A Game Theoretic Framework for Cooperative Benefits in South Africa's Land Redistribution Process: A Case of Northern Kwa-Zulu Natal Sugarcane Farmland Transfers

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Abstract

A good indicator of successful farm redistribution cases has to be the continuation of viable productivity rates in their post transfer periods. Continued productivity benefits all the stakeholders that are involved in the process. Unfortunately negative productivity levels have been reported in numerous South African land redistribution transfers in recent years. A game theoretic perspective is adopted to argue that cooperation among key stakeholders, which could be enforced through long term contracts between a land buyer, sellers and new owners, would lead to higher productivity levels and other benefits. Additional benefits would, for example, include market related prices paid by a buyer. Sugarcane farm transfer cases from two municipality districts in KwaZulu Natal province are used to show that the productivity rates in post transfer periods of cooperative land sales were more than 10% higher than the rates observed before such transfers. At the opposite end of the scale, the productivity rates in non-cooperative land sales dropped by 16% after land takeovers. Furthermore, the prices paid for farms that became less productive after transfers were higher by more than 40% compared to those paid for productive farms. The cases illustrate the values of cooperative strategies in economic transactions.

Key words: Sugarcane, farms, redistribution, productivity, cooperation, games

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1. Introduction

The land redistribution process in South Africa continues to pose challenges for all stakeholders including government agencies, land sellers and beneficiaries. Even though there have been notable successful interventions in recent years, for example the establishment of the Land Redistribution for Agricultural Development (LRAD), the rates of transfers were still below policy targets and more than 50% of land reform projects failed to bestow benefits as reported by Ferrer and Semalulu (2004), Lyne and Ferrer (2006) and CDE (2008).

The redistribution of sugarcane[3] farms in northern Kwa-Zulu Natal province is used to discuss some of the reported challenges in the land reform process within a game theoretic framework. The positive collective contributions of cooperative strategies in the process are advocated. Two types of land transactions with markedly different economic outcomes for stakeholders are presented from the case study. The sale of farmlands by private individuals to government agencies, which happened outside any cooperative institutional arrangements, are presented as typical failures in the land redistribution process with regard to prices paid for the transfers and more importantly with respect to post transfer productivity rates. On the other hand, the sales that happened within some long term arrangements among key players, namely, government agencies, the sellers and new land owners are identified as typically cooperative transactional games resulting in enhanced collective benefits. For example, it is illustrated that government agencies paid prices approximately 40% higher than market values in non cooperative transactions, but the land productivity rates found in those sales were poor and lower by about 16% in comparison to production rates before the transfers. Meanwhile, much lower prices were paid within cooperative transactions and in those sales increases of about 10% of farmland productivity rates were recorded.

In Section 2 the methods used in collecting and analysing data are described. Section 3 presents a game theoretic framework for the discussion and reviews selected trends in the land

[3] The choice of sugarcane farms is partly motivated by the scale and importance of the sugarcane industry at both national and provincial levels (Mkhize, 2008).

redistribution literature in South Africa. Section 4 presents and analyses the data from the case studies. In Section 5 a discussion of important results is provided with a concluding note and some recommendations in Section 6.

2. Methods

Data was collected in the uThungulu and iLembe municipal districts of northern KwaZulu Natal province in South Africa. In the study areas, more than thirty land redistribution transactions took place between 2002 and 2006. Hence quantitative and qualitative data on transaction prices, land sizes, productivity levels and some prevailing local institutions were obtained from respondents including the Department of Land Affairs, Inkezo Company, the South African Cane Growers (SACG), and the Sugar Industry Administrative Board (SIAB) on thirty two farms through formal and informal interviews. Additional data were collected on and off the record from private farmers, business and research documents, agricultural publications such as the South African Abstract of Agricultural Statistics (SAAAS) (2008) and reports from the National Department of Agriculture (NDA, 2008).

Of the thirty-two transactions that took place in the two districts between 2002 and 2006, five were excluded from the analysis for incomplete data. Seven transactions from the ilembe district, which involved a large company, form the basis of the comparative analyses. This is because these transactions occurred within an ongoing contractual and institutional arrangement between the sellers and the government as the buyer. It is argued that the arrangement affected not only the farmland prices but thereafter the rates of productivities during and after the transfer periods.

