Determinants of the demand for regular farm labour in South Africa, 1960-2002

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Abstract

This paper estimates long-run price (wage) elasticities of demand for regular farm labour in South Africa using both Ordinary Least Squares (OLS) regression and a Two-stage Least Squares (2SLS) simultaneous-equation model for the period 1960-2002. Both models include a piecewise interactive slope dummy variable with 1991 as the threshold year to reflect South African (SA) commercial farmers' expectations that farm labour costs would increase as new labour legislation was introduced from the early 1990s onwards. The long-run price (wage) elasticity of demand for regular farm labour in South Africa during 1960-1990 was estimated as -0.25 for OLS and -0.23 for 2SLS regression, respectively. For the period 1991-2002, this elasticity estimate rose to -1.32 and -1.34 for OLS and 2SLS regression, respectively. These results suggest that a marked structural decline in the demand for regular labour has occurred since 1991 that raises questions about the appropriateness of labour laws and minimum wage legislation that have increased the cost of regular farm labour in South Africa.

Keywords: Regular farm labour; SA agriculture; price (wage) elasticities of demand

1. Introduction

Agriculture is a major employer of labour in South Africa with about 9.8% of the total labour force directly involved in agricultural production (Statistics South Africa, 2005). The supply of labour to agriculture in South Africa is relatively price elastic due to the high percentage of relatively unskilled and unemployed people (Nieuwoudt, 1984) – the formal unemployment rate in South Africa is presently about 26% (Statistics South Africa, 2005). The demand for farm labour is also expected to be price elastic as there are many substitutes for farm labour, such as machinery and contractors (Goedecke & Ortmann, 1993). A relative increase in the cost of labour motivates farmers to replace labour with machinery, machinery contractors, labour contractors or

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new technologies that are labour-saving. This in turn can lead to considerable unemployment if the demand for labour is very price elastic (Lianos, 1972; Conradie, 2005), and output will fall as production costs increase (Burton *et al.*, 1970).

According to Statistics South Africa (2004), the number of regular farm workers employed in South Africa fell from 756 397 in 1960 to 728 414 in 1990, or a drop of about 4%. This decline then *accelerated markedly* after 1990, and the number of regular farm workers employed fell by 34% from the 1990 level to 481 375 by 2002. The aim of this paper is to identify the *determinants of this marked decline* in the aggregate demand for regular farm labour in South Africa during 1960-2002. In particular, the paper tries to obtain a reliable estimate of the long-run price elasticity of demand for regular farm labour in South Africa in order to assess the appropriateness of new labour legislation that has probably raised the real cost of farm labour since the early 1990s. This legislation (see section 2 of the paper for more detail) has increased transaction and wage costs by, for example, making staff dismissal procedures more costly and increasing overtime pay (Ortmann & Machethe, 2003).

There are only two documented empirical estimates of the price (wage) elasticity of demand for farm labour in South Africa: Latt and Nieuwoudt (1985) estimated a figure for regular farm labour in KwaZulu-Natal of -1.39 over the period 1972-1978. Secondly, Conradie (2005) reported an estimate of -0.3 for farm labour in the Breërivier Valley of the Western Cape Province. These limited results support Nieuwoudt and Groenewald's (2003) contention that the farm labour market in South Africa *has not been adequately researched*. This paper thus helps to fill a gap in policy-related research in South Africa by updating price elasticity of farm labour demand estimates, and assessing empirically how South African (SA) labour legislation may have affected farm employment levels. Both single equation Ordinary Least Squares (OLS) and Two-stage Least Squares (2SLS) simultaneous-equation demand models are estimated using secondary data obtained for 43 years (1960-2002) from Statistics South Africa (2004, 2005) and the Abstract of Agricultural Statistics (2005). The 2SLS model includes a regular farm labour supply equation.

The next section briefly outlines trends in the farm labour market in South Africa since 1960, and contextualises the advent of farm labour legislation since the early 1990s. Section 3 describes the data and techniques used to estimate the single equation OLS and simultaneous-equation 2SLS regular farm labour demand models. These models are specified and discussed in sections 4 and 5. Section 6 presents the statistical results, and Section 7 concludes the paper by discussing some policy implications of the results.

2. Background to the farm labour market in South Africa

Primary commercial agriculture contributes less than 4% to the Gross Domestic Product (GDP) of South Africa (Statistics South Africa, 2005). However, there are strong backward and forward linkages into the economy so that the agro-industrial sector is estimated to contribute about 15% of GDP. Agricultural products account for more than 30% of the total job opportunities in the manufacturing sector, and represent 25% of this sector's contribution to the GDP (Statistics South Africa, 2005). Bhorat and Hodge (1999) noted that the 25 years of economic development in South Africa prior to 1999 were marked by a decline in the share of primary sectors in the GDP. Figure 1 shows the trends in employment of regular and seasonal (casual) farm workers in South Africa since 1960. Regular (casual) farm labour employment fell from 756 397 (591 882) in 1960 to 481 375 (459 445) in 2002 (Statistics South Africa, 2005). While both regular and casual farm labour employment levels have fallen, the proportion of casual labour (i.e. seasonal and domestic workers employed on farms) rose from 36% of total farm labour in 1991 to 49% by 2002 (Statistics South Africa, 2004). Bhorat and Lundall (2004) suggest that the shift to part-time employment across most economic sectors in South Africa has been both significant and rapid.

