THE IMPACT OF STRUCTURAL ADJUSTMENT ON FOOD PRODUCTION IN ZAMBIA

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Abstract
In the paper, we estimate a system of three output and one Input demand simultaneously. We find that Maize, sorghum and Millet are all responsive to both own and cross price elasticities.Simulation exercises indicate that the removal of exchange rate controls and price subsidies led to increases in grain production.

Introduction

For over two decades, the Zambian economy was dominated by government ownership. The government regulated commodity and food prices and food consumption was heavily subsidised. The mainstay of the economy was mining and revenue from the export, of copper was used not only in financing domestic expenditure but also to import food in years of shortages. The impact of the oil crises of the 1970s, falling copper prices and the resulting general economic deterioration turned the focus to agriculture as a possible source of growth, export revenue and increased food availability.

To recover from the economic problems that the country was experiencing, the government turned to borrowing both domestically and internationally. With no significant recovery in either copper revenues or agriculture, the balance of payments and fiscal deficits became enormous and ultimately the country started to get conditional loans, which was the birth of the Structural Adjustment Program (SAP) in Zambia, At the macro level, SAPs involved the freeing of the exchange rate, trade liberalisation, freeing interest rates, removal of subsidies and all forms of price controls, reducing government expenditure and reducing state participation in the economy.

The general objectives in the agricultural sector were the reduction of government intervention in the market, the promotion of agricultural or non-traditional exports and improvement of food production. In practice these have been implemented by the removal of price controls and subsidies on agricultural products, the abolishing of state agricultural companies and marketing boards. The changes in both the agricultural sector and the macro-economy as a whole have obviously had a significant effect on agricultural and food production.
Take the exchange rate for example. The dependence of Zambian maize production on imported fertilisers and other chemicals means that the liberalisation of the exchange rate will affect the cost of production for maize. Where agricultural produce is exported, this also affects the price farmers receive for their crop. Trade liberalisation will also affect the farmers due to changes m terms of trade between the tradable and non-tradable goods.

Liberalisation of the credit market has also had significant effects on the agricultural sector. Before the reforms, the agricultural sector was a major beneficiary of low interest loans. Removing controls on credit and its pricing has meant that farmers have to compete for credit with other potential borrowers in the country. Where farmers have no adequate collateral and are high risk (especially for small scale fanners), access to credit has reduced and this might have contributed to the fall hi agricultural output- It is clear that both macro economic and agricultural specific reforms have a potentially significant impact on agricultural output and food production in particular.

One of the main arguments in favour of market liberalisation in the agricultural sector is based on the benefits of market prices. It has been argued that controlled prices are in favour of the consumer and are a tax to the producer. The removal of these subsidies and controls would lead to higher output prices, which would in tum act as an incentive for increased production (GRZ, 1995). To this effect, liberalisation attempts were made in the early 1980s and fully embarked upon in 1991.

By 1992, the dismantling of the marketing boards was under way. Prices were liberalised, subsidies removed and all active government participation withdrawn. Despite this, grain production has been falling and food imports increased. By 1994, 33 percent of the population was said to be vulnerable to food insecurity Shawa aad Shuba (1994). By 1997, this figure had risen to 82 percent in some areas of the country CSO (1998). It is feared that with the drought in the 2000/2001 farming season, about 25 percent of the population are threatened with starvation. Without the copper revenues for importing food, the country is now at the mercy of foreign donors hence the controversy over genetically engineered maize.

Despite the Sack of improvement in food production, the export of non-traditional exports such as tlie export of newel's is increasing. Such exports are mainly from commercial farms. One possible reason for this shift into cash crops could be the trade reforms as discussed in the previous section. The dependence of maize production on fertilizer and other imported inputs could have proved its undoing. The nominal exchange rate has been increasing since the reforms, which would decrease maize production (which is mainly consumed locally) while increasing the export receipts from the sale of flowers.
The removal of exchange rate controls however can be a mixed blessing for food producers. While the higher exchange rates resulting from liberalising the exchange rate imply higher production costs due to imported inputs, it also means the removal of the implicit taxatioa of agriculture due to an overvalued exchange rate.For example, Jansen (1990) estimates that domestic maize prices were about 77% of border prices at the official exchange rate. If maize production is responsive to output prices as suggested by some studies, removing these controls imply significant gains in maize production.