From the data, the sellers were classified into three categories, namely, a) private individuals, b) small companies, and c) large corporations. The small companies were classified as those not listed on a stock exchange and who owned property valued at less than R100 million. Large corporations were classified as entities that were either listed on a stock exchange or controlled property in excess of R100 million.

Descriptive tabulated statistics and comparative analyses were used in presenting and analysing the transaction prices and productivity rates data for the farm units in the periods, before, during and after takeovers. For example, the analyses were performed separately for the districts, and specific categories of transfers and periods of productivity.

3. Review of literature

Firstly, the review describes and motivates the adoption of a game theoretical framework. Secondly, a review of concepts and definitions is presented, followed by an overview of trends in South Africa's land redistribution process in the last ten years.

3.1 Theoretical framework

The *new classical economic* assumptions of rational human behaviour have often been criticised for being unrealistic and not very useful, especially, for policy analyses (Coase, 1998, Williamson, 2000 and McCloskey, 2008 in Clift 2008). The criticisms often cite as important the hierarchical nature of human relations alongside the self interested and sometimes competitive behaviours in determining many of the real life outcomes reached by individuals or firms in economic interactions. Some refer to these human relations as institutions, whether they are formal, informal, cultural, traditional, written or unwritten (Williamson, 2000). They conclude that such institutions dictate a majority of outcomes involving community based interactions.

Using a *game theoretic* framework, Ostrom (1990 and 1992) illustrated some of the conclusions of *new institutional economics*[4] using as case studies irrigation farming communities, which she identified the collective merits of collusion (i.e. cooperation) as opposed to competition (i.e. conflict). In the prisoner's dilemma, which is a metaphor, the most likely (or dominant) equilibrium outcome stems from the dominant strategies of prisoners (or game participants). In line with new classical economics theory, it is assumed that the participants are self interested and maximising, and hence the resulting equilibrium is one of conflict or competition. Unlike the

[4] While the old institutional school of economics is identified with men like Thorstein Veblen, Wesley Mitchell, John Commons, etc., the new school is identified with people like Ronald Coase and more recently Douglas North, etc.

new classical economics theory, however, game theory is clear that even though the dominant strategy *equilibria* are those most likely in games, they are not always the final outcomes and are still only conditional. The new classical economics, in contrast, cannot readily explain the other likely and varied outcomes of cooperative *games* and real life situations. In Table 1, a matrix illustrates the players' strategies[5] various predetermined payoffs for individual players and potential *equilibria*. In the abstract case of two prisoners accused of a crime, they have only two strategies (i.e. to confess or to deny the crime), with four possible payoffs for each individual and the group. The individual payoffs are determined by both the personal strategic decisions as well as the strategies of the co-accused (i.e. other participants). The conditions for the game are such that the prisoners cannot meet and negotiate on the best strategy/ies to attain the most optimal outcome for themselves or for the group. They make their strategic and once-off decisions unilaterally.

Table 1: Prisoner's dilemma, strategies and payoffs

Payoffs			
Prisoner's strategies	Both don't confess (cooperate)	One Defects One Cooperates	Both defect
Prisoner one	-2	-10 or -1	-5
Prisoner two	-2	-1 or -10	-5

Source: Pindyck and Rubinfield (2009)

As illustrated, when both prisoners confess, the case is then easy to prove by the prosecution and they are each sentenced to five years. But when they both deny the crime, the case is harder to prove and they receive a lighter sentence of two years each. However, when only one prisoner confesses and the other denies the crime, the one confessing or collaborating with the prosecution gets a lighter sentence, but the one showing no remorse is imposed the worst possible sentence, of ten years. The most optimal outcome for both prisoners is obviously to cooperate with each other and to deny the crime as a group. The best possible outcome for an individual prisoner, on the other hand, is to be a "traitor", but this is only the case if the co-accused denies their own criminal involvement. Because both prisoners are assumed to act in *self maximising* ways, and in line with new classical economic theory, 'confession' by individual

[5] These are limited strategies (i.e. only two per player)

prisoners becomes a dominant strategy. That means the most likely, stable and dominant equilibrium outcome is one that is also the most detrimental to the group.

