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Effect of privatisation on the productivity of sugarcane out-growers in Dwangwa Cane Growers Limited, Malawi

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Abstract

This study examines the impact of privatisation on the productivity of smallholder sugarcane out-growers in Malawi using a case study of Dwangwa Cane Growers Limited (DCGL). The study uses the autoregressive distributed lag model and finds that privatisation had a significant positive impact on the sugarcane productivity of the DCGL scheme, both in the short run and the long run. Furthermore, it shows that price incentives alone cannot drive productivity growth and highlights the significance of sustainable fertilisation practices. The study also underscores the sensitivity of sugarcane productivity to variations in rainfall, with excessive rainfall having adverse effects, emphasising the need for strategies to manage waterlogging. To improve productivity, the study recommends maintaining a supportive framework for out-growers, restructuring institutional arrangements such as better technical assistance and affordable access to credit within the out-grower schemes, revisited pricing structures, ensuring sustainable use of fertilisers and investing in disaster management strategies.

Key words: autoregressive distributed lag model, Dwangwa Cane Growers Limited, out-grower schemes, privatisation, productivity

1. Introduction

This study examines the productivity of smallholder sugarcane out-growers following the privatisation of the sugar industry in Malawi, while focusing on the case of Dwangwa Cane Growers

Limited (DCGL). The privatisation of the sugar industry from state-controlled operations to private ownership occurred in 1998 (African Development Bank 1999). The transition aimed to enhance efficiency, stimulate growth and integrate smallholder farmers into the commercial production of sugarcane through out-grower schemes.

Sugar production in Malawi plays a vital role in the country's agricultural sector and economy. Notably, the industry has been one of the major sources of export earnings, with most of the sugar being exported to regional and international markets, including neighbouring countries in Southern Africa, as well as Europe and the United States (US) (Government of Malawi [GoM] 2023). The industry's role in generating export revenue has been pivotal for Malawi's trade balance, and the crop was marked the third-largest foreign exchange earner after tobacco in 2022. In the 2022 fiscal year, sugar export values reached US$ 23.8 million, claiming almost 3% of Malawi's total export basket. However, this was a decrease from the US$ 74.6 million recorded in 2021. Meanwhile, Malawian sugar exports were expected to reach US$ 27.6 million in 2023 (GoM 2023).

The sugar industry also plays a critical role in enhancing the livelihoods of smallholder farmers through employment in the industry. With an estimated workforce of 16 000 in 2023, the sector directly supported the livelihoods of more than 80 000 people, considering that each worker often has five dependents (Illovo Sugar (Malawi) PLC 2020). The presence of the industry in rural areas has furthermore led to the development of essential infrastructure, such as roads, housing and schools, in the vicinity of sugar estates, contributing to broader rural development (Adams *et al*. 2019).

The cultivation of sugarcane is undertaken primarily by large estates, with a smaller contribution from smallholder farmers and medium-sized farmers through out-grower schemes (Food and Agriculture Organization [FAO] 2015). The evolution of the sugar industry in Malawi has been a captivating journey spanning nearly seven decades, marked by remarkable transformations, obstacles and prospects. Starting from its modest origins to the current era, the industry has experienced noteworthy transformations, shaped the agricultural landscape and contributed to the country's economy.

In the early 1970s, smallholder farmers had limited opportunities to directly participate in sugarcane production. The Special Crops Act (SCA) enacted by the government of Malawi only allowed the cultivation of sugarcane by largely state-owned estates, which included the Sugar Corporation of Malawi (SUCOMA) in Chikwawa District and the Dwangwa Sugar Corporation (DWASCO) in Nkhotakota District (Chinsinga 2017). This denied smallholder farmers the potential benefits that they could have gained from involvement in the industry, and significantly hindered the growth of the industry. However, the Smallholder Sugar Authority (SSA), anchored in the SCA, was established in 1978 to promote and facilitate the development of sugarcane cultivation among smallholder farmers. The performance of the SSA was initially regarded as positive, but operational inefficiencies emerged over time, leading to its eventual collapse in the 1990s (Chinsinga 2017).

To curtail the inefficiencies, SUCOMA, DWASCO and SSA were fully privatised in 1998 through the structural adjustment programmes (SAPs), which were carried out by the government with support from the World Bank and International Monetary Fund (IMF). The privatisation entailed selling previously state-owned estates to the Illovo Sugar Group, which was the main private player in the sugar industry at the time. Out-grower schemes were established to act as intermediaries between member farmers and the Illovo Sugar Group, and possibly to increase farmers' participation in sugarcane production and boost the output contribution from the smallholder sector. These out-grower schemes included Dwangwa Cane Growers Limited (DCGL) in Dwangwa, Nkhotakota District, and Kasinthula Cane Growers Ltd (KCGL) in Nchalo, Chikwawa District. DCGL inherited all the assets and farmers from the SSA.

Under out-grower arrangements like DCGL, smallholders' land is grouped and registered under the Dwangwa Cane Growers Trust (DCGT) as a trust deed, typically consisting of 40-hectare plots (Hinde 2017). This process transfers land ownership from customary tenure to a trust deed, and the lease agreement typically spans 30 years (Adams *et al*. 2019). In return, farmers are supported with farming inputs and granted a five-year contract to supply sugarcane to Illovo Sugar Malawi, which can be renewed subject to DCGT's approval.

Although the out-grower farming system has been paraded as an effective approach to integrate smallholder farmers in cash cropping and to facilitate agricultural commercialisation for decades, studies on the industry have highlighted a lot of flaws and farmer exploitation, particularly in Africa (Chasukwa 2013; Manda *et al*. 2018; Adams *et al*. 2019). Critics are of the view that sugar out-grower schemes are land grabbing, characterised by imbalanced power dynamics between the out-growers and Illovo Sugar Malawi, with long-term implications for land ownership (Bae 2019). The arrangement also gives DCGT the authority to terminate contracts at its discretion, which undermines the security of the out-growers (Adams *et al*. 2019).

