Will availing credit incentives to Zimbabwean farmers trigger a maize output response?

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Abstract

This paper evaluates the impact of credit availability on communal and commercial sector maize output in Zimbabwe. This is important given the increased use of concessionary credit for agriculture as a policy strategy to increase agricultural output and food security, in response to the disruption caused by controversial land reform. The results show that communal sector maize output does not respond to credit availability. Neither does it respond to area under cultivation. Rainfall is the single most important driver of communal agriculture. The commercial sector responds to credit incentives albeit with a very low elasticity. Therefore, credit availability is a rather impotent device for enhancing maize output and, generally, agricultural output in Zimbabwe. Since most of the newly resettled farmers typically operate like communal farmers, both the land reform programme and concessionary credit for agriculture will not be likely to increase agricultural output. An urgent review of the beneficiaries of the controversial land reform programme is needed to ensure that only profit maximizing farmers will have their landownership confirmed, while unproductive farmers are replaced, if the agricultural sector is to help revive the Zimbabwean economy. Thus, commercialisation – rather than communalisation – of the agricultural sector is the appropriate strategy to trigger an increased agricultural output response.

KEYWORDS: ARDL approach to cointegration, credit, maize output response, Zimbabwe

1 Introduction

Theory is inconclusive about the impact of credit on agricultural output. On the one hand, it is argued that liquidity constraints reduce agricultural output. On the other hand, it is argued that liquidity constraints are not binding if agricultural productivity is already low. This paper evaluates the impact of credit availability on communal and commercial farmers producing maize in Zimbabwe.

Modern agricultural systems are capital intensive. Agricultural credit is argued to be an important vehicle for agricultural development because it helps farmers cope with the capital demands required to boost production levels. The continuous change in prices of inputs required in agricultural production is among the major problems that farmers face each year. Inputs include seed, fertilizers, chemicals, labour and transport. Availability of credit makes it easier for farmers to acquire the necessary inputs. In order to enhance utilization of credit by farmers, most governments in developing countries have even introduced subsidized credit.

However, some argue that liquidity constraints are not binding if agricultural productivity is already low. For instance, low levels of fixed capital, infrastructure and working capital are expected to reduce the impact of credit on the productivity of communal farmers (Kochar 1997). Furthermore, if the marginal product of capital is less than the cost of credit, then credit constraints are not

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binding. This is likely to be the case with communal farmers who might have limited access to land, or use primitive production techniques, or are late adopters of technology.

The impact of credit availability on agricultural output is thus an empirical question. The Zimbabwean government holds the view that credit availability increases agricultural productivity. They have been using concessionary credit to enhance agricultural production in the hope that it will counter the disruption caused by the controversial fast-track land reform programme of 2000 The fast-track land reform programme removed white large-scale commercial farmers from their land and resettled the farms with black farmers who were severely undercapitalized and new to commercial farming. These new, undercapitalized farmers were expected to produce agricultural output for the country

In order to assist the new, undercapitalized farmers, the Zimbabwean government sought loans from Iran, Egypt, Malaysia and China for the purchase of equipment such as tractors and combined harvesters (Rukuni *et al.* 2006). The equipment was distributed to farmers on loan. In 2001 the government introduced the Crop and Livestock Inputs Scheme, to assist smallholder farmers. Smallholder farmers are termed thus because they own and farm no more than 30 hectares of land. Under this scheme, smallholder farmers were given inputs on loan, to be paid back at harvest, through a stop order system through the agricultural marketing boards. Even recently, the government has been distributing inputs in the form of seeds, fertilizers, chemicals, tillage services, and loans for labour hire, etc.

These government-supported credit schemes are meant to promote the growing of all major food crops and cash crops, and also encourage restocking of livestock. It is still to be investigated whether these schemes are effective or not, but statistics show that some farmers are not using the disbursed funds or input packs for the intended objectives. Every year, at most two-thirds of the targeted acreage is planted and less than a third of the total funds disbursed has been recovered (Ministry of Agriculture 2004). The government is striving to provide the new farmers with credit to enable them to secure the same resources and equipment similar to those that displaced commercial farmers were using. However, it is not clear whether credit availability is the appropriate intervention. It is important to establish whether credit potentially does play any pivotal role in production levels of communal and commercial farmers in Zimbabwe.

In particular, given that the fast-track land reform had the effect of communalizing the agricultural sector, it would be beneficial to know (i) whether communal farmers respond to credit incentives i.e. will concessionary financing of agriculture increase agricultural production by the new farmers, the majority of whom are essentially communal farmers and (ii) whether the responsiveness of communal farmers is any different from that of commercial farmers i.e. is there a need for institutional change in agriculture in favor of moving to some mode of production. These are particularly relevant questions given that discussions on the impact of credit presume use of marketed inputs to produce marketed output by a profit-maximizing farmer. Such assumptions may not exactly fit the profile of the smallholder farmer (i.e. communal farmers and other farmers resettled under the A1 resettlement scheme - a scheme to decongest the communal areas) who are largely subsistence farmers. Moreover, since the fast-track land reform, marketing of agricultural produce has been controlled in both movement and price, such that the marginal revenue product of capital in agriculture could be less than the cost of credit and returns from alternative investments. When these factors are taken into consideration, doubt is cast on the responsiveness of communal farmers to credit availability.

This paper therefore seeks to answer the following questions: (1) Are communal farmers responsive to credit? (2) Is their response similar to that of commercial farmers? These questions are answered using time series data from Zimbabwe for the period 1980-2001 to estimate the responsiveness of both communal and commercial farmers' maize output to credit and other factors. The rest of the paper provides background information on the structure of the agricultural sector in Zimbabwe, outlines the methodology used in the paper, presents the results of the econometric analysis, and finally summarizes the conclusions and policy implications.

