Agricultural land tax and farm-level resource use and output supply response

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ABSTRACT. *This study develops and uses a programming model for farm-level resource use and output supply response to estimate the effects of agricultural land tax in South Africa: A case study of Free State, a region of extremely large commercial farms that gained their size and economic heft during the apartheid years of aggressive subsidies, favorable tax treatment, lucrative state grants and gifts, and all manner of financial assistance. The results indicate that changes in land use and output supply are marginal. The highest effects are observed on irrigated farming. Relevant policy responses raised by the findings are discussed.*

Key words: Agricultural land tax, farm-level, resource use, output supply, land reform, South Africa, case study, programming model

1. INTRODUCTION

Since 1994, a number of policy measures are being implemented to enhance competitiveness in the farming industry. For instance, markets are being deregulated and trade liberalized. In addition, LRAD programme was formulated and being implemented to transfer land to black, women and youth as small-scale commercial farmers. The programme involves transferring 30% of farmland under large-scale commercial farmers to settle a number of small-scale commercial farmers before 2015 (DLA, 2006). Although the progress in land transfer has been claimed to be low, however, a number of LRAD farmers have been settled leading to a dual typical farm types – the established large-scale commercial farmers and the development, emerging, small-scale commercial LRAD farmers.

Yet, the failure to achieve the planned progress in the land transfer has been attributed to land speculation because of the government's principle of willing-seller-willing-buyer government assisted land market. The government is therefore proposing to implement agricultural land tax under the Local Government Municipal Property Rates Act No 6 of 2004, which, according to the policy document, is to discourage idle land or speculation in the land market thereby speed up the rate of land transfer (WETHU, UMHLABA, 2005). The apparent ineffectiveness of LRAD programme, as evidenced by the slow rollout of redistribution necessitates alternative mechanisms with which to address past racial imbalances, while still adhering to generally market-based approaches. However, levying agricultural land tax based on land value in this context remains contentious. Hence the need to analyse the possible implication and to what extent levying agricultural land tax may be effective given the complexities of the functioning of the land market in South Africa may also prevent levying tax from releasing more land into the market.

Therefore, this study aims to contribute to a discussion on levying agricultural land tax and its probable impacts on land use and regional output supply. The study examines the characteristics of the farm types, costs and returns to selected agricultural enterprises and uses the knowledge of cost implications of levying agricultural land tax based on land value under the Local Government Municipal Property Rates Act No 6 of 2004, given the challenges of a free market. The assumptions underlying the modeling is based on the premise that farmers do respond to changes in exogenous variables such as price or policy variables by changing land allocation and/or cropping patterns. In section 2, the methodology with justification was presented. Section 3 presents the results and discussion. The paper ends in Section 4 with conclusions and policy recommendations drawn from the results.

2. MATERIALS AND METHODS

In this study, a case study of Free State province was undertaken because an analysis of the effects of LRAD implementation, on resource use and output supply response, might be complex at national level. Agriculture is very important in a number of ways to the Free State province. So also is Free State agriculture important to the South African agriculture as a whole. Free State agriculture makes major contribution to agricultural production in South Africa. Of these contributions, established commercial large-scale farms contribute most share of the agricultural production while the LRAD developing farms are still constrained to make appreciable contribution to commercial agriculture. The province has positive trade balance for all the selected agricultural products while the country as a whole has negative trade balance in some of the selected products.

The South African farm industry structure and the characteristics of commercial farms are typified in the Free State province. Large-scale commercial farmers produce nearly all the marketed outputs and utilize about 98.2% of the land in the province. Because the Free State agriculture makes major contribution to agricultural production in South Africa, it has a great consequence for agriculture in southern African region and Africa as a whole as South Africa contributes on average about 69% production and income in the southern Africa as a region and 25% income of the African continent (World Bank, 2006). The study aggregates the established large-scale commercial farmers into a large farm type and the developing, LRAD farms into a small farm type using mathematical modelling approach.