The presented prisoners' dilemma, however, depicts a once off game, with only two players who also cannot communicate with each other in determining collaboratively the group's most optimal payoffs. As argued by Ostrom (1990) that is hardly an accurate depiction of most real life situations or games. It is much more common that business entities or individuals become locked in economic relationships in which they bargain repeatedly over various contracts and for a number of years. In the relationships they could negotiate the terms of engagement and collaboratively plan for optimum and long term business benefits. In addition, there are often more than just two players and two available strategy choices in many economic markets, ensuring that far more than four equilibrium outcomes are a possibility. These varied conditions form the basis for the consideration of the importance of social and economic institutions, which are about social rules and expectations that govern social and business relationships.

It was because of these considerations that Ostrom (1990) introduced to the prisoners dilemma, external intervention, penalty rules, transaction and monitoring costs as added institutions within which players could make decisions leading to realistic outcomes. In Table 2 the considerations are factored into the matrix. The prisoners, as players, are replaced by herders, who are locked in a specific geographical area and form a community of common natural resource users. The setting is highly similar to Hardin's (1968) *tragedy of the commons*, however, the variables at play and the potential outcomes of the game are very different.

Table 2: The herder's dilemma with added institutional variables

PROFITS			
Herders' strategies	Both Cooperate	One Defects One Cooperates	Both Defect
Herder one	10	-1-2x or 11-2y	-2y
Herder two	10	11-2y or -1-2x	-2y

(Source: Ostrom, 1990: 11)

In the table, a local or external agent or body is introduced to the context to manage the use of the natural resources to prevent Hardin's (1968) proverbial tragedy of overgrazing. To ensure

that there is cooperation in the use of the pasture, the managing body imposes a two-profit-point penalty (i.e. 20% of profits – potentially gained from cooperation) on any offender, *when they can be identified*. Prior to the introduction of the penalty, a sustainable (or rather cooperative) use of the resource among herders leads to a collective payoff equilibrium of (10; 10) point profits. The outcome is depicted in the second column. A non-cooperative pastoral use leads to the depletion of the resource, which equals to a payoff of (0; 0) point profits, a tragedy. When one of the herders cheats, while the other cooperates, the outcome is either (11, -1) or (-1, 11) in favour of the cheater. The outcomes are similar to those described in the prisoner's dilemma, i.e. (-10, -1) or (-1, -10). Cheating by each one of the self interested herders is the dominant strategy, and therefore overgrazing in the community is the most likely equilibrium outcome. However, when some effective penalty is introduced to deter cheating behaviour, the possible equilibrium payoffs are modified to those represented in Table 2.

Where:
y = is the probability of punishing defection (an intended move by the agent)
x = is the probability of punishing cooperation (an unintended move by the agent)
And therefore
$y + x = 1$ (in probabilities)

With the penalty effectively sanctioned, cheating by both herders leads to more than overgrazing. The herders pay 20% of potential profits in addition to losing the pasture (-2y; -2y). When applied properly, the penalty acts as a deterrent to cheating. The model however also accounts for the transaction costs that are associated with the monitoring process to correctly identify offenders. This would mean that an agent that is a 100% efficient in its monitoring would be associated with:
$y = 1$ and $x = 0$
Otherwise the penalty measure becomes progressively ineffective the more inefficient the agent is. For a completely ineffective agent:
$y = 0$ and $x = 1$

By discussing the roles of agencies, rules and implementation challenges, Ostrom (1990) illuminates the arguments made in support of the value of institutions in economic transactions. Even though cooperation is not the dominant strategy equilibrium of profit maximising players, institutions, relationships, community bonds, etc., are useful tools for the players in attempts to achieve cooperation. The institutions themselves, however, must be effective to achieve their preconceived goals. Hence, external institutional interventions in transactional games, similar to the land redistribution process, could be useful when they are of the appropriate kind, and are effectively applied. The institutional structures could be based on punishment (disincentives) or additional benefits (incentives), as was the case in sugarcane farm games, which are presented in forthcoming sections. The proposition is argued for in the discussion and illustrated by the different levels of productivity and price premiums in the KwaZulu Natal studies of farm redistribution transfers.