2 Background

2.1 The dual structure of the agricultural sector

Zimbabwe has a total land area of about 39 million hectares, of which 33.3 million hectares are suitable for agricultural purposes, and the remaining 6 million hectares have been reserved for national parks, wildlife reserves and urban settlements. The country first became a political entity as Rhodesia, under British influence, towards the end of the 19^{th} century. The Republic of Zimbabwe attained independence from Britain on 18 April 1980, after 15 years of international ostracism and economic sanctions, and a protracted civil war. At independence, agricultural land was divided along racial lines as follows: (i) about 15.5 million hectares, which is almost half the total agricultural land in the country, controlled by 6,000 white large-scale commercial farmers, and (ii) about 16.4 million hectares controlled by 840,000 black communal farmers. Consequently there was significant over-crowding on land occupied by communal farmers. This uneven land distribution between the large-scale commercial and small-scale communal areas also extended to the suitability of land for agricultural purposes – communal farming land was generally less fertile. Communal farmers in general, also lacked, good husbandry skills, and had poor agricultural and physical infrastructure (Von Blanckenburg 1994).

In an effort to redress the inherited imbalance of land distribution, the Zimbabwean government, in 1980, embarked on a resettlement programme. Land acquisition proceeded in the spirit of the 1979 Lancaster House Constitution's "willing seller, willing buyer" clause, which was not allowed to be changed for ten years from its inception. The targeted beneficiaries were people in communal areas, war-displaced people, and Zimbabwean refugees. 162,000 families were to be resettled on 3.5 million hectares of land, of which 0.5 million hectares was former state land in the large and small-scale commercial farming sectors. As a result of the resettlement programme, about 73,000 families were resettled. By the late 1980s, the land distribution pattern was as follows: (i) 1.4 million hectares was owned by 10,000 small-scale commercial farmers, (ii) 11 million hectares of land was owned by the large-scale commercial farmers, (iii) 0.5 million hectares was owned by the state farming sector, (iv) about 16.4 million hectares was controlled by one million communal farmers, and (v) 3.5 million hectares was controlled by about 73,000 resettled families. In spite of the progress made, there was still a huge demand for land among the congested communal farmers and other landless groups, with over 524,890 families awaiting resettlement.

Most commercial farmers were plainly unwilling to sell any land because, among other factors, they could not repatriate all proceeds from the sale of land due to foreign exchange controls, while others overpriced their land twice or thrice over. The government was powerless in the face of the farmers' resistance because of the "willing seller, willing buyer" clause, so they enacted the Land Acquisition Act of 1992. The Act removed the "willing seller, willing buyer" clause, which resulted in speeding up the land reform process. The Act empowered the government to buy land any land for redistribution, and compensation was to be paid for the acquired land. Landowners were given the right to take the matter to court if they did not agree with the compensation set by the government. Britain had, from the onset of the resettlement programme, been a partner with the Zimbabwean government, and had agreed to fund 50% of the land purchases, contributing about £44 million. In an apparent protest to the Act, Britain withdrew her aid to the resettlement programme, accusing the Zimbabwean government of giving the land exclusively to high ranking government and ruling party officials. The Act had a limited impact largely because the government, without Britain's assistance, did not have the money to compensate landowners, and most compulsory land acquisitions were contested in court.

In 1998 the government made a decision to compulsorily purchase five million hectares of land over five years as part of the resettlement programme. Land was to be identified on the basis of the following criteria: (i) under utilization, (ii) dereliction, (iii) multiple ownership, (iv) absentee ownership, and (v) proximity to congested communal areas. Farmers owning 841 farms were served

with acquisition orders, but the government failed to process the compensation within the legally stipulated time. As a result land reverted back to its owners. The Commercial Farmers Union, an organisation that represents, protects and advances the interests of commercial farmers and furthers the development of an economically viable and sustainable agricultural industry in Zimbabwe, subsequently offered 1.5 million hectares of land from its members for sale to the government for redistribution.

The resettlement programme had to move on but landowners once again dragged their feet in offering more land to the government. As frustration set in on both sides, in 2000, the government drafted a new Constitution of Zimbabwe with a clause to compulsorily acquire land for redistribution without paying compensation, except with respect to improvements made on the land. The proposed Constitution of Zimbabwe failed to win by 55% of the votes in a referendum. Immediately after the defeat of the proposed Constitution of Zimbabwe, the government quickly moved to amend the old Constitution of Zimbabwe and the Land Acquisition Act of 1992 with a clause to compulsorily acquire land for redistribution without paying compensation, except with respect to improvements made on the land. Following that amendment, a long list of farms became the initial target for a new mode of acquisition where compensation was to be only paid with respect to improvements made on the land, rather than for the land itself. This, coupled with decisive demonstrations by the Zimbabwe liberation war veterans and the land-hungry peasants who spontaneously occupied commercial farms throughout the country, caused a huge outcry in the country and internationally.

Under the fast-track land reform, the A1 scheme of land allocation was earmarked for communal farmers while the new commercial farmers were resettled under the A2 scheme - a scheme to create a new generation of commercial farmers. However because of lack of capital and poor allocation criteria most of these new commercial farmers operate like communal farmers.

By mid November 2001, about 160,000 families had been resettled on 3,074 previously large-scale commercial farms covering about 7.3 million hectares (UNDP 2002). Land reform was then announced completed in August 2002 (Chiremba and Masters 2003). Government reports indicated that the government acquired close to 10 million hectares of land and more than 352,000 families were resettled, with priority given to people who were living in congested rural areas. Aggregate agricultural output scaled down by approximately 50% and about 200,000 farm jobs were reported lost in 2002. Zimbabwe's food security and foreign currency earnings were negatively affected by the decline in agricultural output.