The model

To avoid over-specialization, which is a common problem in mathematical modeling, the study uses an extended version of the standard PMP calibration approach (Howitt, 1995). Efforts were also made to make the model's specification and calibration as rich and realistic as possible by incorporating risk and farmers' risk attitudes into the model. Previous trends in regional output producer prices and yields were used to estimate the risk in production revenues. The model also was calibrated to an *a priori* supply response that was estimated with econometric models as reported in the literature (BFAP, 2006). The model features constraints due to resource availability and land quality distribution with the following regional farm income maximization objective function:

$$\begin{aligned} \textit{Maximise} \quad \Pi = & \sum_f \sum_t \sum_c ((E(\mathrm{Re}v_{ftc}) - (\alpha_{ftc} + 0.5\beta_{ftc} X_{ftc}))X_{ftc}) \\ & + \sum_f \sum_s ((E(\mathrm{Re}v_{fs}) - (\alpha_{fs} + 0.5\beta_{fs} X_{fs}))X_{fs}) \\ & + \sum_f (b_{f_l} - \sum_p \omega_l X_{f_l}) \cdot k_l \cdot tc \\ & - \sum_f (\theta_f (\sum_t X_{ftc} + X_{fs})' Cov_{\mathrm{Re}v_p} (\sum_t X_{ftc} + X_{fs})) \end{aligned} \quad (1)$$

$$\textit{Subject to} \quad n_f (\sum_f \sum_t \sum_c X_{ftc} + \sum_f \sum_s a_{fs} X_{fs}) \leq b_l \quad (2)$$

$$\sum_t \sum_c X_{ftc} + \sum_s a_{fs} X_{fs} \leq b_{fl} \qquad (3)$$

Equation 2 is the combination of the total land (irrigable arable, non-irrigation arable and grazing) in the region. It represents the constraint that total cropping and livestock activity levels do not exceed the total farmland available in the region. The variable b_l is the total land constraint in the region/province. Equation 3 is a replicate of equation 2 but at farm type level. The regional irrigation water capacity and farm labour availability were also modeled as constraints both at farm type and regional levels.

Π is the regional farm income; f, the vector of farm types (established and developing farm types); t, the vector of technologies (rain-fed and irrigated); p, the vector of production activities (c and s are subsets of p); c, the vector of crop activities; s, the vector of livestock activities; j, the vector of variable inputs; l, the vector of land qualities (which is a set of arable land, grazing land, dry non-irrigable land and irrigable land); X_{ftc}, the matrix of level of crop activities under technology t by farm type f in the region (ha); X_{fs}, the matrix of level of livestock activities by farm type f in the region (number); b_{fl}, the amount of farm land available under each farm type f (ha); k_l, the average land rent by quality in the region (R/ha); tc, the transaction cost of land rent (%); ω_l, the land requirement (for cropping activities) and carrying capacity of grazing land for livestock activity s in the region (ha/head); ɵ, the simulated risk aversion attitudes of the farm types; n, the number of farming units in each farm type; Cov, the variance co-variance matrix of the selected enterprises' revenues. The quadratic programming model was solved using CONOPT3, a non-linear programming optimization solver.

A scenario analysis of agricultural land tax

This study aims to contribute to a discussion of agricultural land tax from another perspective by assuming that land tax will affect the opportunity costs of land such that the proportional effect of land value tax is reflected in the cost of renting-in land and in the revenue accruable from renting-out land. Levying land tax on the land value was modeled to reflect in the opportunity cost of land. Therefore, rental values of land rented-out are penalized based on those assumptions such that revenue from renting-out land is imputed to compete with the least gross margin production activities in the model. Then 1% and 2% tax rates were applied and the effects are discussed in the section that follows. This scenario represents increase in the cost of production. In strong economic terms, increase in cost of production may result in decrease in activity levels or switching to more productive use of a resource.

3. RESULTS AND DISCUSSION

In this section, before presenting the results of the application of the model in simulating potential impacts of the proposed agricultural land tax, the underlying farm structure and costs and production data are presented.