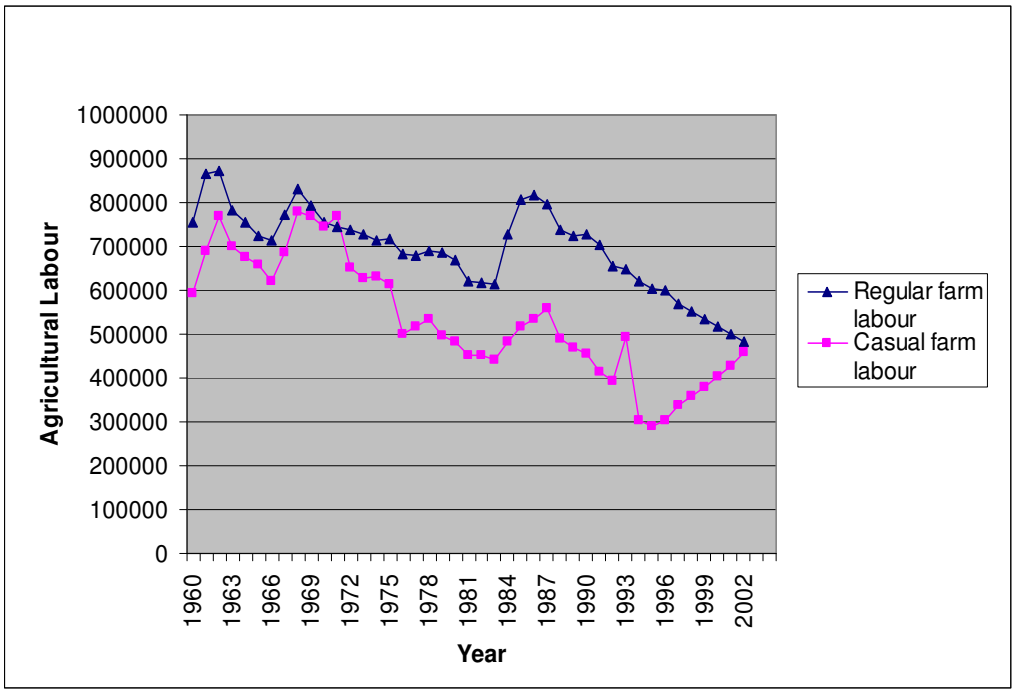

Figure 1: Trends in employment of regular and casual farm labour in South Africa, 1960 – 2002.

Source: Agricultural Census Reports and Labour Force Surveys (Statistics South Africa, 2005)

2.1 Demand for farm labour in South Africa

The quantity demanded of an input (in this case labour) is likely to decrease when the own price of that input (in this case wage) rises, *ceteris paribus*. A change in demand for an input is caused by a change in the demand shifters, such as the prices of substitutes (e.g. machinery and labour contracting in the case of labour) (Petersen & Lewis, 1999). The demand for a factor of production, like labour, is derived from the demand for the final product, and, therefore, is a function of the expected price of the final product, the expected price of the input in question, the expected prices of all other inputs and the level of technology (Friedman, 1962). According to the theory of the competitive firm, variable farm inputs like labour will, for a given level of technology and input and output prices, be hired to the point where the value of their marginal product (VMP) approximately equals the unit cost (wage) of that input (Doll & Orazem, 1984:66). Goedecke and Ortmann (1993) suggest that as the relative cost of farm labour in South Africa increases, it is substituted with machinery (capital) and machinery and labour contractors. Friedman (1962) contends that demand analysis is further complicated by simultaneous reactions of all firms to resource price changes. Individual VMP curves will change in such a way as to make the industry (agricultural sector) labour demand curve less elastic than the sum of the individual (farm) demand curves. This study attempts to estimate the industry demand function for regular farm labour in South Africa.

As noted in the Introduction, there are only two documented empirical estimates of the price (wage) elasticity of demand for farm labour in South Africa, namely -1.39 for regular farm labour in KwaZulu-Natal over the period 1972-1978 (Latt & Nieuwoudt, 1985), and -0.3 for farm labour in the Breërivier Valley of the Western Cape Province (Conradie, 2005). As comparisons for research on unskilled labour, Mazumdar and Van Seventer (2002) estimated the price elasticity of demand for unskilled labour in the SA manufacturing sector as -0.9 for the 1980s and -1.15 for the 1990s. Behar (2004) estimated the price elasticity of demand for unskilled and semi-skilled workers in the SA manufacturing sector as -0.65 and -0.8 respectively, while Fedderke and Mariotti (2002:860) report a wage elasticity of demand estimate for the SA manufacturing sector of about -0.5. Lianos (1972) estimated the price elasticity of demand for hired farm labour in the United States (US) as -1.37, while Gardner (1972) estimated a figure for the US of -1.4.

2.2 Supply of farm labour in South Africa

Approximately 41% of the SA population live in rural areas (Statistics South Africa, 2005). A loss of employment in agriculture due to increases in labour

costs (and accompanied by depressed agricultural economic conditions) is an important push factor driving the least skilled labour out of the agricultural sector (Nieuwoudt & Groenewald, 2003). Farm workers will move to urban areas to seek employment because jobs are unavailable in rural areas. Many unskilled rural workers commute and migrate to jobs in non-farm sectors, such as mining, which generally offer higher wages, thus decreasing the supply of regular labour to the agricultural sector. De Wet and Van Heerden (2003) argue that because unemployment seems to be so prevalent among the unskilled labour force, it seems plausible to assume that the supply of unskilled and informal sector labour in South Africa is highly wage elastic.

The supply of highly skilled and semi-skilled labour (as owners of specialised skills) tends to be relatively more price inelastic (Pasour, 1990). There seems to be very little (if any) unemployment in these two groups in South Africa, and wages tend to adjust as the demand for this type of labour increases or decreases (De Wet & Van Heerden, 2003). Bhorat and Hodge (1999) suggest that increases in the capital intensity of production would lower the demand for unskilled and low-skilled labour in South Africa that is being replaced by new capital equipment, but increase the demand for more skilled labour that are required to operate and maintain the new capital equipment.

There are also very few published estimates of the supply elasticities for farm labour in South Africa. Latt and Nieuwoudt (1985) estimated the price elasticity of regular farm labour supply in KwaZulu-Natal as 5.18, while Behar (2005) estimated the price elasticity of supply for unskilled labour in South Africa as 4.1. A study by the National Food and Agricultural Policy Project (2003) estimates the price elasticity of supply for farm workers in California in the US as 0.75. Salhofer (2000) estimates the price elasticities of labour supply for farm labour in Germany, Denmark and the United Kingdom as 0.16, 0.28 and 0.5 respectively. The price elasticity of supply for farm labour is expected to be much higher in South Africa due to the high levels of unemployment, as the Latt and Nieuwoudt (1985) and Behar (2005) studies indicate.

2.3 Labour legislation and policies that apply to SA agriculture

Prior to the early 1990s, labour issues in SA commercial agriculture were dealt with mainly through common law which was based on legal precedents set on past judgments. According to Lewis *et al.* (1996), SA farmers had begun reducing their labour employment levels in the early 1990s in anticipation that the following labour legislation would be introduced and applied to farm workers (Creamer Media, 2006):

- The Basic Conditions of Employment Act (BCEA) 104 of 1992, that stipulated minimum terms or conditions of employment.
- The Unemployment Insurance Amendment Act (UIA) 130 of 1992.
- The Agricultural Labour Act (ALA) 147 of 1993, that enabled farm workers to organize in the workplace.
- The Occupational Health and Safety Act 85 of 1993.

