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Inequality, Agricultural Production and Poverty: With Focus on Large-scale / Small-scale Sugarcane Farms in South Africa.

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Abstract

International development agencies have renewed interest over agriculture's pro-poor potentials. South Africa's agriculture though contributes less than 3% to GDP, has the highest employment per unit of GDP. The sector is sharply divided into small and large farms. Data reveals an increasing land productivity gap between both types of farms. Using data from various sources[1], this paper assesses the agricultural production impacts of inequality and land redistribution, first in the whole agricultural sector, then the sugarcane sub-sector, comparing small-scale and large-scale farm performances and considering the causes of the productivity gap. It also analyses the comparative poverty effects of both farm-types. Time series are corrected for unit roots and estimated using robust estimation, which corrects for heteroskedasticity and outliers. Specification tests help to determine the right panel model for sugarcane. The results suggest that inequality (land redistribution) is associated with slower (enhanced) agricultural productivity. This positive effect of land redistribution can be because land constraints in South African large farms may not be binding and therefore the negative impact on large-farms does not dominate. The impact of land redistribution though negative for large-scale and positive for small-scale producers is not significant. This implies that redistribution efforts must be accompanied by significant ease of other constraints facing small farmers[2]. Other inputs like fertiliser and irrigation facilities show more significant impact on small farm production than land alone. Much of the difference in productivity arises from disparity in input use, specifically fertiliser and irrigation. There is possibility of positive external effects from large-scale chemical and labour use to small-scale production as they attenuate the gap in productivities. The finding also suggests the need to strengthen the human capital (particularly education) of small-scale producers. Both large and small-scale sugarcane production have significant poverty reduction effects, but the effect from small-scale production is clearly higher.

[1] Data came from South African Department of Agriculture, FAO, South African Cane Growers Association and the presidency of South Africa.

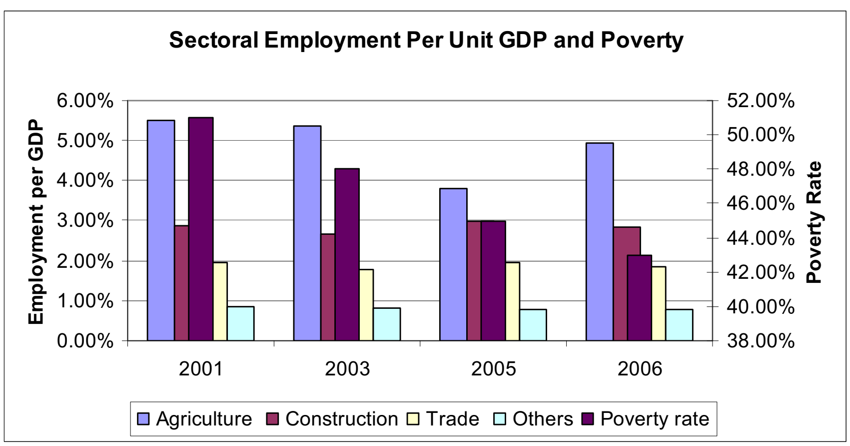
[2] This is more so because for small-scale producers, land does not seem to constitute a binding constraint in the sugarcane sector. Generally, there is always a remarkable difference between area under cane and area effectively harvested for both large-scale and small-scale growers.

1 Introduction

There has been renewed interest over agriculture's pro-poor potentials by international development agencies. The 2008 edition of the World Development Report (WDR) has highlighted three facts concerning agriculture's ability to enhance pro-poor growth especially in Sub-Saharan Africa (SSA). Firstly, GDP growth in agriculture is four times more effective in extreme poverty reduction than GDP growth originating from other sectors. Secondly, in developing countries 75% of the poor live in (agriculture-dependent) rural areas while only 4% of official development aid goes to agriculture. Thirdly, SSA countries rely heavily on agriculture for overall growth, highly taxing the sector while allocating only 4% of total government spending to the sector. World Bank (2008) has therefore reiterated that if the goals of halving poverty and hunger are to be realised, agriculture must be placed at the centre of developing countries' policy agenda, with greater investment to the sector especially in SSA.

In South Africa, though agriculture contributes less than 3% to overall GDP, its employment per unit of GDP (relative to other sectors) remain highest as shown in Figure one.

Figure 1



Source: Author[3]

[3] Generated using employment figure from the Labour Force survey Data of South African National Statistics and GDP data from the South African Reserve Bank. Poverty Data is from the South African Development Indicators (Presidency of SA, 2007).

