

The Impact of Labour Market Liberalization on Maize Productivity and Rural Poverty in Malawi¹

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This paper quantifies the effects of labour market liberalization on employment, maize production and productivity in Malawi. Applying a frontier production function and Divisia Index, we find that total factor productivity declined at 1.2% per annum from 1985 to 2000. Prior to market liberalization (1985 – 1995), productivity increased at an average annual growth rate of 2.0%. However, there was a sharp decline in maize productivity after 1995, implying that market liberalization had a significant impact on maize production efficiency. Coupled with recent droughts experiences, the sharp maize productivity decline could be attributed to sharp decline in the input use, that is, labor (-6.7%), fertilizer (-1.5%) and land (-3.5%). Maize productivity constantly declined from 1995 onwards, and decreased by 2.8% per annum in the post-liberalization era. The largest contributing factor to the maize productivity decline is the decrease in farm labour input share, which is largely affected by shift in policy reform imposed. Market liberalization including labour market reform had directly or indirectly shifted allocation of labour from own farm to other farms or non-farm activities, including critical times of farming activities that resulted in lower technical efficiency and maize productivity in Malawi. Consequently, market liberalization reforms via their influence on the price level and inflation have led to a persistent decline in real wages by 65.3% between the pre- and post-market liberalization periods. This directly implies the weakening of the purchasing power of resource poor farmers who become continuously more food insecure, and this aggravates the poverty level especially in rural areas of Malawi

I. INTRODUCTION

The agricultural labour market in Malawi supports the livelihoods of nearly 90% of the rural population. Most of the population work as full-time farmers on their own land, others are involved in casual agricultural labour and on tenancy arrangements with landlords. Agriculture absorbs 88% of the national labour force leaving only 12% for non-agricultural sectors (Government of Malawi 2000; Mkandawire 2000; Zgovu, 2000). There is overwhelming evidence that due to the chronic food insecurity, most farmers are involved in casual labor (called *ganyu* in the local language), especially during the peak agricultural season (Whiteside and Carr, 1997). Firstly, the fact that people work off their own farms and thus cannot spend the time on their own fields means that most

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agricultural husbandry practices such as early cultivation, weeding and bunding are either performed late or not performed at all. Secondly, since most of the wage income is used for subsistence, as a bridging or coping mechanism, it is highly unlikely that these farmers can also apply adequate quantities of costly inputs in their farming activities in order to compensate for the decline in labour intensity. This results in a spiral of declining agricultural productivity and real wages within the agricultural labour market. With declining real wages, it is unlikely that wage earners can invest in more intensive agricultural production.

In the 1970s and 1980s, agricultural sustainability was not a pressing policy issue because in most regions, especially the north and central regions of Malawi, there was still room for expansion of agricultural areas. Farmers relied on a system of shifting cultivation by opening new farmland leaving the previous farms to regenerate. However, from late 1980s, due to the increasing population density, it is no longer possible for farmers to expand their farms. In most parts of the central and densely populated southern region, this has led to unsustainable intensification due to the ever-declining per capita land holding sizes. Conditions have further been exacerbated by the tremendous increase in the relative prices of inputs following the liberalization of the agricultural input and output market and the removal of input subsidies (Ng'ong'ola, 1996; Masters and Fisher, 1999). In addition, there is also a host of other factors such as weather conditions, access to credit, poor market infrastructure and poor cultivation practices that constrain smallholder productivity.

Given the vicious cycle of low farm incomes and low productivity (or low yield) farming practices, it is obvious that one of the lasting solutions to alleviate rural poverty includes addressing issues of agricultural productivity and sustainability. Given that most people are employed in the agricultural sector, there is need to understand how the dynamics in the rural labour market affect rural poverty, agricultural productivity, as well as, economic, ecological and social sustainability of the agricultural sector. There is no easy way of establishing causation since poor agricultural performance can be the root cause of the core problems in the agricultural labour market. Simultaneously, problems in the agricultural labour market have repercussions in terms of agricultural performance.

Therefore, the specific objectives of this study were [1] to develop clear and measurable indicators of agricultural labour market performance, as well as establishing a conceptual link between agricultural labor market dynamics and lasting land and labour productivity, and [2] to assess the extent to which the agricultural labour market exhibits elements of failure and point to the major reasons to which such failure could be attributed.

