimate consistent parameters. However, statistical packages have improved over time and nowadays enable users to estimate the model without conducting all of the steps.

6.2.2 Single Equation for Regular Farm Labour Demand Model

As mentioned, the Single Equation for Regular Farm Labour Demand Model estimated using OLS regression does not produce consistent coefficient estimates, due to a higher correlation between some explanatory variables and the error term. However, Maddala (1977) argues that the model has its merits, and it is still crucial to use it to estimate results, since sometimes there is a possibility to say something about the biased direction of the estimates. It has also been indicated that the OLS method is relatively robust against specification errors, when compared to many simultaneous equation methods, and predictions from the equations estimated by the OLS method are often well comparable to those obtained from equations estimated using simultaneous equation methods. Hence, the OLS Model is estimated and the results are presented in Appendix B to enable comparison for estimates.

6.2.3 Partial Adjustment Model (PAM)

The appropriate econometric model has an autoregressive term or lag variable of the quantity of farm labour demanded, where it's coefficient estimate measures the time lag adjustment of labour made by growers over time, to reach the desired quantity of labour in the industry, in response to the continuous rise in the labour costs, as the desired quantity of labour is not directly observed. Mark Nerlov rationalised the PAM Model from Koyck's adaptive expectation model (Gujarati and Porter, 2009). The PAM Model is based on the assumption that the long-run or desired quantity of labour is dependent on the costs of labour and a set of other inputs that are required to produce the desired level of output.

The coefficient estimate represents a fraction of the desired change in the quantity of labour over time, and if the adjustment value is equal to one, it means that the actual change in the quantity of labour is equal to the change in the desire quantity of labour. This suggests an immediate adjustment, while the adjustment value that is equal to zero demonstrates no change, as the level of the quantity of labour at a given time is the same as in the previous period.

The coefficient estimate is expected to fall between zero and less than one, since it is unrealistic to expect growers to make a full adjustment to the desired quantity of labour, due to rigidities caused by, e.g., labour legislations, inertia and technology. The inability to perform immediate retrenchments is due to the need for growers to follow SA's LRA and the nature of sugarcane farming, as a long-term perennial crop, with about a 12- to 24-month production cycle and the roots last for many years. The production cycle makes it difficult for growers to change their farming behaviour or production systems immediately in response to the rising costs of labour.

6.3 Econometric Specification of the Model for Analysis of Farm Labour Market in the Sugar Industry

The preceding discussion suggests specification of an appropriate economic model to estimate the demand function for labour in the industry and regions using (6.1) and (6.2) simultaneously.

$Y^{QD}{}_{jkt} = \beta_0 + \beta_1 RWAGE_{jkt} + \beta_2 RCONT_t + \beta_3 RMECH_t + \beta_4 RCHEM_t + \beta_5 RPTON_{kt} + \beta_6 AUC_{kt}$ $+ \beta_7 POLICY_t + \beta_8 Y^{QD}{}_{jkt-1} + U_{1jkt}$ …..…………...…………………………………...…..... (6.1)

$Y^{QS}{}_{jkt} = \beta_9 + \beta_{10} RWAGE_{jkt} + \beta_{11} RALTWAGE_t + \beta_{12} LIFEXP_t + \beta_{13} RPOP_t + \beta_{14} UEMPOP_t +$ U_{2jkt} ...………………………………………………………………………………..… (6.2)

Where in the demand function (6.1):

$Y^{QD}{}_{jkt}$ = Annual quantity of farm labour demanded,

β_0 = Constant term,

$\beta_1 \ldots \beta_8$ = Slope parameters to be estimated,

$RWAGE_{jkt}$ = Real annual average monthly composite wage of farm labour (Rand),

$RCONT_t$ = Real annual price of contractors (Rand),

$RMECH_t$ = Real annual price of machinery and equipment (real price index),

$RCHEM_t$ = Real annual price of farming chemicals (real price index),

$RPTON_{kt}$ = Real average annual price per ton of sugarcane (Rand),

AUC_{kt} = Area under sugarcane plantation (hectares),

$POLICY_t$ = Dummy variable (where 1 is for 1994-2012 and 0 otherwise),

Y^{QD}_{jkt-1} = Lagged annual quantity of farm labour demanded,

U_{1jkt} = Error term,

j = 1, 2, 3, 4 (Driver = 1, Cutters = 2, Permanent Labour = 3, Seasonal Labour = 4),

k = 1, 2, 3 (Industry = 1, Midlands = 2, South Coast = 3), and

t = 1…..35 (1978 - 2012).

And where in the supply function (6.2):

Y^{QS}_{jkt} = Annual quantity of farm labour supplied,

β_9 = Constant term,

$\beta_{10} \ldots \beta_{14}$ = Supply equation slope parameters to be estimated,

$RWAGE_{jkt}$ = Real annual average monthly composite wage of farm labour (Rand),

$RALTWAGE_t$ = Real annual alternative wage (real wage index),

$LIFEXP_t$ = Life expectancy in SA (in years),

$RPOP_t$ = Rural population in SA

$UEMPOP_t$ = Annual unemployment rate in SA,

U_{2jkt} = Error term,

j = 1, 2, 3, 4 (Driver = 1, Cutters = 2, Permanent Labour = 3, Seasonal Labour = 4)

k = 1, 2, 3 (Industry = 1, Midlands = 2, South Coast = 3), and

t = 1…..35 (1978-2012).

6.3.1 Choice of variables and a *priori* expected coefficient signs in the regular farm labour demand function

(a) Quantity of farm labour demanded (Y^{QD}_{jkt}) and real monthly composite wages ($RWAGE_{jkt}$) in sugarcane farming

The industry farm labour data available for this study span a period of 35 years (1978 – 2012), while the data for the two regions span a period of 34 years (1979 – 2012), which presents relatively small time series. Gujarati and Porter (2010) obtained improved estimated regression results by increasing their sample size from 10 to 40 observations. The data is not differentiated by gender. The labour units or full-time equivalent farm works (FTEs) estimate for selected labour categories are used, rather than total employment, as they provide a conservative or standardised estimate of all labour categories employment, by expressing labour as having worked for 12 months and 300 working days, inclusive of annual and sick leave days. The Drivers category was selected to represent semi-skilled labour, while the Cutters/Stackers category was selected due to the importance of harvesting activities in sugarcane farming.

The Drivers and Cutters categories are respectively made up of (Heavy/Lorry/ Ridge, Loader Operator and Tractor Drivers) and (Cutters and Stackers). The Permanent and Seasonal labour categories were chosen to represent the relatively unskilled component of the labour market at different levels. However, the two categories are often substitutes for one another, given differentiated conditions they experience. The Permanent labour category consists of field workers performing irrigation, chemicals application and other field-related activities, while seasonal labour consists mainly of seasonal (Togt) labour. Only these categories are used to estimate aggregate employment in the industry and regions, which excludes non-farm field workers (cooks, security, general staff, etc.) and highly skilled labour (clerk, farm managers, etc.).

The composite wages were adjusted for inflation using the CPI and are expressed in 2012 Rands. The estimated average real monthly composite wage can be expected to inflict a negative impact on labour employment and the demand curve for labour is expected to be negatively sloped i.e. $\beta_1<0$, *ceteris paribus*.

(b) Real annual price of contractors ($RCONT_t$)

The $RCONT_t$ is important because farmers often hire labour or mechanisation contractors for certain services. However, when the real costs of farm labour increases, they are likely to replace their labour with contractors even for activities that they traditionally used their labour. To support the latter, Newman *et al.* (1997), Goedecke and Ortmann (1993), and Murray and van Walbeek (2007) hypothesised the possibility of an increase in utilisation of contractors as the real costs of labour continue to increase. The utilisation of contractors is probably as a result of market failure to appropriately allocate farm labour, due to labour-related legislations. The strength of contractor utilisation will depend on the continuous strength of labour-related legislations, as it is relatively easy to get rid of poor performing contractors, compared to labour.

Sparrow *et al.* (2008) argued that an increase (decrease) in contractor chargers is likely to result in an increase (decrease) in the demand for labour in the industry, i.e. $\beta_2>0$, *ceteris paribus*. Contracting by LSG is likely to be stronger in areas with a higher number of service providers, as competition leads to competitive service and fees.

(c) Real price index of machinery and equipment ($RMECH_t$)

The real interest rate has mostly been used as the cost or price of capital when studding the demand for farm labour, since it is used by central banks to control the availability of money in an economy. The standard theory suggests that the demand for capital in an economy is likely to increase (decrease) when the real interest rates are low (high). Sparrow *et al.* (2008) used the real annual prime overdraft interest rate as a proxy for the price of capital and their findings indicated replacement of farm labour with mechanisation in the farm sector.

The price index of machinery and equipment ($RMECH_t$) was considered after noticing a negative correlation coefficient between the real interest rate and the Y^D_{jkt}. Therefore, an increase (decrease) in the $RMECH_t$ is expected to result in less (more) mechanisation, leading to higher (lower) Y^D_{jkt}, i.e. $\beta_3>0$, *ceteris paribus*. The impact of mechanisation is expected to be more visible in the Midlands, especially the northern part of the region, due to the relatively more conducive terrains. However, the correlation coefficient between $RMECH_t$ and Y^D_{jkt} was also unfavourable, which meant that both the real interest rate and $RMECH_t$ are not suitable. The inappropriate correlation coefficients mean that the trend between the real interest rate and $RMECH_t$, and Y^D_{jkt} are not in line with *a priori* expectation, which may suggest less replacement of farm labour with mechanisation over the study period. The correlation matrix of the industry data is presented in Appendix B1 as an example to show the inappropriate correlation.

(d) Real price index of chemicals ($RCHEM_t$)

Sparrow *et al.* (2008) used the real annual price index of chemicals to explain the demand for farm labour in SA. All visited growers also indicated more performance of spot and boom spray (depending on terrain convenience), rather than hand hoeing during weeding. Hence, an increase (decrease) in the price of chemicals is expected to result in less (more) chemicals application, compared to labour, i.e. $\beta_4>0$, *ceteris paribus*. The impact is likely to be noticed across the industry, since the knapsack or boom sprayer can be easily used as a substitute for hand hoeing.

(e) Real average annual price per ton of sugarcane ($\mathbf{RPTON}_{kt}$)

The variable was used to determine the impact of sugarcane farming income on the quantity of labour demand. Conradie (2005) found a positive relationship between output and the demand for labour, while Latt and Nieuwoudt (1985) and Sparrow *et al.* (2008) showed a positive relationship between product gross value and the demand for labour. Schuh (1962) also presented a positive relationship between the demand for labour and product price in the USA. Therefore, an increase (decrease) in the price of sugarcane is expected to increase (decrease) the demand for labour, i.e. $\beta_5>0$, *ceteris paribus*. The regions in the industry are expected to experience different sugarcane prices and VMPs, as the price of sugarcane is influenced by the quality of sugarcane (RV). Hence, the Midlands is expected to experience a relatively higher sugarcane price, due to good growing conditions, which makes the region better resourced to absorb high labour wages.

(f) The annual area under sugarcane ($\mathbf{AUC}_{kt}$)

The variable was used to measure the impact of change in farming extent on the demand for labour in the industry, given the fact that sugarcane is an extensive operation and labour-intensive. The change in AUC is dependent on the strength of competition between sugarcane and other enterprises for quality farmland, which is expected to impact on the demand for labour. The competition has become stronger in recent decades after deregulation and withdrawal of various supports to the farming sector. In general, the estimated average employment multiplier in the industry is about 0.25 (one labour per four hectares) (SACGA, 2014), in other words, an increase of four hectares under sugarcane is likely to increase employment in sugarcane farming by one employee. However, this multiplier is expected to differ by region, as some regions are relatively undulating (flat), which makes them less (more) convenient for mechanisation, and in turn more (less) labour-intensive. Hence, the impact of the variable on the demand for labour is expected to be positive, i.e. $\beta_6>0$, *ceteris paribus*.

(g) Slope dummy variable to proxy the impact of the anticipated and actual change in labour-related policies in SA Sugarcane Farming ($POLICY_t$)

In econometric modelling sometimes the behaviour of the dependent variable is often not only influenced by quantitative variables, e.g. wage, but also influenced by qualitative variables, such as gender, legislation, etc., (Gujarati and Porter, 2009). A dummy variable has mostly been used to account for the structural change, as a result of factors outside market determination. Sparrow *et al.* (2008) used a dummy variable to account for the change in the demand for labour, due to the change in labour legislation since 1991. The null hypothesis test for this variable is that there is no structural change in the demand for labour, as a result of anticipated and actual change in labour-related policies (BCEA) post-1994 (i.e. during the period 1994-2012). The impact is determined by estimating elasticities pre-1994 and post-1994. It is expected that $\beta_7<0$ as anticipated and actual policy change has increased labour cost, *ceteris paribus*. The impact of the variable is expected to be strong in the Midlands relative to South Coast due to the relatively convenient terrains. However, secular job shedding is expected in the South Coast in the event of relatively suitable technology discovery.

(h) Lagged quantity of farm labour units demanded per annum ($Y^{D}_{jk\,t-1}$)

The autoregressive variable is used to account for the time taken by growers to adjust their labour requirement, and a model without the variable assumes that the labour market completely adjusts immediately, e.g., one year (Gardner, 1972). Sparrow *et al.* (2008) used the variable to measure the adjustment of annual labour utilisation made by farmers in SA. The variable is important as it acknowledges the inability of growers to make immediate changes, to achieve their labour requirements in response to external factors, e.g. legislation. The adjustment is expected to take time due to rigidity, inertia, technology and labour regulations. This is due to the fact that secular job shedding needs to happen in line with SA's LRA and technology is not yet refined enough to improve its substitution ability. Sugarcane is a perennial crop with a growing cycle ranging between about 12- and 24-months, depending on the region. Given the 10% replanting rate per season, it is evident that it will take time for growers to fully change row spacing and lay fields as is required for adopting mechanical harvesting technologies. Therefore, $\beta_8 > 0$ is expected, where the estimated adjustment factor (δ) from β_8 is expected to fall between 0 and 1, to show annual employment adjustment (Gujarati and Porter, 2009).