Farmers furthermore often lack the bargaining power to negotiate fair prices for their produce, leading to exploitative practices (Imani Development International 2021). For instance, Malawian sugarcane out-growers receive prices 23% lower than domestic sugarcane prices, highlighting a significant price disadvantage (FAO 2015). In addition, Illovo retains 40% of the farmer's earnings as a milling fee, and out-grower management companies (OMCs) retain 20% as management fees (Chinsinga 2017).

Several studies demonstrate the manifold positive effects of out-grower farming on increased income, poverty reduction, employment opportunities, access to stable markets with predictable prices, technical assistance, and access to essential farm inputs (Matenga & Hichaambwa 2017; Ripley 2017). Dal Belo Leite *et al*. (2020) revealed that smallholder sorghum farmers engaged in out-grower farming in Mozambique achieved significantly higher productivity and profitability compared to non-contracted farmers. Out-grower farming also plays a pivotal role in connecting smallholder farmers to stable and reliable markets. Out-grower farming enables smallholders to participate in cash crop production, allowing them to diversify their income sources and enhance their overall economic well-being (Eaton & Shepherd 2001).

While an extensive body of literature has explored sugarcane out-grower schemes, the existing studies for Malawi, such as those by Chasukwa (2013), Chinsinga (2017), Adams *et al*. (2018, 2019) and Bae (2019), have largely overlooked a critical aspect – how the evolution of the sugarcane industry has affected the performance of out-grower schemes post-SAPs. Moreover, most of the studies have leaned towards a qualitative approach, leaving a quantitative void in our comprehension of these schemes. To enhance an understanding of the circumstances surrounding the sugar industry, this study assesses the impact of sugar industry privatisation on the performance of the DCGL out-grower scheme in the period from 1990 to 2020. The study employs the autoregressive distributed lag and error correction model (ARDL) to estimate both short-term and long-term relationships and dynamic interactions regarding the performance of the smallholder sugarcane out-growers, using the case of DCGL. By shedding light on these aspects, we aim to provide valuable insights into the dynamics of the sugar industry and its out-grower schemes, which have far-reaching implications for stakeholders and policymakers alike.

2. Methods

2.1 Theoretical framework

This study draws insights from production theory, which examines how inputs such as land, labour and capital are combined to produce outputs efficiently (Lopez 1982). In addition to the inputs, production is also influenced by climatic factors such as rainfall, temperature and sunlight (Frisch 1964). According to production theory, the relationship between inputs and outputs can be represented by a simple production function, expressed as follows:

$$Q_t = f(x_t), \quad (1)$$

where Q_t denotes cane production by DCGL at time t and x_t represents a vector of inputs (fertiliser, land, labour and capital) at time t. The model in Equation (1) is assumed homogeneous of degree 1 in factors (Antle & Capalbo 2015). This implies that an increase in the inputs will result in a proportional increase in output, Q.

The production function in Equation (1) assumes a deterministic relationship between inputs and output. In addition, the model assumes that, given the same level of resource endowment, farms are homogenously efficient (Gollin 2010). However, this assumption is unrealistic. The amount of sugar cane production can also be attributed to climatic factors, along with other factors that determine the farm efficiency of the inputs (Antle & Capalbo 2015). We modified Equation (1) to incorporate the shift in production due to other factors, as expressed in (2):

$$Q_t = A(t) f\left(x_t\right), \quad (2)$$

where $A(t)$ denotes all other factors that influence the efficiency of inputs used in the production output Q at period *t*. From the generic production function, we derive the land productivity of DCGL as the ratio of total cane production (Q) and land under production, as expressed in Equation (3);

$$Prod_t = Q_t / L_t, \quad (3)$$

where $Prod_t$ denotes the total factor productivity of land at time t, L_t represents the land under production at time t, while Q_t is total production at time t.

2.2 Empirical specification

From Equation (3), we introduce a temporal element to capture the cane productivity of the DCGL scheme over time. To examine what drives productivity, we specify the basic regression model in Equation (4). Among the covariates, we include a dummy variable to capture the impact of the privatisation policy.

$$Prod_t = \propto_0 + \propto_1 CaneGr_t + \propto_2 Rainf_t + \propto_3 Price_t + \propto_4 Fert_t + \propto_5 D_t + \mu_t, \quad (4)$$

where $\propto$ represents the coefficients of the model to be estimated, *t* denotes the period from 1990 through 2020, *Prod* denotes smallholder sugar productivity measured in metric tons per hectare, *CaneGr* represents the number of cane growers per hectare in the DCGL scheme as a proxy for labour, *Rainf* represents annual rainfall in Dwangwa, *Price* denotes the sugarcane price received by farmers,

Fert denotes the fertiliser amount used by the scheme, *D* represents the privatisation policy, indexed 1 for the period after 1999 when SSA was privatised and 0 otherwise, and μ represents the error term.

All continuous variables in Equation (4) were converted into their natural log form to minimise variation, and the functional form of the model is expressed as follows:

$$lnProd_t = \propto_0 + \propto_1 lnCaneGr_t + \propto_2 lnRainf_t + \propto_3 lnPrice_t + \propto_4 lnFert_t + \propto_5 D_t + \mu_t \quad (5)$$

The regression model in Equation (5) employs ordinary least squares (OLS) to examine how the privatisation of the sugar industry affected the DCGL's cane productivity. However, the use of OLS to estimate dynamic relationships is misleading (Mose *et al*. 2007). OLS assumes that the data are level stationary, which is often not true for most economic variables. Consequently, the presence of nonstationary time series in the framework can lead to spurious regressions characterised by inflated coefficients of determination and autocorrelation (Wooldridge 2013).