Agricultural labour legislation was introduced because common law was perceived to be inadequate in regulating the working relationship between labourer and farmer (De Jager & Wild (1993), cited by Newman, 1996:12). It is plausible that SA commercial farmers continued to reduce their labour employment levels through to 2002 *in expectation of the increased real costs* of complying with further new legislation that included (Creamer Media, 2006):

- The Labour Relations Act 66 of 1995 (amended in 2002), that provided a new framework for working relationships between employers and employees.
- The Land Reform (Labour Tenants) Act 3 of 1996.
- The Extension of Security of Tenure Act 62 of 1997.
- The Basic Conditions of Employment Act 75 of 1997 (amended).
- The Employment Equity Act 55 of 1998.
- The Skills Development Levies Act 9 of 1999.
- The Unemployment Insurance Act 63 of 2001 (amended) which enabled farm workers to receive unemployment benefits.

The introduction of such new labour legislation has likely increased both monetary and non-monetary costs for SA commercial farmers. The BCEA, for example, increases the time, money and effort spent by farmers in dealing with labour, while the Labour Relations Act increases the risk of industrial action on farms. The Land Reform (Labour Tenants) Act and Extension of Security of Tenure Act expose farmers with more on-farm labour to greater risk of facing claims for land restitution. Moreover, the Skills Development Levies Act results in further costs for the farmer in terms of providing training and education for workers. According to Goedeke and Ortmann (1993) and Vink and Tregurtha (2003), the increase in labour costs (including transaction costs and risk) has led to the substitution of own machinery, contract machinery or contract labour for own labour. In addition, a Sectoral Determination for the Farm Worker Sector introduced in 2002 (in terms of the BCEA 75 of 1997 as amended) included provision for a minimum wage for farm workers. Under this measure, SA commercial farmers were required to pay their staff prescribed minimum wages as from 1 March 2003 (Department of Labour, 2005).

3. Study data and methodology

3.1 Farm labour data

Most of the data on SA farm labour employment and wage levels were obtained from Statistics South Africa. The latest Agricultural Census Report published by Statistics South Africa was conducted in 2002 and prior to that in 1993, but annual data are available up to 1996. Missing observations for quantity and remuneration of farm labour between 1996 and 2002 were estimated with SPSS (version 11.5) (2005) using non-linear interpolation and using data obtained from the Abstract of Agricultural Statistics (2005) and Population Census Reports also published by Statistics South Africa. The SA Consumer Price Index (CPIX) (Statistics South Africa, 2005) with a base year of 2000 was used to deflate annual nominal values to annual real values where necessary in the empirical models.

3.2 Empirical methodology

Both OLS regression and 2SLS regression were used to estimate annual regular farm labour demand in South Africa (Y^D_t) as a function of the annual real regular farm wage ($RWAGE_t$) and other explanatory variables as specified in sections 4 and 5 of this paper. Note that OLS cannot be applied to estimate a single equation embedded in a system of simultaneous equations if one or more of the stochastic explanatory variables are correlated with the stochastic disturbance term in that equation, as the estimators obtained will be inconsistent (Gujarati, 2003:770). The 2SLS regression technique extends regression analysis to cover models which violate the OLS assumption that the disturbance term is uncorrelated with the independent variables (Bollen, 1996). This requires that there is sufficient information about the economic behaviour being modelled by the specified variables in order to estimate (identify) the parameters of each equation. The method of 2SLS can be applied to estimate unique parameter estimates for both exactly identified equations and over-identified equations (Gujarati, 2003:740-748). It replaces the (stochastic) endogenous explanatory variable with an estimated proxy variable that is a linear combination of all the predetermined variables in the model (and hence is uncorrelated with the stochastic disturbance term) and uses this combination as the explanatory variable in lieu of the original endogenous variable.

Both the OLS and 2SLS regression models estimated in this paper include a piecewise interactive slope dummy variable ($POLICY_t$) to represent the marked structural decline in the quantity of regular farm labour demanded in South Africa that followed the introduction of new labour legislation that

applied to SA commercial farms from the early 1990s onwards. $POLICY_t$ is defined as the difference between the observed real wage of regular farm labour ($RWAGE_t$) in any year and that wage in a "threshold" year ($RWAGE_t^*$), multiplied by D_t, where D_t equals 1 for the period 1991-2002 and 0 otherwise. The study used 1991 as the threshold year as major labour policy changes that would raise farm labour costs were likely being anticipated by SA commercial farmers from the early 1990s onwards. This is plausible as Fedderke and Mariotti (2002:839) and Wakeford (2004) suggest that the SA labour market at macroeconomic level was subject to a structural break in 1990 - driven in part by changes in labour market policy that raised both wage and non-wage costs of labour - after which the unemployment rate rose. For example, many farmers were likely to have started reducing their farm employment levels in expectation of higher labour costs following the introduction of the BCEA that was gazetted in 1992.

Piecewise linear regression using $POLICY_t$ splits the SA regular farm labour demand function into two linear segments with the function changing its slope at the threshold real wage level ($RWAGE_t^*$). A test of the hypothesis that there is no break in this regular farm labour demand function at the threshold $RWAGE_t^*$ can then be conducted by noting the statistical significance of the estimated slope coefficient for $POLICY_t$ (see Gujarati, 2003:317-319). The variable $POLICY_t$ is, therefore, a proxy for the increase in monetary and non-monetary costs (transaction costs and risk) of regular farm labour associated with the introduction of new labour legislation that affected SA commercial farms as described in section 2. Log-linear regression models were not considered appropriate as they impose a condition of constant elasticity and, therefore, exclude the possibility of a change in the estimated price (wage) elasticity of regular farm labour demand over the study period.

The OLS and 2SLS regression models also both use an autoregressive scheme to account for time lags in adjustments made by farmers to the size of their annual regular labour force following a change in the expected cost of farm labour. This involves including the lagged value of the dependent variable (Y^D_{t-1}) as an explanatory variable (Gujarati, 2003:665) in the regular farm labour demand function. The rationale is that SA farmers are hypothesized to have a desired annual number of regular farm workers, Y^*_t, that they wish to employ, given the expected regular farm labour wage rate and other factors affecting the annual demand for regular farm labour - but they cannot adjust immediately to Y^*_t when regular farm labour wage rates change. This plausible lag could be due to rigidities such as the time needed to search for and adopt labour-saving technology, machinery or contractors, and other institutional factors such as the transaction costs and time needed to comply with the terms of labour contracts and legislation provisions. For example, the Labour

Relations Act 66 of 1995 prevents farmers from dismissing workers without first showing that the reason for dismissal is related to the worker's conduct or capacity, or is based on the operational requirements of the business. The farmer should consult the relevant trade unions to settle the dispute and issue the worker with prior warnings before dismissal (Government of South Africa, 1995). In the partial adjustment (dynamic) models created by the autoregressive scheme, the estimated parameter for Y^D_{t-1} is $(1 - \delta)$, where δ is the coefficient of adjustment, and shows by how much the adjustment by SA commercial farmers towards Y^*_t is achieved each year (Gujarati, 2003:678). The next two sections specify and discuss the models used to estimate Y^D_t as a function of $RWAGE_t$, $POLICY_t$, Y^D_{t-1} and other explanatory variables suggested by the discussion in section 2 of this paper.