The rest of the paper is arranged as follows: section II presents the data and analytical techniques. Section III presents an overview of agricultural production and productivity in Malawi, with emphasis on maize in the smallholder sub-sector. Section IV reviews the theory related to productivity analysis followed by Section V which presents an analytical framework for analyzing agricultural productivity and technical efficiency based on the Cobb-Douglas and Frontier production functions. Section VI discusses the results. Sections VII and VIII, respectively, present the conclusions and policy implications from the study findings.

II. DATA AND ANALYTICAL TECHNIQUES

This paper developed analytical frameworks and applied various interrelated theoretical models (Cobb-Douglas and Frontier Production Function and Divisia Index) that could point to causal relationships among various factors including labour market performance, agricultural (maize) production and productivity in Malawi. These were based on literature reviews of the past and the present economic and market liberalization periods, as well as, analysis of compiled country level secondary data from the Ministry of Agriculture, National Statistics Office, Agricultural Inputs Markets Development, Ministry of Labour and Vocational Training and National Economic Council (1985-2001) on maize production, productivity and associated factors in Malawi.

III. AGRICULTURAL PRODUCTION AND PRODUCTIVITY

Agriculture continues to be the dominant sector in the Malawi economy as the smallholder sub-sector produces over 80 percent of the country's food products. The economy is heavily dependent on maize as a subsistence food crop and tobacco as a major source of foreign currency earnings. Maize occupies between 60 and 70 percent of the total cultivated land area and 80 to 90 percent of the area devoted to food crops. There is only one agricultural season, which usually extends from November/December to April/May. Most agricultural production is rain-fed and irrigation is still very limited. The country is particularly vulnerable to drought conditions as experienced in 1991/92, 1993/94, 1994/95 and 2000/01 (Ministry of Agriculture, 2001). In this section, we analyze trends of output, land, labor and total factor productivities in the Malawi smallholder sector, focusing mainly on maize (staple food), for several years. This provides important information on policy reforms, such as on how labor market liberalization and technological change (hybrid maize usage) have affected agricultural reform, income generation and rural poverty level.

Maize Production Trend

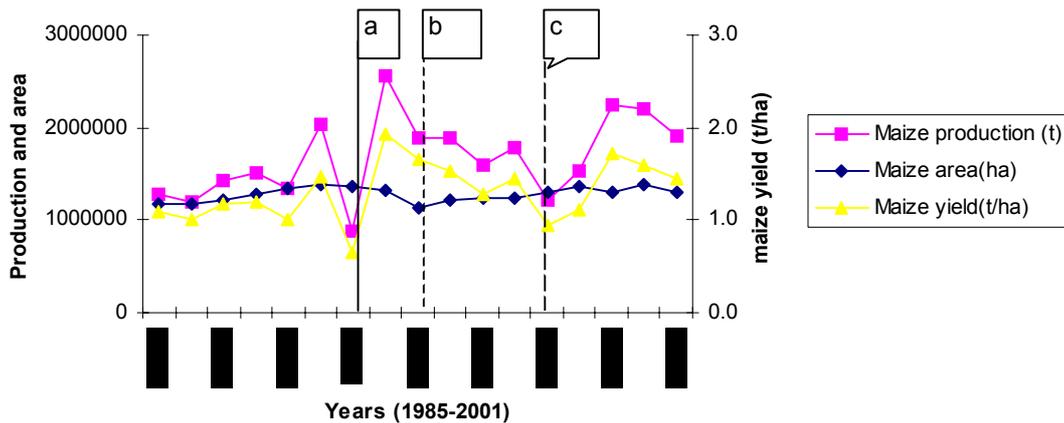
Maize production in Malawi was fluctuating in the last two decades due to mainly draughts and government policies such as labor market liberalization, the removal of fertilizer subsidies, starter pack initiatives and control over the producer price despite a decline in hectarage. The Malawi government and the international donor community have implemented *the starter pack programme* from 1998/99 to 2000/01 farming seasons. This involved free distribution of suitable cereal and legume seeds among farm households in the country according to agro-economic zones. The seed packages were complemented by fertilizer calculated to provide a reasonable yield on a plot size of 0.1 ha. For example, a total of 2897920 starter packs were distributed in the 1999/2000 growing season.