Until the fast-track land reform, the most outstanding characteristic of the agricultural sector in Zimbabwe was dualism. With dualism, the state supported the commercial farming sector, which possessed the most fertile land, and which had access to national and international markets, credit, technology, extension services, manufactured inputs, and consumption goods (Makandiwire and Bourenane 1987). Commercial farmers work mostly with horticulture and intensive crop production of maize, tobacco and soya beans, using mechanised production techniques (Rukuni and Eicher 1994). They hire labour, sometimes from communal farmers in peak periods. Commercial farmers have an advantage over smallholder farmers when it comes to accessing bank loans because they have collateral. They use earnings from their sales to increase their investments on their farms, potentially resulting in better yields in each successive production year.

With dualism, the communal farmers were "settled on poor and small portions of land, producing mainly for family consumption and local markets, were denied equal education and employment opportunities and even salaries for the same job differed with race" (Von Blanckenburg 1994). Communal farmers are self employed and generally involved in subsistence farming in crop and livestock production. Crop production is mainly for food consumption, and the surplus is marketed. Major crops grown in the smallholder farming sector are maize (dominant food crop), sorghum, millet, groundnuts and sunflower. Crop production is not mechanized. Livestock provides animal draught for tillage, transport and manure. It also serves as a stock of wealth, and provides some income as well as food (i.e. milk and meat). Over the years, poverty levels among the communal sector have been increasing. This has been attributed to poor farming systems, low land holdings and a poor

resource base (Von Blanckenburg 1994).

2.2 The agricultural output trends

The contribution of communal farmers to the country's aggregate crop production is generally smaller than that of commercial farmers as shown in Figure 1. On average they contribute only 20% to the total crop production. However, communal farmers are the highest producers of food grains, such as maize, although their yield per hectare is lower than that of the commercial farmers. The commercial farmers dominate the production of cash crops. The commodity, technological and scale bias in the communal and commercial farming sectors is closely related to the differences in capital ownership and farming techniques employed by the two farming sectors.

The communal sector's contribution to total crop production reached its peak of over 30% in 1985. Since then, it has been falling, except for 1993 and 1995. This peak occurred at about the same time that financial support reached its peak, both in absolute amounts and share of total loans, as well as the number of farmers supported.

The same trend is observed with the real value of gross agricultural output for the two sectors, as shown in Figure 2 below. In the early years after independence until 1985 there was a general increase in communal sector output, after which a general decline is observed. The year 1992 is exceptional in that the massive drop in output was due to a severe drought. Nonetheless, the real value of gross communal output levels has been below that of 1985. On the other hand, save for three years from 1987 to 1989 and the severe 1992 drought, the real value of gross commercial output increased until 1996. Clearly, the response of the commercial sector to incentives appears to be different from that of the communal sector.

2.3 The evolution of agricultural credit support

The trend of credit support for agriculture shows that over the years, commercial farmers have always benefited more than communal farmers, as illustrated by Figure 3 below.

This trend can be traced to the country's history. The history of agricultural credit in colonial Zimbabwe goes back to 1924 when the Land and Agricultural Bank of Southern Rhodesia was set up for the purposes of granting loans to white commercial farmers. Since then, a number of state sources of agricultural credit were made available to assist white commercial farmers, among them the African Loan Development Company Limited formed in 1961, and the Agricultural Loan Fund formed in 1964 (Rukuni *et al.* 2006). The Agricultural Finance Corporation (AFC) was then formed in 1971 as a successor to the Land and Agricultural Bank of Southern Rhodesia, with its major function being the granting of medium- and long-term loans at low interest rates (Makandawire and Bourenane 1987). It absorbed the Farm Irrigation Fund, the Agricultural Diversification Scheme, the Tenant Farming Scheme, the Coffee Scheme, and the Land Owners Development Loan Scheme, which were set up in the 1960s as supporting bodies for white commercial farmers.

Until independence in 1980, the financial services available to communal farmers were restricted to deposits and withdrawals only. As a way to complement the resettlement programme after independence, the Zimbabwean government introduced some financial support services for the communal sector which was previously serviced by mostly non-governmental or church organizations. The AFC also opened its doors to the smallholder farmers. In the 1980/81 agricultural season, 18,000 loans amounting to Z$4.8million were disbursed to smallholder farmers (Rukuni *et al.* 2006). Other sources of credit for smallholder farmers after independence were the Small Enterprises Development Corporation, and informal loans and savings schemes such as the Association of Women's Clubs and Rotating Savings Credit Association.

Despite the policy changes, the participation of smallholder farmers in accessing loans was not satisfactory. According to Chimedza (1993), in 1989 only 16.5% of all building society outlets were located in communal lands where 70% of the country's total population resided. The AFC was the

only public lending institution servicing the two farming sectors. Nevertheless this institution failed to meet demand in the rural areas, servicing less than 10% of smallholder farmers in 1986. By 1990, the figure was less than 5% of the total smallholder farmers (Makandawire and Bourenane 1987).

AFC was operating as a parastatal, and dependent on the government for its financing. Between 1981 and 1991, its major obligation was to disburse loans at a subsidized interest rate of 13% while the inflation rate was 15% or more per year, causing huge losses for the corporation (Rukuni *et al.* 2006). According to an AFC income statement, the corporation was losing Z$0.16 on each dollar lent to communal farmers, while lending to commercial farmers yielded Z$0.07 profit on each dollar lent in the 1989/1990 season (Rukuni *et al.* 2006). Most of the loans granted to commercial farmers where medium- and long-term, allowing them to invest in machinery and also cater for variable costs. On the contrary, loans granted to smallholder farmers were mostly short-term, and hence were mostly used for variable costs and immediate expenses.

Although AFC increased its disbursements over the ten year period (1981-1991), with a peak in 1986 where 65,269 farmers benefited, only 10% of these farmers were smallholder farmers (Rukuni *et al.* 2006). From 1986 onwards, the number started declining, with major declines being observed among the smallholder farmers. The major reasons for the decline included poor repayment performance and dissatisfaction with the management of the stop-order repayment system. The communal farmers' explanation for the decline was the high demands of the loans associated with high application failure rates (totalling about 40% of applications) and higher transaction costs (Rukuni *et al.* 2006). In an effort to reach more smallholder farmers, the corporation launched the group lending pilot programme in the 1990 agricultural season.