Farm characteristics, cost and productions structure among the farm types

This section reports on the data underlying the model and the assumptions. On average, most large-scale commercial farmers have high management aptitudes resulting from long histories of financial success, high turnover, economic viability, good socio-economic standing, capital-intensive agricultural production and good marketing facilities (Jooste, Van Schalkwyk, and Groenewald, 2003). These farms contributed about 95% of value added and utilize about 87% of the agricultural land in the country. Compared to the established commercial farmers the developing LRAD farmers lack farm resources such as access to market, credit and management abilities. The few that are progressive do not operate at competitive levels (De Villiers, 2004). In resent time, the emerging policies, specifically the withdrawal of government supports in a more liberal market, has been attributed to the decreasing number of established large-scale farm units while inadequate government support to the emerging small-scale farmers limits their sustainability. Farming debt and its growth are a major concern in the Free State and South African agriculture (Olubode-Awosola, 2007).

Weighted average gives an indication that based on the 2002 Census of Commercial Agriculture – (Statistics South Africa, 2005); there are roughly 8,531 commercial farm units. In addition, there are roughly 495 farm units of the small farm type, as at end of year 2003. A typical large farm type has an average of 1,370.3ha of farmland. Of this amount, about 496.05ha is arable land, of which about 484.64ha is dry, non-irrigable arable land, with the remaining 11.41ha being irrigable. About 874.25ha is grazing land. There is 305,381.29m^3 of irrigation water available per farm unit. For the small farm type, there is an average of 394.69ha of farmland per farm unit. Of this amount, about 82.89ha is arable land of which about 75.76ha is dry non-irrigable arable land and the remaining 7.13ha is irrigable. About 311.81ha is grazing land. There is 37,987.54m^3 of irrigation water per farm unit. Casual labour is assumed limited at regional level at an estimate of about 149,164,800 person-hours per annum. The region also has about 29,222ha of potentially irrigable land. The above was used as inputs in the resource constraints equations

Programming models usually progress from a partial budget analysis, which is still the dominant method for microeconomic analysis of resource use and agricultural production (Howitt, 2005). For both farm types, irrigated crop production is more profitable compared to rain-fed crop production. However, the difference is not very large especially for white maize, soya beans and wheat. This is because prices were generally low in the base year 2004. Opportunity costs of irrigable land (R1000/ha) and dry-land (R130/ha) included in the estimation of the direct costs also increased the direct cost of irrigated crops markedly. These data were used as inputs in the objective function of the model developed to achieve the objectives of this study.

The variance and covariance matrix of per ha and per animal marginal revenue for crops and livestock respectively are incorporated into the model. The variance shows the deviation of marginal revenue from the expected marginal revenue while the covariance shows the correlation between marginal revenues of two outputs. The table shows that white maize has the highest expected marginal revenue of about R4,132/ha but it has second to the highest marginal revenue variance of about R966,818/ha. It is the second riskiest crop production activity after sorghum production. Dairy milk production has the highest expected marginal revenue of about R13,276/cow per annum. It also has marginal revenue variance of R284,249/dairy cow per annum. It is the riskiest among animal production activities.

Potential effects of agricultural land tax on activity level

In contrast to a tax on buildings, a land value tax is levied only on the unimproved value of land. An economic argument that justifies land tax states that land tax is the only tax, which does not distort market mechanisms nor deter production (Hyman, 1973). However this argument holds only if it is implemented properly. A tax is levied on a landowner as a portion of the value of a site or parcel of land that would exist even if that land had no improvements. In quantifying the probable land tax, expert's idea was that the prevailing thought is to levy a highest rate of about 2%. The general inclination informed the choice of a 1% and 2% simulation.

It is interesting to note that if the tax is levied at either 1% or 2%, it will not induce both farm types to decrease production activities in favour of renting-out farmland appreciably (Table 1). However, it is also interesting to note that the decrease in production activity levels is marginal (for large farm type, the highest is about 0.23% and 0.17% for irrigated sunflower seed and wheat productions respectively if 2% tax rate is levied). The response by the small farm type is less. These results support the arguments that land supply is inelastic. The decrease is higher on irrigated cropping. This can be explained by the high cost of irrigable land. It implies that the cost of renting-in irrigable land or acquiring irrigation facilities will be appreciably high or that opportunity cost of irrigable land or irrigation facilities will be relatively higher when tax is levied per land value.