4. Single equation regular farm labour demand model

Equation (1) specifies an econometric model to estimate the demand for regular farm labour in South Africa, while section 4.1 presents the economic rationale for the specified variables:

$$Y^D_t = \beta_0 + \beta_1 RWAGE_t + \beta_2 CWAGE_t + \beta_3 CONTRAC_t + \beta_4 INT_t + \beta_5 CHEM_t + \beta_6 FARMOUT_t + \beta_7 POLICY_t + \beta_8 Y^D_{t-1} + \varepsilon_t \quad \ldots (1)$$

where:

Y^D_t = Quantity of regular farm workers demanded per annum,
β_0 = Constant term,
$\beta_1 \ldots \beta_8$ = Slope parameters to be estimated,
$RWAGE_t$ = Real annual wage of regular farm labour (Rand),
$CWAGE_t$ = Real annual wage of casual farm labour (Rand),
$CONTRAC_t$ = Real annual price of contractors (Rand),
INT_t = Real annual prime overdraft interest rate (proxy for the cost of capital) (%),
$CHEM_t$ = Real annual price of farm chemicals (real chemical price index),
$FARMOUT_t$ = Real annual value of farm output (gross income) (Rand),
$POLICY_t$ = Piecewise slope dummy variable for real annual regular farm labour wages (specified as $[RWAGE_t - RWAGE^*_{1991}]D_t$, where $D_t = 1$ for 1991-2002 and 0 otherwise),
Y^D_{t-1} = Lagged quantity of regular farm workers demanded per annum,
ε_t = Error term, and
t = 1…..43 (1960-2002).

4.1 Choice of variables and expected coefficient signs in the regular farm labour demand model

(a) Quantity of regular farm labour demanded (Y^D_t) and real annual wage of regular farm labour ($RWAGE_t$)

Annual data for the number of regular labourers employed in SA agriculture were obtained from Agricultural Census Reports and Labour Force Surveys for 43 years (1960-2002). The data do not differentiate between the sexes, but it was not considered necessary to make this distinction because much of the work undertaken in agriculture allows for both male and female employment. No attempt was made to consider different skills categories because SA farm labour is predominantly unskilled (Department of Labour, 2005).

Remuneration estimates for regular labour were computed from expenditure data gathered in the Agricultural Census Reports and Labour Force Surveys (Statistics South Africa, 2005). Annual expenditures on wages included payments in kind, and were expressed in real terms with 2000 as the base year (CPIX = 100). The real average annual wage per regular farm worker ($RWAGE_t$) was estimated by dividing total real annual expenditure on regular wages by the number of regular farm employees per year. The hypothesis of a negatively sloped demand curve for regular farm labour suggests that $\beta_1 < 0$. The price elasticity of demand for regular farm labour in South Africa is estimated using β_1 prior to 1991 (the threshold year), and using $\beta_1 + \beta_7$ (where β_7 is the coefficient estimate for $POLICY_t$) after 1991 to capture the marked fall in the quantity of regular farm labour demanded.

(b) Real annual wage of casual labour wage ($CWAGE_t$)

Casual labour in South Africa is considered to be a substitute for regular farm labour. Whether for reasons of increased risk exposure or higher wages and transaction costs associated with regular labour, the casualisation of farm labour is likely to continue (Du Toit & Koekemoer, 2003). The average real annual wage of casual labour was calculated by dividing the total real annual remuneration of seasonal farm labour by the total seasonal labour employment for each year, using data from the Agricultural Census Reports (Statistics South Africa, 2005). *Ceteris paribus*, an increase in $CWAGE_t$ should reduce the quantity of casual farm labour demanded and increase the demand for regular farm labour (i.e. $\beta_2 > 0$).

(c) Real annual price of contractors ($CONTRAC_t$)

Farmers are expected to use more machinery/labour contractors as a way of reducing their exposure to the risk of facing industrial action that is now permitted under farm labour legislation. Contractors may be more easily replaced than regular labour from the farmer's point of view (Newman & Ortmann, 1996), and contractors are considered as a substitute for regular farm labour. *Ceteris paribus*, an increase (decrease) in the price of contractors should result in a decrease (increase) in the quantity of contractors demanded and an increase (decrease) in the demand for regular farm labour (i.e. $\beta_3 > 0$). Unfortunately, annual time series data for prices charged by contractors were not available, and this variable had to be omitted from the empirical model.

(d) Real annual prime overdraft interest rate (INT_t)

The real prime overdraft interest rate was used as a proxy for the cost of capital (Pehkonen, 2003), including machinery and new equipment technologies (Holly, 1999). An increase in INT_t is expected to decrease investment in machinery and equipment, thus causing an increase in the demand for regular farm labour, *ceteris paribus*. Therefore, β_4 and the cross-price elasticity of demand for regular farm labour with respect to INT_t should be positive. Nominal annual interest rates were obtained from the South African Reserve Bank (2004) and converted into real terms using the following formula (Watts & Helmers, 1979):

$$r' = \left(\frac{1 + r}{1 + f} \right) - 1$$

where r′ = real interest rate, r = nominal interest rate, and f = annual inflation rate (SA CPIX).

(e) Real annual price of farm chemicals ($CHEM_t$)

Pesticides and herbicides for crops, and certain dips and sprays for animals, can be considered as labour-saving technologies (Doll & Orazem, 1984:109). Chemical prices were based on the price index for chemicals in the Abstract of Agricultural Statistics (2005), and the index values were converted to real indices by dividing by the relevant SA CPIX figures (2000 = 100). If chemicals are a substitute for regular labour, a decrease (increase) in $CHEM_t$ should result in an increase (decrease) in the use of chemicals and a decrease (increase) in demand for regular farm labour, *ceteris paribus*. Thus, β_5 and the cross-price elasticity of demand for regular farm labour with respect to $CHEM_t$ are expected to be positive.

(f) Real annual value of farm output ($FARMOUT_t$)

The real annual value of farm output was estimated from the Abstract of Agricultural Statistics (2005) using the figures reported for the SA farm sector gross income. Annual nominal values were converted to real values again using the SA CPIX (2000 = 100). The variable $FARMOUT_t$ is a proxy for expected earnings and product price, implying via derived demand, that an increase in $FARMOUT_t$ should increase the demand for regular farm labour, *ceteris paribus* (Friedman, 1962). This suggests that the estimated regression coefficient β_6 should be positive.