In 1999 the AFC was transformed into two entities – Agribank, a commercial bank, and the Agricultural Development Assistance Fund (ADAF), a special fund, Agribank was to cater for commercial farmers while ADAF was to cater for smallholder farmers. ADAF is yet to develop a sustainable rural financial system. Under ADAF, an increase in demand for credit by the smallholder farmers has been observed although there are still problems with satisfying their demands. The traditional banking requirement of requesting collateral cannot be applied to smallholder farmers, but the farmers must show proof of savings in lieu of collateral. Some smallholder farmers are still not able to meet this requirement. The slow transition of the bank led the government to introduce funding through the Ministry of Agriculture working with the Ministry of Finance as a way of boosting agriculture output.

However, it is worth noting that there was a steep drop in loans for the communal sector in 1997, accompanied by a further steep drop in both the communal and commercial sector in 2000, soon after the fast-track land reform programme.

3 Theoretical Framework

The theory of the firm implicitly assumes the absence of liquidity constraints. When applied to agricultural production, this implies that production decisions will be independent of consumption decisions (Feder *et al.* 1990) so that input demands are always optimal. On the contrary, in communal sector agriculture, production and consumption are intertwined with the consequence that the amounts and combinations of inputs used by a communal farmer will deviate from their optimal levels when liquidity constraints are binding.

A theoretical link between credit availability and communal farmers' productivity is provided in a model of household consumption and investment by Feder *et al.* (1990). In this model, the household allocates resources at its disposal between current consumption, investment and purchase of variable inputs at the beginning of each production period. The household's initial endowments of resources, both liquid and illiquid (family labor, capital and land) resources, can be augmented by borrowing at the beginning of the period. Expenditure on current consumption, investment and variable inputs should equal the household's total amount of resources (which includes borrowing).

The objective of the household is to maximize its utility (from current and next period consumption, and the valuation of capital), subject to the constraints imposed by the production function, budget constraint and capital accumulation. Two situations arise. In the first situation, the household is not credit-constrained such that the first order condition for the variable input equates marginal productivity to cost. There is separation between consumption and production decisions. In the second situation, the household is credit-constrained such that both investment and variable input demands are also functions of the household utility parameters. This implies that credit constraints deviate (reduce) input demand from their optimal levels, hence affecting productivity. Furthermore, comparative statics results show that an increase in credit will be split between production and consumption (Feder *et al.* 1990). In this case, the production function incorporates credit availability as an argument as opposed to the first case where there is separation between production and consumption decisions.

The specification of the production function generally follows past studies (Feder *et al.* 1990, Kochar 1997), which used the theoretical framework summarised above. In these models, the reduced form production model is estimated as a function of labour, land, other variable inputs, and the amount of credit available. A key implicit assumption of our analysis, which will allow us to capture the impact of credit, is that capital stock will be purchased mostly using credit, thus replacing the capital stock variable with the credit availability (loans) variable in the production function.

4 Methodology

4.1 Data

The paper's primary interest is the response of communal farmers' maize output to credit availability, and compares it to the response of commercial farmers' maize output to credit availability, in Zimbabwe. The paper uses time-series data from 1980 to 2001 for the Zimbabwean communal and commercial sectors, obtained from the Central Statistical Office's Compendium of Statistics 2000, the Quarterly Digest of Statistics 2004, and the Government of Zimbabwe's Agricultural Sector of Zimbabwe Statistical Bulletin 2001. Rather than investigate the responsiveness of the aggregate sectoral agricultural output, the paper estimates the responsiveness of maize output of both communal farmers and commercial farmers to credit availability. In other words, aggregate sectoral agricultural output is proxied by aggregate maize output (production) for each sector. This choice is motivated by three factors: firstly, there is a need to use a common output for the two sectors; secondly, maize production contributes over 90% of the total production in the smallholder sector; and finally, maize is essential for Zimbabwe's food security.

The explanatory variables chosen include credit availability (loans), employment (labour), area under cultivation, and rainfall. Data for employment in communal agriculture is not available therefore the communal population is used as a proxy. This is appropriate since communal farmers predominantly use family labour. The size of the rural population is a good indicator of the amount of labour available for use in maize production. However, it should be noted that this implicitly assumes a constant dependency ratio over time. There is neither reason nor evidence to doubt that the dependency ratio in rural areas might have been constant over the period under analysis.

4.2 Estimation Technique

The paper uses the autoregressive distributed lag (ARDL) approach to cointegration proposed by Pesaran *et al.* (2001) to estimate the responsiveness of communal and commercial sector maize production to credit availability.[1] Maize output is regressed as a function of labour, rainfall, area

[1] Readers requiring a more detailed explanation of the cointegration approach are referred to time series textbooks such as Enders, W. (1995). *Applied Econometric Time Series*, John Wiley & Sons, USA and Charemza, W. W. and D. F. Deadman (1997). *New Directions in Econometric Practice: General to Specific Modelling, Cointegration and*

under cultivation, and credit availability (loans). The ARDL approach is chosen because it overcomes significant estimation problems when using time series data. Firstly, this approach captures both short-run and long-run dynamics when testing for the existence of cointegration. Secondly, it permits the estimation of cointegration relationships when variables are I(0), I(1) or a mixture of the two, hence there is no need to pretest for the order of integration of the variables in the model. Thirdly, it offers explicit tests for the existence of a unique cointegration vector rather than assuming one. Finally, it takes into account the possibility of reverse causality (i.e. the presence of some explanatory variables that are endogenous, or the absence of weak exogeneity of the regressors) thereby ensuring that the parameter estimates are efficient and consequently valid.