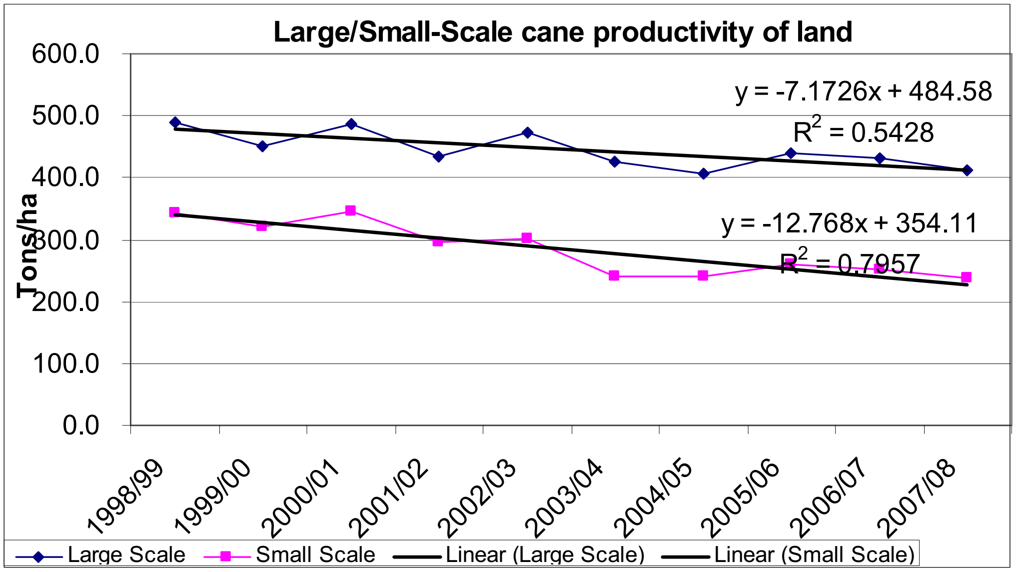
The main challenge of South Africa's policy authority is to uncover and harness agricultural potentials in order to achieve the policy goals contained in the Growth, Employment and Redistribution (GEAR) strategy. More specifically, the challenges are: (1) increase agricultural productivity and output in order to step-up its contribution to national economic growth; (2) Increase the incomes of the poorest groups through creation of production enhancing opportunities for small and medium-scale farmers; (3)creation of additional employment in agriculture; and (4) ensuring more equitable distribution of resources in the agricultural sector. South Africa's biofuel strategy and other policy options have highlighted her resolute determination to pursue the above objectives. The main objective of this strategy is to address the issues of poverty and economic development from a renewable energy angle. It aims to address some of the above challenges, particularly, job creation and enhancement of productive opportunities of the poor in the agricultural sector, in formerly disadvantaged underdeveloped areas of the community (Department of Mineral and Energy - DME, 2007).

In contrast to other developing countries where a whole range of farm sizes exist, South Africa's agricultural sector is sharply divided into small and large farms. Despite Arguments for positive relationship between farm-size and production efficiency, there has been various empirical evidence illustrating that small-scale farmers in developing countries can be efficient (Lipton et al, 1996; Vollrath, 2007). It has been argued that the only reason for any positive relationship is when more than one imperfect markets are facing small producers. Kirsten and Van Zyl (1998) identify such markets in the case of South Africa (land, credit, insurance etc). Such imperfections in input markets are factors generally considered to underlie the disparity between small and large farm productions.

Figure three presents the evolution of sugarcane production per hectare for small[4] and large-scale farmers for South Africa.

[4] Small scale growers are defined as those growers who currently deliver on average not more than 225 tonnes of Recoverable Value (RV).

Figure 3



Source: Author[5]

It is evident from the graph that there is an increasing disparity between the productivities of small- and large-scale farmers as depicted by the sugarcane example.

The post-apartheid government of South Africa has embarked on redressing some of the inequalities that have faced small-scale agriculture. The first is the land reform program that was kicked-off in 1994. This program comprises restitution, tenure reform and redistribution[6]. The redistribution objective aims to reallocate available government land, but also private land (on wiling seller – willing buyer basis) to the disadvantaged and poor, for productive and residential purposes. The SA Cane Growers Association reports that from 1999 to 2005, some 37676 hectares of land had been transferred from white large-scale growers to black growers in the sugarcane sector, on the basis of willing-seller-willing-buyer. Latest statistics show that the figure has increased to 43200 ha, representing 13.6% of black ownership in the sector (Cane Growers, 2008)[7].

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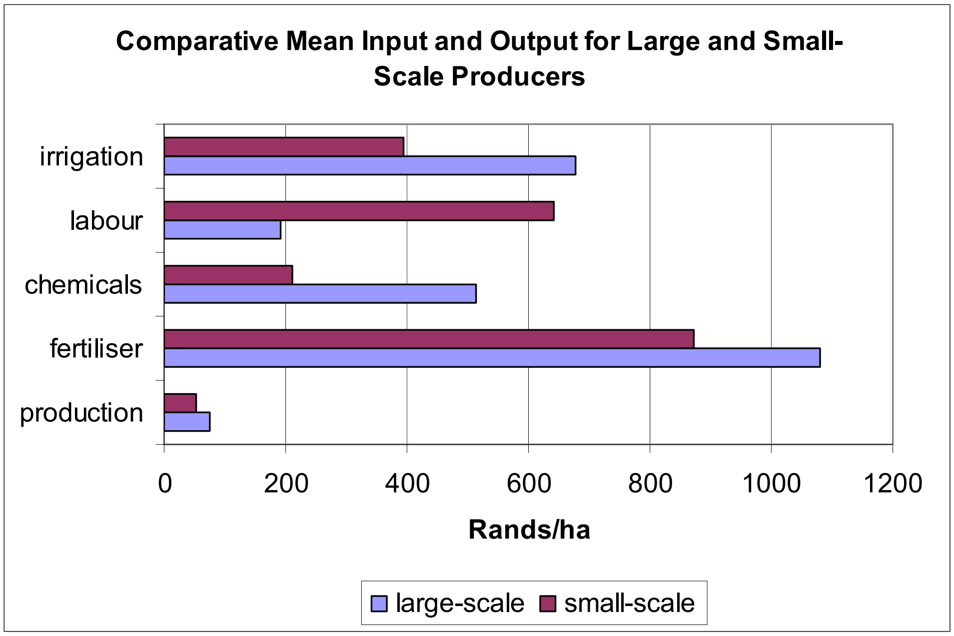
[5] Generated using Sugarcane production data from SA Cane Growers Association.
[6] Restitution covers cases of indigenes who were forcefully removed from their land after 1913. Tenure reform addresses the issue of tenure security of all south Africans in order to accommodate the diverse tenure systems. The focus on this work is on redistribution because of available data.
[7] See www.sacanegrower.co.za.

The mean inputs data from SA Cane growers Association for the sugarcane sub-sector suggests that small-scale farmers use more labour per unit land than large-scale counterparts as suggested in Figure four. This may have poverty reduction implications.