Table 1: Base level and % changes in activity levels because of agricultural land tax

	Base			*1% tax rate*			*2% tax rate*		
	Established farm type	**Developing farm type**	**region**	**Established farm type**	**Developing farm type**	**region**	**Established farm type**	**Developing farm type**	**Region**
Crop		**('000 ha)**				**(%)**			
White maize:	659.96	1.80	661.76	-0.01	0*	-0.01	-0.03	-0.01	-0.03
Dry-land	640.19	1.75	641.91	-0.01	0	-0.01	-0.02	-0.01	-0.02
Irrigated	19.80	0.05	19.85	-0.04	-0.01	-0.04	-0.09	-0.03	-0.09
Yellow maize:	385.00	3.40	388.40	-0.01	0	-0.01	-0.02	-0.01	-0.02
Dry-land	373.45	3.30	376.75	-0.01	0	-0.01	-0.02	-0.01	-0.02
Irrigated	11.55	0.10	11.65	-0.04	-0.01	-0.04	-0.07	-0.02	-0.07
Wheat:	190.50	0.13	190.63	-0.03	-0.01	-0.03	-0.05	-0.02	-0.05
Dry-land	180.97	0.12	181.09	-0.02	0	-0.02	-0.04	-0.02	-0.04
Irrigated	9.52	0.006	9.53	-0.08	-0.03	-0.08	-0.17	-0.07	-0.16
Soya:	12.37	-	12.37	-0.01		-0.01	-0.03		-0.03
Dry-land	9.90	-	9.90	-0.01	-	-0.01	-0.02	-	-0.02
Irrigated	2.47	-	2.47	-0.04		-0.04	-0.07	-	-0.07
Sorghum:	42.48	-	42.48	-0.01		-0.01	-0.02		-0.02
Dry-land	42.06	-	42.06	-0.01	-	-0.01	-0.02	-	-0.02
Irrigated	0.42	-	0.42	-0.05		-0.05	-0.10	-	-0.10
Sunflower seeds:	185.04	-	185.04	-0.03		-0.03	-0.07		-0.07
Dry-land	181.34	-	181.34	-0.03	-	-0.03	-0.06	-	-0.06
Irrigated	3.70	-	3.70	-0.12		-0.12	-0.23	-	-0.23
Livestock		**('000 herd)**				**(%)**			
Cattle-beef	443.61	0.50	448.56	0	0	0	-0.01	0	-0.01
Sheep-mutton	1,117.56	11.39	1,128.95	-0.01	0	0	-0.02	-0.01	-0.02
Pig-pork	17.06	0.50	17.56	0	0	0	0	0	0
Broilers-chicken	49,010.64	6.44	49017.08	0	0	0	0	0	0
Layers- eggs	1,868,590	2475	1870765	0	0	0	0	0	0
Dairy milk	51186	495	51681	0	0	0	0	0	0

Source: Own simulation results from the model

Note: * denotes absolute value less than 0.005%

Another interpretation is that levying land tax may discourage intensive production such as irrigated farming because the rental cost of irrigable land would be higher when land tax is levied. These results support the arguments by Nieuwoudt (1995) that land tax may discourage investment (e.g. irrigation infrastructure) on land in the end and that such a tax has a minimum impact on production level.

Potential effects of agricultural land tax on output supply

The decline in irrigation area does not cause substantial decline in total area grown to crops with 1% and 2% land value tax rates (Table 2) because on average very small area is irrigated. It is noticed that there are negative but marginal responses to relatively land intensive (crop production) activities especially high value crop production activities. The economic justification of a land tax that, land tax, if properly implemented will not deter production nor distort market mechanism significantly is supported by these results. This is similar to the inelastic land-used changes in response to property tax as simulated by Polyakov and Zhang (2008) for Louisiana.

However, there are constraints to the expectations that land tax discourages speculation bubbles in land market and encourages the efficient and productive use of land with respect to crop production because the declines in activity level and supply were noticed in the production of relatively land-intensive high value production activities (irrigated cropping). The declines in supply are 0.07% for sunflower seeds; 0.06% for wheat; 0.04% for soya bean; 0.03 for each of white maize and sorghum; 0.02% for yellow maize productions at 2% land value tax. This though marginal decrease in regional supply resulted from decreases in irrigation cultivations of these crops. The supply response is only marginal because few areas are irrigated generally.

