THE EFFECTS OF AGRICULTURAL INPUT SUBSIDY PROGRAMSON MAIZE PRODUCTION IN MALAŴI USING INTERVENTION ANALYSIS

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Abstract

Maize dominates Malaŵi's agriculture and is the staple food for the majority of the population.It occupies 90 % of cultivated land and contributes 61.4 % of total calories in Malaŵian diet. However, most farmers fail to realize good maize harvests because of the high input cost. Malaŵi faced maize deficits in the 1990's and had to rely on food aid. This necessitated the resumption of agricultural input intervention programs from 1998 onwards. The programs were the Starter Pack (SP) program from 1998 to 2000; the Targeted Input Program (TIP) from 2001–2005; and the Agricultural Input Subsidy Program (AISP) from 2005 to date. This paper uses intervention analysis to analyze the success of these programs.From the results, it is clear that both starter pack and the agricultural input subsidy programs successfully improved maize production. However, targeted input program had no statistical impact on the production.

Key words: Staple food, ARIMA, Fertilizers, Hybrid, National Statistical Office, Green revolution.

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1 Introduction

Maize dominates Malaŵi's agriculture and is the staple food for the majority of the population.It occupies 90 % of cultivated land (McCann 2001) and contributes 61.4 % of total calories in Malaŵian diet (Ecker and Qaim 2011).However, most farmers fail to realize good maize harvests because of the high input cost. In light of the chronic food shortages in the 1990's, the Government of Malaŵi introduced three major input intervention programs: the Starter Pack (SP) program from 1998 to 2000; the Targeted Input Program (TIP) from 2001–2005; and the Agricultural Input Subsidy Program(AISP) from 2005 to date (Chinsinga 2011). These interventions were meant to ensure food security at both household and national level.

The SP program provided a tiny pack offree inputs containing roughly 0.1 ha-worth of fertilizer, maizeseed and legume seed. It provided universal coverage from 1998 to 2000. In the 2001, the SP program wasscaled down and efforts were made to target the inputs tothe poorest smallholders. To reflect this change, it becameknown as the Targeted Inputs Program (TIP). This program lasted in 2005. Thereafter, the AISP program was launched where the beneficiary households were entitled to two 50 kg bags of maize fertilizer at 8% of the prevailing market price, and 2 kg of hybrid maize seed (or 4 kg of open pollinated maize) for free. Some households also received coupons entitling them to 50 kg of tobacco fertilizer, again at a subsidized price.

A lot of studies have been done to evaluate the impacts of subsidizing inputs on overall maize production in Malaŵi. None of these have used intervention analysis where the actual maize yield is compared to the forecasted yield. The basis of intervention analysis is that interventions change the mean function or trend of a time series.A natural way to consider the possible effect of such a change is to compare, with actuality, forecasts made from a stochastic model which was appropriate before the change (Box and Tiao 1976). The ARIMA models, used in this paper, are attractive from the standpoint of data requirements in that only one series of data is required (Myer and Yanagida 1984). This paper shows how interventions into maize production in Malaŵi through agricultural input subsidies could be studied by comparing forecasts of maize yield made from a model built from data before the intervention with actual maize production.

2 Methodology

The yearly data on maize production in Malaŵi from 1983 to 2009 from the Malawi National Statistical Office were used in this article.An ARIMA(p, d, q) time series model was developed that could estimate time series trend in maize production before a subsidy program was implement. The model considered the last p-known values of the series as well as $q$values of the past modeling errors after d numbers of differencing. The basic model is described below:

$$X_t = \sum_{i=1}^{p} \phi_i X_{t-i} + \sum_{j=1}^{q} \theta_j w_{t-j} + w_t$$

whereX_t is the original data series or differenced of degree d of the original data at time t;w_t is the white noise at time t;ϕ_i are the autoregressive (AR) parameters;p is the autoregressive order;$\theta_i$are the moving average (MA) parameters; and q is the moving average order.

Differencing of the tie series was used to solve the problem of non-stationary mean. Model coefficients ($\phi$and θ) were estimated by the maximum likelihood method. Verification of the model was performed through diagnostic check of residuals (plot of standardized residuals, plot of autocorrelation function of residuals and plot of p-values for Ljung-Box statistic). The number of AR and MA parameters to include in the time series model were estimated through simultaneous inspection of the autocorrelation function (ACF) and the partial autocorrelation function (PACF). The Akaike Information Criterion (AIC) was used in identifying the optimal ARIMA model. The optimal ARIMA model was then used to forecast maize production during the period of the subsidy program. These forecasts were then compared with actual production levels to determine if the intervention resulted in significantly high maize output or not. All analyses were performed using R statistical software (R Development Core Team, 2006).