This study utilised the Pesaran *et al*. (2001) autoregressive distributed lag and error correction model (ARDL) to estimate the long-run and short-run relationships and dynamic interaction among the variables of interest. The ARDL model was considered the most suitable econometric method compared to alternative approaches, since the variable set comprised of I (0), I (1) and cointegrated series (Nasrullah *et al*. 2021). Stationarity was confirmed through the augmented Dickey-Fuller and Philip Perron unit root tests, while the Pesaran *et al*. (2001) bounds test was used to assess the existence of cointegration within the variables.

Following the general regression model in Equation (5), an ARDL model for the study is expressed as follows:

$$\Delta \ln Prod_t = \alpha_0 + \sum_{k=1}^{n} \alpha_1 \Delta \ln Prod_{t-k} + \sum_{k=1}^{n} \alpha_2 \Delta lnCaneGr_{t-k} + + \sum_{k=1}^{n} \alpha_3 \Delta lnRainf_{t-k} + \sum_{k=1}^{n} \alpha_4 \Delta lnPrice_{t-k} + \sum_{k=1}^{n} \alpha_5 \Delta lnFert_{t-k} + \sum_{k=1}^{n} \alpha_6 D_{t-k} + + \delta_1 \ln Prod_{t-1} + \delta_2 \ln CaneGr_{t-1} + \delta_3 \ln Rainf_{t-1} + \delta_4 lnPrice_{t-1} + \delta_5 \ln Fert_{t-1} + \delta_6 D_{t-1} + \mu_t, \quad (6)$$

where α_0 represents the drift component, while Δ denotes the first difference and μ_t illustrates the white noise. The study uses the Bayesian information criterion (BIC) to identify the optimal lag length. After estimating the long-run association between the variables, the error correction model (ECM) was used to estimate the short-run effects. The canonical functional form of the ECM is presented below:

$$\Delta \ln Prod_t = \alpha_0 + \sum_{k=1}^{n} \alpha_1 \Delta \ln Prod_{t-k} + \sum_{k=1}^{n} \alpha_2 \Delta lnCaneGr_{t-k} + \sum_{k=1}^{n} \alpha_3 \Delta lnRainf_{t-k} + \sum_{k=1}^{n} \alpha_4 \Delta lnPrice_{t-k} + \sum_{k=1}^{n} \alpha_5 \Delta lnFert_{t-k} + \sum_{k=1}^{n} \alpha_6 D_{t-k} + \emptyset ECM_{t-k} + \mu_t, \quad (7)$$

where Δ represents the first difference, while $\emptyset$ is the coefficients of ECM for short-run dynamics. ECM shows the speed of adjustment in the long-run equilibrium after a shock in the short run.

2.3 Data

The study utilises time-series secondary data collected from the DCGL, spanning from 1990 through 2020. The time-series framework over more than three decades ensures a comprehensive analysis of the long-term trends and patterns, as it is a long enough period to observe how these variables evolved and their potential influence on smallholder sugar production within the DCGL. The variables used in the study include the number of cane growers, landholding under the scheme in hectares, total sales in Malawi Kwacha, annual rainfall in millimetres, cane price in Malawi Kwacha (MK), and fertiliser

used in kilograms. Most importantly, the study highlights the 1998 privatisation policy in the model, which is believed to have affected the performance of out-grower schemes significantly. Rainfall represents the climatic factors that influence production, fertiliser usage signifies technical factors, price represents the incentive structure, and the change in the privatisation policy depicts the shifts in the institutional arrangement within the industry following the SAPs. Data analysis was done in Stata version 17.

3. Results

3.1 Descriptive analysis

Table 1 presents the descriptive statistics of the variables. The number of sugarcane out-growers under the scheme was found to average approximately 291 between the years 1990 and 2020. This metric serves as an indicator of the participation in and scale of the cane out-grower programme. Smallholder sugar production during the period of interest (1990 to 2020) was observed to average 91.04 thousand metric tons per annum. On the other hand, the landholding under the scheme varied, with an average of 986.02 hectares and a spread of 242.92 hectares from the mean.

Table 1: Summary statistics of the variables

Variable	N	Mean	Min	Max	SD
DCGL out-growers	31	290.87	189.00	692.00	127.92
Hectarage (ha)	31	986.02	672.00	1 743.17	242.92
DCGL growers per ha	31	0.29	0.18	0.54	0.07
DCGL production (mt)	31	91 039.83	54 126.61	145 571.11	23 746.14
DCGL productivity (mt/ha)	31	93.30	62.89	123.53	15.37
Total sales (MK 'million)	31	1 041.36	127.62	2 522.65	772.65
Annual rainfall (mm)	31	1 296.99	815.70	1 861.40	305.69
Sugarcane price (MK/mt)	31	76 151.44	470.32	305 775.24	97 912.56
Fertiliser used (mt/ha	31	1 049.47	544.75	1 835.33	246.82
Privatisation policy	31	0.71	0.00	1.00	0.46

In terms of revenue, the scheme generated an average of nearly MK 1.04 billion per annum. Furthermore, the average sugarcane price was found to be MK 76 151.44 per metric ton. Using the estimates of production and hectarage, smallholder yield was calculated to average 93.3 metric tons per hectare, higher than the Southern Africa region's average of 70.16 metric tons per hectare (FAO 2023). This shows that Malawi's smallholder growers are 1.3 times more efficient than their regional counterparts in terms of sugarcane production per unit of land.