The policy of 'pan-territorial' and 'pan-seasonal' pricing entailed same prices throughout the country and through the year.The margin set by the government between the buying and selling prices were small and often the gains were for deficit rather than surplus areas. This itself had a potential to stifle grain production hi the country. Liberalising the market therefore implied higher margins and possibly higher output. There are potential dangers to grain production however resulting from reforms. The liberalisation of markets done simultaneously with trade reforms had the possible impact of shifting farm activity into cash crops. This shift would mainly be amongst commercial farmers leaving food production to small-scale farmers whose access to the export, markets and possibly required technology is limited.

Liberalising the market also affects the transportation of both inputs to the production centres and output the the consumption centres. Most of the small scale fanners growing grains are in remote areas of the country that are not easily accessible and far from the urban areas which are the main consumption centres. If the state of the roads in these places is not good, their access to the market is even more constrained. Without proper or organised marketing arrangements hi rural areas as was the case before the reforms, output is likely to reduce not only because of limited access to output markets but input markets as well. Mwauaumo and Preckel (1997) simulate possible effects of liberalisation on maize marketing and find that there are likely to be positive welfare gains despite the increases in transport costs.

Economic reforms have now been in place for over a decade. The exchange rate has been floating since 1992 and food subsidies were abolished by 1995. However, food production has uot unproved much. In fact output has gone down over the years for some crops. The interest in the paper is to look at the effect of changes resulting from the implementation of policies under SAP on food production. We estimate price elasticities and use these to simulate effects of policy on the production of maize, sorghum and millet in Zambia.

A number of studies have shown the responsiveness of both small scale and large-scale farmers to prices in developing countries. A few studies that were accessible on Zambia show that supply response to output prices is aot very strong. Mwansa (1992) in a study of maize and cash crops found that crop supply responds to prices. The same conclusion was reached at by Hamusaukwa (1997) in a study on the responsiveness of maize and sorghum. An earlier study by Mwanza (1989) shows that although farmers are responsive to output prices, they are more responsive to non-price factors such as the performance of the uou-agricultural sector and prices of other crops. A study by Kraft (1990) found that maize supply was more responsive to fertilizer prices than to own prices.

Despite these studies, a substantial knowledge gap remains *in* the area of factors that affect grain output in Zambia. Firstly, all these studies have focused on maize. Although maize is still the most important staple for the country, it has become quite important to explore the possibility of diversification into more drought resistant and less input demanding crops. Secondly, except for the study by

Hamusaukwa (1997), all these studies have covered periods before structural adjustment was fully undertaken. Tlie study also differs in that we take account of the simulteiieous decision making process of the farmer where a household grows more than one of the grains in question).

The Empirical Model

We start by assuming that the farmers are optimising economic agents whose motive *is* profit maximisation. Let p be a vector of output prices, w a vector of input prices, x a vector of variable input and z a vector of fixed inputs. Let q be planned output so that we can write the farmer's problem as below (for strict profit maximisation), $maxpq — wx$

$$s.tf(xz) > q \qquad (1)$$

f(x, z) is the production function. The function is assumed to be continuous, strictly increasing and quasi-concave. Since the function is assumed to be strictly increasing, we can replace the inequality in the constraint with an equal sign and rewrite equation 1

$$pf(xz) — wx \qquad (2)$$

The solution to this maximisation problem is a set of input demand and output supply functions that can be written as

$$x = x(p, w, z)$$

$$q=q(p, w, z)$$

Substituting these functions into the profit function gives us the optimal profit function. Let p be the profit function. Then

$$\pi = pq(p, w, z) - wx(p, w, z) \qquad (3)$$

This profit function must be non-decreasing in output prices and non-increasing in input prices. It must be of homogenous degree one, convex in prices and continuous. Once we have our profit function, we can differentiate with respect to prices and by Retelling's lemma obtain the supply arid input, demand functions. Hence

$$\frac{\delta\pi}{\delta pi}(p,w,z) = qi \qquad (4)$$

The obtained supply function must be homogenous and the substitution matrix symmetric and positive semi-definite.

The specific form of the function to be used in the study is the translog. This form is a second order function in prices and fixed in factors and a good approximation to any arbitrary functional form. Because of its flexibility, the estimated parameters can be tested to see if they satisfy relevant restrictions imposed by theory.