6.3.2 Choice of variables and *a priori* expected coefficient signs in the regular farm labour supply function

(a) Real monthly basic wages of farm labour in the industry ($RWAGE_{jkt}$)

This variable was defined in the demand function variables and a positive sloping supply curve is expected for the industry's labour market, implying that $\beta_{10}>0$, *ceteris paribus*.

(b) Real composite monthly alternative wage index for employees in the steel industry ($RALTWAGE_t$)

The variable is important to represent non-farm wages and the availability of non-farm job opportunities. According to Gardner (1972), a broad index of non-farm wages is not a good measure due to schooling, work experience and other characteristics variance that would reduce the possibility of farm labour to find employment elsewhere. A narrow index would also not be a good measure, given the low availability of options and evolvement over time. Hence, it is important to account for the latter factors, in order for the variable to impact on farm labour supply. Gardner (1972) opted to use wages of manufacturing workers, as a measure of expected non-farm earnings available to farm labour, while in SA Ardington (1976, as cited by Latt and Nieuwoudt, 1985), suggested existence of a strong competition between agricultural, industrial and mining sectors. For this reason, the wage index (Rates E to H = Semi skilled, unskilled general labourers) obtained from SEIFSA (2014) was used as a proxy of an alternative wage available for farm labour, as it satisfies suggested sectors. The SEIFSA is an institution that represents the metal and engineering industry. Similarly, the alternative wage is inclusive of the basic wage and supplementary benefits as prescribed in the agreement. The impact of the variable on the supply of labour is expected to be negative i.e., $\beta_{11}>0$, *ceteris paribus.*

(c) Life Expectancy ($LIFE_t$)

Sparrow *et al.* (2008) used a life expectancy variable to measure the impact of morbidity on the supply of farm labour. They justified their use of the variable based on the spread of HIV/AIDS epidemic since the 1980s and its momentum in the early 2000s, as statistical material indicated a drop in life expectancy in SA from 63 to 48 years between 1989 and 2004. Their argument was based on the higher vulnerability of the rural community to HIV/AIDS and related diseases, due to limited education about the disease and in adequate health services in rural areas. However, awareness, treatment of HIV/AIDS and related diseases has improved in recent years.

The World Bank life expectancy data show an average of 57 years in SA, between 1978 and 2012, with a peak of 62 years in the early 1990s. The STATSSA's mid-year 2014 life expectancy report show an improvement to 59.6 years and a change in population composition from youth to adult base. Despite this improvement, the variable still has an impact on farm labour supply, as the rural community still face health service access challenges. *A priori*, β_{12} is expected to be positive.

(d) Rural Population ($RPOP_t$)

The supply of farm labour is highly dependent on changes in the rural population. It would be an ideal variable if the data were production or provincial area specific. However, due to the non-availability of a reasonable time series data of at least rural population by province from STATSSA, SA rural population data is the only option. While it can be argued as a broad and biased proxy, KZN accounts for a larger proportion of the rural population, which means it is likely to follow KZN rural population trends. *A priori*, β_{13} is expected to be positive.

(e) Annual unemployment rate ($UEMPOP_t$)

Both Schuh (1962) and Gardner (1972) used the variable to adjust the alternative wage, to account for unavailability of non-farm employment, by multiplying non-farm wage by one minus the unemployment rate. Schuh (1962) initially used the variable without adjustment and found it statistically ineffective, as correction results in average income of both the employed and unemployed proportion of the labour force, where the unemployed have a zero income. The unemployment rate accounts for the probability of obtaining non-farm employment opportunities and can be expected to approach zero as the unemployment rate increases. Sparrow *et al.* (2008) computed the unemployment rate as the proportion of the unemployed population in the SA total population. As a result, a higher unemployment rate would increase the supply of labour in the farming sector, which implies that $\beta_{14}>0$, *ceteris paribus*.

6.4 Empirical Simultaneous-Equation Regression

The economic model presents a structural change in the demand for labour in the industry estimated using a 2SLS technique. The empirical model excludes the $RCONT_t$ and $UEMPOP_t$ variables, due to the unavailability of a good proxy of contractor charges and the unreliability of using the national unemployment data to estimate an industry and regional models.

The wage variable was treated as an endogenous variable determined by the intersection of the demand and supply functions, despite it being influenced by the SD of farm workers since 2003, as a large proportion of the time series is made up of the years before introduction of the SD, e.g. 1978 to 2002 (25 years), compared to 2003 to 2012 (10 years). The SD guidelines also provide farmers with an opportunity to pay less than the full minimum wage, by accounting for non-cash payments limited to 20%. Furthermore, the minimum wage is set hourly, daily, weekly and monthly, which allows growers to control the amount that they can pay labour through labour adjustment at the intensive margin by cutting working hours or days. Therefore, the equilibrium quantity of labour demanded can be estimated simultaneously using the demand and supply functions, where the wage is determined endogenously as:

$$Y^{QD}_{jkt} = \beta_0 + \beta_1 RWAGE_{jkt} + \beta_4 RCHEM_t + \beta_5 RPTON_{kt} + \beta_6 AUC_{kt} + \beta_7 POLICY_t + \beta_8 Y^D_{jkt-1} + U_{1jkt} \quad (6.3)$$

$$Y^{QS}_{jkt} = \beta_9 + \beta_{10} RWAGE_{jkt} + \beta_{11} RALTWAGE_t + \beta_{12} LIFEXP_t + RPOP_t + U_{2jkt} \quad (6.4)$$

High levels of collinearity are anticipated in the dataset, which poses challenges for estimating the econometric model. The next section explains the problem of multicollinearity and how it may be detected and how to remedy the problems of multicollinearity.

6.5 Multicollinearity

A multiple regression is used to fit data sets with multiple variables to predict and explain a relationship between the dependent and multiple explanatory variables. However, in order for the estimated relationship and prediction to be meaningful, the underlying regression assumptions must be satisfied (Tu *et al.*, 2004). The important assumption relevant to multicollinearity requires that all explanatory variables must be linearly independent from one another. If the assumption is not satisfied, the estimated regression coefficients will likely have a higher variance, standard error and an inconsistent sign. Maddala (1977) suggested that collinearity is not a problem, unless if its strength is stronger, relative to multiple correlation. Furthermore, multicollinearity is a problem for coefficient estimates, but not for prediction purposes, especially when the collinearity between explanatory variables is stable.

A strong collinearity makes it difficult to separate the influence of each explanatory variable on the response variable, and to estimate coefficients with precision. The coefficient estimates are subjected to huge changes, even when a small change is made on one observation. If the assumption of nonlinear dependence between explanatory variables is satisfied, the coefficient estimates can only change when the scale of explanatory variables are changed. There are various methods that can be used to address multicollinearity, but each technique is dependent on the attributes of the problem, as multicollinearity is often mistaken for model specification. There are also various indicators that are used to examine the extent of multicollinearity in a data set. However, they are not meaningful since multicollinearity is a problem associated with the behaviour of explanatory variables in drawn samples, rather than the population from which they are drawn (Maddala, 1977).

6.5.1 Multicollinearity Detection

A number of methods can be used to detect multicollinearity, however, only a select few that were applies in this study are are briefly discussed in this section. The pairwise correlation matrix is widely used to determine the strength of a linear association between the response and independent variables, to determine conformity with *a priori* expectation, and to examine the presence and degree of collinearity between the explanatory variables. According to Maddala (1977), using a simple correlation to examine the strength of collinearity may only be appropriate for a data set with two explanatory variables, since in a data set with many explanatory variables sometimes a simple correlation may indicate low or acceptable level of collinearity, while multicollinearity is very serious.

The magnitude of R^2, the coefficient of determination, can also guide suspicion or detection of multicollinearity (Maddala, 1977; Gujarati and Porter, 2009). The R^2 statistic indicates the variability of farm labour employment explained by the model in the industry and regions. A model with a relatively high R^2, but with few or no statistical significant explanatory variables due to high variances and standard errors, compared to the coefficient estimates, and either with incorrect or correct signs but with less meaningful coefficient estimates, may suggest the presence of strong collinearity. According to Maddala (1977) and Gujarati and Porter (2009), if the R^2 is less than R^2_{x1x2}, it can be concluded that there is strong collinearity; this criteria is known as Klein's rule. However, this procedure sometimes can be misleading, as sometimes the R^2 is greater than R^2_{x1x2}, while other procedures show strong presence of collinearity. Another indicator is the variance inflation factor (VIF), which is the diagonal element of the inverse of the correlation matrix. The general rule of thumb is that a VIF greater than or equal to 10 indicates severe multicollinearity.

6.6 PCA Regression Methodology

The PCA Regression method may be used to identify and attempt to address collinearity problems between explanatory variables, by identifying explanatory variables that are a major source of multicollinearity and variability. The application of the model is based on Chatterjee and Price (1977). The procedure is based on utilisation of a subset of PCs, while retaining all original explanatory variables, given that each PC is a linear combination of all explanatory variables (Hadi and Ling, 1998; Rook e*t al.*, 1990). Empirical applications of the PCA Regression method include Rook *et al.* (1990), Khuele and Darroch (1997), Tu *et al.* (2005) and Lin *et al.* (2006).

The PCA regression method entails use of the OLS Model to regress the standardised dependent variable on selected PCs (Draper and Smith, 1981; Hadi and Ling, 1998). This is necessary as it follows that the estimated linear regression model using orthogonal variables can be restated in terms of original explanatory variables using mathematical and statistical concepts. However, these orthogonal variables are often difficult to interpret, since they are a linear combination of original variables. The PCs are a set of p variables, which are a linear combination of p original explanatory variables, and the number of PCs is equivalent to the number of explanatory variables. The presentation of the technique in this section is based on Chatterjee and Price (1977) and an application by Rook e*t al.* (1990):

$$W = XC \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6.5)$$

Where W = n X p matrix of PCs; X = n X p matrix of original variables; C = p X p matrix satisfying $C'(X'X)\ C = \Lambda$ and $C'C = CC' = I$; Λ = diagonal matrix of the ordered eigenvalues ($\lambda_1 \geq \lambda_1 \ldots . \ \lambda_k$) of X'X; n = number of samples. The columns of C are the normalized loading factors associated with respective eigenvalues. The PCs were obtained using all original explanatory variables for the industry and regional data sets.

The loading factors are examined to identify explanatory variables that are strongly linearly related, which gives a clear indication of the explanatory variables that provide major variability and multicollinearity within the data sets. The eigenvalues (λ_i) are also examined and each eigenvalue (λ_i) is considered as a sample variance measure of a given PC, which means the variability of explanatory variables captured by each PC. The closer the eigenvalue is to zero ($\lambda_i < 0.01$), the more observations associated with the PCs will be closer to zero (Chatterjee and Price, 1977).

The eigenvalues that are closer to zero indicate a strong level of collinearity between explanatory variables captured by the PCs that correspond to the eigenvalues with smaller values. It is possible to identify variables contributing significantly to collinearity through observation of the loading factors that correspond to each PC and smaller eigenvalues. The correlation between the PC scores and the quantity of labour demanded can also be used to indicate the source of variability between explanatory variables. This is achieved by examining the loading factors associated with each PC, to identify variables dominating each PC. In (6.5) $W = XC$ and the original regression model is presented as follows:

$$Y = b_0 + b_1X_1 + \ldots\ldots + b_pX_p \qquad (6.6)$$

And can be restated in standardised form as:

$$Y = X\beta + u \qquad (6.7)$$

Where β is a p x 1 vector of regression coefficients and u is an n X 1vector of residuals. It is assumed that $E(u) = 0$, $E(uu') = \sigma^2 I$ and that X and Y have been centred and scaled so that $X'X$ and $X'Y$ are matrices of correlation coefficients to satisfy C matrix in (6.5). Therefore, the model can be restated in terms of PCs as:

$$Y = W\alpha + u \qquad (6.8)$$

Where $W = XC$ and $\alpha = C'\beta$. Hence, it is possible to calculate the regression coefficients in terms of the PCs (α) and restate them in terms of the β using the relationship $\beta = C\alpha$. If there are PCs with small eigenvalues, serious collinearity is eminent, which cannot be resolved by the procedure. However, collinearity can be removed by excluding PCs with smaller eigenvalues, when regressing the standardised dependent variable on selected PCs, which sets the contribution of other PCs with smaller eigenvalues to variables to zero. If all PCs are used, estimated results will be exactly the same as those from the original model and the collinearity problem is not addressed. As much as it is more attractive to use a subset of PCs with larger eigenvalues, the procedure uses less than full information, depending on the amount of variability accounted by the few eigenvalues of selected PCs (Chatterjee and Price, 1977; Rook et *al.*, 1990).

Despite using less than full information, estimating the coefficient of each original explanatory variable is possible, since the reduced model can be restated in terms of the original model as discussed. The coefficient estimate of each original explanatory variable is achieved by multiplying each respective coefficient estimate of the explanatory variable by the division of the standard deviations of the dependent and respective explanatory variable, i.e., $b_i = \tilde{b}_i\,(s_y/s_{xi})$. It should be noted that the computed t values for testing the null hypothesis of b_i and $\tilde{b}_i$ equal to zero are identical and the $\tilde{b}_i$ is a scaled version of the b_i. Hence, when constructing t values as either b_i/s_{bi} or $\tilde{b}_i/s_{\tilde{b}i}$, the scaling factor is cancelled (Chatterjee and Price, 1977; Chatterjee and Hadi, 2006; Chatterjee and Hadi, 2012).

Computation of the intercept term is explained in Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012). The estimation is done only after the coefficient estimates of the explanatory variables are adjusted to their original state. Hence, the estimation of the intercept coefficient is as follows:

$$Y - \bar{y} = \beta_1(X_1 - \bar{X}_1) + \beta_2(X_2 - \bar{X}_2) + \cdots\cdots\cdots + \beta_p(X_p - \bar{X}_p) \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(6.9)}$$

Where Y and y are the observation and mean of the dependent variable and X, $\bar{X}$ and β are the observation, mean and the restated coefficient estimate of each explanatory variable.