3.2 Trend analysis

Figure 1 shows the trend in the number of cane growers under the DCGL, with an upward trajectory. Fluctuations in participation occurred over the years. Notably, a decline in participation from 1999 to 2001 coincided with the transition from state-led to privately led out-grower schemes. After privatisation, participation increased, peaking at 692 farmers in 2012, but subsequently declining, for instance by almost 50% in 2013.

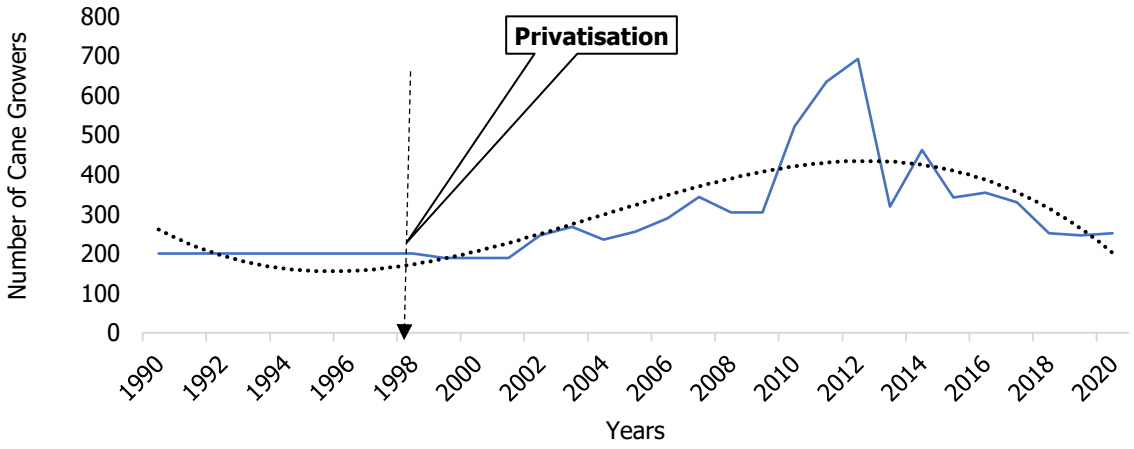

Figure 1: Trend in the number of cane growers under DCGL

There has been an overall decline in productivity of the DCGL since 1990 (Figure 2). The trendline indicates that DCGL faces an average decline in productivity of 0.0029 metric tons per hectare annually.

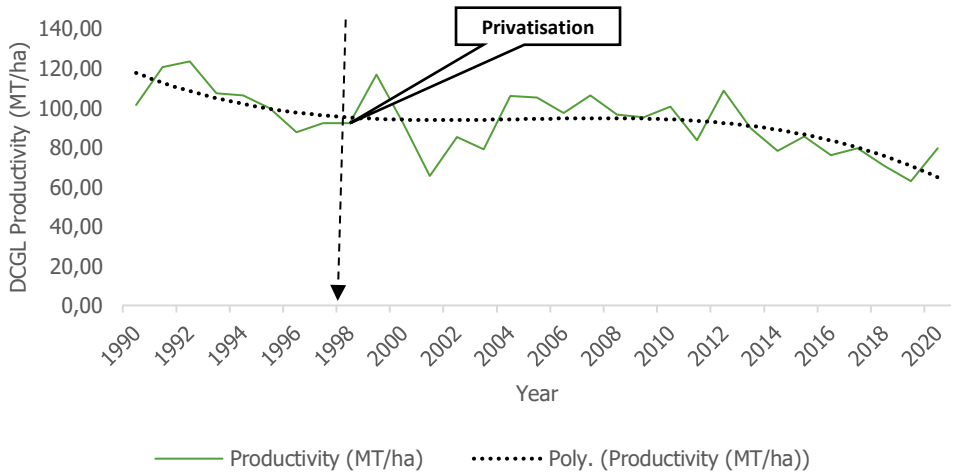

Figure 2: Productivity of DCGL since 1990

Figure 3 shows an upward trend in the nominal total revenue of DCGL from 1990 to 2020, with average annual sales of MK 1.04 billion. However, the considerable fluctuation, with spreads ranging from MK 128 million to approximately MK 2.52 billion, is noteworthy.

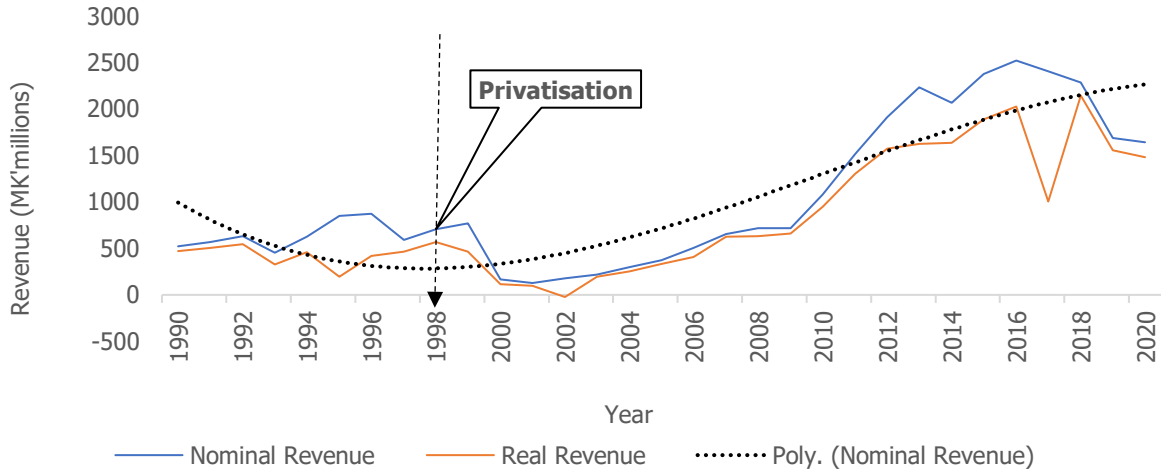

Figure 3: Trend in DCGL revenue since the 1990s

Figure 4 shows an upward trend in nominal sugarcane prices from 1990 to 2020, with an average annual increase of MK 25.77 per metric ton. However, the real price curve consistently falls below the nominal one. The peak in nominal sugarcane prices was in 2018, at MK 305 775 per metric ton. A noticeable decline to MK 266 729 per metric ton was observed in 2019.