If we take a second order Taylor approximation of the equation and differentiate with respect to prices, we obtain

$$\frac{\delta\pi}{\delta pi}Si = a_i + \sum b_{ij}\ln p_j + \sum b_{ik}\ln wk + \sum b_{im}\ln z_m \qquad (5)$$

Si is the profit share of crop i in total profit. The share equations are easier to estimate than the profit functions since they are less demaudiug in information. If information on some observations is missing, share equations can be estimated by dropping the corresponding equations. Moreover if we assume that the behaviour of the farmers is stable over the estimation period and we can aggregate over them, supply functions can exist independent of profit maximisation (De Janvry and Sadoulet (1995)}.

To ensure homogeneity

$$\sum a_i = 1$$

$$\sum b_k = 1$$

$$\sum b_m = 1$$

$$\sum b_{ij} = \sum b_{ik} = \sum b_{im} = \sum b_{kl} = \sum b_{mn} = \sum b_{mk} \qquad (6)$$

With the givea restrictions above, the obtained share function will be homogenous of degree zero in prices. We can impose this property by using one of the prices as a numeraire so that the last item in each row and column in the parameter matrix is dropped. The coefficients of the eliminated equations are identifiable from the restrictions. The estimation equation is a stochastic form of equation 5 for a panel data set. From the share equations, we will compute the elasticities of choice. To do this we will employ a method due to Weaver (1983).

$$\hat{\eta}_{ij} = \frac{\hat{b}_{ij}}{si} + \hat{s}j \qquad (7)$$

$$\hat{\eta}_{ii} = \frac{\hat{b}_{ii}}{si} + \hat{s}i - 1 \qquad (8)$$

Where the subscript ij represents cross elasticities and ii represent own elactities.

Data and Estimation

The data used in the study are from the national Post-Harvest Survey(PHS)in Zambia spanning the years 1996 to 1998. The original data are at household level but were aggregated to census Supervisory area level for the purpose of the study. The system estimated includes three crops-maize, sorghum and millet and three variable inputs-expenditure on hired labour, fertiliser and seed input.[3] A stochastic form of equation was used to obtain estimates of profit shares. As a number of households did not produce all three crops each year, several aero observations were observed. To correct for the resulting bias, we obtained an inverse of the mills ratio using the Heckinau procedure. To do this, a probit regression of sorghum, millet and fertiliser are estimated with a binary choice model as shown below

$$D = H\theta + u \qquad (9)$$

where D is an unobserved latent variable determining the Fanners' choice whether to grow any of these crops and/ or use fertiliser. H is a set of characteristics of the households hypothesised to affect their choice of crop to grow and u is the error term. D equals one when the CSA in question grows the crop and zero otherwise. The resulting 0 vector is used to compute the inverse mills ratio which is then used as the dependent variable in the respective equations in the model.

The equations are estimated using Zelluer's Seemingly Unrelated Regression (SUR). Data on seed use was unreliable and actual hired labour data could not be disaggregated to reflect the number of people hired. As a result, we drop these two equations and estimate only the three output equations and the fertiliser demand equation. The miliet equation is dropped because of linear dependency and its parameters are recovered using the restrictions shown in equation 6. We calculate the elasticities from the estimated parameters at mean values and these are shown in table 1. Homogeneity and symmetry were not imposed but tested for. Homogeneity was found to hold while symmetry holds for all except millet cross prices.

Table 1: Own and cross price elasticities

quantities	*prices*			
	maize	sorghum	millet	fertiliser
maize	0.011	1.069	0.406	1.138
sorghum	1.077	-0.313	1.142	0.467
millet	0.996	0.524	0.166	0.942
fertiliser	1.229	0.467	0.942	-1.460

All the own price coefficients are significant and correctly signed. The own price elasticities for all the crops are quite low indicating that these crops may not be grown for commercial purposes. These estimates are also lower than other estimates such as those of Katepa (1984) and Hamusankwa (1997) who find own price elasticity for maize at 0.21 and 0.22 respectively. This can be attributed to the fact that the estimation method used in the study takes simultaneous account of all the related changes taking place within the farrnhold. The two studies cited used single equation estimations. All the output cross price elasticities are positive reflecting complementary relationships. The lack of competition in the crops reflects the way in which these crops are grown. In mast districts; Sorghum and millet are grown for beer brewing in which both maize and the other two grains are used as complements. In areas where sorghum and millet are consumed as the staple food, maize is not generally grown and its importance hi these areas began with the introduction of maize subsidies in the late 1960's.