3.2 What determines productivity rates on farms?

Farm unit productivity or performance is generally influenced by a varied and interconnected number of factors. But an increase in output does not always indicate an increase in general productivity, which Fryer (2008) defines as an increase in output given the same level of inputs. Nonetheless, the overall performance of production systems should indirectly also indicate the availability of given inputs *as well as* their efficient use. For farm units, the inputs would include, among others, good soils and topography, appropriate climate, availability of water resources, pesticides, labour and management skills, capital (equipment and machinery), other technologies, etc. (Denison and Manona, 2007). It has already been mentioned that the availability of these inputs does not guarantee optimal production rates. It is the efficient mix and use of inputs that impact positively on yield rates. Theoretically, optimum production mix requires inputs to be employed in combination ratios that enhance output levels and for associated marginal contributions to benefits (or to marginal revenue products) to equal marginal costs (including opportunity costs) (Mohr *et al.*, 2009). The current discussion's focus is on the physical contribution of selected inputs to yield rates, not necessarily the profit maximizing decision making process, which requires market prices to be known to accurately account for all kinds of costs.

Of the important farmland inputs in this regard, the most important is therefore technology, defined as an effective processing and coordination of information and other complementary inputs (Brinkman, 1995). It has been indicated that the increase in production levels per given some level of inputs depends on input mix ratios. The process requires a human involvement, his/her experimenting spirit and foresight, even if the insights are stored as codes in computable devices or processors. The use of labour inputs also requires human coordinating skills. Therefore, as observed by both the old and new institutionalists (e.g. Myrdal, 1957; Brinkman, 1995; Williamson 2000, and others) human capital, in the form of experience or training, the management of resources (like labour, cultural practices, technological equipment, etc.) is derived from the same sources. Those are institutions that govern human conduct. In turn the human capital based inputs interact with each other to contribute to the evolution of future social institutions (Kuznets, 1973 and Brinkman, 1995). Hence, even at a micro farm level, the importance of social and economic institutions cannot be overlooked.

3.3 Some productivity and price trends in farmland markets

Varied and sometimes conflicting trends have been found in South Africa's land reform and redistribution landscape. For instance, Van der Riet and Darroch (1993) found the expected returns - mostly based on levels of productivity - to have a positive influence on land prices in the country. Van Schalkwyk and van Zyl (1996), on the other hand, observed that because of poor historical policies, farmland prices did not often reflect the expected returns. Therefore, because of additional and more complex land policies, the gap between potential returns or productivity of farmlands, compared to selling prices, should be higher within land redistribution markets. In fact Mbatha, *et. al.* (2010) found that in the early to mid 2000s higher than market price premiums were paid in land redistribution transactions in sugarcane cases in northern Kwa-Zulu Natal. They concluded that part of the premium discrepancy could be attributed to the urgency within which the South Africa government has had to fast track land transfers for redistribution purposes to meet its timeline targets, through avenues including the LRAD. And as discovered by Ferrer and Semalulu (2004), interventions like the LRAD did inject positive stimuli to the rate of land transfers. They found that in some locations, grant financed transfer

rates doubled and the programme also increased the total size of land transfers in comparison with the total from privately financed transfers. Unlike Mbatha, *et. al.* (2010), however, the CDE (2008) found that the effect of the whole land reform process on prices was itself not unreasonably strong.

Most of the reported trends indicate the presence of either positive or negative impacts of varied institutional factors and interventions, often in the form of policies in specified land markets. Nevertheless, other economic factors have played significant roles in determining transfer prices and expected returns or productivity levels in farmland markets. As observed, for example, by Janse van Rensburg (1984) and Obi (2005), these included the rising levels of inflation, exchange rates, product prices, which have had positive impacts on prices, while input costs and rising interest rates have displayed negative correlation coefficients.

The present discussion uses this review, which highlights the importance of institutions in economic games or transactions as its framework. Appropriate institutions are not only the most important determining factors of higher levels of productivity on systems like farmlands, but like appropriate external intervention strategies, they could ensure that cooperative outcomes are reached in interactions of normally self interested economic players to achieve comparatively higher collective benefits. In the land redistribution transactions the three important players are: a) the various government agencies (who are the buyers), b) the sellers and, c) the new owners. Regarding the position of these players, it could be argued that the economic interests of government agencies would be most closely aligned with those of the new owners. Government agencies, for instance, acted as buyers of land on behalf of the new owners. It can be argued the two players would have preferred that lower prices are paid in land transfers and that farmlands became productive and viable businesses post transfers. Hence, the two players can be seen and treated as a single front in game theoretic analyses and the optimisation of collective benefits in the land redistribution game could be indicated or measured by the price, productivity and market success variables.