(g) Piecewise slope dummy variable to proxy the introduction of new farm labour legislation in SA agriculture ($POLICY_t$)

This variable, as specified in section 3 of this paper, was estimated to account for SA commercial farmers' expectations of the cost impact that new legislation would have on the demand for regular farm labour. The price elasticity of demand for regular farm labour post-1991 (i.e. during the period 1991-2002) is estimated from $\beta_1 + \beta_7$ (where β_7 is the regression coefficient estimated for $POLICY_t$) to capture the structural fall in regular farm labour employment. It is expected that $\beta_7 < 0$ as the new labour legislation has raised the cost of regular farm labour and, hence, reduced the quantity of regular farm labour demanded.

(h) Lagged quantity of regular farm workers demanded per annum (Y^D_{t-1})

The costs of employing regular farm labour in South Africa are expected to have increased as a result of the new labour legislation that was introduced since the early 1990s as described in section 2 of this paper. Farmers are likely to adjust the size of their regular labour force in response to these cost increases with a lag as discussed in section 3. For Y_{t-1}, the estimated coefficient β_8 is expected to be positive and is equal to $(1 - \delta)$, where δ is the coefficient of adjustment, implying that δ can be estimated from the β_8 estimate.

4.2 Empirical OLS model

Equation (2) presents the empirical structural demand model for regular farm labour in South Africa that is estimated using OLS regression for the period 1960-2002. There is no β_3 coefficient or its associated $CONTRAC_t$ variable in equation (2) because no annual time series data for prices charged by contractors were available for the analysis.

$Y^D_t = \beta_0 + \beta_1 RWAGE_t + \beta_2 CWAGE_t + \beta_4 INT_t + \beta_5 CHEM_t + \beta_6 FARMOUT_t + \beta_7 POLICY_t + \beta_8 Y^D_{t-1} + \varepsilon_t$ … (2)

The next section specifies the 2SLS regular farm labour demand model for South Africa for the same period.

5. Simultaneous-equation regular farm labour demand model

Given that wage and employment levels in a labour market are determined by the intersection of the labour demand and supply curves, a labour supply function needs to be included in a simultaneous-equation model as wages are determined endogenously in this approach. A simultaneous-equation econometric model to estimate the demand for regular farm labour in South Africa during 1960-2002 is postulated as:

$Y^D_t = \beta_0 + \beta_1 RWAGE_t + \beta_2 CWAGE_t + \beta_4 INT_t + \beta_5 CHEM_t + \beta_6 FARMOUT_t + \beta_7 POLICY_t + \beta_8 Y^D_{t-1} + \varepsilon_t$
… (2)
$Y^S_t = \beta_9 + \beta_{10} RWAGE_t + \beta_{11} LIFEXP_t + \beta_{12} UEMPOP_t + \mu_t$
… (3)

where:

Y^D_t = Quantity of regular farm workers demanded per annum,
Y^S_t = Quantity of regular farm workers supplied per annum,
β_0 and β_9 = Constant terms,
$\beta_1 \ldots \beta_8$ = Demand equation slope parameters to be estimated,
$\beta_{10} \ldots \beta_{12}$ = Supply equation slope parameters to be estimated,
$LIFEXP_t$ = Life expectancy of farm workers (in years),
$UEMPOP_t$ = Annual unemployment rate in South Africa (number of unemployed divided by population size),
μ_t = Error term, and
t = 1…..43 (1960-2002).

5.1 Choice of variables and expected coefficient signs in the supply equation

(a) Real wage of regular farm labour ($RWAGE_t$)

This variable was defined in section 4, and an expected positive sloping supply curve for regular farm labour in South Africa implies that β_{10} should be positive.

(b) Labour morbidity ($LIFEXP_t$)

Average life expectancy in South Africa in the 15 years from 1989 to 2004 has fallen from 63 to 48 years of age (Statistics South Africa, 2005). Since the onset of HIV/AIDS in the 1980s, the epidemic has spread rapidly across South Africa. Statistics South Africa (2005) estimates that one in four South Africans is HIV positive, and that as many as 5 000 people die every week of AIDS and AIDS-related diseases. Moreover, the incidence of HIV/AIDS is higher amongst the rural poor who supply most of the country's agricultural labour (De Waal, 2003). For this reason, the supply equation includes life expectancy ($LIFEXP_t$) (measured in years) as a proxy for labour morbidity in South Africa (Statistics South Africa, 2005). Decreasing life expectancy reduces the supply of labour to agriculture, suggesting that $\beta_{11} > 0$.

(c) Annual unemployment rate ($UEMPOP_t$)

The burden of unemployment in South Africa tends to fall most heavily on labour force participants who lack job skills (Strydom, 2002). A relatively high unemployment rate, such as the current 26% cited in the introduction of this paper for the formal sector in South Africa, suggests that the supply of unskilled labour to agriculture would increase as the availability of jobs nationwide decreases. An increase in the aggregate rate of unemployment indicates fewer alternative job opportunities and should, therefore, increase the supply of labour to agriculture. The rate of unemployment is computed as the annual proportion of unemployed people in the total SA population. *A priori*, β_{12} is expected to be positive. The next section reports and compares the results of the empirical OLS and 2SLS regression models of the demand for regular farm labour in South Africa that were estimated for the period 1960-2002.

6. Empirical results

The parameters estimated for $FARMOUT_t$ in both the OLS and 2SLS regression models had *t*-values less than unity and were thus omitted from the estimated regular farm labour demand models presented in Table 1. The adjusted R^2 values of 90.4% and 90.1% for the OLS and 2SLS models, respectively, are relatively high (see Gujarati, 2003:212-226) and show that the specified variables explain about 90% of the variation in regular farm labour demand in South Africa over the study period. Given the estimated highly statistically significant F statistics (at the 1% level of probability), these variables in each equation *as a group* influence regular farm labour demand. For the 2SLS model, $RWAGE_t$ is endogenous, while the specified exogenous variables imply that both the demand and supply equations are over-

identified. The Runs (or Geary) test of the estimated residuals was statistically significant at the 5% level of probability, so the null hypothesis of randomness was not rejected (Gujarati, 2003).

The estimated coefficients for $RWAGE_t$ are statistically significant at the 1% level of probability, with t values of -3.951 and -2.669 for OLS and 2SLS, respectively. The negative coefficient estimates (-17.764 for OLS, and -15.317 for 2SLS) show that an increase in the real wage rate of regular farm labour would reduce the quantity of regular farm labour demanded in South Africa, *ceteris paribus*. The standardized Beta coefficients for $RWAGE_t$ (-0.508 for OLS, and -0.437 for 2SLS) are relatively high, and rank $RWAGE_t$ as the most important determinant of regular farm labour demand in the OLS model, and second most important factor in the 2SLS model.