Mathematically, (6.9) can be represented as:

$$Y = \bar{y} - (\beta_1\bar{X}_1 + \beta_2\bar{X}_2 + \beta_p\bar{X}_p) + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_pX_p \quad \ldots\ldots\ldots\ldots\ldots \text{(6.10)}$$

Where the intercept can simply be obtained from the following equation:

$$\beta_0 = \bar{y} - (\beta_1\bar{X}_1 + \ldots\ldots\ldots + \beta_p\bar{X}_p) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6.11)}$$

The constant does not appear clearly in (6.11), hence when dealing with no-intercept models, one only need to scale the data. The relationship between the estimates, $\beta_1, \beta_2, \beta_p$, obtained using the original data and those obtained using the standardised data is given by:

$\beta_i = \tilde{b}_i\,(s_y/s_{xi})$, $\quad i = 1, 2, 3, 4, p$,

$\beta_0 = \bar{y} - \sum_{i=1}^{5} \beta i \bar{X}\iota$, ……………………………………………………………..….. (6.12)

Reducing the level of collinearity using the procedure may result in coefficient estimate signs that are stable and consistent with theoretical expectation. The results can be better interpreted, compared to the results obtained using the original model. Maddala (1992) and Draper and Smith (1981) highlighted the following considerations regarding use of the procedure:

- The first PC usually accounts for a higher proportion of the variability of explanatory variables, but it may not be highly correlated with the dependent variable and the order of PCs does not suggest the strength of correlation between the PC and dependent variable. However, according to Draper and Smith (1981), the order of selection is irrelevant, given that all the PCs are orthogonal to one another and the fitted equation can be restated back into original explanatory variables.
- One might find it compelling to use PCs that are highly correlated with the dependent variable and leave out other PCs. However, the same procedure can be used to select original explanatory variables based on their correlation with the dependent variable.
- Sometimes it is difficult to attach economic interpretation to the linear combination of PCs.
- A change in unit measurement of explanatory variables will result in a change in PCs.

If the eigenvalues of the first two, three or few PCs can account for a large proportion of the total variability of explanatory variables, the methodology can yield reliable results and show original variables that provide major variability. However, Hadi and Ling (1998) argue that the PCR sometimes may fail, as theory suggests removal of the last PC, yet it might be contributing everything to the fit with the dependent variable. They used an example to show the possibility of the first few PCs to account for almost, if not all, of the total variability of the explanatory variables, but poorly explain the variability of the dependent variable, which may fit perfectly with the last PC. The scatter plot of the residuals against each PC also showed a perfect linear relationship with the last PC. Hence, to avoid PCR failure, they suggested the selection of PCs to also account for their contribution to the regression sum of squares, rather than mainly focussing only on PC variance decomposition. Lin *et al.* (2006) also suggested selection of statistically significant PCs only. While taking nothing away from all the arguments, the interpretability of the PCs is important and each choice should depend on the objective of the researcher and the nature of the problem with the data set.

CHAPTER 7: EMPIRICAL RESULTS

Having developed a suitable econometric methodology to analyse the time series wage and employment data with data of other appropriate predictor variables in Chapter 6, this chapter presents the results of the econometric analysis. Because multicollinearity is anticipated in the dataset, the chapter starts with an analysis of correlation amongst the variables used in the analysis in section one and two. Having confirmed the presence of multicollinearity in the dataset, the third section presents results of the 2SLS regression analyses of the demand for farm labour. The fourth section outlines the procedural estimation of the coefficients of appropriate predictor variables and the constant term using the PCA regression analysis of the demand for farm labour as an approach to remedy the collinearity, while the final section presents the estimated results using the PCA regression analysis. The 2SLS Model estimate results for the supply functions are inflicted with heavy multicollinearity and the PCA procedure did not adequately remedy the problem. Hence, the supply functions estimate results are not presented in this chapter; however, the estimated results of the industry supply equation estimated using the 2SLS model are reported in Appendix C.

7.1 Correlation Matrices for Farm Labour Demand Functions

Table 1 reports correlation coefficients for variables used in estimating the Industry-level demand for labour. It shows a statistically significant (99% level of statistical confidence) negative relationship between the industry $Y^{QD}{}_{jkt}$ and $RWAGE_{jkt}$. The relationship between the $Y^{QD}{}_{jkt}$ and $Y^{QD}{}_{jkt-1}$ is statistically significant (99% level) and positive – this means that farmers have been making labour adjustments of $(1 - \delta) = 1 – 0.9223 = 0.777$, which is about 8%. The same approach is followed for the Midlands and South Coast. The correlation coefficient estimates signs between the Y^{QD}_{jkt} and other explanatory variables are in line with *a priori* expectations, except for $RMECH_t$, hence it was omitted from the analysis. The results also show a strong correlation between the explanatory variables – the $RWAGE_{jkt}$ is negatively related to Y^{QD}_{jkt-1}, while it is positively related to the AUC_{kt} and $POLICY_t$. The Y^{QD}_{jkt-1} and $POLICY_t$ are strongly related to most of the explanatory variables, except for $RPTON_{kt}$ and AUC_{kt}.

Table 1: Industry Aggregate Demand Function Correlation Coefficients Matrix

VARIABLES	Y^{QD}_{jkt}	$RWAGE_{jkt}$	$RCHEM_t$	$RPTON_{kt}$	AUC_{kt}	$POLICY_t$	Y^{QD}_{jkt-1}
Y^{QD}_{jkt}	1						
$RWAGE_{jkt}$	**-0.4312*** **	1					
$RCHEM_t$	**0.5893*** **	-0.3405**	1				
$RPTON_{kt}$	0.0469	0.3041*	0.2474	1			
AUC_{kt}	0.0297	**0.7626*** **	-0.1708	0.2476	1		
$POLICY_t$	**-0.7751*** **	**0.7562*** **	**-0.5603*** **	0.0363	**0.4505*** **	1	
Y^{QD}_{jkt-1}	**0.9223*** **	**-0.4580*** **	**0.5864*** **	0.083	-0.0543	**-0.8296*** **	1

Note: *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence. The subscripts are defined in Chapter 6, similarly for all the results tables in this Chapter, excluding elasticity Table.

Table 2 shows a statistically significant (99% level) negative relationship between the Y^{QD}_{jkt} and $RWAGE_{jkt}$. The correlation coefficient estimate sign between Y^{QD}_{jkt} and Y^{QD}_{jkt-1} is statistically significant (99% level) and positive – this implies farm labour adjustment of about 36% over the study period, which is higher, compared to the industry outcome. The Y^{QD}_{jkt} is also strongly negatively related to $POLICY_t$. The correlation coefficient estimates signs between the Y^{QD}_{jkt} and other explanatory variables are in line with *a priori* expectations. The results also show a strong correlation between the explanatory variables – $RWAGE_{jkt}$ is negatively correlated with the Y^{QD}_{jkt-1} and positively correlated with $POLICY_t$ and AUC_{kt}. The Y^{QD}_{jkt-1} and $POLICY_t$ are strongly correlated with most of the explanatory variables, except $RPTON_{kt}$ and AUC_{kt}.

Table 2: Midlands Aggregate Demand Function Correlation Coefficients Matrix

VARIABLES	Y^{QD}_{jkt}	$RWAGE_{jkt}$	$RCHEM_t$	$RPTON_{kt}$	AUC_{kt}	$POLICY_t$	Y^{QD}_{jkt-1}
Y^{QD}_{jkt}	1						
$RWAGE_{jkt}$	-0.3015*	1					
$RCHEM_t$	**0.5493***	-0.3731**	1				
$RPTON_{kt}$	0.0013	0.1665	0.1368	1			
AUC_{kt}	0.2724	**0.4258**	-0.0277	0.2478	1		
$POLICY_t$	**-0.6237***	**0.7986***	**-0.5379***	-0.0265	0.1111	1	
Y^{QD}_{jkt-1}	**0.6367***	**-0.4082**	**0.5037***	0.0388	0.1996	**-0.7456***	1

Note: *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence.

Table 3 indicates a statistically insignificant (94.96%) negative relationship between the Y^{QD}_{jkt} and $RWAGE_{jkt}$. The relationship between Y^{QD}_{jkt} and Y^{QD}_{jkt-1} is statistically significant (99% level) and positive – which implies about 13% of farm labour adjustment over the study period. The magnitude is lower (higher), relative to the Midland (industry), respectively, which is in line with expectation. The Y^{QD}_{jkt} is also strongly positively related to the $RCHEM_t$ and AUC_{kt}. The relationship between Y^{QD}_{jkt} and other explanatory variables are in line with *a priori* expectations. The results also show a strong correlation between the explanatory variables – $RWAGE_{jkt}$ is negatively related to the AUC_{kt}, and positively related to the $POLICY_t$. The Y^{QD}_{jkt-1} and $POLICY_t$ are strongly related to most of the explanatory variables, except $RPTON_{kt}$.

Table 3: South Coast Aggregate Demand Function Correlation Coefficients Matrix

VARIABLES	Y^{QD}_{jkt}	$RWAGE_{jkt}$	$RCHEM_t$	$RPTON_{kt}$	AUC_{kt}	$POLICY_t$	Y^{QD}_{jkt-1}
Y^{QD}_{jkt}	1						
$RWAGE_{jkt}$	-0.3383	1					
$RCHEM_t$	**0.5478***	-0.3128*	1				
$RPTON_{kt}$	0.1716	0.3896**	0.1878	1			
AUC_{kt}	**0.7490***	**-0.5080***	**0.4401***	0.1185	1		
$POLICY_t$	**-0.7795***	**0.6523***	**-0.5379***	0.0436	**-0.7958***	1	
Y^{QD}_{jkt-1}	**0.8658***	-0.3784**	**0.5880***	0.1319	**0.7956***	**-0.8341***	1

Note: *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence.

7.2 Correlation Matrices for Farm Labour Supply Functions

Table 4 show correlation coefficients between the variables used in the industry and regional supply functions over the study period. The estimate results show a strong positive correlation between $RWAGE_{jkt}$ and $RALTWAGE_t$, which is consistent with the findings from Latt and Nieuwoudt (1985). This suggests that wages in the sugar industry moved in sympathy (similar rate) with wages in the steel industry over study period, since it is important to ensure labour supply in these industries, as there is strong competition for labour between the farm and non-farm sectors, given that they absorb most of the unskilled labour. It is worth noting the similar correlation coefficient estimate strength between the industry and South Coast, which is relatively higher compared to the Midlands. This was expected, given that the Midlands has relatively more competitive sectors for labour and is more conducive for mechanisation.

The results indicate a statistically strong relationship between $RWAGE_{jkt}$ and $RALTWAGE_t$ and $LIFE_t$ and $RPOP_t$. These relationships suggest that an increase in rural population and improvement in life expectancy results in a decrease in sugarcane farming and steel industry wages. This is possible, as an increase in rural population would raise the supply of labour in these industries; and an improvement in life expectancy would increase the number of old people in employment, who are usually relatively unproductive and expected to earn lower wages, especially when they are paid hourly wages. The negative (positive) correlation between Y^{QS}_{jkt}, and $RWAGE_{jkt}$ and $RALTWAGE_t$, and $LIFE_t$ and $RPOP_t$ are, respectively also in line with *a priori* expectations in sugarcane farming.

Table 4: Aggregate Supply Function Correlation Coefficients Matrices

Industry Correlation Coefficients Matrix					
VARIABLES	$\mathbf{Y^{QS}_{jkt}}$	**RWAGE**$_{jkt}$	**RALTWAGE**$_t$	**LIFE**$_t$	**RPOP**$_t$
$\mathbf{Y^{QS}_{jkt}}$	1				
RWAGE$_{jkt}$	**-0.431*** **	1			
RALTWAGE$_t$	-0.396**	**0.963*** **	1		
LIFE$_t$	0.137	**-0.801*** **	**-0.786*** **	1	
RPOP$_t$	**0.736*** **	**-0.897*** **	**-0.884*** **	**0.633*** **	1
Midlands Correlation Coefficients Matrix					
VARIABLES	$\mathbf{Y^{QS}_{jkt}}$	**RWAGE**$_{jkt}$	**RALTWAGE**$_t$	**LIFE**$_t$	**RPOP**$_t$
$\mathbf{Y^{QS}_{jkt}}$	1				
RWAGE$_{jkt}$	-0.324*	1			
RALTWAGE$_t$	-0.2624	**0.9468*** **	1		
LIFE$_t$	0.0763	**-0.7821*** **	**-0.8061*** **	1	
RPOP$_t$	**0.5608*** **	**-0.9240*** **	**-0.8845*** **	**0.6716*** **	1
South Coast Correlation Coefficients Matrix (K = 3)					
VARIABLES	$\mathbf{Y^{QS}_{jkt}}$	**RWAGE**$_{jkt}$	**RALTWAGE**$_t$	**LIFE**$_t$	**RPOP**$_t$
$\mathbf{Y^{QS}_{jkt}}$	1				
RWAGE$_{jkt}$	-0.338*	1			
RALTWAGE$_t$	**-0.452*** **	**0.963*** **	1		
LIFE$_t$	0.264	**-0.851***	**-0.806***	1	
RPOP$_t$	**0.756*** **	**-0.826***	**-0.885***	**0.672***	1

Note: *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence.

Table 5 presents the correlation coefficients between the RWAGE$_{jkt}$ and RALTWAGE$_t$ for labour categories in sugarcane farming and sugarcane farming regions over the study period. All estimated coefficients in the table for drivers and cutters, and permanent and seasonal labour are respectively less (greater) than the aggregate coefficient estimates of the industry as whole and the regions. The findings are in line with *a priori* expectations. However, it is worth noting the lower coefficient estimates for drivers, relative to cutters in the industry, which probably exhibits the relatively low supply of cutters, compared to drivers in sugarcane farming. The coefficient estimates of permanent and seasonal labour on the South Coast are higher, relative to the industry as whole and the Midlands, espectively the Midlands, which is expected given the farming conditions in the region.