Furthermore, the sugarcane cases of northern Kwa-Zulu Natal illustrate an appropriate application of institutional intervention in the form of formally negotiated and long term working

relationships between government agencies, the sellers and new owners. These resulted in comparatively better economic outcomes for players, as shown through data in the coming section. In land transaction cases where there were no negotiated long term relationships between players, the outcomes as evaluated using the price and productivity variables, were less beneficial. Such cases of collective losses could be classified as dominant strategy equilibriums in which players behaved conservatively and without long term foresights.

4. Data presentation from northern Kwa-Zulu Natal

Realising the importance of support mechanisms for the new owners, in 2006 the government established a specialist advisory committee in the LRAD programme to: a) carry out pre-settlement evaluations (benchmarks) of properties earmarked for transfer, b) produce a business plan to serve as a budget for the property, and c) to appoint external mentor/s to oversee and guide the properties' operations (DLA, 2008). By October 2008, however, none of the appointed advisors had received an assignment (van Rooyen, 2009). The story illustrates a lack of proper planning from the government side resulting in a general lack of support for the new farmers and leading to some of the observed data trends which are presented in this section.

The data on transaction prices and productivity levels, drawn from the iLembe and uThungulu municipalities, is grouped into two main categories for comparative analyses, namely, on individual private transactions and on group sales (large corporation). An analysis focused only on price premium discrepancies and only on individual private transactions was presented by Mbatha *et al.* (2010), who argued and illustrated that the land prices paid by government agencies were in most cases higher than prices paid outside the land redistribution process. The main results of their analysis are also briefly summarized and then compared to transactional data for large corporation price premiums. The rest and majority of data presented and discussed is on comparative discrepancies on productivity trends on private individual versus large corporation sales during and after the long drawn out transfer periods[6]. In the game theoretic framework, the individual private versus large corporation data sales and productivity levels, represent the non-cooperative versus cooperative transactions, respectively.

[6] In some cases it took more than 18 months to transfer the land to new owners (Mbatha *et al*., 2010).

4.1 Summary of individual price premiums paid in iLembe and uThungulu districts

As illustrated in Table 3, private individual sales in iLembe district cost the government more than 44% on average above market prices in transaction sales between 2004 and 2005 (see column 5).

Table 3: Premiums paid by government for sugarcane farmland in iLembe (2004 and 2005)

Farm cases	Total market value of farms (R)	Total paid by government per farm (R)	Total value of government's premuim (R)	Total value of government's premium (%)
Total	12 310 426	17 744 997	5 434 571	44.2
Average - per farm unit	1 758 632	2 535 000	776 367	44.2

Adapted from SACG (2008a; 2008b); DLA (2008)

On average the government paid more than R2.5 million per farm, an amount higher than the average market price by more than R 770 000. A similar trend is observed in uThungulu as illustrated in Table 4.

Table 4: Premiums paid by government for sugarcane farmland in uThungulu (2004 and 2005)

Farm cases	Total market value of farms (R)	Total paid by government per farm (R)	Total value of government's over-payment (R)	Total percentage of government's over-payment
Total (all units sold)	13 649 320	18 817 079	5 167 759	37.9
Average - per farm unit	2 274 887	3 136 180	861 293	37.9

Adapted from SACG (2008a; 2008b); DLA (2008)

A similar amount was paid by government for private individual land transfers in the uThungulu district in 2004 and 2005 at close to R19 million. The total was higher than market prices by more than R860 000 (i.e. 37.9 %). Both cases illustrate that higher prices were paid in similar

institutional arrangements. In cases where there were binding contracts of some kind between government agencies and sellers as illustrated in Table 5, lower prices were paid.