These features are very important in an analysis where *a priori*, an important variable such as rainfall is likely to be stationary but will then need to be analysed alongside other variables that are non-stationary. Also, in this framework, credit availability (loans) is a policy variable that enhances agricultural output but could itself be a response to low agricultural output levels, hence endogenous.

The empirical application of the ARDL involves three steps: (i) identifying the order of integration of variables using the unit root tests; (ii) testing for the existence of a unique cointegrating equation using the bounds testing approach; and (iii) estimation of the ARDL to obtain the short-run and long-run coefficients.

5 Results

5.1 Unit root tests

The unit root tests are based on the Augmented Dickey Fuller (ADF) and the Phillips-Peron tests. The ADF results are reported in the table below alongside the Phillips-Peron test.

The unit root tests for the communal sector presented in Table 1 above show that output and rainfall are stationary, while area under cultivation is I(1). However credit availability is I(1) from the Phillips-Peron tests as opposed to the conclusion from the ADF test that its first difference is non-stationary. Credit availability to the communal sector has structural breaks (see year 1997 in figure 3) as such the ADF overestimates the order of integration for this variable. Accordingly, we go by the result from the Phillips-Peron test indicating that credit availability is I(1). Unit root test results for the commercial sector presented in Table 2 show that maize output and labour are stationary while credit availability and area under cultivation are I(1). Thus for both sectors, the data is a mixture of I(1) and I(0) variables. We thus proceed by means of the bounds test for cointegration.

5.2 Bounds tests for cointegration

This test is used to identify the cointegrating vectors in the system by testing for the exclusion of the error correction term in the equation of interest. Let us consider the application to the estimation of response of maize output to credit availability. As mentioned above, output (Q_t) is a function of labour (L_t), credit availability (C_t), rainfall (R_t) and area under cultivation (A_t). Define the error correction term as

$$ECT = Q_{t-1} - \hat{\beta}_1 L_{t-1} - \hat{\beta}_2 A_{t-1} - \hat{\beta}_2 R_{t-1} - \hat{\beta}_3 C_{t-1} \tag{1}$$

The ARDL representation is thus

$$\begin{aligned} \Delta Q_t &= \alpha + \sum_i^p \beta_{1i} \Delta Q_{t-i} + \sum_i^p \beta_{2i} \Delta L_{t-i} + \sum_i^p \beta_{3i} \Delta A_{t-i} + \sum_i^p \beta_{4i} \Delta R_{t-i} + \sum_i^p \beta_{5i} \Delta C_{t-i} \\ &\quad + \alpha_1 Q_{t-1} + \alpha_2 L_{t-1} + \alpha_3 A_{t-1} + \alpha_4 R_{t-1} + \alpha_5 C_{t-1} + \varepsilon_t \end{aligned} \tag{2}$$

Vector Autoregression, 2^{nd} Edition, Edward Elgar, UK. For the ARDL approach see Pesaran et al. (2001).

If a long run relationship exists, the error correction term should be significant. Therefore the coefficients of the lagged variables in equation (2) should be jointly significant. Thus the null hypothesis in the bounds test is $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$ against the alternative hypothesis that at least one $\alpha_i \neq 0$. Rejection of the null hypothesis implies the existence of a cointegrating vector while failure to reject the null hypothesis is an indication that there is no cointegration. This procedure is repeated on all variables in the system (except for those assumed to be weakly exogenous). In this paper, only rainfall is assumed to be weakly exogenous. Thus, one estimates equation (2) four times, each time using one of the variables in the system as the dependent variable. A unique cointegrating vector exists if the null hypothesis is not rejected for all but one estimated equation.

The test statistic for the null hypothesis is the Wald statistic or the F-statistic. However, their asymptotic distribution, which depends on the dimension and cointegration rank of the forcing variables, is non-standard. Pesaran *et al.* 2001 consider two polar cases, (i) when all the variables are integrated of order zero and (ii) when all variables are integrated of order one. They generate two sets of critical values for the F-statistic, the lower bound corresponding to the case where all variables are $I(0)$and the upper bound corresponding to the case where all variables are $I(1)$. These provide critical value bounds for all possible classifications into $I(0)$, $I(1)$and mutually cointegrated processes. If the F-statistic is below the lower bound, it can be concluded that there is no cointegration, and if the F-statistic is above the upper bound, it can be concluded that there is cointegration. However, inference would be inconclusive when the F-statistic falls within these bounds. Thus, knowledge of the cointegration rank of the forcing variables is required to proceed further.

Narayan (2005) however argues that critical values generated by Pesaran *et al.* (2001) cannot be used in small samples since they are based on large samples. Narayan (2005) then compares the critical values generated from smaller samples of 30 to 80 observations using the same gauss code as Pesaran *et al.* (2001) and finds that Pesaran *et al.* (2001) critical values are generally smaller than critical values generated from a small sample. Hence Narayan (2005) argues against the use of these critical values in small samples, and provides critical values for 30 to 80 observations for use in small samples. The bounds test results for both communal and commercial sectors are shown in Table 3 below.

The cointegration test results show the existence of a unique cointegrating vector for the commercial sector at the 5% level of significance. This cointegrating vector is normalized on output. In comparison, the cointegration test results only show the existence of a unique cointegrating vector for the communal sector at the 10% level of significance. The unique cointegrating vector is also normalized on output. On this basis, the ARDL estimation on the communal sector is carried out and then compared to the results obtained from the ARDL estimation for the commercial sector.

5.3 Estimation of the ARDL of the communal and commercial sectors

The table below presents the results for the long-run ARDL estimation for the two sectors.

An ARDL estimation of the responsiveness of communal sector maize production to credit availability shows that communal farmers are not responsive to credit incentives. This is indicated by an insignificant long-run coefficient of loans in Table 4. In contrast, there is a significant long-run response by the commercial sector maize producers to credit incentives, although the response is inelastic.