In addition, the Agricultural Productivity Investment Programme (APIP) continues to be implemented with the support from the European Union. The objective of the programme is to increase farm productivity among resource-poor farmers by

providing hybrid maize (seed technology) and fertilizer through credit guarantees that enable private traders to buy fertilizer and seed to be distributed to farmers.

Figure 1 summarizes maize production, area and yield from 1985/86 to 2001/02 growing seasons including all maize types (local, commercial hybrid and composite varieties).

Figure 1: Maize production (t), maize area (ha) and maize yield (t/ha), 1985-2001



Source: National Economic Council and Ministry of Agriculture & Irrigation (Famine Early Warning Systems (FEWS), Malawi).

Note: a. 1991/92 was a drought year
 b. 1994/95 was the start of the post reform period
 c. 1997/98 was also a drought year

For the 1999/2000 growing season it is no surprise that land productivity was 1.6% because of starter pack initiative (free hybrid maize and fertilizer), while labor productivity was 1.4%. According to NSO (2002), the mean national maize yield over 1995/96 to 1999/2000 period was 1375 kg per hectare; however, small-scale agricultural production growth rate had declined from 5.1 percent (1990) to 4.5 percent (2003) in the post-liberalization period.

Labor, Land Productivity and Induced Technological Change

Malawi has one of the highest Nitrogen-Maize price ratios in the world, a fact that has inhibited the adoption of fertilizer and hybrid maize (seed technology). In turn, this has led to low productivity of land and labor, and declining soil fertility throughout the country. This section will examine and discuss in depth the issues surrounding labor, land productivity and seed technology changes.

Productivity is the ratio of output to input. The earliest approach to productivity measurement was based on the ratio between aggregate output and a single input, which results in a partial productivity measurement such as land or labor productivity. Different

development paths in different countries or regions within a country could be studied using partial productivities. Hayami and Ruttan (1985) in their pioneering study of the induced innovation concept used partial productivity changes over time in different countries to test their theory. In economic development, labor is typically the most significant input for traditional agriculture. In land-constrained countries, such as Malawi, agricultural production is mainly constrained by the quantity and quality of land input. The ranges of possibilities for land utilization and agricultural production therefore are delineated by the major geo-environmental parameters of topology, climate, and soils. Within this range, the actual patterns of land use are determined by a number of factors, such as the demand for agricultural products, available technologies (mainly seed technology and fertilizer use), and the land/labor ratio. Although it is possible to increase production through increased labor input, the effect on production is normally low. Use of off-farm inputs, such as fertilizers, pesticides and other chemicals typically provide greater potential for increased production and productivity, as observed during the starter pack initiative in 1999/2000 (see Figure 1).

Table 1 reports the changes in both land and labor productivity for Malawi's maize production over pre- and post-liberalization periods, 1985-2000. Land productivity is calculated as kilograms of maize per hectare of land devoted to maize production. Labor productivity is calculated as kilograms of maize per person-year.

TABLE 1
AVERAGE LABOR AND LAND PRODUCTIVITY ESTIMATES IN MALAWI'S
MAIZE SECTOR

Years	Labor price (real wage) MK/person-day	Labor requirements Days/year/ha	Labor productivity kg/person-year	Land productivity kg/ha
Pre- liberalization 1985 – 1994	13.8	97.3	1112.9	1383.15
Post- liberalization 1995 – 2000	4.8	84.1	1065.1	1342.6
Annual Growth Rate (%)				
1985 – 1994	2.6	0.9	1.2	1.0
1995 – 2000	-1.3	-2.7	-0.9	-0.6

Sources: Calculations are based on production and area data (NSSA 1994) and production and crop budgets (various issues) from the Ministry of Agriculture and NSO, respectively.

Though, maize production was marginal higher between 1999-2002 (Figure 1) than the previous years because of starter pack initiative and favorable rainfall, the over all land and labor productivity in the post-liberalization period (1994 – 2000) declined by 0.6% per annum. Labor productivity declined by 0.9 % per annum, and similarly labor requirements for maize cultivation declining by 2.7% per annum.

Based on crop budget estimates from the Ministry of Agriculture (1998/2000), the average labor requirements for maize production including days required to apply fertilizers is on average 110 days per year per hectare. However, labour requirements

further declined further from 97.3 days/ha/year during the pre-liberalization era to 84.1 days/ha/year in the post-liberalization era. This result may suggest that more smallholder farmers were engaged in off-farm work mainly during the early planting and weeding stages of their farming activities. The combined effect of sub-optimal labor inputs and the removal of fertilizer subsidies, which had put several smallholder farmers in disarray.