Table 5: Prices paid by government for large corporate farmland units in iLembe district (2004)

Farm case numbers	Total market value of each unit	Total paid by government per farm (R)	Total value above or below market price (R)	Total percentage above or below market price
I11a	1 559 272	1 377 288	- 181 984	- 11.7
I11b	1 647 490	1 538 240	- 109 250	- 06.6
I11c	1 900 080	1 920 240	20 160	01.1
I11d	2 219 776	1 860 608	- 359 168	- 16.2
I11e	1 452 958	1 545 454	92 496	06.2
I12	1 682 928	1 531 152	-151 776	- 09.0
I13	1 483 872	1 617 696	133 824	09.0
Total	**11 946 376**	**1 190 678**	**- 555 698**	**- 03.9**
Average	**1 706 625**	**1 627 240**	**- 79 385**	**- 03.9**
I: iLembe				

Adapted from SACG (2008a; 2008b); DLA (2008)

The majority of the values of sales represented in Table 5 correspond to – or in some cases are lower than - market price valuations. This is a marked difference compared to trends in Tables 3 and 4. In fact, on average, the prices paid by government were lower than market prices by close to four percent, with a saving of more than R550 000 as illustrated in Table 5. Regarding this trend, Huletts (2008:1) stated that "[w]ith the growth of economic development and empowerment of previously disadvantaged people, a growing number of medium-scale farmers are continuing to enter sugarcane agriculture on farms made available at market-related prices by the major milling companies". A complementary picture was found with respect to levels of productivity for the sales categorized as per foregoing tables.

4.2 The productivity levels in uThungulu and iLembe districts

To compare the impacts of transfers between cooperative and non cooperative cases, the productivity data are presented for the periods, a) before farm takeover, b) during the transfers, and c) post transfers.

Productivity performance of private farm sales

Three levels of productivity are presented for in Table 6, with respect to tonnes per hectare per year for private individual sales in both districts. Column 3 depicts the best observed level of output for each given farm unit between the years 1999 and 2007. That level is then used as a benchmark around which other productivity levels for specified periods are evaluated for their performances.

Table 6: Productivity levels available for privately sold farms in both districts (tonnes/ha)

Farm case	Start date of new owner	Best observed level of output 'optimum'**	Production during takeover year	Average production prior takeover (3 years)	Average production post takeover (years vary)	Changes (%) prior vs. post takeover production
U 1	2004	52.79	34.39	48.39	15.48	68.01 -
U 2	2004	38.96	12.66	36.32	25.04	31.06 -
U 3	2004	38.84	30.12	34.34	24.34	29.12 -
U 4	2005	61.05	49.20	39.77	55.23	38.87 +
U 5	2004	40.91	17.91	32.76	16.10	50.85 -
U 6	2007	67.01	40.51	33.16		
U 7	2006	89.26	47.11	74.30	58.25	21.60 -
U 8	2007	73.07	35.42	58.46		
U 9	2008	87.54		70.32		
U 10	2006	50.32	50.32	27.36	17.40	36.40 -
I 1	2002	50.41	43.63	37.25	43.77	17.50 +
I 2	2004	53.16	33.91	40.72	40.36	0.01 -
I 3	2005	65.02	65.02	36.68	56.64	54.42 +
I 4	2004	57.74	52.78	50.39	55.04	9.23 +
I 5	2005	33.13	10.92	13.14	29.05	121.08 +
I 6	2004	62.83	46.46	46.78	48.40	3.46 +
I 7	2006	41.98	5.22	14.96	5.04	66.31 -
I 8	2005	57.51	36.83	43.89	29.12	33.65 -
I 9	2007	38.19	33.47	35.08		
I 10	2005	70.12	33.25	41.02	53.46	30.33 +
Total		**1129.84**	**679.13**	**815.09**	**715.88 ***	**16. 56 -**
Average		**56.50**	**35.74**	**40.75**	**35.79**	

U: uThungulu
*Adjusted using average for missing data
** Best output recorded between the years 1999 and 2007

Source: SACG (2008a and 2008b)

From Table 6, only one farm unit (I3) performed at its 'optimal' level (i.e. 65.02 tonnes/ha) during the takeover period, but thereafter the productivity dropped slightly (to 56.64 tons/ha)

after the takeover. Only in 25% of the farms was productivity higher during the takeover period compared to the period prior (e.g. U4 and U10), but in some instances the productivity deteriorated after transfer (e.g. U10). Across all farms, productivity was on average lowest during the takeover period (i.e. 35.74%) and it remained low thereafter with a total percentage drop of more than sixteen percent. Therefore, in private farm sales the average levels of productivity dropped during and after the transfer periods. That was especially the case in the uThungulu district.