There are two possible explanations for the lack of significance of the communal sector output response to credit availability. Firstly, communal production is characterised by a combination of low soil fertility and primitive production techniques which results in the credit constraint not binding. Secondly, when the liquidity constraint is binding, additional liquidity is shared between purchase of variable inputs and current consumption, implying that an elastic response of communal output to credit availability would only be observed if the output elasticity with respect to the variable input is highly elastic. The first explanation seems more plausible because productivity, measured

by yield per hectare, is very low for communal farmers. Moreover, the share of marketed variable inputs in maize production is low, hence liquidity constraints may not be binding. In the event that liquidity constraints are expected to bind, they may be eased by remittances from family members and relatives in urban areas.

In the long run, the only significant determinant of communal sector output is rainfall with an elasticity of 1.79. To enhance communal agriculture, without any institutional change, the emphasis should rather be on water provision i.e. investments in dam construction and supplementary irrigation.

As shown in Table 5, the error correction term is significant for both sectors. However, in both cases, it is negative and greater than one, indicating an oscillating adjustment to equilibrium. Table 6 shows the ARDL coefficients alongside the LM tests for serial correlation. The p-values for the LM statistic are 0.34 and 0.49 for the communal and commercial sectors respectively. Thus, the diagnostic statistics indicate no serial correlation for both sectors. The results are also free from the problem of heteroscedasticity.

In short, the results conclude that communal farmers do not respond to credit availability while commercial farmers do respond to credit availability. However, the commercial sector's response is inelastic. This result means that credit availability is an impotent device for enhancing agricultural output in Zimbabwe. The immediate implication is that the massive credit incentives, which are being considered by the government to stimulate agricultural production by the newly resettled farmers, are not likely to trigger an increase in maize production since most of the resettled farmers (i.e. A1 farmers and a majority of A2 farmers) typically operate like communal farmers.

Furthermore, for the communal sector, output is not responsive to area under cultivation hence *ceteris paribus* the land allocations under the A1 scheme are not likely to increase maize production by the communal sector.

However, the significant output response to area under cultivation and credit availability by the commercial sector implies that credit incentives may work for profit-maximising, newly resettled A2 farmers. The key factor for credit incentives to be effective thus lies in channelling credit to profit-maximising farmers. This requires careful screening of credit recipients and design of incentive-compatible financial support, otherwise extending credit to all farmers alike will not be effective.

The results show that there is a need for a careful review of the beneficiaries of the controversial fast-track land reform programme in Zimbabwe to ensure that only farmers who operate in a profit maximising framework will keep their land. In future stages of land reform, farmers who do not produce profit should be replaced with farmers who do, if Zimbabwe is to satisfy its food security and, possibly, reclaim its former position as the breadbasket of southern Africa.

6 Conclusion and policy implication

The major conclusion drawn from the above analysis is that unlike the commercial sector, communal sector maize production does not respond to credit incentives. Nevertheless, although significant, the response of the commercial sector is inelastic. Another major conclusion is that communal maize output is also non-responsive to area under cultivation. The results therefore imply that a huge increase in concessionary provision of credit that started in 2004, and is set to continue, is a futile exercise if all else remains equal, because it will have little or no impact on maize production. Indeed, maize production in particular, and agricultural output in general, has not risen in tandem with credit availability. Furthermore, giving communal farmers more land does not appear to increase maize production and consequently agricultural output at all. Thus commercialisation of the agricultural sector seems to be the first appropriate strategy to trigger increased maize production and consequently agricultural output response to credit availability. As things stand, rainfall is the single most important driver of communal agriculture and, without any institutional change, the emphasis should rather be on water provision i.e. investments in dam construction and sup-

plementary irrigation. In the future, there is a need for a careful review of the beneficiaries of the controversial fast-track land reform programme to ensure that only those farmers who operate in the profit-maximising framework will have their landownership confirmed, and unproductive farmers be replaced with more productive ones in the future stages of land reform if Zimbabwe is to enhance its food security and, possibly, reclaim its position as the breadbasket of southern Africa.