Furthermore, due to lack of well-established labor market in the rural areas, small-scale farmers tend to sell their labor for better off farmers, thereby delaying work on their farms. Their involvement in casual labor (*ganyu*) to earn a living (or as a survival or coping mechanism) resulted in reducing labor productivity over the post-liberalization period. In fact, the results demonstrate the continuing loss of productivity over years as the Ministry of Agriculture (1992/93-95/96) reported that 1 to 2 weeks delay in planting maize, let alone not weeding in time, might reduce yield by as much as 25%.

IV THEORETICAL OVERVIEW

Theoretically, Hicks' theory of induced innovation implies that a rise in the price of one factor relative to the other factor prices induces technological changes that reduce the use of the factor that becomes relatively more expensive (Hicks, 1932). As a result, technological advances that facilitate the substitution of relatively abundant factors for relatively scarce factors counter the constraints imposed by resource scarcity on economic growth. In the case of most agriculture systems, technology has been developed to facilitate the substitution of relatively abundant (hence cheap) factors for relatively scarce (hence expensive) factors of production. The constraints imposed on agricultural development by an inelastic supply of land have been offset by the development of high yielding crop varieties designed to facilitate the substitution of fertilizer for land. Advances in output per unit of land area have been closely associated with advances in biological technology, but this reality has not been manifested itself in Malawi's smallholder agriculture due to high prices of seeds (such as hybrid maize) and fertilizer use (Masters and Fisher, 1999).

For a land-scarce and labor-abundant country like Malawi, efficient resource utilization would have meant that more land-saving and labor-using technology should have been developed and adopted. Such technological adaptations would absorb the abundant unskilled labor thereby improving the output per labor input (Table 2). In market economies, distortions in factor as well as product markets can result in pattern of relative factor prices that in the short, intermediate, and (in some instances) even longer run bear little resemblance to underlying endowments. With relatively scarce resource endowments, and continuous cultivation of marginal land, causing inefficient use of land resources and the "wrong" direction of the seed technology (hybrid maize and composite varieties) change path. With the already inefficient labor in the rural areas, the government's distortions of the labor markets, causing rural wages to be less than urban areas, would draw rural people to the cities.

Furthermore, the land/labor ratio would artificially be high, causing less agricultural production, and in turn eroding the poverty level further. In effect, there is virtually no change in reducing the poverty level, as there would be no improvements in the labor type and usage in this agrarian economy. The above discussion basically

introduces the reader to the following conceptual framework linking various agricultural socio-economic factors to poverty in Malawi.

V. ANALYTICAL FRAMEWORK: AGRICULTURAL PRODUCTION PRODUCTIVITY AND TECHNICAL EFFICIENCY

Cobb-Douglas Production Function

The Cobb-Douglas (C-D) function was used to fit the stochastic production frontier for maize production using maximum likelihood procedures. The Cobb-Douglas was used, despite its well-known limitations, because the methodology employed requires that the selected production function be self-dual. The Cobb-Douglas functional form has been the most widely used in production analysis, directly gives elasticities and permits calculation of the return to scale. It is generally flexible and allows for analysis of interactions among variables (Bravo-Uteta and Evenson, 1994; Bravo-Ureta and Reiger, 1991).

The general form of the C-D production function is given as:

$$Y = f(X^{\beta_j})e^{\varepsilon} \quad j = 1, 2, 3, \dots, k \quad [1]$$

Where Y is a farm's output level of a particular crop, X_j is a vector of variable production inputs, β_j are parameters to be estimated and ε is a composed error term, assumed to be randomly distributed with mean of zero and constant standard deviation $((0, \sigma^2))$. The C-D function is linear in logarithmic transformation and in our case can be expressed as:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \dots + \beta_5 \ln X_5 + \varepsilon \quad [2]$$

Where Y is annual total farm output (maize) in kilograms; X_1 is labour in persons-day; X_2 is land in hectares; X_3 is total fertilizer applied in kilograms, X_4 is seed variety (0=local and 1=hybrid maize) and X_5 is policy reform (0=pre-liberalization and 1=post-liberalization).