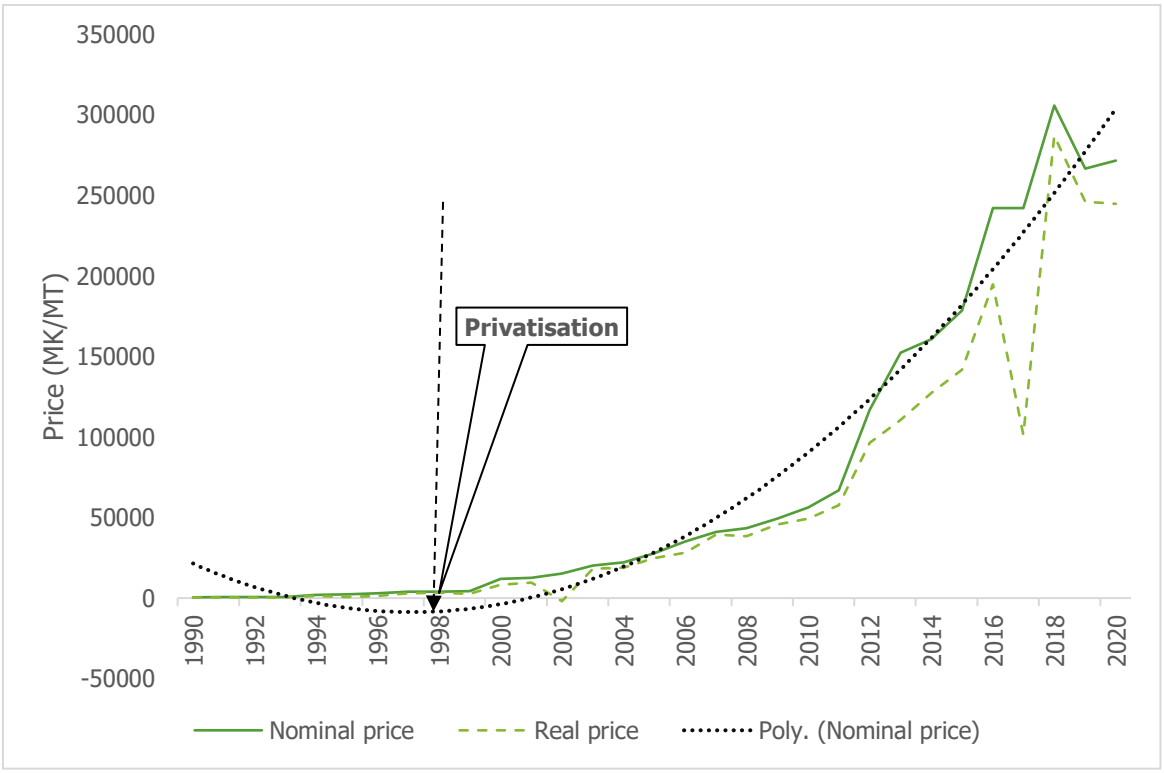

Figure 4: Trend in the price of sugarcane

3.3 ARDL estimation

3.3.1 Diagnostic and stability tests

Table 2 presents diagnostic tests confirming the robustness of the analytical framework. The adjusted R-squared value of 0.7544 indicates that the model effectively explains approximately 76% of variations in DCGL productivity. Durbin-Watson and Breusch-Godfrey tests showed no significant serial correlation in model errors. The Breusch-Pagan/Cook-Weisberg and White tests confirmed constant variance in the residuals. The Jarque-Bera test and Ramsey RESET test validated the normality of residuals and correctness of the model specification. Engle's LM test indicated no autoregressive conditional heteroscedasticity. Collectively, these results therefore ensure the reliability of the findings and support the empirical model's validity.

Table 2: Diagnostic tests

Diagnostic	Test	Statistic	Value	P-value	Conclusion
Coefficient of determination	Adj. R-squared		0.754		Good fit
Serial autocorrelation	Durbin-Watson	*d-statistic*	1.732		No first-order serial autocorrelation
	Breusch-Godfrey test	*F-test*	0.811	*0.3798*	No higher-order serial autocorrelation
Heteroskedasticity	Breusch-Pagan/Cook-Weisberg test	*Chi-square*	0.56	*0.4559*	Constant variance
	White's test	*Chi-square*	30.00	*0.4140*	Constant variance
Autoregressive conditional heteroskedasticity (ARCH)	Engle's Lagrange multiplier (LM) test	*Chi-square*	0.701	*0.4023*	No ARCH effects
Normality	Jarque-Bera normality test	*Chi-square*	0.431	*0.8061*	Normally distributed
Specification-error test	Ramsey RESET test	*F-test*	0.20	*0.8965*	No evidence of omitted variables

The study employed the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests to assess the stability of the short-run and long-run estimates (Nasrullah *et al*. 2021). Figures 5 and 6 show the results of the CUSUM and CUSUMSQ tests, respectively. The findings indicate that all model parameters remained within the 5% level of significance bound. This suggests the stability of the ARDL model over time, affirming the robustness of the estimates.