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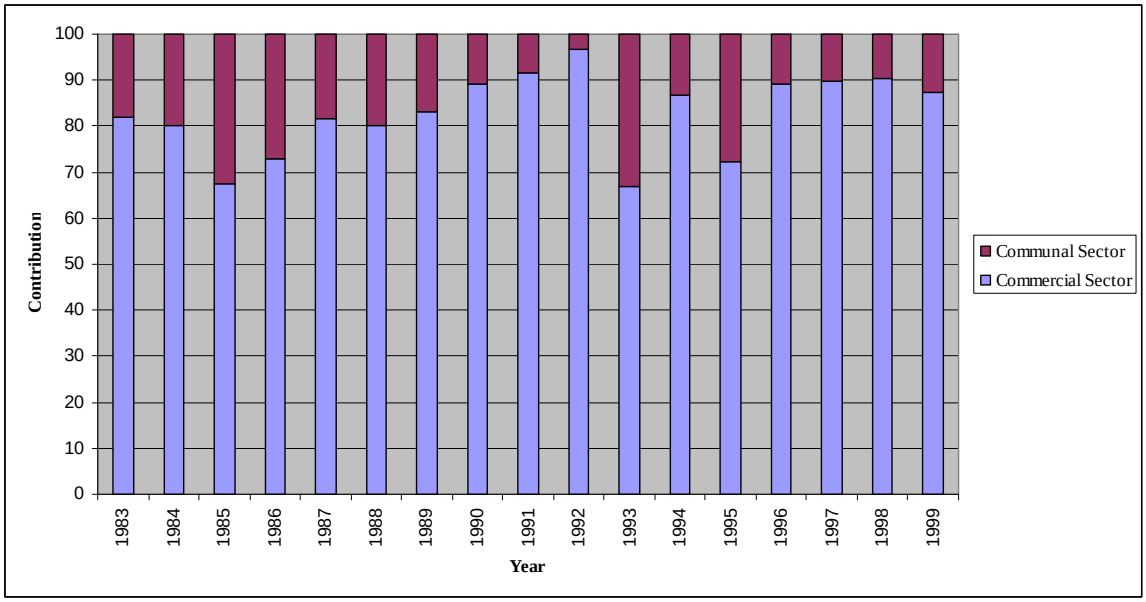
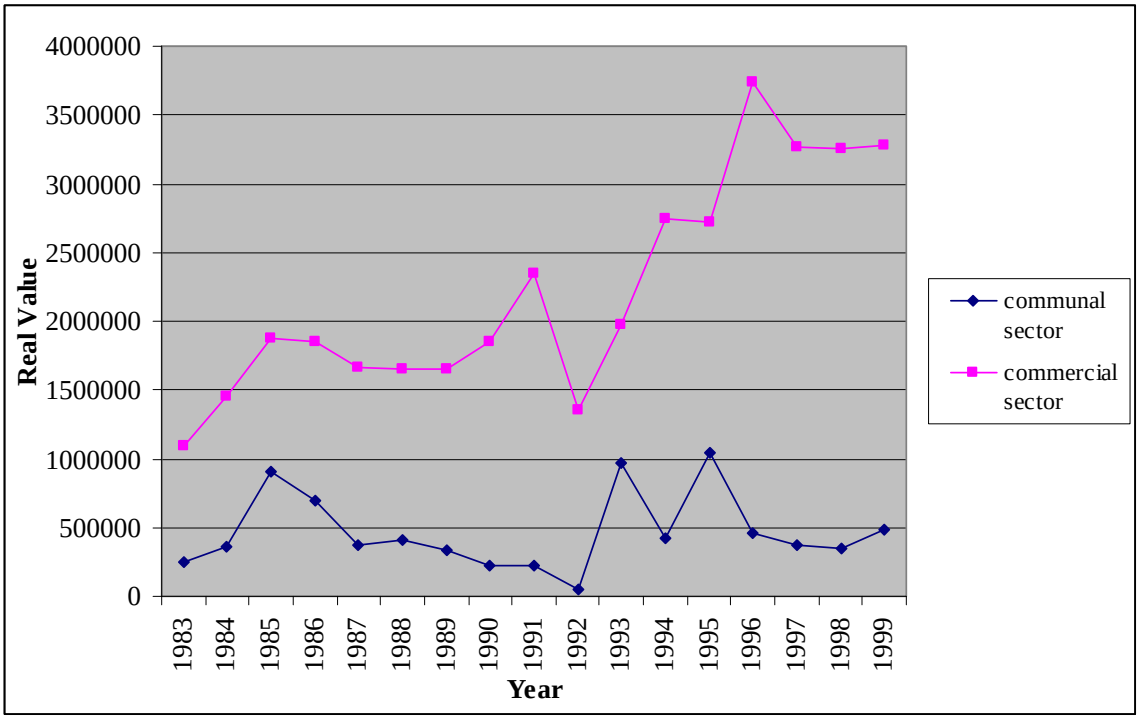
Figure 1: Communal and commercial sectors' share of aggregate crop production



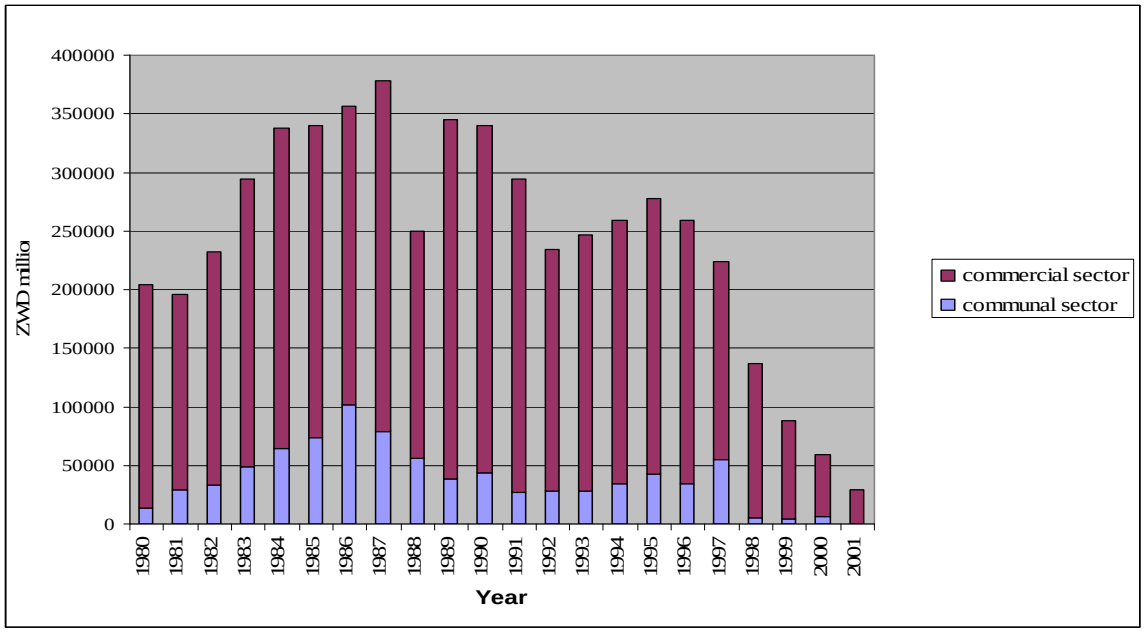
Source of data: The Agricultural Sector of Zimbabwe Statistical Bulletin 2001

Figure 2: Real value of gross output from communal and commercial farmers



Source of data: The Agricultural Sector of Zimbabwe Statistical Bulletin 2001 and Rukuni *et al.* (2006)