Table 5: Correlation Coefficients Between Real Farm Wages and Alternative Wage

Labour Categories	Industry (K = 1)	Midlands (K = 1)	South Coast (K = 3)
Drivers (J = 1)	0.939***	0.942***	0.833***
Cutters (J = 2)	0.906***	0.861***	0.861***
Permanent Labour (J = 3)	0.968***	0.961***	0.980***
Seasonal Labour (J = 4)	0.970***	0.916***	0.980***

Note: *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence.

7.3 Estimated Empirical Results of Farm Labour Demand Models

The 2SLS Model results reported in Table 6 were estimated using STATA 11 (2009). The results show mixed signs of coefficient estimates of the predictor variables, where some are in (not in) line with *a priori* expectations. The results also show high adjusted R^2 in all models, ranging from 71.34% to 98.24%, but with very few statistically significant coefficient estimates of the predictor variables. The estimated F statistics that ranges between 10.95 and 230.82 are highly statistically significant (at the 1% level of probability), which means that all the predictor variables *as a group* influence various sugarcane farming demand models.

However, the estimated mean VIFs of each estimated model are less than 10, the indicator of severe multicollinearity. The VIFs of each predictor variable in each estimated model were also below the indicator level, but with relatively high VIF values for the $RWAGE_{jkt}$, $POLICY_t$ and Y^{QD}_{jkt-1} variables. Despite the lower mean VIFs, there is enough evidence to suggest the presence of multicollinearity in all data sets, as other indicators suggest the presence of multicollinearity. Hence, it is not reliable to make a conclusion based on one indicator, which makes it important to explore other possible indicators to guide decision making. For this reason, the results are not interpreted, as it would be impossible to assign the impact of each explanatory variable on the quantity of labour demanded in each model.

Table 6: Estimated Results for Empirical Farm Labour Demand Functions using 2SLS Model, 1978 – 2012

VARIABLES	AGGREGATE EMPLOYMENT			DRIVERS DEMAND (J = 1)			CUTTERS (J = 2)			PERMANENT LABOUR (J = 3)			SEASONAL LABOUR (J = 4)		
	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)
	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)
$RWAGE_{jkt}$	-6.986**	0.344	0.335	0.224	0.096	0.171**	-2.805*	0.531***	0.422	0.257	0.859	0.049	-4.974***	-1.745***	-0.776*
	(-1.97)	(0.42)	(0.38)	(0.64)	(1.2)	(2.26)	(-1.7)	(2.7)	(1.25)	(0.14)	(1.62)	(0.12)	(-3.03)	(-2.98)	(-1.66)
$RCHEM_t$	45.67	53.656**	3.938	-4.746	0.067	0.227	6.819	9.608*	-6.961	138.151***	25.392**	38.285**	-40.762	20.192*	-26.66**
	(0.61)	(2.38)	(0.15)	(-0.61)	(0.02)	(0.1)	(0.28)	(1.78)	(-1.05)	(3.12)	(2.01)	(2.54)	(-1.25)	(1.89)	(-2.04)
$RPTON_{kt}$	-5.837	-6.984**	1.465	-0.006	-0.592	0.466	-8.459**	-2.77***	0.541	-0.892	-2.705	-1.779	5.559	-1.492	4.245*
	(-0.45)	(-2.37)	(0.34)	(0)	(-1.61)	(1.13)	(-1.96)	(-3.89)	(0.5)	(-0.13)	(-1.59)	(-0.77)	(0.97)	(-1.11)	(1.76)
AUC_{kt}	0.151***	0.072***	0.026	0.013***	0.003	0.0002	0.052***	0.008	0.003	0.061***	0.022*	0.011	0.055***	0.035***	0.016
	(3.41)	(2.87)	(1.01)	(2.92)	(0.91)	(0.11)	(3.23)	(1.47)	(0.45)	(2.84)	(1.68)	(0.84)	(3.16)	(2.91)	(1.26)
$POLICY_t$	-2413.276	-1694.935**	-767.63	-626.328**	-69.088	-204.828***	-534.789	-7.69	-72.896	-3647.91***	-1266.921***	-493.284	-931.396	-159.352	-416.627
	(-0.86)	(-2.27)	(-0.87)	(-2.29)	(-0.83)	(-2.96)	(-0.6)	(-0.06)	(-0.32)	(-2.7)	(-2.63)	(-1.15)	(-0.89)	(-0.52)	(-1.13)
Y^{QD}_{jkt-1}	0.633***	0.029	0.571***	0.083	0.383**	0.055	0.620***	0.192*	0.662***	0.177	0.033	0.421**	0.564***	-0.099	0.198
	(4.69)	(0.17)	(3.09)	(0.42)	(2.13)	(0.33)	(4.33)	(1.66)	(4.24)	(1.02)	(0.17)	(2.15)	(4.01)	(-0.47)	(1.35)
CONSTANT	-18067.8*	459.048	1222.925	1294.496	545.886	437.877*	-3561.727*	499.475**	468.736	-13434.94**	-302.863	-1412.359	-4411.694	-539.719	2737.497*
	(-1.77)	(0.19)	(0.44)	(1.07)	(1.48)	(1.68)	(-1)	(0.86)	(0.65)	(-2.42)	(-0.22)	(-1)	(-1.02)	(-0.5)	(1.87)
Adj. R^2	95.55%	93.12%	93.41	89.84%	93.79%	71.39%	84.46%	71.34%	83.02%	97.26%	97.2%	97.41%	98.24%	91.61%	97.93%
F – Value	88.54***	55.16***	57.7***	37.47***	61.4***	10.98***	23.42***	10.95***	20.55***	147.55***	139.9***	151.67***	230.82***	44.67***	189.84***
Mean VIF	4.37	2.87	3.44	3.21	2.44	2.38	3.41	1.68	2.74	4.42	3.17	3.9	3.74	3.14	2.74

Note: [(a)] *t*-statistics values are in parentheses; *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence.

7.4 Principal Component and Regression Analyses

As suggested by theory, the 2SLS Model was used to relate farm labour employment variation to a select of predictor variables, where higher collinearity between explanatory variables resulted in inconsistent coefficient estimates. However, since the estimation of reliable coefficients is important to provide good prediction, contribute towards labour policy and interpretation of the economic impact on employment in a labour-intensive industry, the procedure was applied to improve the quality of estimated results, as presented in Table 6.

7.4.1 Principal Component Analysis and Regression Results

As indicated, the PCA extraction technique was used to reduce the level of multicollinearity in the data sets, following guidelines from Chatterjee and Price (1977), Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012). The selection of retained PCs was based on the Kaiser Criterion (Manly, 1994), as it seemed to produce more favourable results than other prominent criterions. Hence, only two out of six PCs were selected, as it is required that each selected PC must have an eigenvalue greater than one. The procedure is illustrated using the industry aggregate demand for farm labour data and the results for all demand functions are reported in Table 9.

Table 7 shows that the first two PCs explain 76.79% of the total variability in the explanatory variables. The loading factors of these PCs are relatively evenly distributed, compared to the loading factors of the last four PCs (the omitted PCs), as they show highly variable loading factors and dominance by few explanatory variables, which suggest high presence of multicollinearity within these PCs. Hence, an attempt to add at least the third PC was resulting in unfavourable results, even though the PC was only contributing 12.46% more to the total variability accounted by the PCs. It may seem appropriate to consider rotating the PCs to resolve the high dominance in the last four PCs; however, it is relatively less important since the aim is to work back to original dependent variables than improving the interpretation of the PCs, and it would be difficult to work back to original variables after rotation or distort the process.

Table 7: Industry Extracted Principal Components

VARIABLES	PC1	PC2	PC3	PC4	PC5	PC6
$RWAGE_{jkt}$	0.4984	0.3126	0.1108	0.1326	0.7715	-0.1695
$RCHEM_t$	-0.3675	0.4178	-0.1611	0.811	-0.0601	-0.0546
$RPTON_{kt}$	0.0685	0.6101	-0.6571	-0.42	-0.1168	0.037
AUC_{kt}	0.3538	0.466	0.5674	-0.021	-0.5408	-0.2069
$POLICY_t$	0.5392	-0.0916	-0.1467	0.2995	-0.1775	0.7471
Y^{QD}_{jkt-1}	-0.4426	0.3605	0.4319	-0.2411	0.2521	0.6049
EIGENVALUES	3.04395	1.56329	0.747697	0.449765	0.120708	0.074585
% VARIATION	50.73%	26.05%	12.46%	7.50%	2.01%	1.24%
CUMULATIVE %	50.73%	76.79%	89.25%	96.75%	98.76%	100.00%

7.4.2 Standardised Coefficient Estimates Illustration

The standardised aggregate demand function of the industry is estimated using the two selected PCs, where ZY^{QD}_{jkt} (j = 0, k = 1) is the standardised quantity of labour demanded estimated as:

$ZY^{QD}_{jkt} = \alpha_1 PC1 + \alpha_2 PC2$ ……………………………………………..…………………. (7.1)

The estimated aggregate industry demand function:

$ZY^{QD}_{jkt} = -0.3498PC1 + 0.3404PC2$ …………………………………………………....... (7.2)

Following Chatterjee and Price (1977), Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012), procedure, ZY^{QD}_{jkt} is estimated using OLS regression as follows:

$ZY^{QD}_{jkt} = \tilde{b}_1 ZRCWAGE_{jkt} + \tilde{b}_3 ZRCHEMt + \tilde{b}_4 ZRPTON_{kt} + \tilde{b}_5 ZAUC_{kt} + \tilde{b}_6 ZPOLICYt + \tilde{b}_7 ZY^{QD}_{jkt-1} + U_1$ ………..……………...……………………………...……........ (7.3)

Equation 7.5 implies that the $\tilde{b}_i$ coefficient estimates corresponding to each predictor variable can be estimated from equation (7.1) to (7.3) coefficient estimates, using the loading factors of PC1 and PC2 (α_1 and α_2) in Table 7 as follows:

$\tilde{b}_1$ = (0.4984 x -0.3823) + (0.3126 x 0.3328) = -0.0865

$\tilde{b}_2$ = (-0.3675 x -0.3823) + (0.4178 x 0.3328) = 0.2795

$\tilde{b}_3$ = (0.0685 x -0.3823) + (0.6101 x 0.3328) = 0.1768

$\tilde{b}_4$ = (0.3538 x -0.3823) + (0.466 x 0.3328) = 0.0198

$\tilde{b}_5$ = (0.5392 x -0.3823) + (-0.0916 x 0.3328) = -0.2366

$\tilde{b}_6$ = (-0.4426 x -0.3823) + (0.3605 x 0.3328) = 0.2892

7.4.3 Computation of Standard Errors

The standard errors of estimated coefficients are estimated from the standard errors of the estimated standardised demand model as:

s.e.($\tilde{b}_i$) = SQRT ((PC1 x s.e.(α_1))^2 + (PC2 x s.e.(α_2))^2) …………..………………....….. (7.4)

Following the Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012) procedure, the standard error s.e.($\tilde{b}_i$) of each estimated coefficient can be estimated using OLS to regress ZY^{D}_{jkt} on standardised explanatory variables. Equation (7.4) implies that the s.e.($\tilde{b}_i$) of each coefficient estimate corresponding to each predictor variable can be estimated from (7.1) to (7.4) coefficient estimates, using the loading factors of PC1 and PC2 in Table 7:

s.e.($\tilde{b}_1$) = SQRT (((0.4984 x 0.0565) ^2) + ((0.3126 x 0.0788) ^2)) = 0.0014 s.e.($\tilde{b}_2$) = SQRT (((-0.3675 x 0.0565) ^2) + ((0.4178 x 0.0788) ^2)) = 0.0015

s.e.($\tilde{b}_3$) = SQRT (((0.0685 x 0.0565) ^2) + ((0.6101 x 0.0788) ^2)) = 0.0023

s.e.($\tilde{b}_4$) = SQRT (((0.3538 x 0.0565) ^2) + ((0.466 x 0.0788) ^2)) = 0.0017

s.e.($\tilde{b}_5$) = SQRT (((0.5392 x 0.0565) ^2) + ((-0.0916 x 0.0788) ^2)) = 0.0010

s.e.($\tilde{b}_6$) = SQRT (((-0.4426 x 0.0565) ^2) + ((0.3605 x 0.0788) ^2)) = 0.0014

Table 8 presents the summary statistics used to restate the coefficient estimates of the explanatory variables to their original state, and to estimate the constant term demand function.

Table 8: Summary Statistics for Variables used in Industry Aggregate Demand Model

VARIABLES	OBSERVATIONS	MEAN	STD. DEV.	MIN	MAX
$\mathbf{Y^{QD}_{jkt}}$	35	44290.37	8799.22	33776.00	60779.00
$\mathbf{RWAGE_{jkt}}$	35	1330.09	356.99	962.38	2057.87
$\mathbf{RCHEM_t}$	35	86.46	9.10	70.27	104.94
$\mathbf{RPTON_{kt}}$	35	298.98	43.93	223.83	402.54
$\mathbf{AUC_{kt}}$	35	279354.20	21638.56	244108.00	311293.00
$\mathbf{POLICY_t}$	35	0.54	0.51	0.00	1.00
$\mathbf{Y^{QD}_{jkt-1}}$	34	44448.82	8880.72	33776.00	60779.00

7.4.4 Computation of the Original Coefficient Estimates for the Explanatory Variables

As per Chatterjee and Price (1977), Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012), the t value for testing the null hypothesis of b_i and $\tilde{b}_i$ equals to zero are identical and $\tilde{b}_i$ is a scaled version of b_i. Hence, when computing t values as either b_i/s_{bi} or $\tilde{b}_i/s_{\tilde{b}i}$, the scaling factor is cancelled. The b_i can be transformed to its original state by multiplication of $\tilde{b}_i$ and (s_y/s_{xi}), where s_y and s_{xi} are the standard deviations of the dependent and respective predictor variables.