Figure 4



Source: Author[8]

The objective of this paper is to assess the pro-poor agricultural impacts of inequality and land redistribution, first in the whole agricultural sector, then focusing on the sugarcane sub-sector, comparing small-scale and large-scale farm performances. Specifically, it aims to analyse:

- The impact inequality on agricultural production, with emphasis on the land redistribution process as a measure of inequality attenuation.
- Analyse the comparative productivity[9] performances of large- and small-scale sugarcane producers with respect to various production inputs.

[8] Generated using Sugarcane production data from SA Cane Growers Association.
[9] Productivity here and elsewhere in this work refers to cane output per hectare.

- Attempt to explain the determinants of the widening productivity gap between small- and large-scale producers using the South African Cane sectors as a case study.
- Analyse the poverty impact of the sugarcane sub-sector, comparing large-scale and small-scale productions.
- Draw policy recommendations

The rest of the work is structured as follows: section two explores related literature, section three explains the methodology. In section four, results are presented alongside the interpretations. Section five concludes with some policy recommendations.

2 Literature Review

The literature on this topic follows the growth-inequality-poverty framework (Easterly, 2002; Ravalion, 2004; Bourguignon, 2004 etc). The impact of inequality on development has received much attention since the early 1990s. The works of Galor and Zeira (1993), then Persson and Tabelini (1994) and Alesina and Rodrik (1994) are pioneers in this area. Two prominent channels often highlighted in literature are credit constraints and political economy, both of which have implications for human and physical capital accumulation.

2.1 The Credit Channel

The underlying mechanism here can be typified by the following: In the credit market, if 10 and 50 percent are the respective interest rates of rich and poor individuals (due to lack of collateral by the poor), then all projects with return rates of 10 percent and above will be undertaken by the rich while only projects of 50 percent and above return rate will be carried by the poor. But if there is redistribution of wealth (or resources) from the rich to the poorer individuals, it will reduce their need to borrow while allowing them to undertake projects with returns lower than 50 percent. As such, redistribution will lead to higher investment and/or higher return to capital (Bourguignon, 2004: 17). More formalised models (like Galor and Zeira, 1993;

Banerjee and Newman, 1993; Aghion and Bolton, 1997) put information asymmetry at the centre of credit constraints. In these models, the evolution of inequality and output is influenced by the limited choice by poor people (and possibly middle class) of occupations and investment due to credit rationing. When the poor are thus prevented from making productive investment (that would benefit them and the society), a low and inequitable growth process can result. In the case of land, it can either be used as input or collateral for investment loans, thus playing a role to ease credit rationing. Thus these models establish the link between persistent high inequality, inefficiencies and slower production.

2.2 Political Economy

Two main channels are identified here. One relies on the notion of the median voter where wealth inequality increases the gap between the median voter and the average capital endowment of the economy. This leads him to support higher capital tax rates, which in turn reduces incentives to invest in physical and human capital hence reducing growth. Persson and Tabelini (1994) suggest an alternative along this line, in which the rich spend their wealth to lobby for preferential (tax) treatment, leading to more inequality and slower production.

The other channel is the social conflict and political instability. Alesina and Perotti (1993) have argued that higher political instability can result from high inequality, the resulting uncertainty then reduces investment levels. Rodrik (1998) has noticed that divided societies with weak institutions also witnessed the sharpest fall in post-1975 growth.

Empirical attempts have been made to test the hypothesis - hat high inequality leads to low investment in physical and human capital, resulting to slower growth. Various authors have found negative impact of initial inequality on growth. Persson and Tabelini (1994) using data for nine OECD countries found that a one standard deviation increase in income share of the top quintile reduces growth rate by half a percentage point. Other verifications have been made, for a sample of developing countries (Clarke, 1995) and a combination of both, in an extended dataset (Deininger and Squire, 1996b).

Regarding the agricultural sector, a number of studies have considered cross-country productivity determinants (Kawagoe et al, 1985; Fulginiti and Perrin, 1993; Craig et al, 1997). All of these attempt to model the role of factors such as capital, land quality, infrastructure, and research and Development (R&D) on agricultural production. Time dimension of such analysis has been considered. One of such work is Vollrath (2007) who expressely introduces the role of inequality while trying to empirically investigate the inverse farm size – productivity relationship. Using panel data for countries, he finds that the gini coefficient has a significant negative effect on agricultural production per hectare.

Prior to him, Jeon and Kim (2000) have looked at land reform issues focusing on its impact on rice production in Korea, in which they use dummy variables to capture land reforms. They find a significant positive impact. Along the same line, Besley and Burgess (2000) in a panel data model investigate the impact of land reforms on poverty reduction in India. Their finding suggests that the fourth lag of land reform variable is significantly associated with poverty reduction.

This work adapts the approach of Vollrath (2007) for the South African agricultural sector to investigate the impact of inequality and land redistribution on agricultural production and cane production, distinguishing between small and large growers. Building on Kawagoe et al (1985), a simple framework is developed to assess the determinants of large- and small-scale productivity difference. Lastly, following Besley and Burgess (2000), poverty impacts of large and small-scale sugarcane production is analysed. However, due to few observations, other factors could not be controlled for in the poverty model.

3 Methodology

3.1 Model for inequality and production

Model applied to the agricultural sector and to (both small- and large scale) sugarcane sector for the analysis of land redistribution and agricultural productivity follows Vollrath (2007). Rather than a cross-section regression, this method is here applied first to time series data covering 1980 to 2006 for South Africa's agricultural sector and then a panel of all cane producing regions in South Africa over the period of 1998 to 2007.