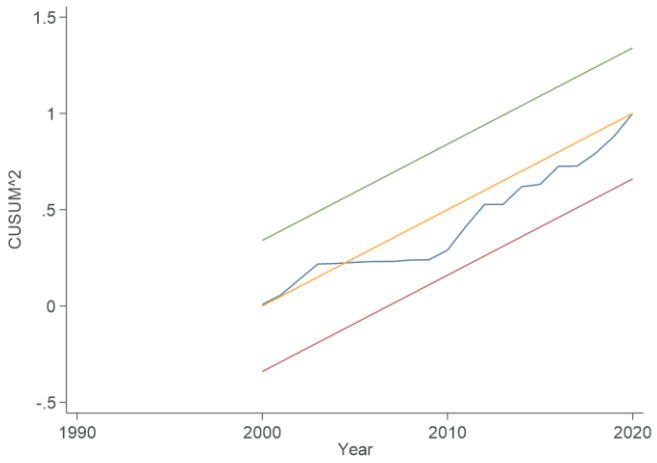

Figure 5: CUSUM for the ARDL estimates

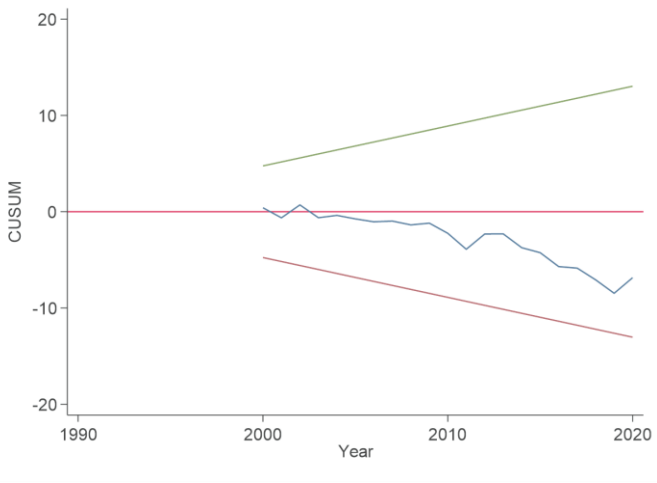

Figure 6: CUSUMSQ for the ARDL estimates

3.3.2 Unit root test

The augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests were used to check for unit roots (Table 3). Rejecting the null hypothesis when the test statistic exceeds critical values indicates stationarity. The results in Table 3 indicate that all the variables showed either level stationarity, I(0), first difference stationarity, I(1), or a combination. Specifically, the number of cane growers, sugarcane price, fertiliser usage and the 1998 policy change exhibited first difference stationarity, while rainfall, sugarcane productivity and number of growers per hectare (using the Phillips Perron test) were level stationary.

The unit root test results confirm that the variables meet the stationarity criteria necessary for conducting the ARDL bounds test, establishing a strong foundation for the further analysis and modelling of the relationships among these variables.

Table 3: Augmented Dickey-Fuller and Philip Perron unit root tests

Variable	Optimal lag (SBIC)	Augmented Dickey-Fuller (ADF)		Philips-Perron (PP)		Order of Integration
		Level	1st difference	Level	1st difference	
Ln*Prod*	1	-2.883	-5.514***	-3.860**	-7.465 ***	I (0)pp
Ln*CaneGr*	1	-1.751	-4.712***	-2.801	-9.045***	I (0)pp
Ln*Rainf*	0	-5.692***	-8.099***	-5.623***	-8.099***	I (0)
Ln*Price*	1	-1.405	-4.189***	-1.325	-5.409***	I (1)
Ln*Fert*	1	-0.393	-3.572**	-0.496	-3.962***	I (1)
D_{1998}	1	-1.629	-3.742*	-4.332	-11.076 ***	I (1)

Notes: *** = p < 0.01, ** = p < 0.05 and * = p < 0.10. Ln denotes the natural log of the variable. SBIC is the Schwartz Bayesian Information Criterion

3.3.3 Structural breaks unit root test

The study utilised the Zivot and Andrews (1992) test to identify structural breaks in the series due to policy or macroeconomic shifts. The results in (Table 4) reveal significant changes in smallholder sugar productivity in 2004 and in the number of cane growers in 2010. To account for the structural changes, a dummy variable, D_2010, was introduced, with a value of 1 after 2010 and 0 before, to capture the effects of this break. The literature suggests substantial support for smallholder farmers

through projects before 2010, contributing to increased participation and production during that period. This is exemplified by the AfDB-funded project Outgrower Sugarcane Production between 2001 and 2008 (FAO 2015).

Table 4: Zivot Andrews structural break unit root test

Variable	Break in intercept		Break in intercept and trend	
	t-statistic	Break	t-statistic	Break
Ln*Prod*	-6.451***	2004	-6.509***	2004
Ln*CaneGr*	-4.486	2010	-6.065***	2010
Ln*Rainf*	-5.893	2015	-6.678	2015
Ln*Price*	-2.698	2000	-3.962	2000
Ln*Fert*	-1.957	2004	-3.460	2010
D_{1998}	-4.332	1990	-4.232	1998

Note: *** = p < 0.01, ** = p < 0.05 and * = p < 0.10

3.3.4 Bounds test of cointegration

Before using the ARDL model, it was necessary to confirm the existence of long-term convergence in the variables. To this end, the study employed the ARDL bounds test developed by Pesaran *et al*. (2001). The results in Table 5) show that the absolute t-statistic value of -8.267 exceeded the lower and upper bound critical values at a 1% level of significance. Thus, the ARDL bounds test rejected the null hypothesis of no cointegration, indicating a significant long-term association among the variables of interest.