$b_i = \tilde{b}_i\,(s_y/s_{xi})$ …………………………………………………………………...……..… (7.5)

b_1 = -0.0865*(8799.22/356.9943) = -2.132

b_2 = 0.2795*(8799.22/9.0951) = 270.421

b_3 = 0.1768*(8799.22/43.9287) = 35.423

b_4 = 0.0198*(8799.22/21638.56) = 0.008

b_5 = -2366*(8799.22/0.5054) = -4118.951

b_6 = 0.2892*(8799.22/8880.718) = 0.286

7.4.5 Computation of the Constant Term

The coefficient estimate of the constant term is derived from restated coefficient estimates following Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012) as:

$Y = \bar{y} - (\beta_1\bar{X}_1 + \beta_2\bar{X}_2 + \beta_p\bar{X}_p) + \beta_1X_1 + \beta_2X_2 + \cdots + \beta_pX_p$ ……….…………………….……...... (7.6)

Y^{QD}_{jkt} = 44290.37 - (((-2.132)*(-1330.087)) + (270.421*(-86.4638)) + (35.423*(-298.9751)) + (0.008*(-279354.2)) + (-4118.951*(-0.5429)) + (0.286*(-44448.82))) - 2.132RWAGE$_{jkt}$ + 270.421RCHEM$_t$ + 35.423RPTON$_{kt}$ + 0.008AUC$_{kt}$ - 4118.951POLICY$_t$ + 0.286Y^{QD}_{jkt-1}

Therefore, the original industry aggregate quantity of farm labour demand function is presented as:

Y^{QD}_{jkt} = 402.116 – 2.132RWAGE$_{jkt}$ + 270.421RCHEM$_t$ + 35.423RPTON$_{kt}$ + 0.008AUC$_{kt}$ – 4118.951POLICY$_t$ + 0.286Y^{QD}_{jkt-1}

7.5 Principal Component Analysis Regression Results

The estimated regression coefficients for the farm labour demand functions obtained using the Chatterjee and Price (1977), Chatterjee and Hadi (2006) and Chatterjee and Hadi (2012) procedure are reported in Table 9. The estimated regression equations exhibit reduced multicollinearity; evident from the relatively stable coefficient estimates signs and an improvement in their statistical significance. However, the results show a relatively low magnitude of the coefficient estimates of Y^{QD}_{jkt-1}, which may suggest a shorter period of adjustment, relative to *a priori* expectations. Whilst this unexpected finding may have arisen from the loss of information from discarding four out of the six generated PCs, the magnitude of the coefficient estimates of other predictor variables seem relatively in line with expectations.

The estimated adjusted R^2 from all estimated demand functions ranges between 15.88% (drivers demand function) and 68.34% (South Coast aggregate demand for labour function), which show that the specified predictor variables explain about 16% to 68% of the total variability in the aggregate and labour categories (drivers, cutters, permanent and seasonal labour) demand function for farm labour. Given the estimated relatively highly statistically significant F statistics (at the 1% level of probability), the variables in each demand function *as a group* influence the various demand functions for farm labour in sugarcane production.

(a) The Coefficient of Estimate of the Lagged Regressand (Y^{QD}_{jkt-1})

The coefficient estimates of the lagged regressand Y^{QD}_{jkt-1} variable presented in Table 9 have the expected positive sign and are highly statistically significant at the 1% level of probability, with t values ranging between 2.6 and 10.274.

Table 9: Estimated Short-Run Results for Empirical Farm Labour Demand Functions using Chatterjee and Price (1977) Procedure, 1978 – 2012

VARIABLES	AGGREGATE EMPLOYMENT			DRIVERS (J =1)			CUTTERS (J = 2)			PERMANENT LABOUR (J = 3)			SEASONAL LABOUR (J = 4)		
	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)
	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)
RWAGE$_{jkt}$	-2.132**	-0.348*	-0.413	0.128**	0.02	0.056**	-0.236	0.188***	0.52***	-0.459	-0.183	-0.563***	-1.997***	-0.855***	-0.353***
	(-2.312)	(-1.748)	(-1.433)	(2.417)	(1.191)	(2.194)	(-0.615)	(3.67)	(6.222)	(-1.352)	(-1.604)	(-5.516)	(-5.845)	(-5.947)	(-2.874)
RCHEM$_t$	270.421***	37.536***	52.288***	7.743***	0.268	3.115***	61.774***	-2.309	7.607***	111.449***	19.653***	25.044***	76.517***	37.575***	15.406***
	(7.181)	(5.394)	(7.211)	(2.793)	(0.317)	(4.962)	(5.272)	(-0.725)	(3.463)	(8.401)	(5.175)	(5.698)	(3.79)	(6.149)	(4.284)
RPTON$_{kt}$	35.423***	3.556**	6.222**	2.268***	0.354***	0.739***	7.854***	0.687*	3.231***	18.217***	2.117**	0.66	3.624	1.594	1.21
	(3.666)	(2.435)	(2.195)	(4.410)	(2.757)	(3.569)	(3.029)	(1.845)	(7.185)	(5.219)	(2.518)	(0.421)	(0.666)	(0.962)	(0.719)
AUC$_{kt}$	0.008	0.025**	0.038***	0.004***	0.004***	0.002***	0.003	0.008***	0.002	0.011*	0.013**	0.02***	-0.017***	0.003	0.013***
	(0.474)	(1.985)	(8.558)	(3.364)	(2.867)	(4.066)	(0.604)	(3.05)	(1.436)	(1.809)	(1.98)	(9.39)	(-2.572)	(0.254)	(5.698)
POLICY$_t$	-4118.9***	-656.7***	-913.7***	-55.932	-9.332	-36.469***	-955.2***	109.464**	9.81	-1357.9***	-342.39***	-534.6***	-1602.5***	-785.6***	-330.18***
	(-7.559)	(-4.838)	(-7.584)	(-1.093)	(-0.436)	(-2.779)	(-4.945)	(2.196)	(0.21)	(-6.881)	(-4.66)	(-10.226)	(-6.944)	(-7.551)	(-5.286)
Y^{QD}_{jkt-1}	0.286***	0.252***	0.24***	0.255***	0.199***	0.245***	0.262***	0.156***	0.34***	0.313***	0.253***	0.225***	0.214***	0.245***	0.172***
	(7.64)	(5.273)	(8.229)	(4.235)	(2.727)	(5.185)	(5.217)	(2.6)	(7.128)	(8.388)	(5.092)	(10.274)	(7.043)	(7.33)	(4.924)
CONSTANT	402.116	568.088	-932.05	1263.763	518.48	-16.301	1103.719	969.866	-983.18	-5723.83	-800.507	-301.498	7817.775	3598.789	-47.942
Adj. R^2	64.45%	45.31%	68.34%	34.04%	15.88%	43.06%	44.65%	26.88%	60.12%	67.78%	43.05%	75.87%	58.68%	62.52%	48.35%
***F* - Value**	31.81***	14.67***	36.62***	9.77***	4.11**	13.48***	14.71***	7.07***	25.83***	36.76***	13.48***	52.89***	25.14***	28.53***	16.45***

Note: [a] *t*-statistics values are in parentheses; *** = statistically significant at the 99% level of statistical confidence; ** = statistically significant at the 95% level of statistical confidence; * = statistically significant at the 90% level of statistical confidence.

The industry aggregate coefficient estimate implies that the coefficient of adjustment of the aggregate demand for farm labour (δ) in sugarcane farming over the study period is given by ($1 - \delta = 0.286$), *ceteris paribus*. Therefore, LSGs are estimated to adjust their farm labour levels by closing the gap between the beginning year actual and their desired level of farm labour by about 71% each year. If about 71% of the gap is closed in the first year, about 29% of the desired change is still to be made at the beginning of year two. In that year, about 71% of that remaining gap is closed, implying that a further 21% of the desired change is achieved by the beginning of year three, and so on for subsequent years. On aggregate, LSGs are thus estimated to take about three years to make the full adjustment toward their desired (equilibrium) farm labour levels in response to a change in the predictor variables.

The coefficient of adjustment of farm labour in the industry, regions and labour categories ranges between 0.156 and 0.34. Therefore, the adjustment magnitude ranges between about 66% and 84%, with an average full adjustment period of three years, which is higher than the sector estimates reported by Sparrow *et al.* (2008). The higher rate of adjustment compared to Sparrow *et al.* (2008) is surprising considering that sugarcane is a perennial crop; however, relatively more rapid adjustment may be possible because a relatively high proportion of the workforce in sugarcane farming are seasonal farm workers.

(b) The Long-Run Coefficient Estimates of Estimated Demand Functions

Table 10 shows long-run coefficient estimates excluding $Y^{QD}{}_{jkt-1}$, as the adjustment factors derived from $Y^{QD}{}_{jkt-1}$ coefficient estimates were used to convert the short-run to long-run impact. The larger magnitude of the long-run coefficient estimates suggests a higher impact of the predictor variables over time. In the long-run LSGs have enough time to change their habits (reduction of labour requirements), adopt new technology (replace labour with mechanisation) and become more familiar about the implication of relevant legislations.

Table 10: Estimated Long-Run Results for Empirical Farm Labour Demand Functions using Chatterjee and Price (1977) Procedure, 1978 – 2012

VARIABLES	AGGREGATE EMPLOYMENT			DRIVERS (J = 1)			CUTTERS (J = 2)			PERMANENT LABOUR (J = 3)			SEASONAL LABOUR (J = 4)		
	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)	(K = 1)	(K = 2)	(K = 3)
	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)	(βs)
$RWAGE_{jkt}$	-2.986	-0.465	-0.543	0.172	0.025	0.074	-0.320	0.223	0.788	-0.668	-0.245	-0.726	-2.541	-1.132	-0.426
$RCHEM_t$	378.739	50.182	68.800	10.393	0.335	4.126	83.705	-2.736	11.526	162.226	26.309	32.315	97.350	49.768	18.606
$RPTON_{kt}$	49.612	4.754	8.187	3.044	0.442	0.979	10.642	0.814	4.895	26.517	2.834	0.852	4.611	2.111	1.461
AUC_{kt}	0.011	0.033	0.050	0.005	0.005	0.003	0.004	0.009	0.003	0.016	0.017	0.026	-0.022	0.004	0.016
$POLICY_t$	-5767.507	-877.941	-1202.237	-75.077	-11.650	-48.303	-1294.309	129.697	14.864	-1976.565	-458.233	-689.806	-2038.168	-1040.530	-398.671
CONSTANT	563.179	759.465	-1226.316	1696.326	647.291	-21.591	1495.554	1149.130	-1489.667	-8331.630	-1071.629	-389.030	9946.279	4766.608	-57.901

(c) The Coefficient Estimate of Real Monthly Composite Wages ($RWAGE_{jkt}$)

Most of the coefficient estimates of $RWAGE_{jkt}$ are statistically significant with *a priori* expected sign; however the coefficient estimates of the Midlands and South Coast drivers, and cutters in the industry signs are unexpectedly positive. These estimated positive relationships are statistically significant for the industry and the South Coast, except for the Midlands. The findings probably reflect that the econometric model of the demand for drivers does not adequately account for substitution of machinery for elementary farmworkers giving rise to an increase in the demand for drivers in sugarcane production. Nonetheless, the lower impact on drivers in the Midlands suggests that mechanisation in sugarcane farming was relatively more advanced in that region by the early 1980s than on the South Coast and the industry as a whole. The statistical significance of the positive coefficient estimates for cutters reflects the limited availability of cutters in sugarcane farming, which can be backed by anecdotal evidence. The higher impact on the South Coast (-0.52) than in the Midlands (-0.118), is reflective of the high labour-intensity of the South Coast, as the Midlands is relatively flat and convenient for mechanisation harvesting, hence it requires a lower number of sugarcane cutters.

The industry and Midlands permanent labour, South Coast aggregate and the industry as a whole sugarcane cutters coefficient estimates are statistically insignificant within the common reference probability levels (1%, 5% and 10%). Therefore, a unit increase in wages will have a statistically significant effect on seasonal labour, South Coast permanent labour, and the aggregate industry and Midlands demand for labour, *ceteris paribus*. The magnitudes of the statistically significant coefficient estimates with *a priori* expected sign, suggest more impact of an increase in wages in the industry as a whole (-2.132), compared to the Midlands (-0.348). The labour category results show strong impact on Industry (-1.997) and the Midlands (-0.855) seasonal labour, and South Coast permanent (-0.563) and seasonal (-0.353) labour were strongly impacted, relative to sugarcane cutters and drivers.

(d) The Coefficient Estimate of Real Price Index of Chemicals ($RCHEM_t$)

Majority of the coefficient estimates of $RCHEM_t$ are statistically significant at a 1% probability level with an expected positive sign, except for cutters and drivers in the Midlands. In addition, the coefficient estimate of cutters in the Midlands is statically significant with an unexpectedly negative sign. This finding probably reflects the replacement of cutters with chemical applicators, as seasonal labour often perform field work such as weeding during off-harvesting.

In general, the application of chemicals as a substitute for farm labour has had more impact in the industry as a whole (270.421) and the South Coast (52.288), compared to the Midlands (37.536), *ceteris paribus*. The relatively lower magnitude in the Midlands is indicative of the relative convenience (the strength of chemicals application) of the region to various mechanisation and tools that are used to apply chemicals, e.g. boom sprayers, knapsacks, etc. Permanent (between 19.653 and 111.449) and seasonal (between 15.406 and 76.517) labour were relatively more affected than cutters (7.607 and 64.774) and drivers (between 0.268 and 7.743). It seems more permanent labour were replaced with chemicals application on the South Coast, while more seasonal labour were replaced in the Midlands. Permanent labour is more costly on the South Coast due to the high labour-intensity, compared to the Midlands, since seasonal labour is less costly on the South Coast and can be replaced easily in the Midlands.

(e) The Coefficient Estimate of Real Price per Ton of Sugarcane ($RPTON_{kt}$)

Most coefficient estimates of $RPTON_{kt}$ are statistically significant with an expected positive sign at the common reference probability levels (1%, 5% and 10%), except for the South Coast permanent and all seasonal labour. The results suggest that a unit increase in $RPTON_{kt}$ will result in more demand for farm labour in the industry as a whole (35.423) and the South Coast (6.22) than in the Midlands (3.556), *ceteris paribus*. The higher demand for farm labour is likely to favour permanent labour (2.17 and 18.217), cutters (between 0.687 and 7.854) than drivers (between 0.354 and 2.268). The insignificance of seasonal labour coefficient estimates implies that farmers are largely prepared to maintain employment of relatively skilled farm labour.