The model considers a simple decomposition of all farms into $1-\lambda$ small farms and λ large farms. As such, λ is a proxy for land inequality. Let θ_s and θ_l be the respective average land areas of small and large farms, with $\theta_l > \theta_s$. The total output per hectare can be expressed as the weighted average of each type as follows:

$$y = A[(1-\lambda)\theta_s f_s(x_s) + \lambda\theta_l f_l(x_l)] \tag{1}$$

where *A* is Total Factor Productivity (TFP), *x* is a vector of per hectare inputs and *f* denoting production function. If we suppose that both farm types share a common production function *f(x)* with vector of aggregate inputs x, then:

$$y = A[(1-\lambda)\theta_s + \lambda\theta_l]f(x) \tag{2}$$

While the focus of Vollrath (2007) is on the inverse relationship between farm size and productivity, the interest in this work is to use the model to assess the impact of inequality in general and land redistribution (an inequality attenuating measure) on production. If we assume that the above framework can be generalised not only to land distribution, but also to other farm input distribution, then the relationship between λ and y can reveal information on the link between general input distribution and productivity. Following the credit channel explanation of how inequality affects production, one can conveniently proxy inputs inequality with income inequality, such that $\lambda = gini$.

The empirical specification adopted for this is as follows:

$$\ln y_t = \beta_0 + \gamma t + \beta_1 g_t + \beta_2 Nred_t + \sum_i \alpha_i X_{it} + \varepsilon_t \tag{3}$$

where γ is productivity growth rate, t is time trend, β and α are parameters, g is gini coefficient, Nred is cumulative amount of land redistributed, X_i is input *i*, and ε_t an error term.

The model for small and large farm production is the panel specification of (3), i.e.

$$\left(\ln y_{jt} = \beta_0 + \lambda t + \beta_1 g_t + \beta_2 Nred_t + (\sum_i \alpha_i X_i)_{jt} + \eta_j + \varepsilon_{jt} \right)_{l,s} \tag{4}$$

where *j* denotes cane producing regions ($j = 1...14$), the subscripts *l,s* denote turn by turn consideration of equation (4) as large- and small-scale farms respectively, $\eta_j + \varepsilon_t$ is a composite error term including unobserved region-specifics effects.

3.2 Model for Large- and small-scale productivity difference

In attempting to explain the widening productivity differential between large- and small-scale farmers, the following model is developed:

Consider the production functions y_l and y_s for large- and small-scale farmers respectively, and assuming that both farmer categories are faced with the same technology, such that:

$$y_l = Ae^{\lambda t} \Pi_i X_{li}^{\alpha_i} \tag{5}$$

$$y_s = Ae^{\lambda t} \Pi_i X_{si}^{\beta_i} \tag{6}$$

where *i* denotes input *i* and Π is the product operator, α and β are respective parameters for large-scale and small-scale production functions. Dividing (5) by (6) and taking log implies:

$$\log y_l - \log y_s = \log(\Pi_i X_{li}^{\alpha_i}) - \log(\Pi_i X_{si}^{\beta_i}) \tag{7}$$

$$\Delta_p y = \sum_i \alpha_i \log X_{li} + \sum_i \beta_i \log X_{si} \tag{8}$$

where $\Delta_p y$ is productivity difference between large and small farms. The empirical specification of (8) in panel data form is:

$$\Delta_p y_{jt} = \left(\sum_i \alpha_i \log X_{li} \right)_{jt} + \left(\sum_i \beta_i \log X_{si} \right)_{jt} + \eta_j + \varepsilon_{jt} \tag{9}$$

3.3 Model for poverty effect

Two panel data specifications for poverty are estimated, one for large-scale and the other for small-scale. These follow the works of Berg and Krueger (2003), Dollar and

Kraay (2002 and 2004) and Ravallion and Chen (1997), in which poverty (P) is a function of growth Δy, inequality g and other controls variables. However, here, only a parsimonious specification involving changes in cane production, and inequality is considered:

$$Pov_{jt} = \beta_0 + \beta_1 \Delta y_{jt} + \beta_2 g_{jt} + \eta_j + \varepsilon_{jt} \qquad (10)$$

3.4 Variables, theoretical expectations and data sources

Following are the description of the variables with theoretically expected signs and their source of data.

The dependent variable in most of the models is production. In the agricultural sectors model, the total value of all agricultural production after deduction of feed and seed, spanning 1983 to 2007 is used. This was obtained from FAOSTAT online dataset and also the South African department of agriculture (Abstract of Agricultural statistics, 2007). Time series of gini coefficient and quantity of land redistributed was obtained from the SA Development Indicators (2007) published by the presidency of South Africa. Both series span the period of 1993 to 2007. The gini coefficient is therefore truncated for the ten observations of 1983 to 1993. These were replaced with the mean of the observed fifteen observations. Theoretically, it is expected to have a negative impact. The land redistribution variable was not truncated, since observation starts at the beginning of the process, and prior to which the variable was zero. In order to avoid the problem of log of zero, the adhoc method common in trade literature is used i.e. a near zero (0.00001) value was added to the land redistribution series (Raballand, 2003; Van Bergeijk and Oldersma, 1990 and Wang and Winters, 1991). The land redistribution variable is theoretically expected to have positive impact on production. However, this sign can be ambiguous, especially if large farmers are land constrained, then the impact on large-scale farmers would be negative and positive for small-scale farmers.

The input variables are all expected to have positive effect on agricultural production and they are:

- Labour: as employment in the agricultural sector, taken from SA department of Agriculture (DoA, 2007).

- Fertiliser: As kilograms of fertiliser used, taken from the fertiliser society of South Africa.

- Livestock: Cow equivalent sum of livestock production, from the DoA(2007) [10]

- Tractors: Measured as the agricultural tractors in use. This was obtained from the WDI (2008).