Figure 3: Short term credit to communal and commercial farmers



Source of data: The Agricultural Sector of Zimbabwe Statistical Bulletin 2001 and Rukuni *et al.* (2006)

Table 1: Unit root tests for the communal sector

Variable	Levels		First Difference	
	Test-Statistic	95% Critical Value	Test-Statistic	95% Critical Value
Output	-4.690814**	-3.012363		
Labour	4.332207	-3.644963	-5.188825**	-3.658446
Loans[a]	-1.801084 *-0.381113*	-3.710482 *-3.644963*	-0.521254 *-5.207534***	-1.961409 *-3.658446*
Area under cultivation	-2.794064	-3.012363	-5.890654**	-1.959071
Rainfall	-3.918067**	-3.012363		

** *Variable is stationary at 5% level of significance*

a. *The italicised numbers are from the Phillips-Peron Test*

Table 2: Unit root tests for the commercial sector

Variable	Levels		First Difference	
	Test-Statistic	95% Critical Value	Test-Statistic	95% Critical Value
Output	-6.217325**	-3.658446		
Labour	-4.262725**	-3.098896		
Loans*	1.437298	-3.658446	-4.870467**	-3.658446
Area under cultivation	-0.785343	-1.958088	-4.9232**	-1.959071
Rainfall	*See Communal Sector*			
** *Variable is Stationery at 5% level of significance*				

Table 3: Testing for a unique cointegrating vector – the Bounds test results

	Dependant Variable	*Output*	*Loans*	*Labour*	*Area under cultivation*
Communal Sector[a]	F-Statistic[c]	4.1257*	1.06550	0.29377	2.15260
Commercial Sector[b]	F-Statistic[d]	6.6008**	0.52869	1.23100	0.29036

***There is cointegration at 5% Level of Significance;* There is Cointegration at 10% Level of Significance*

a. *Specification includes intercept, no trend*
b. *Specification includes intercept and trend*
c. *The critical values for case of **unrestricted intercept and restricted trend for k=5** are Lower Bound I(0)– 3.504; Upper Bound I(1)– 4.743 using Narayan (2005) Critical Values at 5% LOS. The Pesaran-Shin-Smith Critical Values for **intercept and trend** are I(0) – 3.189; I(1) – 4.329 at 5% LOS; I(0) – 2.722; I(1) – 3.827 at 10% LOS*
d. *The critical values for case of **intercept and no trend for k=5** are I(0)– 3.504; I(1)– 4.743 using Narayan (2005) critical values at 5% LOS. The Pesaran-Shin-Smith Critical Values for **intercept and no trend** are I(0) – 2.649; I(1) – 3.805 at 5% LOS; I(0) – 2.262; I(1) – 3.367 at 10% LOS*

Table 4: Long-run estimates

Variable	**Communal Sector**		**Commercial Sector**	
	Coefficient	**Std Error**	**Coefficient**	**Std Error**
Loans	-0.35478	0.36070	0.31260**	0.10194
Labour	0.9121E-6	0.16319E-5	-1.4203***	0.36291
Area under cultivation	2.2906	1.6319	0.82191**	0.27042
Rainfall	1.7886***	0.51144	0.54859	0.38077
C	-33.6499	26.3448	14.3291	7.7551
Trend	-0.048148	0.29354		

****Significant at 1% level of significance (L.O.S); **Significant at 5% LOS; *Significant at 10% L.O.S*

Table 5: Error correction representation

	Communal Sector ARDL(1,1,1,1,1)		**Commercial Sector ARDL(2, 1, 1, 0, 2)**	
Variable	**Coefficient**	**Std Error**	**Coefficient**	**Std Error**
D(Output,1)			0.51827***	0.12649
D(loan)	-0.47904	0.26858	-0.41731***	0.19760
D(Labour)	0.1640E-4[a]	0.9916E-5	4.9972*	1.4253
D(Area)	2.9137*	1.3717	0.98287***	0.22230
D(Rainfall)	1.3600***	0.44668	-0.59637***	0.15861
D(Rainfall,1)			-0.62179**	0.23878
C	-41.8717	35.1740	17.1353	11.4577
dTrend	0.059912	3.36901		
ECM	-1.2443***	0.33788	-1.1958***	0.21158
Adjusted R^2	0.76298		0.881	
F –stat	12.3968[0.000]		21.5241[0.000]	
****Significant at 1% level of significance (L.O.S); **Significant at 5% LOS; *Significant at 10% L.O.S*				

Table 6: ARDL representation

	Communal Sector ARDL(1,1,1,1,1)		**Commercial Sector ARDL(2, 1, 1, 0, 2)**	
Variable	**Coefficient**	**Std Error**	**Coefficient**	**Std Error**
Output (-1)	-0.24433	0.33788	0.32243*	0.14862
Output (-2)			-0.51827**	0.12649
Loan	-0.47904	0.26258	-0.41731*	0.19760
Loan(-1)	0.037574	0.32760	0.79113**	0.2734
Labour	0.1640E-4[a]	0.9916E-5	4.9972***	1.4253
Labour(-1)			-6.69556***	1.2388
Area	2.9137*	1.3717	0.98287***	0.22230
Area(-1)	-0.063414	1.6833		
Rainfall	1.3600**	0.0446	-0.59637***	0.15861
Rainfall(-1)	0.86567	0.74440	0.63061**	0.17900
Rainfall(-2)			0.62179	0.23878
C	-41.8717	35.1740	17.1353	11.4577
Trend	-0.059912	0.36901		
Adjusted R^2	0.49082		0.84970	
LM Serial Correlation Test	0.88304[0.347]		0.47289[0.492]	
DW-statistic	1.7471		1.7454	
F –stat	2.9279[0.053]		11.7413[0.001]	
****Significant at 1% level of significance (L.O.S); **Significant at 5% LOS; *Significant at 10% L.O.S* *a. Communal Labour is in its levels not natural logs*				