The magnitude of the coefficient estimates suggest that more drivers and cutters were employed on the South Coast (0.739 and 3.231), relative to the Midlands (0.354 and 0.687), whilst the Midlands employed more permanent labour (2.117). These findings reflect relatively high utilisation of permanent labour (mechanisation) on the South Coast (in the Midlands). Hence, it seems that with higher sugarcane prices the Midlands LSGs would prefer more utilisation of permanent labour, whilst the South Coast LSGs would prefer to utilise more mechanisation. The latter is highly dependent on other factors, such as the topographical convenience of mechanisation on the South Coast, which has been the main limiting factor.

(f) The Coefficient Estimate Area under Sugarcane (AUC_{kt})

Many coefficient estimates of AUC_{kt} are statistically significant, except for the industry aggregate employment. The coefficient estimates of the variable are statistically insignificant for the industry as a whole, industry cutters, South Coast cutters and the Midlands seasonal labour. Despite the statistical significance of some of the coefficient estimates of AUC_{kt}, their magnitudes are lower, relative to *a priori* expectations, since usually an additional hectare is expected to bring about a 0.1 to 0.3 increase in FTEs. It is speculated that the lower estimates may be related to dropping 4 of the 6 PCs or 23% of the information, which may indicate that whilst multicollinearity is reduced, it resulted in unintended consequences. However, as expected, an additional hectare will add more FTEs on the South Coast (0.038), compared to the Midlands (0.025). More permanent labour were employed on the South Coast (0.02) per additional hectare, followed by permanent labour in the Midlands (0.013), whilst an additional hectare is likely to result in job shedding for seasonal labour in the industry as whole.

(g) The Coefficient Estimate of Labour Policy Impact in Sugarcane Farming ($POLICY_t$)

Most of the coefficient estimates of $POLICY_t$ are statistically significant (at the 1% level of probability), except for the industry and Midlands drivers, and South Coast cutters. Therefore, the coefficient estimates of the industry aggregate demand function suggests that changes in labour legislation has resulted in a short-run reduction in employment of an estimated 4119 FTEs in commercial sugarcane farming, including 56 Drivers, 1358 permanent elementary workers and 2557 seasonal elementary workers (seasonal and harvesting/cutters staff), *ceteris paribus*. Considering that in 1978, LSGs employed 60405 FTEs in sugarcane production, the policy changes reduced aggregate employment by LSG in sugarcane farming by 6.82 per cent, i.e. (4119/60405)*100 = 6.82. This presentation can be replicated for the two regions; however, in summary, more jobs were lost on the South Coast (about 914 employees), compared to the Midlands (about 657 employees).

The long-run impact estimates in Table 10 show a relatively higher reduction of 5768 FTEs, including 75 Drivers, 1977 permanent elementary workers and 3332 seasonal elementary workers (seasonal and harvesting/cutters staff). Considering that in 1994, LSGs employed 33776 FTEs, the change in policy over time has reduced employment by LSGs in sugarcane farming by 17.1 per cent, i.e. (5768/33776)*100 = 17.1. In comparison, the long-run shows relatively higher disemployment on the South Coast (about 1202 employees) and in the Midlands (about 878 employees). The statistically insignificant relationships in the Midlands and the industry as a whole confirm that relative to more elementary categories of farm workers, the demand for drivers has been impacted less by the changes in labour policy.

(h) Estimated Long- and Short-Run Wage Elasticities of Demand and Cross-Price Elasticities of Farm Labour for Chemicals

Given that real aggregate farm wages (FTEs employment) in sugarcane farming increased (decreased) by about 70% and 36%, respectively, from 1978 to 2012, the simple wage elasticity estimate of employment without considering other factors is -0.51 (Δemployment/Δwage = -0.36/0.7). The wage and cross-price elasticities of chemicals for permanent and seasonal labour, the industry and regions were estimated from the empirical results, given that their estimate results are in line with expectations (appropriate estimate signs), compared to estimate results of drivers and cutters (inappropriate estimate signs). At face value, the elasticities presented in Table 11 show increases in absolute values of wage and cross-elasticities in the long-run. The relatively lower magnitude of estimate wage elasticities than sector estimate reported (-1.34) by Sparrow *et al.* (2008) reflects few availability of effective substitutes in many sugarcane producing arears. Sugarcane farming is generally less mechanised than other extensive field cropping land uses. In the long-run, the impact of a 1% increase in wages on employment is relatively similar in the industry (-0.091), South Cost (-0.084) and the Midlands (-0.080). This impact was stronger on permanent labour in the South Coast (-0.222), while it was stronger on seasonal labour in the Midlands (-0.647) and industry (-0.203).

The long-run cross-elasticity estimates of chemicals show more impact on labour (between 0.55 and 2.791, compared to estimate of 0.13 by Sparrow *et al.* (2008), especially on seasonal labour, which confirms that chemicals have been a good substitute for labour in the sector. The differing estimates confirm suggestions that the demand for labour is impacted differently by a wage increase and substitutes at an industry, production areas and by labour category in the sector, which depends on growing conditions, resource profile, risk, etc. It is prevalent that the impact of a unit increase in wage and the price of chemicals have been stronger on seasonal labour, compared to permanent and the aggregate demand for labour. The impacts of wage and the price of chemicals on the aggregate demand for labour have been strong in the industry, South Coast and Midlands, respectively, while the impact on permanent (seasonal) labour was high (low) in the South Coast and Midlands, respectively.

Table 11: Estimated Wage Elasticities (E_i) of Demand and Cross-Price Elasticities (E_{ij}) of Labour for Chemicals, 1978 – 2012

AGGREGATE MODEL ELASTICITIES				
ELASTICITIES	**WAGE (E_i)**		**CHEMICALS (E_{ij})**	
	SHORT RUN	**LONG RUN**	**SHORT RUN**	**LONG RUN**
INDUSTRY	-0.065	-0.091	0.530	0.743
MIDLANDS	-0.060	-0.080	0.412	0.550
SOUTH COAST	-0.064	-0.084	0.515	0.678
PERMANENT LABOUR ELASTICITIES				
ELASTICITIES	**WAGE (E_i)**		**CHEMICALS (E_{ij})**	
	SHORT RUN	**LONG RUN**	**SHORT RUN**	**LONG RUN**
INDUSTRY	-0.028	-0.041	0.586	0.852
MIDLANDS	-0.065	-0.087	0.589	0.788
SOUTH COAST	-0.172	-0.222	0.687	0.887
SEASONAL LABOUR ELASTICITIES				
ELASTICITIES	**WAGE (E_i)**		**CHEMICALS (E_{ij})**	
	SHORT RUN	**LONG RUN**	**SHORT RUN**	**LONG RUN**
INDUSTRY	-0.160	-0.203	0.624	0.794
MIDLANDS	-0.488	-0.647	2.106	2.791
SOUTH COAST	-0.125	-0.151	0.570	0.689

The confirmation of chemicals as a strong substitute for labour in sugarcane farming is in line with expectation as it is relatively easy to practise, especially spot spraying using knapsacks. The impact is expected to get stronger with improvement in the quality of knapsacks and chemicals application mechanisation. However, it is apparent that chemicals application has reduced employment headcount significantly on weeding activities, which is usually a task of less costly seasonal labour, hence it has not made a noticeable dent on the overall cost of labour.

CHAPTER 8: CONCLUSIONS AND POLICY IMPLICATIONS

The SA government has yielded to sentiments about the relative poor employment conditions on the farm and other low income sectors considered vulnerable by introducing SDs. The SDs stipulates minimum labour employment conditions and wages. However, the legislation has resulted in higher real costs of hiring farm labour (higher wages, transaction costs and risk), which is an important input in sugarcane farming and accounts for a relatively high proportion of production costs. Increases in the real wages relative to the real prices of other factors of production have resulted in labour substitution in sugarcane farming. The objective of this study was to investigate how the impact of changes in labour-related policy (including the introduction of the minimum wage legislation) on employment and wages in sugarcane farming has varied by sugarcane farming region and by labour category over the period 1978-2012.

A 2SLS Model was used to estimate the supply of and demand for farm labour by LSGs in sugarcane farming. However, due to a high multicollinearity level within the data sets, the PCA extraction procedure proposed by Chatterjee and Price (1977) was used to estimate the supply and demand functions separately. The procedure improved the statistical fit of the estimated farm labour demand functions significantly, while the theoretical fit of the functions were satisfactory.

The wage elasticities of demand were estimated for the aggregate, seasonal and permanent employment of farm labour. The short-run wage elasticities of demand ranged between -0.028 and -0.488, while the long-run ranged between -0.041 and -0.647. The absolute wage elasticities are relatively higher for the industry, followed by the South Coast and Midlands, whilst the wage elasticities for unskilled seasonal labour are relatively higher than for permanent unskilled labour. The demand for permanent workers is relatively more responsive to a change in wage on the South Coast, while the demand for seasonal workers is relatively more responsive to a change in wage in the Midlands. This finding reflects the feasibility of mechanical harvesting and chemicals application as a replacement for seasonal labour in parts of the Midlands, and efforts to reduce the costly permanent labour by using more seasonal labour on the South Coast.

It is concluded that the demand for farm labour in sugarcane farming is highly inelastic in the short-run, but less inelastic in the long-run, and that wage elasticities vary between labour categories, regions and at an industry level. The elasticities can be expected to become more wage elastic over time if the real cost of farm labour continues to increase, *ceteris paribus*. The estimates of wage elasticities of demand for farm workers derived from this study are consistent with observations that, by and large, sugarcane farming methods in South Africa have remained relatively unchanged over the period 1978-2012, due to limited availability of appropriate substitutes for farm labour. Also bearing in mind that the data used do not account for other unskilled labour categories in the LUCS and changes in the average number of hours worked per worker per day, and considering various anecdotal accounts that many sugarcane farmers have reduced working hours in response to increases in wage rates, it is likely that the wage elasticities of demand in this study are under-estimated.

The cross-elasticity of demand for the price of chemicals on the demand for farm labour was also estimated, where the short-run elasticities ranged between 0.412 and 2.106, while the long-run ranged between 0.550 and 2.791. Similarly, the cross-elasticities are relatively higher in the industry, followed by the South Coast and Midlands, whereas the average elasticity for permanent labour is lower than for seasonal labour. Therefore, it is concluded that the relative increase (decrease) in the price of chemicals will results in an increase (decrease) in the demand for farm labour in sugarcane farming. The substitution is stronger for seasonal labour in the Midlands, where mechanised chemical application is more feasible than on the South Coast.

The coefficient estimate of the policy variable of the industry aggregate employment shows a short-run decrease in aggregate employment of 4119 FTEs (including 56 Drivers, 1358 permanent and 2557 (the sum of Togt labour and cutters) seasonal labour) and a larger long-run decrease of 5768 FTEs employment (including 75 Drivers, 1977 permanent and 3332 (the sum of Togt labour and cutters) seasonal labour) in sugarcane farming by LSGs, *ceteris paribus*. Other things beings equal, considering employment levels in 1978 and 1994, the policy changes reduced employment by LSGs in sugarcane farming by 6.82% and 17.1% in the short- and long-run, respectively. In other words, when LSGs have had enough time to adjust to the farm labour legislation, they reduced their labour force (mostly unskilled seasonal and permanent labour) since the mid-1990s.

On the other hand, the estimates of the coefficient of adjustment ranges between 0.156 and 0.34, which means that LSGs are estimated to make annual adjustments of between 66% and 84%, with an average full adjustment period of three years. The adjustment percentage is relatively higher on the South Coast (76%), compared to the Midlands (75%) and Industry (71%). Therefore, it is concluded that LSGs have adjusted the size of their labour force according the current and their expectation of future policy changes in the costs of labour. The higher rate of adjustment for sugarcane farming compared to Sparrow *et al.'s* (2008) findings for the agricultural sector as a whole is surprising considering that sugarcane is a perennial crop; however, relatively more rapid adjustment may be possible because a relatively high proportion of the workforce in sugarcane farming are seasonal workers.

Anecdotal information from LSGs suggest that they are now restricting labour from staying with their families, which can reduce the productivity of male labour due to consumption of less energy food, since some LSGs have reduced the provision of either raw or cooked rations. At the end, LSGs have to employ more cutters and offer productivity bonuses to get the same amount of work done. It is therefore evident that the BECA and ESTA have also resulted in unintended consequences for farm labour, as some LSGs responded by introducing strict accommodation rules.

The descriptive analysis of wage and employment data were presented, showing no wage benefits for drivers and cutters, as the basic wage of drivers and cutters on the South Coast and in the Midlands are relatively higher than the real minimum wage between 2003 and 2012. Permanent labour gained more wage increases than seasonal labour, probably because the number of hours and days worked by seasonal labour were significantly decreased. In general, the basic wage has improved from around 30% to about 80% of the composite wage, which is roughly in line with the SD stipulations. The change has strongly benefited unskilled labour categories, as they now earn above 80% of the composite wage in cash, compared to drivers and cutters. In other words, wage standardisation has mainly been achieved between unskilled labour, with wage differentiation largely driven by the number of hours and days worked. The legislation has also impacted on the wage structure and resulted in some wage redistribution from semi-skilled to unskilled labour. It is also apparent that wages have improved in general, but with job-shedding, especially of unskilled labour and on the South Coast.

The positive relationship between farm labour employment and the price per ton of sugarcane and the area under sugarcane (except for the negative relationship for South Coast seasonal labour) suggests a need to consider the support provided to farmers, since some of the lost support, such as the price support, trade protection etc., have negatively impacted farming profit margins, which has an impact on investments in farming and farm labour employment. However, the sugar industry remains relatively protected through the dollar-based reference price tariff application and the notional price. Therefore, higher sugarcane prices will have a positive impact on farm labour employment in the sugar industry through affordability of more labour employment and increased investments in sugarcane farming, which requires more labour employment due to limited availability of appropriate substitutes for farm labour in sugarcane farming.