Table 5: Pesaran *et al*. (2001) bounds test of cointegration

Dependent variable	Critical values						t-statistic	P-values	
	10% level		5% level		1% level				
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)		I (0)	I (1)
Ln*Prod* = *f* (Ln*CaneGr*, Ln*Rainf*, *LnPrice*, *LnFert*, D_{1998}, *D_2010*)	-2.498	-4.106	-2.891	-4.610	-3.716	-5.674	-8.267	0.000	0.010

Note: ARDL (1, 1, 0, 0, 0, 1) is based on the Schwartz Bayesian Information Criterion

3.4 Long-run estimates

Table 6 presents the long-run estimates from our ARDL model. The privatisation of the sugar industry in 1998 had a significant and positive impact on the cane productivity of DCGL, leading to an approximate 0.112% increase in the long run. However, the 2010 dummy, D_{2010}, had a negative impact on sugarcane productivity in the long run, resulting in a decrease of approximately 0.188%.

Table 6: Long-run estimations from the ARDL model

	(1)	(2)	(3)	(4)
VARIABLES	**Coefficient**	**SE**	**t-statistic**	**P-value**
Ln*CaneGr* (-1)	0.405***	0.125	3.249	0.00422
Ln*Rainf* (-1)	-0.101**	0.0458	-2.199	0.0404
Ln*Price* (-1)	-0.0789***	0.0171	-4.605	0.000193
Ln*Fert* (-1)	0.398***	0.104	3.836	0.00111
*D*_1998 (-1)	0.112**	0.0505	2.213	0.0393
*D*_2010 (-1)	-0.188***	0.0587	-3.198	0.00474
Constant	5.081***	1.043	4.870	0.000106

Notes: *** = p < 0.01, ** = p < 0.05 and * = p < 0.10. The ARDL model (1, 1, 0, 0, 1, 0, 1) is based on the Schwartz Bayesian Information Criterion. (-1) represents the first lag of the variable.

3.5 Short-run estimates

Table 7 shows the short-run estimates of the ARDL model. The coefficient of the error correction model (ECM) was negative and significant at the 1% level, indicating long-run convergence (Abodi *et al*. 2021; Nasrullah *et al*. 2021). The ECM value is -1.352, suggesting that around 135% of long-run disequilibrium was corrected in the current period. However, an ECM value above 1 implies oscillating convergence rather than a smooth process (Abodi *et al*. 2021). The introduction of sugar out-grower schemes in the private sector in 1998 had a significant positive influence on smallholder sugar productivity, resulting in a 0.151% increase in productivity in the short run.

Table 7: Short-run estimations from the ARDL model

	(1)	(2)	(3)	(4)
VARIABLES	**Coefficient**	**SE**	**t-statistic**	**P-value**
D.Ln*CaneGr* (-1)	0.193*	0.110	1.756	0.0953
D.Ln*Rainf* (-1)	-0.136**	0.0626	-2.174	0.0425
D.Ln*Price* (-1)	-0.107***	0.0265	-4.031	0.000713
D.Ln*Fert* (-1)	0.00742	0.107	0.0694	0.945
*D*_1998 (-1)	0.151**	0.0685	2.204	0.0401
*D*_2010 (-1)	-0.426***	0.0943	-4.513	0.000238
ECM (-1)	-1.352***	0.164	-8.267	1.03e-07

Notes: *** = p < 0.01, ** = p < 0.05 and * = p < 0.10. The ARDL model (1, 1, 0, 0, 1, 0, 1) is based on the Schwartz Bayesian Information Criterion. (-1) represents the first lag of the variable. D represents the first difference.

The study shows a significant association between the 2010 breaks and cane productivity by the DCGL. Precisely, the 2010 breaks were associated with a decline in productivity growth of 0.426 in the short run. Furthermore, the findings show that a percentage increase in rainfall led to a 0.136% decrease in sugarcane productivity in the short run. Moreover, a short-term increase in nominal price corresponded to a 0.107% decline in sugar productivity, in line with the quiet life hypothesis, suggesting that higher prices can discourage labour-intensive activities and reduce the productivity of the DCGL. The number of cane growers, on the other hand, had a positive effect on DCGL's productivity in the short run.

4. Discussion

From the trend analysis, it can be seen that the first major jump in nominal revenue occurred between 1999 and 2000, followed by a substantial drop attributed to poor sugarcane production due to severe droughts from 2000 to 2004. Sales recovered by 2008, with a significant increase from 2009 to 2013, coinciding with rising production and inflation. Peak sales were in 2016 due to higher nominal prices. Since then, a declining trend in total sales has been observed, mainly due to decreasing out-grower production, despite price increases. When inflation is considered, the real total revenue consistently

falls below the nominal revenue, illustrating the negative effect of inflation on earnings. Price fluctuations underscore market vulnerability and challenges for Malawian sugarcane farmers, affecting their income, financial stability and the sustainability of their operations. Reduced prices may discourage further investment in sugarcane cultivation and lead to decreased production levels.

The findings of the long-run trend analysis are consistent with the existing literature in different sectors, highlighting the productivity benefits of privatisation (Gilmore *et al*. 2011; Dal Belo Leite *et al*. 2020). Privatisation led to better management practices, increased marketing efforts, investments in modern equipment, and the adoption of advanced farming techniques, all of which contributed to the enhanced productivity of the scheme. Pre-2010, farmers participating in the sugar value chain received substantial support from various donor-funded projects, including assistance with farm inputs, technical guidance, and loans (FAO 2015). Notably, the Smallholder Outgrower Sugarcane Project implemented by the DCGL played a significant role during the period from 2001 to 2009. However, as these projects were phased out, incentives and support for out-growers waned, significantly affecting production levels and overall scheme productivity.