Frontier Production Function

Production possibility frontiers are estimated through two distinct approaches. Data Envelopment Analysis (DEA) is a non-parametric method and its main weakness is the inability to allow for stochastic shocks to the frontier. It is arguable that this characteristic of DEA renders it an unsuitable instrument of investigating production frontiers in noisy environments such as agriculture. Stochastic Frontier Analysis (SFA), in contrast, is designed to incorporate stochastic disturbances and shocks (such as market reforms,

weather conditions, etc.), but requires strong parametric specifications in its implementation (Roy, 2002).

Stochastic Frontier Analysis was developed by Aigner et al. (1977) and is based on an econometric specification of a production frontier. The production frontier is given by

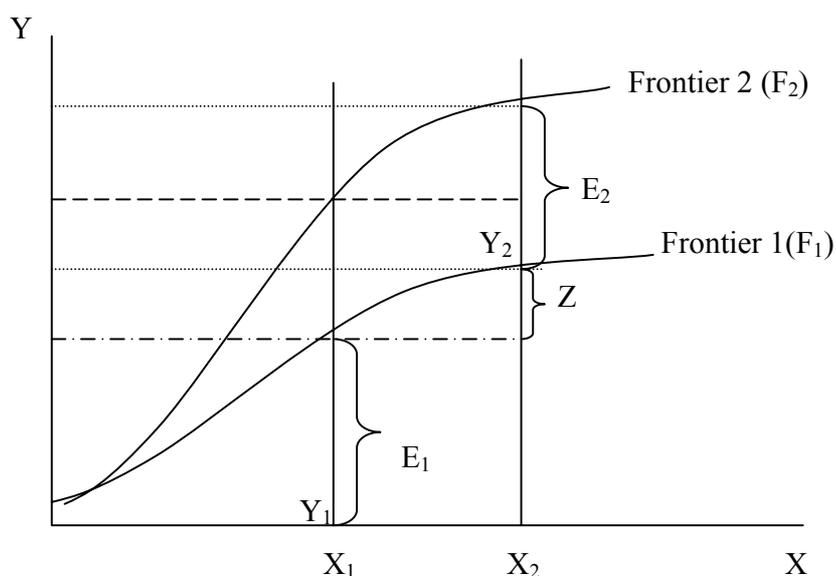
$$Y = g(X_a; \beta) \quad [3]$$

Where Y is per hectare output measured in kilograms, X_a is a vector of variable inputs and β is a vector of respective input parameters to be estimated. Following Nishimizu and Page (1982) and Fan (1991), in this study we define technological change (local maize to hybrid maize) as a shift of the frontier production function. Efficiency improvement is defined as the reduction in the distance between the farms' actual output to their potential output, given the same level of inputs. The different sources of production growth are illustrated in Figure 2. At times 1 and 2, the farmers face technology frontiers 1 and 2, respectively. If production were perfectly efficient, output would be F_1 at time 1 and F_2 at time 2. However, farmers' actual output is Y_1 at time 1 and Y_2 at time 2 due to production inefficiency. Technological change is measured by the distance between frontier 1 and frontier 2, that is, $F_2 - F_1$. Inefficiency is measured as the distance between the frontier and the actual output by the farmers. Hence, improvement of efficiency over time is the difference between E_1 and E_2 . The contribution of input change is measured as Z .

Therefore, total production growth can be decomposed into three components: input growth, technological change, and efficiency improvement.

$$Y_2 - Y_1 = Z + (F_2 - F_1) + (E_1 - E_2)$$

FIGURE 2
EFFECTS ON PRODUCTION GROWTH OF INPUT, TECHNOLOGICAL
CHANGE AND EFFICIENCY



Source: Nishimizu and Page 1982

Before the market reforms, government controlled the price of maize through the pan-territorial pricing implemented through the parastatal crop marketing board, ADMARC. Government also provided fertilizer subsidies and restrained wage changes. Although this implied a distortion of both input and output markets (and inefficient resource allocation), the policy resulted in stabilizing the production of maize. When the reforms were abolished, fertilizer subsidies were removed and agricultural output prices were deregulated although maize prices were still being partially controlled through the price-band system. Hence farmers diversified their farm outputs (groundnut, beans, pigeonpea, etc.), and labour was used to produce different farm produce. Furthermore, due to changes in real wages and other economic hardship, farmers opted to sell their labour as *ganyu* to support themselves. Therefore, technical efficiency (TE) changed since market liberalization, and in this study TE is used to capture the effect of such policy reform on maize production growth.