Overall, it is concluded that the impact of the SD on employment and wages varies by labour category and by sugarcane producing region. The impact on employment was greater for seasonal labour relative to permanent labour, and it was greater in the region (South Coast) with relatively higher labour intensity in sugarcane farming. However, real average wage rates of both permanent and seasonal workers increased. The SD increased the average basic wage approximately in line with the 80% stipulated by the SD, after accounting for deductions of 20% for non-pecuniary benefits (10 % for accommodation and 10% for food rations and other handouts). Much of the benefit was realised by permanent and seasonal labour, as they earned relatively low wages before the SD.

It is inevitable that the loss of employment can be alleviated by relaxing labour legislation rigidities that were captured by the policy variable, e.g. employment contract conditions, when hiring and dismissing labour to provide flexibility to employers, as employment decreased by 6.82% and 17.1% in the short- and long-run. However, it remain necessary to ensure that farm labour in this vulnerable sector are treated *fairly* by farmers, since there is no evidence that all farmers will treat their labour *fairly* without government intervention due to the relatively low bargaining power of unskilled labour. There is also a need to strengthen compliance inspection e.g. improving their strategy from the list approach to proper sampling of farmers to determine compliance rate.

The government should consider improving access to education (availability of schools and quality of education) and skills development initiatives (training for various skills acquisition) in rural areas, as it is expected to improve labour productivity and income, and the employability of rural people in non-farm sectors (Gisser, 1965; Gallasch and Gardner, 1978; Roberts and Antrobus, 2013), given the strong negative correlation between the rural population and non-farm wage. The sugar industry should explore and expedite the implementation of options (maximising revenue from sugarcane production) that are expected to grow sugarcane profit margins, as an increase in the price per ton of sugarcane is expected to have a positive impact on farm labour employment.

The results of this study compared to those of Sparrow *et al.* (2008) indicate that the impact of SD on employment of farm workers is not uniform across the farm sector. Despite sugarcane farming being relatively labour intensive, the wage elasticities of demand for labour in sugarcane farming are less elastic than those for the farm sector as a whole. In other words, the extent of labour substitution in response to the introduction of minimum wages in the sector has been relatively less in sugarcane farming. However, the results of this study cannot be extrapolated to higher real wage rates than those that prevailed during the study period – hence it cannot necessarily be expected that the 2013 and beyond increases in the minimum wage will also result in relatively low rates of labour substitution in sugarcane farming. Therefore, research is recommend to up-date this study once sufficient data on post 2013 employment in sugarcane farming is available.

To some extent the study has explored and highlighted the importance of compliance on the effectiveness of the SD on the farm labour market, but there is limited information to make conclusive remarks. Hence, more research dedicated to the issues of compliance is recommended to contribute towards the limited availability of such research and the improvement of effective methods of monitoring compliance.

SUMMARY

The democratic government of SA embarked on a comprehensive policy reform in line with the country's Constitution since its inception in 1994, to reposition the country in the global community and facilitate the lifting of various sanctions on the country. In the process, labour legislations were introduced and extended to cover vulnerable labour in the farm and other low income sectors. The important farm labour legislations relevant to this study are the BCEA, which includes the farm sector SD, and ESTA, as they influence wage computation and farm labour employment conditions.

The legislations are considered necessary to improve the conditions of employment, income level and the rights of farm labour to land. These changes were intended to make employment in the low income sectors attractive to unskilled labour, as it is expected to reduce the dependence on social security, since most of the unskilled labour resides in rural areas. However, the legislation has resulted in unintended consequences, as LSGs have reacted by replacing labour with close substitutes, e.g. chemicals application. The BECA and ESTA also resulted in unintended consequences, as some LSGs have introduced strict accommodation rules. Labour is no longer allowed to stay with family members, which can be counter-productive as it may result in male labour consuming less energy food stuff, since they do no longer receive raw or prepared rations. As a result, LSGs have to employ more cutters or offer more productivity bonuses to get the same amount of work done.

The secondary time-series data on employment in sugarcane farming for the period 1978-2012 was obtained from the SACGA, the 2014 Abstract of Agricultural Statistics, SEIFA and the World Bank. These data were analysed using descriptive statistics, the 2SLS and PCA extraction regression to determine the impact of the BECA and ESTA on employment and wage computation in sugarcane farming. The study bridges the gap by estimating the short- and long-

run elasticity of demand for farm labour to determine structural changes, as well as the adjustment of labour by LSGs, in order to differentiate the impact at the industry as whole, regions and labour category level in sugarcane production. The estimated short-run wage elasticities ranged between -0.028 and -0.488, while the estimated long-run elasticities ranged between -0.041 and -0.647. This finding that the demand for farm labour in sugarcane production is relatively inelastic is consistent with observations that, by and large, sugarcane production methods remained relatively unchanged in the industry and each of the two regions over the study period. The demand for permanent unskilled workers is relatively more responsive to a change in wage on the South Coast, while the demand for seasonal unskilled workers is relatively more responsive to a change in wage in the Midlands. This finding reflects the feasibility of e.g., chemicals application as a replacement for seasonal labour in parts of the Midlands, and efforts to reduce costly permanent labour on the South Coast.

The legislation decreased aggregate employment in the short-run by 4119 FTEs and 5768 FTEs in the long-run, *ceteris paribus*. When considering employment levels in 1978 and 1994, the legislation reduced employment by 6.82% and 17.1%, respectively. Other things being equal, the estimated coefficients of adjustment range between 0.156 and 0.34, which means LSGs are estimated to make annual employment adjustments ranging between 66% and 84%, with an average full adjustment period of 3 years. The higher rate of adjustment compared to Sparrow *et al.* (2008) is surprising considering that sugarcane is a perennial crop; however, it suggests that relatively more rapid adjustment of labour may be possible because a relatively high proportion of the workforce are seasonal workers.

The legislation has impacted on the wage structure and resulted in some wage redistribution from semi-skilled to unskilled labour. Cutters did not benefit since they earned relatively higher wages. Permanent labour gained more wage increase than seasonal labour, probably because the number of hours and days worked by seasonal unskilled labour were significantly reduced.

The average cash wage improved from around 30% to about 80% of the composite wage. This change has mainly benefited unskilled permanent and seasonal labour, since drivers and cutters earn more cash wages substantiated by monthly productivity and annual bonuses. Drivers and cutters still earn relatively higher wages than unskilled labour, which indicates that wage standardisation has mainly been achieved between permanent and seasonal unskilled labour. The wage difference between the unskilled labour categories is influenced mainly by the number of hours and days worked. It seems that the legislation has improved wages with a decrease in employment, especially the employment of unskilled labour and employment on the South Coast. The South Coast and Midlands aggregate, drivers and cutters real basic wages are relatively higher than the real minimum wage between 2003 and 2012.

In order to prevent further employment loss, the government should consider relaxing certain elements of the legislation, e.g. employment contract conditions, when hiring and dismissing labour. The support provided to farmers must be considered, since some of the lost support has negatively impacted farm profit margins. The sugar industry also needs to explore and expedite the implementation of options that can improve farm profit margins. More focus should be directed on education and skills development in rural areas, as it is expected to improve farm labour productivity and income, and the employability of the rural community in non-farm sectors given the strong negative correlation between rural population and non-farm wages. The relatively less estimated wage elasticities of the demand for labour in sugarcane farming than for the farm sector as a whole should not necessarily lead to a conclusion that the 2013 and beyond increases in the minimum wage will also result in relatively low rates of labour substitution in sugarcane farming. Hence, this research must be updated when sufficient data about employment after 2013 is available. Furthermore, more research on the issues of compliance is needed in order to improve the effectiveness of compliance monitoring methods.

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APPENDICES

Appendix A: Empirical Data for Demand and Supply Functions

Due to the high amount of data used in the empirical analysis, only the industry as whole demand and supply functions data are presented. The Appendices below contains data presented in real terms for the supply of and demand and for farm labour functions, where the demand function is made up of: aggregate quantity of labour demanded (Y^{QD}_{jkt} = AGQ_d), based on selected labour categories and regions; industry average real wage ($RWAGE_{jkt}$ = AVGRWAGE), based on selected labour categories and regions; real interest rates ($RINT_t$); real price index of machineries and equipment ($RMECH_t$); real price index of chemicals ($RCHEM_t$); real price per ton of sugarcane ($RPTON_{kt}$); area under sugarcane (AUC_{kt}); proxy for policy effect ($POLICY_t$) and the lag aggregate quantity of labour demanded (Y^{QD}_{jkt-1} = AGQ_{d-1}), based on selected labour categories and regions. While the supply function consists of: Aggregate quantity of Labour supplied (Y^{SD}_{jkt} = AGQ_s), based on selected labour categories and regions; real alternative wage ($RALTWAGE_t$), life expectancy ($LIFE_t$) and rural population ($RPOP_t$).

Appendix A1: Industry Aggregate Demand Function Data

Year	Y^{QD}_{jkt}	$RWAGE_{jkt}$	$RINT_t$	$RMECH_t$	$RCHEM_t$	RP/TON_{kt}	AUC_{kt}	$POLICY_t$	Y^{QD}_{jkt-1}
1978	60405	1097.516	0.895	55.41	104.9419	309.7602	272713	0	
1979	60779	1042.949	-2.907	54.47	96.40901	323.5209	282077	0	60405
1980	52625	1027.16	-3.660	54.77	95.63276	402.5362	283644	0	60779
1981	59023	1109.354	-1.088	54.31	89.46922	318.0182	284054	0	52625
1982	55775	1160.094	4.092	55.52	93.77902	309.3091	285495	0	59023
1983	56624	1100.011	3.888	56.68	93.03265	373.7836	285295	0	55775
1984	56576	1109.15	9.687	57.33	91.45778	262.0562	286773	0	56624
1985	52419	1060.314	4.476	61.49	98.08825	273.3024	279322	0	56576
1986	53466	1015.01	-3.645	65.96	102.3321	288.1123	273007	0	52419
1987	53372	969.9986	-3.151	67.11	94.99247	223.8318	268165	0	53466
1988	51590	965.1876	2.261	68.98	90.06606	250.674	257548	0	53372
1989	50636	1011.477	4.444	72.95	87.22447	269.5475	256235	0	51590
1990	45992	1029.656	5.842	70.79	86.25898	258.5856	246937	0	50636
1991	42050	1000.688	4.314	66.78	87.28573	230.185	248023	0	45992
1992	37932	962.378	4.352	62.06	81.49177	337.3314	248763	0	42050
1993	36580	981.4809	5.881	63.83	78.53946	325.6412	244108	0	37932
1994	33776	1047.015	6.097	64.47	77.22557	310.323	247943	1	36580
1995	35687	1145.818	8.483	65.6	76.02653	289.7793	246178	1	33776
1996	35958	1121.069	11.332	64.92	81.6958	278.112	251701	1	35687
1997	33934	1417.644	10.500	65.04	92.4898	281.1459	255587	1	35958
1998	36050	1274.109	13.950	65.66	87.43293	276.6886	275863	1	33934
1999	34417	1285.426	12.187	67.55	85.9693	254.4196	278170	1	36050
2000	36529	1490.73	8.697	67.94	80.35235	259.3827	289485	1	34417
2001	38223	1467.356	7.633	75.49	81.21059	302.7262	295519	1	36529
2002	35564	1476.058	6.033	88.78	85.15445	295.7162	299426	1	38223
2003	39250	1511.921	8.597	89.58	78.74713	275.1196	299918	1	35564
2004	40483	1603.89	9.769	87.42	74.61946	255.6481	306342	1	39250
2005	40609	1629.361	6.993	82.64	70.26905	269.3411	306423	1	40483
2006	38361	1805.884	6.239	81.98	70.64401	294.5426	310397	1	40609
2007	42109	1843.59	5.669	74.92	72.6081	289.7986	311293	1	38361
2008	48655	1862.387	3.222	76.03	76.56615	311.8304	303663	1	42109
2009	39847	2057.87	4.275	81.9	81.28306	329.5089	303344	1	48655
2010	39525	1944.733	5.345	90.27	88.98646	368.9887	301929	1	39847
2011	36439	2057.028	3.809	95.16	93.9521	373.1639	293160	1	39525
2012	38903	1868.74	2.936	100	100	391.6985	298897	1	36439

Appendix A2: Industry Aggregate Supply Function Data

Year	Y^{SD}_{jkt}	$RWAGE_{jkt}$	$RALTWAGE_t$	$LIFE_t$	$RPOP_t$
1978	60405	1097.516	58.08	55.89	51.70
1979	60779	1042.949	58.07	56.41	51.64
1980	52625	1027.16	58.76	56.97	51.58
1981	59023	1109.354	60.04	57.56	51.39
1982	55775	1160.094	62.64	58.17	51.20
1983	56624	1100.011	63.27	58.77	51.01
1984	56576	1109.15	61.72	59.35	50.82
1985	52419	1060.314	59.62	59.91	50.63
1986	53466	1015.01	56.72	60.45	50.10
1987	53372	969.9986	56.13	60.96	49.56
1988	51590	965.1876	54.39	61.42	49.03
1989	50636	1011.477	56.47	61.82	48.50
1990	45992	1029.656	59.44	62.12	47.96
1991	42050	1000.688	60.02	62.29	47.47
1992	37932	962.378	58.14	62.33	46.98
1993	36580	981.4809	58.06	62.19	46.49
1994	33776	1047.015	58.08	61.89	46.00
1995	35687	1145.818	58.31	61.37	45.51
1996	35958	1121.069	62.39	60.61	45.03
1997	33934	1417.644	63.69	59.61	44.55
1998	36050	1274.109	66.43	58.44	44.07
1999	34417	1285.426	69.42	57.16	43.59
2000	36529	1490.73	70.25	55.84	43.11
2001	38223	1467.356	70.09	54.57	42.64
2002	35564	1476.058	69.07	53.44	42.16
2003	39250	1511.921	76.29	52.52	41.69
2004	40483	1603.89	86.45	51.87	41.22
2005	40609	1629.361	89.25	51.56	40.74
2006	38361	1805.884	90.43	51.61	40.29
2007	42109	1843.59	90.40	52.00	39.83
2008	48655	1862.387	88.48	52.64	39.37
2009	39847	2057.87	90.03	53.47	38.91
2010	39525	1944.733	93.83	54.39	38.45
2011	36439	2057.028	97.14	55.30	38.01
2012	38903	1868.74	100.00	56.10	37.57