- In order to control for land quality and to some extend, weather and other land uses, two other variables were added. The first is the percentage of irrigated land, derived as irrigated land divided by total crop land. The other is percentage of pasture land, derived as the ratio of the amount of permanent pasture land and total agricultural land. All were obtained from the FAOSTAT database.

All data related to the sugarcane sector was obtained from the South Africa Cane Growers Association (SACANEGROWERS). This data is a panel for small and large growers organise around fifteen mill areas over the period from 1998 to 2007. Input information for small-scale growers did not cover all the years. The assumption was made that the gap in input use between large and small farmers varied across regions but remained constant over time. This allowed for the generation of inputs for small growers to fill the omitted years. Land productivity difference was generated as indicated in equations (7) and (8) above. Other variables needed to complete the poverty model were the three poverty measures - P^{α} , for α =(0, 1, and 2) being the Foster Greer and Thorbecke (1987) family of indices. They are all taken from the SA Development Indicators (2008) released from the presidency.

A number of variables had missing data between periods. The missing values were interpolated on assumption that the series follow a relatively smooth path over time (see Vollrath, 2007: p215). Thus for a variable X, with missing value at time s, falling between two observations at time t and $t+n$, $X_s = X_t + (s-t)(X_{t+n} - X_t)/n$. This technique was applied particularly to labour, livestock, irrigation and input of small-scale farmers.

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[10] One large stock unit = one head of cattle, horse, mule or donkey; seven sheep; seven goats; five pigs; five ostriches; 100 poultry (DA, 2007), instead of 1horse, 1 mule, 1 buffalo, 1.25 cattle, 1.25 asses, 0.9 camels, 5pigs, 10 sheep, 1o goats, 100 chicken ducks geese, turkeys (Hayami and Ruttan, 1985)

3.5 Estimation procedure

Most agricultural time series are not stationary at levels. A stationary stochastic time series is that in which a joint distribution of any set of observations is invariant to a change of time origin (Box and Jenkins, 1976). In the presence of non-stationarity, Ordinary Least Squares (OLS) yield biased estimates. The first step in estimation of the agricultural production function in equation (3) starts with the analysis of the time series properties of the variables in the data. The most prominent and most frequently used of all the methods proposed in literature are the Augmented Dickey Fuller (ADF) of Dickey and Fuller (1979; 1981) and the Phillips and Perron (PP) of Phillips and Perron (1988) tests. The PP test is employed here because of its advantages over the ADF test[11]. Following the unit root test results, the model is specified with variables at their appropriate difference. The model is then estimated using the Iteratively Reweighted Least Squares (or robust regression) option, which is robust to heteroskedasticity and outliers.

In the estimation of the three Panel data models, the issue is the choice between fixed (FE) and random effect (RE) models. Hausman tests are carried out to compare both specifications in order to make the right choice. The test, developed by Hausman (1978) is based on the idea that under the null hypothesis of no correlation between individual effects (η_i) and the other regressors in the model, both ordinary Least Square (OLS) and generalised least squares (GLS) are consistent, but OLS is inefficient, whereas under the alternative, only OLS is consistent. The test statistics indicates whether the two sets of coefficients (OLS and GLS) are significantly different.

4 Results

This section presents the results from the estimation of the models described above. The summary statistics for the agricultural output and inputs and other determinants are presented in table 1A below. Outputs and inputs for small and large-scale farmers

[11] There are two main advantages of PP tests over ADF tests: One is that PP tests are robust to general forms of heteroscedasticity in error tem. The other is that the test regression does not require user specification of lag length (Zivot and Wang, 2006).

in the sugarcane sector together with land redistribution, inequality and poverty measure in Table 1B.

Table 1A: Summary Statistics for Agricultural Sector

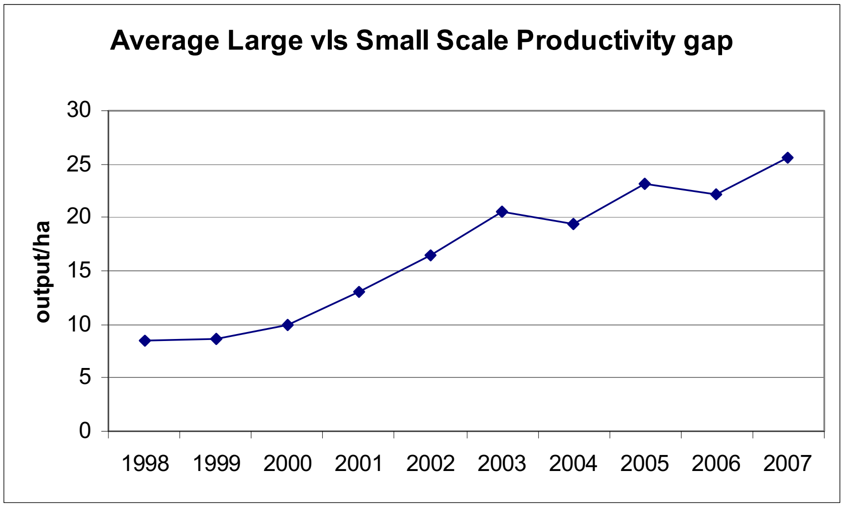
Variable	Obs	Mean	Std. Dev.	Min	Max
Agric output per ha (lcu)	27	2.269586	0.2340011	1.651342	2.680263
Agric machinery/1000ha	27	8.229419	3.528376	4.009674	13.28568
Livestock/1000ha	27	0.937205	0.058471	0.8698782	1.057169
Labour /1000 ha (number)	27	6.865615	1.339499	4.661508	9.195083
Fertiliser/1000ha (tons)	27	42.2777	7.466372	32.70379	65.99917
Share of irrigated crop land	27	0.009632	0.0020422	0.0042379	0.011562
Share of pasture land	27	0.000849	7.97e-06	0.000841	0.000861
Life expentancy	27	55.05751	6.309577	44.60717	62.92683