Table 1: OLS and 2SLS regular farm labour demand model results, SA agriculture, 1960–2002

MODEL / VARIABLE	OLS[(a)]		2SLS[(a)]	
	Regression coefficient estimates (βs)	**Standardized regression coefficient estimates (Betas)**	**Regression coefficient estimates (βs)**	**Standardized regression coefficient estimates (Betas)**
CONSTANT	321649.458*** (3.245)	---	281441.631** (2.441)	---
$RWAGE_t$	-17.764*** (-3.951)	-0.508	-15.317*** (-2.669)	-0.437
Y^D_{t-1}	0.511*** (4.558)	0.481	0.552*** (4.351)	0.518
$CWAGE_t$	14.557** (2.319)	0.225	12.777* (1.876)	0.197
INT_t	4096.961*** (2.884)	0.201	4039.615*** (2.827)	0.198
$CHEM_t$	75214.751*** (2.521)	0.144	76541.611*** (2.55)	0.146
$POLICY_t$	-18.091*** (-2.611)	-0.259	-18.316*** (-2.629)	-0.262
Adjusted R^2	90.4%		90.1%	
F	65.291***		63.348***	
Degrees of freedom	36		36	

Note: [(a)] *t*-statistics are in parentheses; * = statistically significant at the 10% level of probability; ** = statistically significant at the 5% level of probability; and *** = statistically significant at the 1% level of probability.

Based on these β estimates, the estimated long-run wage (price) elasticity of demand (E_{ii}) reported in Table 2 for regular farm labour prior to 1991 in South Africa is -0.25 for OLS, and -0.23 for 2SLS. For the post-1991 period (identified by the highly statistically significant negative coefficient estimates for $POLICY_t$ in both models), the estimated long-run elasticity (see Table 2) was -1.32 for OLS, and -1.34 for 2SLS. Conradie (2005) estimated a price elasticity of demand for farm labour in the Breërivier Valley of the Western Cape of -0.3, but did not allow for a structural change in farm labour demand driven by farmers' expectations of higher labour costs associated with implementing the requirements of new labour legislation that affected SA commercial farms from the early 1990s onwards. The long-run price elasticity estimates reported in this paper are similar to Latt and Nieuwoudt's (1985) estimate of -1.39 for regular farm labour in KwaZulu-Natal during 1972-1978.

Table 2: Estimated long-run demand elasticities for regular farm labour using 1991 as the threshold year, OLS and 2SLS, SA agriculture, 1960-2002

MODEL / ELASTICITY	OLS		2SLS	
	Pre-threshold period (1960-1990)	**Post-threshold period (1991-2002)**	**Pre-threshold period (1960-1990)**	**Post-threshold period (1991-2002)**
Own price (wage) elasticity of demand for regular farm labour (E_{ii})	-0.25	-1.32	-0.23	-1.34

The estimated coefficients for the lagged regressand Y^D_{t-1} have the expected positive signs and are highly statistically significant in both models. The coefficient estimates imply that the coefficient of adjustment of regular labour demand (δ) over the study period ranges between about 49% (1 - δ = 0.511) for OLS, and 45% (1 - δ = 0.552) for 2SLS. Commercial farmers in South Africa, therefore, are estimated to adjust their regular labour employment levels by closing the gap between the beginning year actual and their desired level of regular farm labour by 45-49% each year. For example, if 45% of the gap is closed in the first year, 55% of the desired change is still to be made at the beginning of year two. In that year, 45% of that remaining gap is closed, implying that a further 25% of the desired change is achieved by the beginning of year three, and so on for subsequent years. Commercial farmers in South Africa are thus estimated to take about six years to make the full adjustment toward their desired (equilibrium) regular farm labour levels in response to a change in the real annual regular farm labour wage. This lagged adjustment

process is the major determinant of regular farm labour demand in the 2SLS model and the second ranked determinant in the OLS model.

The coefficient estimate for $CWAGE_t$ is positive and statistically significant at the 5% level of probability for the OLS model and at the 10% level for the 2SLS model, suggesting that casual labour was a substitute for regular farm labour in South Africa during the study period. The estimated cross-price elasticities of demand for regular farm labour with respect to casual wages (E_{ij}) reported in Table 3 are 0.05 for OLS and 0.04 for 2SLS - a 1% increase in the wage of casual labour would increase the demand for regular farm labour by between 0.04% and 0.05%, *ceteris paribus*.

Table 3: Estimated long-run cross-price elasticities (Eij) of demand for regular farm labour for selected explanatory variables, OLS and 2SLS, SA agriculture, 1960-2002

VARIABLE & MODEL / ELASTICITY	$CWAGE_t$		INT_t		$CHEM_t$	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Cross-price elasticity of demand for regular farm labour (E_{ij})	0.05	0.04	0.02	0.02	0.13	0.13

The INT_t coefficient estimate is positive and statistically significant at the 1% level of probability for both models, implying that capital was a substitute for regular farm labour in South Africa during 1960-2002. The estimated cross-price elasticity of demand in Table 3 is 0.02 in both models - a 1% increase in the real prime overdraft interest rate would cause a 0.02% increase in the demand for regular farm labour, *ceteris paribus*. Finally, the estimated $CHEM_t$ coefficient is also positive and statistically significant at the 1% level of probability for both models, identifying chemicals as a substitute for regular farm labour in South Africa. The estimated cross-price elasticity of demand (see Table 3) of 0.13 for both models predicts that a 1% increase in the real price of chemicals would cause a 0.13% increase in the demand for regular farm labour, *ceteris paribus*.

The Normal Probability Plot of the regression standardized residuals showed no outliers or abnormalities in either the OLS or 2SLS model. Some multicollinearity was expected between $POLICY_t$ and $RWAGE_t$, where data in $RWAGE_t$ accounted for most of $POLICY_t$. The estimated variance inflating factors (VIFs) for $RWAGE_t$ and $POLICY_t$ were equal to seven and four,

respectively, with a VIF value above 10 indicating relatively high collinearity (Gujarati, 2003:362). The estimated VIFs for the other specified variables were relatively low (less than four), suggesting that little collinearity existed between them using OLS and 2SLS regression.

Figure 2 shows the relationship between the real annual regular farm labour wage and regular farm labour employment levels in South Africa during 1960-2002. An overall increase in the real wage is associated with a decrease in regular farm labour employment. Segment A-B shows the effect of rising real wages on regular farm labour employment in South Africa after new labour legislation that raised the cost of labour for SA commercial farmers was implemented from the early 1990s onwards. Point A shows predicted regular labour employment at the 2002 real wage rate (R10 827), while point B shows predicted annual regular labour employment at the 1991 real wage rate (R7 306). Point D represents the mean real wage (R9 794) and mean annual quantity predicted (542 621 workers) for the period 1991-2002. The demand curve (A–B) for regular farm labour is relatively more price elastic (-1.34) during this period. Segment B-C traces the demand for regular farm labour over the period 1960-1991. Point E shows the mean real wage (R4 993) and mean annual quantity predicted (723 622 workers) for this period which has a relatively less price elastic demand for regular farm labour (-0.23).