The approach of this study is to express maize output, Y , as a function of conventional inputs including labour (X_1), land (X_2) and fertilizer (X_3). A time trend, T , is included to capture the effects of seed technology and policy reform (pre- and post-liberalization) on maize production over time. Annual observations for the years 1985 through 2000 are denoted by $t = 1, 2, 3, \dots, 16$. The specified model is:

$$\ln Y_{it} = \alpha_0 + \sum \alpha_j \ln X_{ijt} + \alpha_4 T + \varepsilon_{it} \quad [4]$$

The disturbance term, $\varepsilon_{it} = u_{it} + v_{it}$, is assumed to be consistent with the frontier production function concept. We assume v_{it} to be normally distributed to reflect the random factors such as weather (droughts in 1987, 1992 and 2000/01), and use a one-sided disturbance u_{it} to represent the technical inefficiency component in maize production. We further assume for $t_i \neq t_j$, $E(u_{it}u_{jt}) = 0$ for all $i \neq j$. In this case, none of the farms' inefficiency or efficiency is maintained over time. It is also assumed that u_{it} and v_{it} are independent of each other.

Based on the conditional distribution of u_{it} , given the distribution of ε_{it} , the technical efficiency for maize farmers at time t can be measured as (for details cf. Jondrow et al., 1982).

$$TE_{it} = E \left\{ \exp\left(\frac{u_{it}}{\varepsilon_{it}}\right) \right\} = \exp\left(\frac{\sigma_u \sigma_v}{\sigma [f(\cdot)/(1-F(\cdot)) - (\varepsilon_{it} \lambda / \sigma)]} \right) \quad [5]$$

Where $\lambda = \frac{\sigma_u}{\sigma_v}$ and $\sigma^2 = \sigma_u^2 + \sigma_v^2$, $f(\cdot)$ and $F(\cdot)$ are the standard normal density

function and the standard normal distribution function, respectively evaluated at $\frac{\varepsilon_{it}}{\lambda \sigma}$.

To account for the separate contribution of each input, policy reforms (labor market liberalization or not) and technological changes (hybrid maize varieties) to the production growth of maize, the first derivatives of [4] with respect to t was taken so that the rate of growth in total production can be expressed as:

$$\frac{\partial \ln Y_t}{\partial t} = \sum \alpha_j \frac{\partial \ln X_{jt}}{\partial t} + \alpha_4 \frac{\partial T}{\partial t} + \frac{\partial u_{it}}{\partial t} + \frac{\partial v_{it}}{\partial t} \quad [6]$$

The first term on the right-hand side in [6] measures the effect of increased/decreased use of inputs on production growth. It is the sum of growth rates in inputs weighted by the relevant production elasticities. The impact of technological change (maize seed variety) on production growth is captured as the sum of the second and fourth terms. Therefore, technological change measures the effects of using hybrid maize, time trend and any unmeasured or omitted variables on production growth (Solow, 1957). The third term captures the impact of policy reforms (labor market liberalization, pricing policy, etc.) on maize production, which is the contribution of efficiency improvement to production growth due to policy reforms.

Dividing each of the terms in equation [6] by $\left(\frac{\partial \ln Y_t}{\partial t}\right)$ and setting the left-hand side equal to 100 we can then interpret each of the right-hand side terms as measuring the percentage contribution of each factor to production growth. The model can similarly be adopted to study the smallholder tobacco sector in Malawi, however, we analyzed effects

of the factors considered above on only maize production, which in turn provides some indication concerning the effect on rural poverty in the country.

A more comprehensive approach to study total factor productivity changes over time (pre-liberalization to post-liberalization periods) is used to isolate the factors influencing the sustainability of agricultural production in Malawi. Various studies in Capalbo and Antle (1988) have shown that Tornqvist-Theil index is an appropriate approach to measure total factor productivity changes because it can be viewed as a discrete approximation to the continuous Divisia index, which is defined as:

$$\ln\left(\frac{TFP_t}{TFP_{t-1}}\right) = \ln\left(\frac{Y_t}{Y_{t-1}}\right) - \sum_j \left\{ (S_{it} + S_{i,t-1})/2 \right\} * \ln\left(\frac{X_{it}}{X_{i,t-1}}\right) \quad [7]$$

Where $\frac{TFP_t}{TFP_{t-1}}$ is the total factor productivity index at time t with respect to time $t-1$; Y_t and Y_{t-1} are total output at time t and $t-1$, respectively; S_{it} and $S_{i,t-1}$ are factor shares (or production elasticities) of the i^{th} inputs X_{it} and $X_{i,t-1}$ at time t and time $t-1$, respectively.