Table 1B: Summary Statistics for Sugarcane Sector, inequality-poverty variables

Variable	Obs	Mean	Std. Dev.	Min	Max
		Large-scale			
Output (tons)	136	1116474	325150.7	275863	1998841
Output (tons/ha)	136	74.78333	15.81157	42.01948	108.6046
Fertiliser (R/ha)	136	1081.344	418.5893	488.58	2854.588
Chemicals (R/ha)	136	514.0288	235.8004	182.46	1270.58
Labour(R/ha)	136	190.9182	135.2566	25.31	823.766
irrigation(R/ha)	136	678.9094	241.3355	327.12	1359.472
Other inputs(R/ha)	136	4100.037	1762.187	1695.45	8473.292
Area under cane (ha)	136	20444.79	7102.167	6225	33328
Area harvested (ha)	136	15334.68	4878.567	3975	26253
		Small-scale			
Output (tons)	136	194692.7	119006.5	35306	522937
Output (tons/ha)	136	52.52325	28.01978	10.03234	177.8947
Fertiliser (R/ha)	136	871.4174	598.5149	1.56e-09	2707.497
Chemicals (R/ha)	136	210.2158	172.7399	1.56e-09	839.3578
Labour(R/ha)	136	641.5799	828.2614	1.56e-09	7599.737
irrigation(R/ha)	136	395.8051	818.9186	1.00e-05	3214.094
Other inputs(R/ha)	136	3358.6	2471.952	1.56e-09	10060.36
Area under cane (ha)	136	5715.934	3807.2	1201	18008
Area harvested (ha)	136	4583.471	3317.241	531	16238
		Others variables			
Land redistributed (ha)	136	216293.9	83685.44	135084	403273
Gini coefficient	136	0.6797941	0.0079229	0.66	0.686
Poverty Incidence	136	47.91176	3.555841	41	52
Poverty Gap	136	23.17647	2.378553	19	26
Sq. of Poverty Gap	136	14.15441	1.869358	11	17

Figure five presents the evolution of large-scale/ small-scale productivity gap from 1998 to 2007. It suggests a significance increase over time. The values for each year are averages for all the cane growing localities.

Figure 5



Source: Author, using data from SA Cane growers Association.

Table 2 below gives the Phillip-Perron (PP) unit root test result for the variables considered in the agricultural productivity model. Lag lengths are selected using the Akaike Information Criterion (AIC)

Table 2: Unit Root Test Results

Variable	level			1st difference			Inference
	Lag AIC	PP-stat	p-val	Lag AIC	PP-stat	p-val	
ln *y*	1	-3.408**	0.010	-	-	-	I(0)
ln *landred*	1	-0.914	0.783	0	-5.11***	0.000	I(1)
ln *gini*	0	-3.668***	0.005	-	-	-	I(0)
ln *ls*	2	-1.611	0.478	3	-3.217**	0.019	I(2)
ln *fer*	2	-3.407**	0.011	-	-	-	I(0)
ln *mac*	2	-0.172	0.942	2	-3.350*	0.06	I(1)
ln *lab*	2	-1.336	0.613	1	-3.378**	0.012	I(2)
ln *irrig*	2	-12.66***	0.000	-	-	-	I(0)
ln *pasture*	2	-1.221	0.665	1	-1.694	0.434	I(2)[12]
ln *le*	2	-0.211	0.937	1	-2.610	0.109	I(2)[13]

Source: Author

The results suggest that agricultural output, gini coefficient, share of irrigated cropland and fertiliser use are not integrated, so are considered in the model at level.

[12] PP statistics for second difference are -5.182 with corresponding p-value of 0.000.
[13] PP statistics for second difference are -7.936 with corresponding p-value of 0.000.

Land redistribution[14] and agricultural machinery variables are integrated of first order, are so are specified in first difference. The rest of the variables – livestock, agricultural labour, share of pasture land and life expectancy are integrated of second order and therefore are specified in the model in second difference.

The following table presents robust estimation for three models. The first contains only inequality variables – gini coefficient and land redistribution, with a constant term. The second includes other inputs. The third adds a time trend.

Table 3: Robust estimation Results for Agricultural sector

Dependent Variable: Log of Agric. output (at constant 2000 Rands)									
	Model 1			**Model 2**			**Model3**		
	Coef[15]	**SE**	**t-stat**	**Coef**	**SE**	**t-stat**	**Coef**	**SE**	**t-stat**
Constant	0.13	0.256	0.51	2.681***	0.220	12.17	2.889	6.752	0.43
$\ln Nred_{t-2}$	0.008**	0.003	2.67	0.002**	0.001	2.01	0.002**	0.001	2.01
$\ln gini$	-0.091**	0.033	-2.76	-0.041***	0.008	-4.92	-0.041**	0.016	-2.62
$\ln ls$				2.383***	0.217	10.98	2.385***	0.241	9.89
$\ln fer$				0.058**	0.052	2.13	0.057*	0.066	1.87
$\ln mac$				0.761***	0.086	8.86	0.763***	0.110	6.92
$\ln lab$				0.252***	0.052	4.83	0.252***	0.059	4.29
$\ln irrig$				0.504***	0.045	11.30	0.505*	0.067	7.54
$\ln pasture$				-2.753*	12.47	2.06	-2.829*	13.29	-1.94
$\ln le$				0.103	0.124	0.83	0.100	0.145	0.69
t							-0.0001	0.003	0.03
OBS	**26**			**23**			**23**		
F-STAT	**3.97**			**58.60**			**46.69**		
P-VAL	**0.033**			**0.000**			**0.000**		

Overall, the model F-statistics and probability values indicate good fit. The inequality variables have the expected signs and are all significant through out the three models. After the addition of control variables, the magnitudes of the inequality coefficients dropped while their significance improved. The control variables have their theoretically expected signs and are all significant. Adding time trend to the model did not make any difference except that the constant term lost it significance. Since the time trend is not significant, the model considered is the second. This model suggests that a percentage increase in inequality index and land redistribution brings about 0.04 and 0.002 percent decrease and increase, respectively in agricultural output. This

[14]To safe degrees of freedom because of few observations for land redistribution, it was specified at level and the first lag was considered.