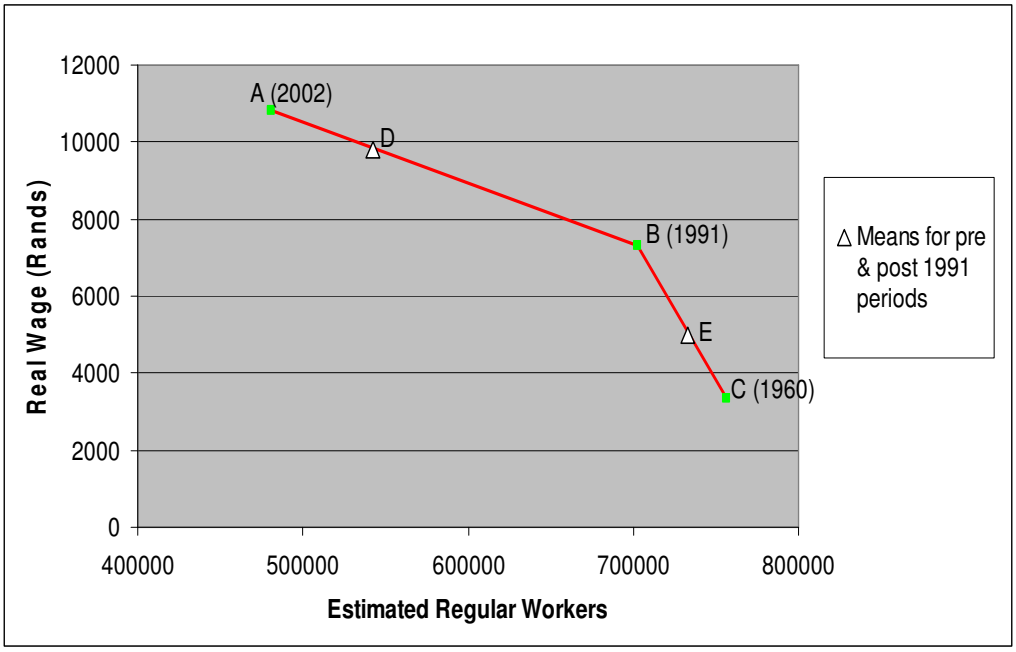

Figure 2: Piecewise demand function estimated for regular farm labour in South Africa, 1960-2002

7. Conclusions

Demand models for regular farm labour estimated by OLS and 2SLS regression for South Africa during 1960-2002 generated similar long-run price (wage) elasticities of demand. In the pre-1991 period, these estimates ranged from -0.25 to -0.23, and in the 1991-2002 period varied from -1.32 to -1.34 for OLS and 2SLS, respectively. Clearly, the demand for regular farm labour has become markedly more price elastic since the implementation of new labour legislation that has applied to SA commercial farms from the early 1990s onwards. Other things being equal, this implies that further increases in the real cost of farm labour may result in substantial job losses for regular farm workers in South Africa, depending on the extent to which SA commercial farmers have already discounted expected further real cost increases (such as those associated with the introduction of minimum wages since March 2003). In order to reverse the rising regular farm labour unemployment trend in South Africa, the government could adopt more flexible labour market regulations (for example, those relating to hiring and dismissal procedures) that would reduce real labour costs and encourage farmers to employ more regular labour.

Highly statistically significant coefficient estimates for the lagged annual level of regular farm labour employment in both regression models support the use of dynamic models in the study. These findings suggest that SA commercial farmers take time to adjust (reduce) their regular labour employment levels towards their desired (equilibrium) levels when real regular farm labour wages increase. Based on the estimated annual rates of adjustment of 45%-49%, they would make over 80% of the desired change in three years, and take about six years to reach their equilibrium regular labour levels. Policymakers need to be aware of these lags to better understand the short- and long-term effects that changes in labour legislation have on employment levels in SA agriculture.

Real wages paid to casual workers also had a statistically significant impact on the demand for regular farm labour. New labour legislation that has applied to the SA commercial farm sector since the early 1990s has encouraged commercial farmers to substitute casual workers for regular workers because they command lower wages, incur lower transaction costs and expose farmers to less risk of industrial action and/or claims for land restitution. However, the inclusion of all casual workers in minimum wage legislation from 2006 onwards (Department of Labour, 2005) is likely to slow the rate of casualisation of the farm sector labour force as farmers may turn to labour contractors, chemicals and machinery as the next best substitutes. Furthermore, a relative increase (decrease) in the price of chemicals increases (decreases) the demand for SA regular farm labour, and regular farm labour demand also increases as the real prime overdraft interest rate (proxy for the

cost of capital) increases. These findings identify chemicals and machinery and equipment as technical substitutes for regular farm labour in South Africa.

More flexible labour market legislation relating to the hiring and dismissal of farm workers could decrease the transaction costs and time spent by SA commercial farmers in dealing with labour employment issues. A shift away from the collective bargaining process to accommodate personalised employment contracts and wage negotiations may reduce the risk of industrial action and improve cost efficiency by rewarding more productive workers. Given that higher real wages are likely to reduce the quantity of regular labour demanded, and that casual farm labour will be included under minimum wage legislation from 2006, the content of labour legislation that affects commercial farms in South Africa needs to be reconsidered. The marked structural fall in demand for regular farm labour since 1991 in South Africa raises questions about the appropriateness of labour laws and minimum wage legislation that have raised the cost of regular labour. Government policy could rather focus more on encouraging investment in skills development to improve farm wages through higher productivity and increased competition with more skill-intensive sectors of the economy.

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References

Abstract of Agricultural Statistics (2005). National Department of Agriculture, Pretoria, South Africa.

Behar A (2004). *Estimates of labour demand elasticities and elasticities of substitution using firm-level manufacturing data*. CSSR, Working Paper No. 98, Cape Town: Centre for Social Science Research, University of Cape Town. http://www.nuff.ox.ac.uk/users/behar/rw/wp98.pdf (Accessed 07/09/2005).

Behar A (2005). *Does training benefit those who do not get any? Elasticities of complementarity and factor price in South Africa*. Discussion Paper Series, Paper No. 244, University of Oxford.
http://www.economics.ox.ac.uk/Research/wp/pdf/paper244.pdf (Accessed 08/10/2005).

Bhorat H & Hodge J (1999). Decomposing shifts in labour demand in South Africa. *South African Journal of Economics* 67(3):348-380.