The findings in Table 7 also indicate a persistent negative and inelastic relationship between the sugarcane price and DCGL's productivity in the long term, which is statistically significant at the 1% level. A one percentage point increase in sugarcane price in the first lag was associated with a 0.079% decline in DCGL's productivity, all other factors being controlled for. The findings contradict standard production theory, which suggests a positive relationship between price and production (Ogundari 2016). However, the findings are consistent with Abodi *et al*. (2021), who also found a negative relationship. In the context of this study, the difference in the observations is potentially due to the supply response to price changes, which can be inelastic because of resource constraints like land and labour. Even if prices for sugarcane rise in the out-grower scheme, limitations in available resources and other constraints can lead to a negative response of the supply system, and hence reduced productivity. In addition, the negative and inelastic correlation between price and productivity can be explained by the "quiet life" hypothesis, which stipulates that smallholders may exhibit complacent behaviour when they receive higher prices, leading to a lack of motivation to increase their productivity (Fulginiti & Perrin 1993).

There is a positive long-term relationship between fertiliser usage and sugarcane productivity. The findings indicate that a one percentage increase in fertiliser quantity in the first lag leads to a 0.398% increase in the productivity of DCGL. This aligns with existing studies by Tchereni and Tchereni (2013), Ogundari (2016), Shoko *et al*. (2016) and Abodi *et al*. (2021), who emphasised the pivotal role of fertilisers in enhancing productivity. However, the gradual and long-term nature of this response highlights that fertiliser effects on sugarcane productivity accumulate over time. This underscores the importance of sustainable fertilisation practices and the need to consider long-term benefits, rather than expecting immediate results.

The results in Table 7 further show that the productivity of DCGL, in the long run, responds positively to the number of growers. A percentage increase in the number of growers per hectare in the first lag was associated with a 0.405% increase in the scheme's productivity in the long run. This indicates that the increase in out-growers decreases the size of land allocated to individual farmers. However, this increases sugarcane productivity, suggesting that smaller farms often achieve higher productivity, which can be attributed to intensive labour application, better resource management and closer attention to crop care. Knezevic *et al*. (2023) argue that small farms play a crucial role in global food production and security, demonstrating higher levels of productivity than larger farms when measured in terms of output per hectare. Similarly, Omotilewa *et al*. (2021) provide empirical evidence from Nigeria showing that productivity exhibits a U-shaped relationship with farm size, where small farms

(up to 22 hectares) outperform larger farms due to more efficient use of the available resources and labour. Opposing evidence suggests that the relationship between farm size and productivity is more complex and may not always follow the inverse pattern. Aragón *et al*. (2022) argue that using yields as a measure of productivity can be misleading due to market distortions and diminishing returns to scale in smallholder agriculture. Their findings indicate that larger farms might achieve higher levels of productivity when assessed using broader measures that consider efficiency, input costs and market access.

On the other hand, a 1% increase in rainfall corresponds to a 0.101% decrease in productivity. Sugarcane, being a tropical crop, exhibits a heightened sensitivity to the amount of rainfall. While sufficient rainfall is beneficial, surpassing optimal levels can have detrimental effects on sugar production. Previous studies, such as those by Srivastava and Rai (2012), Chandio *et al*. (2020) and Nasrullah *et al*. (2021), have emphasised the negative influence of excessive rainfall on sugarcane production in the long run. Waterlogging, soil erosion, increased disease incidence and nutrient imbalances contribute to reduced yield and compromise the quality of sugarcane. In this light, Malawi has recorded 19 major flooding events in the past five decades, such as the 2015 floods that affected over 1.1 million people and the 2019 Cyclone Idai, which severely affected agricultural lands (GoM 2023). Warnatzsch and Reay (2019) have highlighted how recurrent floods disrupt farming activities, leading to significant losses in the productivity and quality of crops, including sugarcane.

The short-term results in Table 7 correspond to the expected effect observed in the long-term estimates, although with varying magnitudes and levels of significance. This improvement can be attributed to economic reforms that accompanied the out-grower scheme, including enhanced access to credit, inputs and extension services, motivating smallholders to engage in sugar production and adopt efficient agricultural practices.

5. Conclusion

This study investigated the impact of privatisation, among other factors, on sugarcane productivity using the case of the DCGL smallholder out-grower scheme in Malawi. The study employed an ARDL model to analyse the long-run and short-run relationships among the number of cane growers, rainfall, sugarcane price, fertiliser usage, privatisation policy changes (1998) and structural breaks identified in 2010 on smallholder sugar productivity

A key conclusion of the study is that privatisation of the sugar industry in 1998 had a significant and positive impact on DCGL's long-run sugarcane productivity. However, post-2010 institutional changes show reduced support for out-growers in long-run sugarcane productivity. In addition, inelastic prices stagnate DCGL's long-run productivity, while fertiliser usage has a positive long-run association with sugarcane productivity. Nevertheless, excessive rainfall negatively affects long-run sugarcane productivity.

Based on the findings, the study recommends restoring institutional support to pre-2010 levels through improved extension services and timely access to inputs, and strengthening cooperative support mechanisms. Reforming sugarcane pricing models to reflect production costs and market dynamics is essential to ensure fair compensation and incentivise higher yields. Expanding access to targeted fertiliser subsidy programmes will enhance accessibility and affordability, improving productivity and soil fertility management. Furthermore, investment in improved drainage infrastructure is critical for mitigating the effects of flooding

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