[15] (*), (**) and (***) denote 10%, 5% and 1% levels of significance respectively.

positive effect of land redistribution can have four possible explanations. The first is the inverse farm size/productivity relationship, which is contrary to general opinion in the South African community especially as the cases of good performance are among emerging black farmers which cannot be classified as small-scale. The second is that land constraints in South African large farms may not be binding, since they often ration production especially in moments of unfavourable crop prices (Collier, 2002 and FAO, 2002) so that the negative impact on large-farms does not dominate. The third and most plausible is that as land is being redistributed, the remaining lands under large farmers are more efficiently exploited with greater mechanisation. The fourth explanation may point to the way subsector organisation may affect redistribution's impact on production, so that crop specific case studies may reveal varying impacts. As for the control variables, livestock has the strongest impact on agricultural production with elasticity of 2.38, followed by agricultural machinery, share of irrigated land, then labour and fertiliser use, with elasticities of 0.76, 0.50, 0.25 and 0.06 respectively. Share of land devoted to pasturing significantly reduces production, with up to 2.8% decrease following one percent increase in the share of land devoted to pasture.

The Hausman test results of panel data for large and small-scale sugarcane production and their productivity difference favoured the choice of fixed effect (FE) model. The fixed effect estimation results are presented in tables 4A for large and small-scale sugar cane production and 4B for productivity difference.

Table 4A: Fixed Effect Estimation Results for Large- and Small-scale Production

Dependent Variable: Sugarcane output (Tonnes)						
	Large-Sacle			**Small-Scale**		
	Coef	**SE**	**p-val**	**Coef**	**SE**	**p-val**
Constant	44.806**	17.389	0.011	171.90***	30.818	0.000
Land	0.306**	0.128	0.018	0.181**	0.068	0.009
Fertiliser	0.001	0.162	0.282	0.024**	0.112	0.043
irrigation	0.059*	0.033	0.089	0.088***	0.021	0.000
Chemicals	0.066	0.050	0.188	0.033**	0.027	0.034
Labour	0.025	0.020	0.231	0.034	0.043	0.433
Other inputs	0.256***	0.079	0.002	0.117	0.170	0.491
Redist	-0.019	0.024	0.436	0.085*	0.049	0.086
Cross yield	0.149***	0.043	0.001	0.786***	0.184	0.000
t	-0.021**	0.009	0.021	-0.088***	0.016	0.000
OBS	**136**			**136**		

R-sq	**0.54**	**0.57**
F(8, 114)	**11.93 (0.000)**	**24.69(0.000)**
Hausman	**66.17 (0.000) - FE**	**48.81 (0.000) - FE**

Judging by the probability of Fisher, the overall model statistics are satisfactory for all three models. The coefficient of land redistribution is negative but not significant for large-scale and positive significant for small-scale producers. The insignificance for large-scale could indicate that land is not a very binding constraint. Secondly, most of the land redistributed in the sugarcane sector is "mill area" i.e. own by organisation, not individual large farmers. This minimises conflicts are reduction in production. Besides, there is a remarkable difference between area under cane and area effectively harvested for both large-scale and small-scale growers. Generally, the coefficiants of all other inputs suggest that there is more room for small-scale farmers' production enhancement than large-scale. This suggests that land redistribution should also be accompanied by identification of various constraints to access of other inputs, especially fertiliser and irrigation facilities. The result of the determinants of productivity difference in table 4A below corroborates the above view.

Table 4B: Fixed Effect Estimation Results for Large/Small Productivity Difference

Dependent Variable: log of ratio of large- and small –scale outputs per ha			
	Coef[16]	**SE**	**t-stat**
Large-scale inputs per ha			
$\ln fer$	2.142*	1.184	1.81
$\ln irrig$	0.679***	0.187	3.62
$\ln Chem$	-2.138*	1.157	-1.85
$\ln lab$	-0.038	0.060	-0.64
Small-scale inputs per ha			
$\ln fer$	-2.028*	1.183	-1.71
$\ln irrig$	-0.715***	0.121	-5.91
$\ln Chem$	-1.901	1.158	-1.64
$\ln lab$	-0.034	0.027	0.214
Other determinants			
$\ln Landred$	-0.094	0.070	-1.35
$\ln le$	-0.295	0.454	0.65
$\ln literate$	-2.041***	0.694	-2.94

[16] Variables are evaluated are three significance levels: *** denote 1% level, ** 5% and *10% level of significance.

Constant	-10.50***	2.539	-4.14
OBS	**136**		
R^2	**0.58**		
F(11, 111)	**14.03**		
$\Pr ob > F$	**0.000**		
$Hausman\chi^2$	**57.32**		
$\Pr ob > \chi^2$	**0.000**		

Large-scale farmers' use of fertiliser has significant positive impacts on the productivity gap, while chemical and labour use attenuate the difference, but only chemical is significant. All small-scale inputs have negative impact on the gap, but only fertiliser and irrigation are significant. One percent increases in large-scale fertiliser and irrigation increases the gap by 2.14 and 0.68 percent, respectively, while it decreases by 2.03 and 0.72 percent respectively for small-scale use of the same factors. The significant negative impact of large-scale chemical use on the gap suggests a type of positive externality. Other factors considered are land redistribution and human capital (life expectancy and literacy rate). These all have attenuating effects on the gap, but only literacy rate is significant. There is need therefore to strengthen the human capital and input capacities of small-scale producers.