Bhorat H & Lundall J (2004). Employment, wages, and skills development: firm-specific effects – Evidence from a firm survey in South Africa. *South African Journal of Economics* 72(5):1022-1055.

Bollen KA (1996). An alternative Two-Stage Least Squares (2SLS) estimator for latent variable equations. *Review of Economic Studies* 64:385-398.

Burton JF, Benham LK, Vaughn WM & Flanagon RJ (1970). *Readings in Labour Market Analysis*. New York: Holt, Rinehart and Winston.

Conradie BI (2005). Wages and wage elasticities for wine and table grapes in South Africa. *Agrekon* 44(1):138-156.

Creamer Media (2006). Legislation and Policy: Acts. http://www.polity.org.za/page.php?rep_id=70 (Accessed 02/02/2006).

Department of Labour (2005). Government of South Africa. http://www.lab.gov.org/ (Accessed 13/10/2005).

De Waal A (2003). Macro-economic implications of HIV/AIDS. *SARPN*, Paper No. 24: South African Regional Poverty Network, Addis Ababa, Ethiopia.

De Wet TJ & Van Heerden JH (2003). The dividends from a revenue neutral tax on coal in South Africa. *The South African Journal of Economic and Management Sciences* 6(3):34-48.

Doll JP & Orazem F (1984). *Production economics: theory with applications*. New York: John Wiley & Sons.

Du Toit C & Koekemoer R (2003). A labour model for South Africa. *South African Journal of Economics* 71(1):18-30.

Fedderke JW & Mariotti M (2002). Changing labour market conditions in South Africa: a sectoral analysis of the period 1970 – 1997. *South African Journal of Economics* 70(5):830-864.

Friedman M (1962). *Price theory: a provisional text*. Chicago: Aldine.

Gardner B (1972). Minimum wages and the farm labor market. *American Journal of Agricultural Economics* 54(2):473-476.

Goedecke EJ & Ortmann GF (1993). Transaction costs and labour contracting in the South African forestry industry. *South African Journal of Economics* 61(1):67-83.

Gujarati DN (2003). *Basic econometrics* (4th ed). New York: McGraw-Hill.

Holly P (1999). The effect of technology growth on money supply and demand and their determinants: a co-integration approach. *The Park Place Economist*, VII:63-75.
http://titan.iwu.edu/~econ/ppe/1999/patrick.pdf (Accessed 26/09/2005).

Government of South Africa (1995). Labour Relations Act 66 of 1995. http//www.lab.gov.org/ (Accessed 15/11/2005).

Latt EA & Nieuwoudt WL (1985). A supply and demand analysis of regular black labour in Natal. *Agrekon* 24(2):1-7.

Lewis DH, Ngoasheng MM, Baskin JM, Buhlungu SM, Bird AP, Cheadle HM, Kaplan DE, Lamprecht AI, Leibbrandt DMV, Santho S & Segal NS (1996). *Restructuring the South African labour market*. Report of the Presidential Commission to Investigate Labour Market Policy. Parow, South Africa: CTP Book Printers (Pty) Ltd.

Lianos TP (1972). Impact of minimum wages upon the level and composition of agricultural employment. *American Journal of Agricultural Economics* 54(2):477-484.

Mazumdar D & Van Seventer DEN (2002). A decomposition of growth of the real wage rate for South Africa: 1970-2000. Development Policy Research Unit Working Paper #02/63. Cape Town: Development Policy Research Unit. http://www.sarpn.org.za (Accessed 27/08/2005).

National Food and Agricultural Policy Project (2003). The economic impact of the Guest Worker Program. Policy Briefing Paper No. 3. California. www.econ.ucsc.edu/faculty/lkletzer/1midw02a.pdf (Accessed 12/09/2005).

Newman RA (1996). Implications of the new labour legislation for commercial agriculture in KwaZulu-Natal. Unpublished MScAgric thesis, Department of Agricultural Economics, University of Natal, Pietermaritzburg.

Newman RA & Ortmann GF (1996). Machinery and labour contracting among commercial farmers in KwaZulu-Natal. *South African Journal of Economic and Management Sciences* 20:85-97.

Nieuwoudt WL (1984). Agriculture in Southern Africa: shaping the future. *Agrekon* 23(1):1-7.

Nieuwoudt WL & Groenewald J (2003). Demands on and challenges for South African agriculture. In: Nieuwoudt WL & Groenewald JA (eds). *The challenge of change: agriculture, land and the South African economy*. Pietermaritzburg: University of Natal Press.

Ortmann GF & Machethe C (2003). Problems and opportunities in South African agriculture. In: Nieuwoudt WL & Groenewald JA (eds). *The challenge of change: agriculture, land and the South African economy*. Pietermaritzburg: University of Natal Press.

Pasour EC Jnr (1990). *Agriculture and the state: market processes and bureaucracy*. New York: Holmes and Meier.

Pehkonen J (2003). Wage formation in Finland, 1960-1994. *Finnish Economic Papers* 12(2):82-93.
www.taloustieteellinenseura.fi/ fep/articles/f1999_2c.pdf (Accessed 18/09/2005).

Petersen HC & Lewis WC (1999). *Managerial economics* (4th ed). New Jersey: Prentice-Hall.

Salhofer K (2000). *Elasticities of substitution and factor supply elasticities in European agriculture: a review of past studies*. Report to the Policy Evaluation Matrix (PEM) Project Group, OECD, Paris.
https://www.gtap.agecon.purdue.edu/resources/download/175.doc (Accessed 29/09/2005).

South African Reserve Bank (2004). *Change in the prime overdraft rates of banks*. http://www.reservebank.co.za/ (Accessed 22/08/2005).

SPSS (2005). *SPSS for Windows* (Version 11.5), SPSS Inc., Chicago.

Statistics South Africa (2004). *Unemployment surveys 2000 – 2004*. Statistical Release P1104. http://www.statssa.gov.za/ (Accessed 01/07/2005).

Statistics South Africa (2005). Statistical release 11-02-01. http://www.statssa.gov.za/ (Accessed 03/07/2005).

Strydom PDF (2002). Macroeconomic policy: 1970-2000. In: Jones S (ed). *The decline of the South African economy*. Cheltenham, UK: Edward Elgar.

Vink N & Tregurtha N (2003). A theoretical perspective on a minimum wage in South African agriculture. *Agrekon* 42(1):49–57.

Wakeford J (2004). The productivity-wage relationship in South Africa: an empirical investigation. *Development Southern Africa* 21(1):109-132.

Watts MJ & Helmers GA (1979). Inflation and machinery cost budgeting. *Southern Journal of Agricultural Economics* 11(2):83-87.