3 Results and discussion

3.1 The Starter Pack Program

The ARIMA model that best described the maize production between 1983 to 1997 was an ARIMA(1, 1, 1). Since the Starter Pack program was implemented from 1998 to 2000, the above ARIMA model was used to forecast maize production between these years. The observed and forecasted maize productions are shown in Table 1 below:

Table 1.Actual and forecasted maize production from 1998 to 2000 during the Starter Park program.

		Forecasted maize production (kg)	
Year	Actual production (kg)	Production (kg)	95 % confidence interval
1998	1534326	1483366	(1229969.8, 1736762.2)
1999	2245824	1328351	(1038552.1, 1618149.9)
2000	2290018	1430554	(1122362.3, 1738745.7)

The actual maize production in 1998 of 1534326 kg was not significantly different from the forecasted production of 1483366 kg. This was because the actual maize production was within the 95 % confidence interval of the forecasted production (1229969.8, 1736762.2 kg). However, for the years 1999 and 2000, the actual maize production was significantly higher than the forecasted production because the actual yield is outside the upper limit of the 95 % confidence level of the forecasted production. This program was a success because it resulted in an increase in maize production. This could be attributed to its universal coverage.

3.2 The Targeted Input Program

The ARIMA model that best described the maize production between 1983 to 2000 was an ARIMA(0, 1,1).The Targeted Input program was implemented from 2001 to 2004 and the ARIMA (0, 1, 1) model was used to forecast maize production between these years. The observed and forecasted maize productions are shown in Table 2 below:

Table 2.Actual and forecasted maize production from 2001 to 2004 during the Targeted Input Program.

Year	Actual production (kg)	Forecasted maize production (kg): Production (kg)	Forecasted maize production (kg): 95 % confidence interval
2001	1589437	1784077	(1390667, 2177487)
2002	1485272	1817416	(1424006, 2210826)
2003	1847476	1850756	(1457346, 2244166)
2004	1608349	1884095	(1490685, 2277505)

During the Targeted Input program, the actual maize production did not differ significantly from the forecasted yield. This is because the actual production was within the 95 % confidence intervals of the forecasted production. This is because few farmers benefited from the program.

3.3 The Agricultural Input Subsidy Program

The ARIMA model that best described the maize production between 1983 to 2004 was an ARIMA(0, 1, 1). Since the Agricultural Input Subsidy program was implemented from 2005 todate, the above ARIMA model was used to forecast maize production between 2005 and 2009. The observed and forecasted maize productions are shown in Table 3 below:

Table 3.Actual and forecasted maize production from 2005 to 2009 during the Agricultural Input Subsidy Program.

Year	Actual production (kg)	Forecasted maize production (kg): Production (kg)	Forecasted maize production (kg): 95 % confidence interval
2005	1225234	1787082	(1425339, 2148825)
2006	2611486	1812271	(1450528, 2174014)
2007	3226418	1837460	(1475717, 2199203)
2008	2634701	1862650	(1500907, 2224393)
2009	3582502	1887839	(1526096, 2249582)

3.4 Malaŵi's green revolution

Malaŵi'snational food requirement is about 2.1 million tons (Sanchez et al. 2009). Under the starter park program, the country harvested more than 2.1 million tons of maize in 1999 and 2000. There was a deficit during 2001 to 2005 during the Targeted input program. From 2006, the country started registering food surplus again under the agricultural input subsidy program. The agricultural input subsidy program has turned the country into a food exporter and donor. Malaŵi has been exporting maize to countries like Zimbabwe and selling maize to world bodies like the World Food Program. It has also donated maize to Lesotho and Swaziland.Although donors initially opposed the subsidy programs, they are now providing money for logistical support to the implementation of the subsidy program. The economy of Malaŵi is growing about 6 % annually and the government is increasing its budget to the agricultural sector. Economically, it makes sense to support the input subsidy program instead of relying on food aid during maize deficit years. There is a need to carry an economic and financial evaluation of the starter pack program and the agricultural input subsidy program to determine the one that is financial and economically feasible. However, Malaŵi's agricultural input subsidy program remains a textbook example of an Africa green revolution.

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