Appendix B: Aggregate Demand Model Econometric Results

Appendix B1: Correlation Matrix Including Real Interest Rates and Price Index of Machinery and Equipment Variables

```
. pwcorr agqd avgrwage rint rmech rchem rpton auc policy agqd1, sig star(5)

             |     agqd avgrwage     rint    rmech    rchem    rpton      auc
-------------+---------------------------------------------------------------
        agqd |   1.0000 
             |
             |
    avgrwage |  -0.4312*  1.0000 
             |   0.0097
             |
        rint |  -0.6804*  0.2287   1.0000 
             |   0.0000   0.1863
             |
       rmech |  -0.5492*  0.7884*  0.2275   1.0000 
             |   0.0006   0.0000   0.1886
             |
       rchem |   0.5893* -0.3405* -0.5205* -0.3148   1.0000 
             |   0.0002   0.0454   0.0013   0.0655
             |
       rpton |   0.0469   0.3041  -0.3370*  0.1231   0.2474   1.0000 
             |   0.7892   0.0757   0.0477   0.4811   0.1519
             |
         auc |   0.0297   0.7626* -0.0074   0.5221* -0.1708   0.2476   1.0000 
             |   0.8654   0.0000   0.9665   0.0013   0.3267   0.1516
             |
      policy |  -0.7751*  0.7562*  0.6023*  0.6619* -0.5603*  0.0363   0.4505*
             |   0.0000   0.0000   0.0001   0.0000   0.0005   0.8360   0.0066
             |
       agqd1 |   0.9223* -0.4580* -0.6847* -0.5329*  0.5864*  0.0830  -0.0543 
             |   0.0000   0.0064   0.0000   0.0012   0.0003   0.6407   0.7602
             |

             |   policy    agqd1
-------------+------------------
      policy |   1.0000 
             |
             |
       agqd1 |  -0.8296*  1.0000 
             |   0.0000
             |
```

Appendix B2: Correlation Matrix

```
. pwcorr agqd rwage rmech rchem rpton auc policy agqd1, sig star(5)

             |     agqd    rwage    rmech    rchem    rpton      auc   policy
-------------+---------------------------------------------------------------
        agqd |   1.0000 
             |
             |
       rwage |  -0.4312*  1.0000 
             |   0.0097
             |
       rmech |  -0.5492*  0.7884*  1.0000 
             |   0.0006   0.0000
             |
       rchem |   0.5894* -0.3405* -0.3149   1.0000 
             |   0.0002   0.0453   0.0654
             |
       rpton |   0.0469   0.3041   0.1231   0.2474   1.0000 
             |   0.7892   0.0757   0.4811   0.1519
             |
         auc |   0.0297   0.7626*  0.5221* -0.1709   0.2476   1.0000 
             |   0.8654   0.0000   0.0013   0.3264   0.1516
             |
      policy |  -0.7751*  0.7562*  0.6619* -0.5604*  0.0363   0.4505*  1.0000 
             |   0.0000   0.0000   0.0000   0.0005   0.8360   0.0066
             |
       agqd1 |   0.9223* -0.4580* -0.5329*  0.5863*  0.0830  -0.0543  -0.8296*
             |   0.0000   0.0064   0.0012   0.0003   0.6407   0.7602   0.0000
             |

             |    agqd1
-------------+---------
       agqd1 |   1.0000 
             |
```

Appendix B3: Summary Statistics

. summarize agqd rwage rchem rpton auc policy agqd1

Variable	Obs	Mean	Std. Dev.	Min	Max
agqd	35	44290.37	8799.22	33776	60779
rwage	35	1330.087	356.9943	962.378	2057.87
rchem	35	86.464	9.094528	70.27	104.94
rpton	35	298.9754	43.92843	223.83	402.54
auc	35	279354.2	21638.56	244108	311293
policy	35	.5428571	.5054327	0	1
agqd1	34	44448.82	8880.718	33776	60779

Appendix B4: Ordinary Least Squares

. reg agqd rwage rchem rpton auc policy agqd1

Source	SS	df	MS
Model	2.0981e+09	6	349685834
Residual	267059478	27	9891091.78
Total	2.3652e+09	33	71671953.9

Number of obs =	34
F(6, 27) =	35.35
Prob > F =	0.0000
R-squared =	0.8871
Adj R-squared =	0.8620
Root MSE =	3145

agqd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rwage	-4.969648	3.571516	-1.39	0.175	-12.29779	2.358499
rchem	45.41349	83.22449	0.55	0.590	-125.3491	216.176
rpton	-8.553396	14.22862	-0.60	0.553	-37.74811	20.64132
auc	.1346888	.047415	2.84	0.008	.0374014	.2319763
policy	-3117.12	3086.53	-1.01	0.322	-9450.157	3215.917
agqd1	.6359439	.150494	4.23	0.000	.3271558	.9447321
_cons	-15064.18	11084.9	-1.36	0.185	-37808.51	7680.155

Appendix B5: Two Stage Least Squares

```
. ivregress 2sls agqd rchem rpton auc policy agqd1 ( avgrwage =  raltwage life ruralpop), first
```

First-stage regressions

Number of obs	=	33
F(8, 24)	=	93.29
Prob > F	=	0.0000
R-squared	=	0.9688
Adj R-squared	=	0.9585
Root MSE	=	71.9346

avgrwage	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rchem	2.498203	2.317223	1.08	0.292	-2.28431	7.280716
rpton	.4659234	.3458888	1.35	0.191	-.247956	1.179803
auc	.0049289	.0022506	2.19	0.038	.0002838	.0095739
policy	163.2172	73.14156	2.23	0.035	12.26047	314.174
agqd1	.008682	.0044132	1.97	0.061	-.0004265	.0177904
raltwage	8.342995	3.895945	2.14	0.043	.30216	16.38383
life	20.94843	13.9757	1.50	0.147	-7.896002	49.79286
ruralpop	-45.79008	13.43697	-3.41	0.002	-73.52262	-18.05754
_cons	-612.1039	1492.395	-0.41	0.685	-3692.255	2468.047

Instrumental variables (2SLS) regression

Number of obs	=	33
Wald chi2(6)	=	260.07
Prob > chi2	=	0.0000
R-squared	=	0.8866
Root MSE	=	2835.9

agqd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
avgrwage	-7.328648	3.540771	-2.07	0.038	-14.26843	-.3888641
rchem	12.56032	84.46272	0.15	0.882	-152.9836	178.1042
rpton	-8.221502	13.25442	-0.62	0.535	-34.19969	17.75668
auc	.1475457	.0444674	3.32	0.001	.0603913	.2347001
policy	-2005.321	2867.955	-0.70	0.484	-7626.41	3615.768
agqd1	.6743251	.1442129	4.68	0.000	.391673	.9569773
_cons	-15199.17	10735.96	-1.42	0.157	-36241.25	5842.92

Instrumented: avgrwage
Instruments: rchem rpton auc policy agqd1 raltwage life ruralpop

Appendix B6: Principal Component Analysis

```
. pca rwage rchem rpton auc policy agqd1
```

Principal components/correlation

Rotation: (unrotated = principal)

Number of obs	=	34
Number of comp.	=	6
Trace	=	6
Rho	=	1.0000

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.04395	1.48066	0.5073	0.5073
Comp2	1.56329	.815595	0.2605	0.7679
Comp3	.747697	.297932	0.1246	0.8925
Comp4	.449765	.329057	0.0750	0.9675
Comp5	.120708	.0461231	0.0201	0.9876
Comp6	.074585	.	0.0124	1.0000

Principal components (eigenvectors)

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Unexplained
rwage	0.4984	0.3126	0.1108	0.1326	0.7715	-0.1695	0
rchem	-0.3675	0.4178	-0.1611	0.8110	-0.0601	-0.0546	0
rpton	0.0685	0.6101	-0.6571	-0.4200	-0.1168	0.0370	0
auc	0.3538	0.4660	0.5674	-0.0210	-0.5408	-0.2069	0
policy	0.5392	-0.0916	-0.1467	0.2995	-0.1775	0.7471	0
agqd1	-0.4426	0.3605	0.4319	-0.2411	0.2521	0.6049	0

Appendix B7: Principal Component Regression

. reg Zagqd PCA1 PCA2, noconstant

Source	SS	df	MS
Model	20.391334	2	10.195667
Residual	10.2547493	32	.320460916
Total	30.6460833	34	.901355391

Number of obs	= 34
F(2, 32)	= 31.82
Prob > F	= 0.0000
R-squared	= 0.6654
Adj R-squared	= 0.6445
Root MSE	= .56609

Zagqd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PCA1	-.3822511	.0564822	-6.77	0.000	-.4973016	-.2672006
PCA2	.3328054	.0788153	4.22	0.000	.1722639	.4933469

Appendix C: Aggregate Supply Model Econometric Results

Appendix C1: Correlation Matrix

. pwcorr agqd avgrwage raltwage life ruralpop, sig star(5)

	agqd	avgrwage	raltwage	life	ruralpop
agqd	1.0000				
avgrwage	-0.4312*	1.0000			
	0.0097				
raltwage	-0.3962*	0.9626*	1.0000		
	0.0185	0.0000			
life	0.1372	-0.8008*	-0.7856*	1.0000	
	0.4318	0.0000	0.0000		
ruralpop	0.7364*	-0.8974*	-0.8840*	0.6330*	1.0000
	0.0000	0.0000	0.0000	0.0000	

Appendix C2: Summary Statistics

. summarize agqd avgrwage raltwage life ruralpop

Variable	Obs	Mean	Std. Dev.	Min	Max
agqd	35	44290.37	8799.22	33776	60779
avgrwage	35	1330.087	356.9943	962.3781	2057.87
raltwage	35	69.4741	14.26437	54.39288	100
life	35	57.45733	3.637654	51.55734	62.32517
ruralpop	35	45.39435	4.644101	37.5724	51.7014

Appendix C3: Ordinary Least Squares

. reg agqd avgrwage raltwage life ruralpop

Source	SS	df	MS
Model	2.2638e+09	4	565950652
Residual	368690810	30	12289693.7
Total	2.6325e+09	34	77426277

Number of obs	= 35
F(4, 30)	= 46.05
Prob > F	= 0.0000
R-squared	= 0.8599
Adj R-squared	= 0.8413
Root MSE	= 3505.7

agqd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
avgrwage	9.930603	7.220075	1.38	0.179	-4.814758	24.67596
raltwage	452.8435	159.8639	2.83	0.008	126.3579	779.3291
life	-279.6035	295.2658	-0.95	0.351	-882.6168	323.4098
ruralpop	3448.585	317.1873	10.87	0.000	2800.802	4096.367
_cons	-140860.1	33252.05	-4.24	0.000	-208769.8	-72950.32

Appendix C4: Two Stage Least Squares

```
. ivregress 2sls agqd raltwage life ruralpop (avgrwage = rchem rpton auc policy agqd1), first
```

First-stage regressions

Number of obs	33
F(8, 24)	93.29
Prob > F	0.0000
R-squared	0.9688
Adj R-squared	0.9585
Root MSE	71.9346

avgrwage	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
raltwage	8.342995	3.895945	2.14	0.043	.30216	16.38383
life	20.94843	13.9757	1.50	0.147	-7.896002	49.79286
ruralpop	-45.79008	13.43697	-3.41	0.002	-73.52262	-18.05754
rchem	2.498203	2.317223	1.08	0.292	-2.28431	7.280716
rpton	.4659234	.3458888	1.35	0.191	-.247956	1.179803
auc	.0049289	.0022506	2.19	0.038	.0002838	.0095739
policy	163.2172	73.14156	2.23	0.035	12.26047	314.174
agqd1	.008682	.0044132	1.97	0.061	-.0004265	.0177904
_cons	-612.1039	1492.395	-0.41	0.685	-3692.255	2468.047

Instrumental variables (2SLS) regression

Number of obs	33
Wald chi2(4)	153.90
Prob > chi2	0.0000
R-squared	0.8211
Root MSE	3561.7

agqd	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
avgrwage	22.09059	10.17322	2.17	0.030	2.151438	42.02975
raltwage	231.217	234.103	0.99	0.323	-227.6165	690.0506
life	72.39662	299.4664	0.24	0.809	-514.5468	659.34
ruralpop	3533.515	323.3196	10.93	0.000	2899.821	4167.21
_cons	-164658.7	30986	-5.31	0.000	-225390.2	-103927.3

Instrumented: avgrwage
Instruments: raltwage life ruralpop rchem rpton auc policy agqd1

Appendix C5: Principal Component Analysis

```
. pca avgrwage raltwage life ruralpop
```

Principal components/correlation

Rotation: (unrotated = principal)

Number of obs	35
Number of comp.	4
Trace	4
Rho	1.0000

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.49146	3.11053	0.8729	0.8729
Comp2	.380932	.288791	0.0952	0.9681
Comp3	.0921409	.0566751	0.0230	0.9911
Comp4	.0354658	.	0.0089	1.0000

Principal components (eigenvectors)

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
avgrwage	0.5258	0.0911	0.3299	0.7787	0
raltwage	0.5219	0.1056	0.5844	-0.6123	0
life	-0.4583	0.8198	0.3358	0.0713	0
ruralpop	-0.4910	-0.5554	0.6610	0.1165	0

Appendix C6: Principal Component Regression

```
. reg Zagqd PC1 PC2, noconstant
```

Source	SS	df	MS
Model	19.8981991	2	9.94909955
Residual	14.1018007	33	.427327294
Total	33.9999998	35	.971428566

Number of obs	35
F(2, 33)	23.28
Prob > F	0.0000
R-squared	0.5852
Adj R-squared	0.5601
Root MSE	.6537

Zagqd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PC1	-.2457497	.0599981	-4.10	0.000	-.3678167	-.1236828
PC2	-.9913646	.1816423	-5.46	0.000	-1.360919	-.6218105