The own price elasticity of fertiliser is quite high at 1.46. This shows a high sensitivity of fertiliser demand to changes hi prices. The cross price elasticities with respect to output prices are positive. This is expected since higher crop prices indicate a good profit and fertiliser use tends to have a positive impact on output.

Impact of Reforms

Agricultural reforms implemented in Zambia over the past decade have led to significant changes in factors affecting grain production. Most, of these have been, price policies that have raised both input and output prices. Other significant changes include the liberalisation of the grain market which in turn has implications for the prices tliat farmers get for tlieir produce. In this section, we want to estimate possible impacts on the output of maize, sorghum and millet given identified policy changes.

Estimated Price Effects

We describe the effect of a policy as a percentage price change resulting from tlie policy change. In the discussion, we focus on the possible effects of the removal of exchange rate controls and price subsidies. Jansen (1990) estimates that the domestic price of maize was only 76% of the border price at the official excliange rate and 52% at the equilibrium exchange rate. Using these figures, we will assume that the effect of the overvalued exchange rate is a 24% a figure quite close to Fulginiti and Perrin (1990)'s estimate of the price wedge due to export taxes in Argentina. Mwanaumo (1999) states that maize subsidies in Zambia had reached 16% of the price of maize by the late 1980s while Deininger and Olinto (1999) have a higer estimate of 70%. We use the more conservative figure from Mwanaumo (1999) as our price wedge due to maize price subsidies. The removal of price subsidies on sorghum and millet was began in the early 1980's and so we assume a zero price wedge due to subsidies on these crops. We have not accessed clear estimates of the fertiliser subsidies and we assume the same percentage as that of maize.

To run the simulations, we use a linear model similar to that of Fulginiti and Perrin (1990) shown in equation,

$$\delta q = \theta \delta \ln p \qquad (10)$$

Where δq is the vector of quantities, θ is the matrix of elasticities and $\delta \ln p$ is the vector of price changes as surmised above.

Table 2: Own and cross price elasticities

Table 2: Own and cross price *elasticities*[a]

	%Exchange Rate	%subsidy	%effect of Rate	%effect of Subsidy	%total effect
maize	24	16	8.3	-18	-9.7
sorghum	24	0	31	7.4	38.4
millet	24	0	26.8	6.8	33.6
fertiliser	24	16	28.3	-3.7	24.6

[a] calculated using equation 10

From the simulations, freeing the exchange rate alone would lead to a meagre 8.3% rise in maize output. This reflects the effect of increases in prices of all the three crops and fertiliser prices. Subsidy removal reduces maize output by 18% giving a net, effect of a fall by 9.6%. Mainly the fall in output is due to the high responsiveness of maize output to fertiliser prices.

This may have contributed to the sluggish response hi maize production kt the last few years (CSO (2000), Mwanaunio (1999)).

The effect, on sorghum and millet, is much higer than that of maize with an effect of the exchange rate at 31 and 27 percent respectively. Subsidy removal lias a small impact of 7 % on both crops. The removal of exchange rate controls would increase fertiliser demand by 28% mainly due to increases ha output prices while the removal of subsidies reduces fertiliser demand by 4%. A fall has been observed in fertiliser use since the reforms (Mwanaumo (I999)and Deininger and OUnto (1999)).

It is also important to note that the linear model used for the simulations tends to over estimate the effect of price changes. However, although we cannot take the quantitative values at they are, we can defiuately say that without other constraints in production, price changes resulting from the removal of exchange rate controls and subsidies can lead to increases ingrain output.

Conclusion

This study looks at the impact of policy reform measures implemented under the Structural Adjustment Programm on the production of three food grains in Zambia. A system of three outputs and one input is estimated. Elasticities are estimated for own crass prices. These elasticities are then used to conduct simulations to look at the impact of the reforms. We find that with no significant non-price constraints, the removal of subsidies and exchange rate controls would lead to increases in food production.

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