Productivity performance of large corporation

The case of large corporation sales provides a different picture, which is presented in Table 7. It can be noted that many of the farm units performed close to their best levels during the takeover periods and that the productivity levels were also higher after the land transfers, when compared to the period before the takeover, for the majority of the farms.

Table 7: Productivity levels available for large corporation sales (tons/ha)

Farm case	Start date of new owner	Best observed level of output 'optimum'	Production during takeover year	Average production prior takeover (3 years)	Average production post takeover (years vary)	Changes (%) prior vs. post takeover production
I 11a	2004	53.97	53.14	44.49	41.25	7.28 -
I 11b	2004	60.29	50.13	44.49	51.05	14.74 +
I 11c	2004	59.45	56.79	44.49	56.21	26.34 +
I 11d	2004	53.97	50.43	44.49	29.97	32.64 -
I 11e	2004	70.68	56.29	44.49	60.80	36.66 +
I 12	2004	57.68	42.84	49.59	42.98	13.33 -
I 13	2004	49.90	44.16	27.48	48.05	74.85 +
Total		405.94	353.78	299.52	330.31	10.28 +
Average		57.99	50.54	42.79	47.19	10.28 +

I: iLembe
*Adjusted using average for missing

Source: SACG (2008a and 2008b)

Table 7 shows that the best average output levels were similar to those in Table 6 for private sales and in the region of 57 tonnes/ha per given year. However, unlike the private sales, there was an increase in productivity of more than 10 % after the takeover period. Such productivity levels must have been the most preferred by all stakeholders, but especially by the government

agencies, new owners and stakeholders higher up on the value chain. Not only did the farms continue being used productively, but there were output increases on most of the farms signalling higher collective benefits.

5. Discussion and analysis

The preceding section showed that government agencies acquired farm units at more than 44% and 37% in iLembe and uThungulu districts respectively from private individual sales. The agencies paid around R770 000 and R860 000 per farm unit above market prices in the respective districts. On the other hand, the same expensive farm acquisitions were also associated with underperformances, with total production rates dropping by more than 16% after transfers to new owners. In fact, the collective costs of the underperformance, estimated for a total of 1443 hectares of land, was R78 million for the 2006 to 2007 period alone (van Rooyen, 2009). The land prices within contractual long term agreements, in contrast, were lower than market related prices, namely -3.9 % below the market price range, with a total saving of more than R550 000per unit with increased productivities of more than more than 10% in total after transfers.

From a game theoretic perspective, institutional cooperation was identified as being very important for the success of any economic transaction, such as the land redistribution process. From the data, farm sales without any institutional support and occurring outside long term arrangements were more costly to government and those farms had poor performances with respect to productivity during and after transfers. In sales where an agreement was in place among stakeholders the results were markedly different. The cooperative contractual agreements meant the company, as a buyer, provided the necessary support to new farmers during and after the transfer periods with payment for the services received from government agencies. The type of support provided included financial and informational assistance as well as formal mentorship. This would have encouraged a transfer of crucial human capital and skills to produce and to market output. The three way agreements also ensured easier access to markets for the new farmers, with such benefits accruing from economies of scale. It was also in the sellers' best interests for the contractual arrangements to succeed. The collective benefits accrued

not only to the government agencies and new farmers but to the sellers as well, in terms of assurances for continued future business and guaranteed output from the highly productive units. Hence, the data in the preceding section identified and quantified some of the important collective benefits in monetary terms and output units per specified unit in the land redistribution 'game'.

In theoretical terms, the sugarcane farm redistribution process in northern Kwa-Zulu Natal was an illustrative case study of how a cooperative game's Nash equilibrium bestows higher collective benefits to players. The move away from competitive game strategies and outcomes could be achieved also with more than just two players. The long term contractual arrangements among stakeholders ensured that the game was not a once off event but a repetitive one, allowing players considerable bargaining power, with potential incentives to cooperate. The land redistribution game of higher collective benefits displayed similar attributes to Ostrom's (1990) case of water irrigators, where a sustainable use of natural resources was attainable through cooperative management and appropriate external intervention and in which transaction costs were minimised. The sugarcane case illustrated that in a market management system of similar natural resources, contractual agreements could be game changers in enhancing collective gains, which are typically absent in instances where competitive and shortsighted strategies are employed by self interested players. Conceptually, the different element between the two games was the use of disincentives (i.e. a 20% profit penalty) in the herders' game and the creation of positive incentives in the sugarcane farm context. A game theoretic matrix applicable to the sugarcane farm game is illustrated in Table 8.