Other potential factors which are not analysed here are disparities in the effect of market forces.

The following gives the outcome of the parsimonious estimates of equation (10) for large and small-scale cane production over poverty incidence (P_0), poverty gap (P_2) and the square of poverty gap (P_2).

Figure 5: Estimation results for Large- and Small-scale poverty effects

	$\ln P_0$			$\ln P_1$			$\ln P_2$		
	Coef[17]	**SE**	**z-stat**	**Coef**	**SE**	**z-stat**	**Coef**	**SE**	**z-stat**
Large-Scale Production									
Constant	5.458**	0.268	20.37	5.241***	0.379	13.82	5.123***	0.493	10.38
$\ln gini$	3.364***	0.477	7.05	4.318***	0.675	6.40	5.195***	0.878	5.91
$\ln y$	-0.023**	0.011	-2.09	-0.028***	0.012	-2.33	-0.034*	0.02	-1.7
$Hausman\chi^2$	**0.04 (0.980)**			**0.09 (0.955)**			**0.01 (0.994)**		
$Wald\chi^2$	**53.89 (0.000)**			**45.16 (0.000)**			**38.12 (0.000)**		
Small-Scale production									

[17] (*), (**) and (***) denote 10%, 5% and 1% levels of significance respectively.

Constant	2.926^{***}	0.275	10.64	1.646^{***}	0.390	4.22	1.470^{**}	0.502	1.94
$\ln gini$	2.926^{***}	0.390	6.05	2.96^{***}	0.553	5.25	3.319^{***}	0.712	4.66
$\ln y$	-1.55^{***}	0.156	-9.94	-2.18^{***}	0.163	-13.37	-0.288^{***}	0.029	-9.93
$Hausman\chi^2$	**19.04 (0.000)**			**19.51 (0.000)**			**19.30 (0.000)**		
F(2, 120)	**41.49 (0.000)**			**36.89 (0.000)**			**33.69 (0.000)**		
OBS	**136**			**136**			**136**		

Hausman test suggest the estimation of a Random Effect model for large-scale and Fixed Effect model for small-scale production. The model ch2 statistics of Random Effect for large-scale and F-statistics of Fixed Effect for small-scale are all significant. The gini coefficient has the expected positive sign, with larger magnitude for large-scale model than the small-scale model. The suggestion here is that in the presence of large-scale production, inequality is significantly associated with higher poverty than small-scale. Both large and small-scale productions are associated with significant poverty reduction, with higher effects from small-scale production. A percentage increase in small-scale output is associated with 1.6%, 2.18% and 0.29% reductions in P_0, P_2 and P_2. But these elasticities are only 0.02, 0.03 and 0.03 respectively for large-scale production.

5 Conclusion and Policy Recommendations

The objective if this work was to investigate the inequality determinants of agricultural productivity in South Africa, distinguishing between small and large-scale productions in the sugarcane sector. It also aimed to analyse the comparative poverty effects of large and small-scale producers. The impact of inequality was captured by gini coefficient, and land redistribution as an inequality attenuating measure. The work used data for the whole agricultural sector from departments of Agriculture and FAO database. Sugarcane production data came from SA Cane Growers Association. Poverty, inequality and land redistribution data was taken from SA development indicators published by the Presidency of South Africa (2008).

Agricultural time series were corrected for unit roots using Phillips and Perron test. Following the unit root test results, the model was specified with variables at their appropriate difference. The agricultural productivity model was estimated using the Iteratively Reweighted Least Squares (or robust regression) option, which is robust to heteroskedasticity and outliers. Hausman tests were carried out on the sugarcane panel data models. Based on the test results, large-scale and small-scale production functions, and small-scale poverty were estimated by means of fixed effect model and the large-scale/small-scale productivity gap function and large-scale poverty were done using random effect model.

The results suggest that inequality is associated with slower productivity and land redistribution with weakly enhanced production. The positive effect of land redistribution can have four possible explanations. The first is the inverse farm size/productivity relationship, which is contrary to general opinion in the South African community especially as the cases of good performance are among emerging black farmers which cannot be classified as small-scale. The second is that land constraints in South African large farms may not be binding, since they often ration production especially in moments of unfavourable crop prices (Collier, 2002 and FAO, 2002) so that the negative impact on large-farms does not dominate. The third is that as land is being redistributed, the remaining lands under large farmers are more efficiently exploited with greater mechanisation. The fourth explanation may point to the way subsector organisation may affect redistribution's impact on production, so that crop specific case studies may reveal varying impacts.

The impact of land redistribution on large/small scale sugarcane seems to corroborate the second explanation (i.e. though-as expected-, negative for large-scale and positive for small-scale producers are not significant). The implication is that redistribution efforts must be accompanied by significant ease of other constraints facing small farmers. This is more so because for small-scale producers, land does not seem to constitute a binding constraint in the sugarcane sector. Generally, the data show a remarkable difference between area under cane and area effectively harvested for both large-scale and small-scale growers. Other inputs like fertiliser and irrigation facilities are likely to have more significant impact on small farm production than land alone. The determinants of differences in productivities of both farm types corroborate the above view. Much of the difference arises from disparity in input use, specifically fertiliser and irrigation. There is possibility of positive external effects flowing from large-scale chemical and labour use, enhancing small-scale production as they attenuate the gap in productivities. Human capital variables suggest that there is need to strengthen the human capital (particularly education) of small-scale producers in addition to their input capacities.

Both large and small-scale sugarcane production have significant poverty reduction effects, but the effect from small-scale production is higher, which emphasise the need to strengthen their capacities.

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