It therefore follows that in regions where there are high levels of irrigation facilities; decline in irrigated area would have substantial effects on output supply. By implication, these relatively low effects of land tax are in line with the claim by Van Schalkwyk *et. al.* (1998) that if farmers can downshift land tax to the tenant, the effect of levying land tax may not be substantial even on land prices or shadow prices of land. However, its effects on the cost of production could worsen the soaring food prices.

Table 2: Base and % changes in supply because of agricultural land tax

	Base			*1% increase*			*2% decrease*		
	Established farm type	Supply Developing farm type	Region	Established farm type	Supply Developing farm type	Region	Established farm type	supply Developing farm type	region
Crop	(‘000 ton)					(%)			
White maize	2,718.40	6.06	2,724.45	-0.01	0	-0.01	-0.03	-0.01	-0.03
Yellow maize	1,617.42	12.56	1,629.98	-0.01	0	-0.01	-0.02	-0.01	-0.02
Wheat	517.67	0.28	517.96	-0.03	-0.01	-0.03	-0.06	-0.02	-0.06
Soya beans	30.51	-	30.51	-0.02	-	-0.02	-0.04	-	-0.04
Sorghum	162.90	-	162.90	-0.01	-	-0.01	-0.03	-	-0.03
Sunflower seeds	269.34	-	269.34	-0.04	-	-0.04	-0.07	-	-0.07
Livestock	(‘000 ton/litre/unit)					(%)			
*Beef-cattle	60.26	0.34	60.59	0	0	0	-0.01	0	-0.01
*Sheep-mutton	30.00	0.15	30.15	-0.01	0	-0.01	-0.02	-0.01	-0.02
*Pig-pork	10.23	0.26	10.49	0	0	0	0	0	0
*Broilers-chicken	74.36	0.008	74.37	0	0	0	0	0	0
**Layers-eggs	515199.60	568.75	515768.70	0	0	0	0	0	0
***Dairy-milk	357984.70	274069.60	360725.40	0	0	0	0	0	0

Source: Own simulation results from the model

* ton

**unit;

***litre

4. CONCLUSIONS AND POLICY RECOMMENDATIONS

It is demonstrated that if farmers are rational, the proposed agricultural land tax may have limited negative impacts on the selected farming enterprises. Levying land tax at 2% of land value given the assumptions will induce the large farm type to decrease marginally the level of production activities in favour of renting-out farmland. Based on the level of realism, which this model captures, these results show one of the realistic reactions from the farmers – switching away from activities with more decrease in profits, higher revenue risk and increased revenue from renting-out farmland given other constraints. This implies that the amount of unused land increases marginally by same amount as there are reductions in area used. This may imply that levying land tax may bring more land to market for transfer however, the complexities of the functioning of the land market as the process of willing-buyer-willing-seller government assisted land market is yet to be effective may not increase the land market.

Since the decrease is higher on irrigated cropping, it can be concluded that the high cost of irrigable land will increase the cost of renting-in irrigable land or acquiring irrigation facilities or that opportunity cost of irrigable land or irrigation facilities will be appreciably higher when tax is levied per land value. Therefore levying land tax may discourage intensive production such as irrigated farming. It may also discourage investment (e.g. irrigation infrastructure) on land in the end. In regions where there are much irrigation resources and facilities, decline in irrigated area because of levying a land tax would have substantial effects on output supply in such a region. The decrease in activity levels and output supply by the LRAD farm type is lesser. Therefore, the assumptions behind these simulations give results that are close to *a priori* expectations and therefore could serve as information for policy formulation on agricultural land tax.

The South African government, as much as it has a responsibility to redress the imbalance in farm resource use and output supply potentials in the farm industry, also has the challenge to maintain sustainability of the emerging LRAD farms, continuous production of established commercial large-scale farmers and agricultural intensification for tradable volume in a free market economy. This may weaken the competitiveness of South Africa's and Africa's farming industry since South Africa is the largest economy in Africa.

To this end, policy should specifically address the risk in production revenues as this affects both farm types. On levying land tax, there is a need for continuous and high frequent studies on land valuations because the effective tax rate will depend on proper and efficient valuation of land. This implies that land tax need not be static but dynamic with respect to the market value of land in each community. Neither should land tax be general but it should be related to positional advantages, fertility or natural resources, etc. that affect land value.

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