Table 8: The sugarcane farm redistribution with added institutional variables

PROFITS			
Players' strategies	Contractual agreement for cooperation	One cooperates One competes	Both compete
Buyer and user: (government & new owner)	C + B	C - D or C + D	C
Seller (individual or company)	C + B	C - D or C + D	C

Where:

C = Competition gains accruing to individual player

B = Additional benefits for cooperating

D = B + B (possible extra individual benefit from cheating)

From the table, the collective gains accruing to players from cooperation are clearly greater than those from competing, (i.e. 2 X (C +B) > C + C). Similarly to the prisoners' and herders' games, the gains accruing to an individual sugarcane player who behaves cooperatively, but in isolation, are lower than the potential individual gains in a game where all players are competitive (i.e. C – D < C). Such a potential payoff must discourage cooperation. Again, the potential gains accruing to an individual sugarcane player who behaved competitively but in isolation are larger than, a) individual gains accruing when all players are competitive, and b) greater than the individual gains when all players are cooperating. The payoff must again discourage cooperation. The hierarchy of all potential individual payoffs from the sugarcane game is summarized in equation 1.

C + D > C+ B > C > C – D …….…..…….(1)

As in the prisoners' and herders' games the dominant strategy equilibrium in the sugarcane game is still competition in column 4 of Table 8. However, the greatest collective payoffs would be gained from cooperation, and are illustrated in column 2. The hierarchical order of collective payoffs from the game is summarized in equation 2.

[2x (C+B)] > **[(C + (B+B) + C - (B+B))]** = **[C + C]** ……..(2)

Using the cases of iLembe and uThungulu districts specifically, the estimation of the B and C values would require that, a) the C values are estimated from competitive market prices with respect to premiums in land sales as well as the estimates of values of farm unit productivities prior to the land transfers, and b), the estimated benefits from cooperation among stakeholders are represented in the B variable. The district municipality data showed that the potential savings from non cooperative price premiums were R770 000 and R860 000 on average per farm unit and the actual benefits from cooperative sales were R550 000 on average per farm sale. Moreover, the collective benefits in both districts from reversing underperformance for the 2006 to 2007 period were estimated at R78 million for 1443 hectares of land. The total sum of these values per farm or total sales constitutes an important proportion of benefit variable (B) as depicted in Table 8. The values of B and C (especially B) would rely on geographic location and the time period. Moreover, an accurate estimation of these values is not only game theoretically important, but it is also important for policy formulation and direction.

6. Concluding note and recommendations

Essentially the paper identified and illustrated the usefulness of a game theoretic perspective in analyzing the land redistribution process in South Africa in general, and in sugarcane farms of northern KwaZulu Natal, specifically. The case provided evidence supporting similar findings in the application of the theory by Ostrom (1990 and 1992) in irrigation farming. It was illustrated that long term cooperation leads to higher collective benefits in long drawn out economic transactions. However, the conclusion is not readily recognizable by self interested stakeholders and often cooperation is not the dominant strategy equilibrium in these games. Instead, it is common that natural resources are wasted by competing players. A similar conclusion was reached, but within a different theoretical framework, by Hardin (1968) in *The Tragedy of the Commons*. Hence, policy intervention has a big role to play in steering the game outcomes towards more beneficial results.

In the KwaZulu Natal land redistribution process it should be clear to stakeholders and policy makers that institutional support for new farmers is vital. Secondly, the best support would most likely come from experienced players in varied agricultural production processes and markets. The involvement of these players cannot be ignored by government agencies and policy makers. Properly thought out long term relationship agreements, with specified outcomes to be achieved and benefits to be gained by players need to be outlined and estimated in policy formulation for given geographical contexts. Thirdly, for the contractual agreements or institutional arrangements to be effective or beneficial, their associated transactional costs should never exceed the potential benefits of the B as illustrated in Table 8 and also by Ostrom (1990). For example, government agencies in northern Kwa Zulu Natal could not enter into a contract agreement that cost the agencies more than the potential collective benefits (B), similar to the one estimated in the forgoing discussion.

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