VI. RESULTS AND DISCUSSION

Cobb-Douglas and Frontier Production Approaches

First, we estimated the Cobb-Douglas (C-D) and the frontier production functions for Malawi's maize sector. The output is defined as the total maize production measured in tones (later converted into kg). Labor input is measured in person-days and derived from labor cost and wage rates. Land input is measured as the cropped maize area (hectares). The total fertilizer input is measured in kilograms (bags converted into kg) using prices as weights in the aggregation of different fertilizers used. The production function estimations are presented in Table 3.

TABLE 3
PRODUCTION FUNCTION ESTIMATIONS FOR MAIZE IN MALAWI

Variables	Average (C-D)	Frontier
Labor	0.155 ^{**} (1.401)	0.181 ^{**} (1.303)
Land	0.244 [*] (2.809)	0.271 [*] (2.454)
Fertilizer	0.0053 (1.032)	0.0075 (1.260)
Time trend	0.0553 [*] (6.541)	0.0623 [*] (8.501)
σ_u^2 / σ_v^2	-	404 [*] (2.861)
$(\sigma_u^2 + \sigma_v^2)^{1/2}$	-	0.1422 [*] (6.981)
R ² _{adjusted}	0.852	0.893

Notes: numbers in parentheses are t-test values. * and ** indicate significance at the 5% and 10% level, respectively. Labour data for selected crops were specified monthly in Ministry of Agriculture crop budgets (FEWS) data, however, labour requirements are used on annual basis in the models here. Calculations were done following Carr (1994), FEWS and Keyser and Lungu (1997) for maize only. Similarly, combined maize production to major fertilizers yearly aggregated data from Ministry of Agriculture and Agricultural Inputs Markets Development Project (AIMs) were used in both models.

Two different specifications were estimated. The first regression represents the traditional approach, C-D functions [1 & 2], resulting in an average production function. The second regression is estimated based on the frontier function as specified in equations [3 & 4]. Table 3 displays that most of the estimates are statistically significant at the 5% significant level. The R² values for both regressions suggest that the general fitness of the functions are very good. The coefficients of the time trend variable in both regressions are positive and statistically significant, implying that technological change (use of hybrid maize varieties) has contributed to maize production significantly.

Moreover, the value of $\lambda\left(\frac{\sigma_u^2}{\sigma_v^2}\right)$ is 404, which indicates that the one-sided error, u_{it} dominates the systematic error v_{it} . Note that fertilizer is marginally and positively, but not significantly affecting maize production as estimated in both functions. The annual positive maize production growth may suggest that with removal of fertilizer subsidies and unaffordability of fertilizers, more farmers perhaps switched or preferred to plant hybrid maize varieties that gave higher yield (with little or no fertilizer) than local maize; and perhaps those farmers who had some fertilizer might have applied to their local maize. Benson (1999) made similar observation that even unfertilized; the most common hybrids significantly out-yield the local unimproved maize most farmers plant. In fact, he reported that not only does unfertilized local maize yield much less than unfertilized hybrid, local maize does not respond as well to fertilizer as does hybrid maize (just about two-thirds). Moreover, he reported that if farmers cannot afford to use hybrid maize seed, they also would be unable to afford fertilizer. However, there would be a few farmers who would not have access to hybrid seed, but who do have some

fertilizer which they would like to apply to their local maize. Even though this practice cannot be recommended, farmers would follow this practice because they cannot afford the recommended optimal fertilizer practice of using hybrid maize seed.

According to the Agricultural Inputs Markets Development Project (IFDC 2003), the changes in prices for both fertilizer (MK45/50kg bag in 1991 to MK1650/50kg bag in 2002) and hybrid maize (MK120/50kg bag in 1991 to MK1000/50kg in 2002) have increased. Though both hybrid maize and fertilizer have become expensive, hybrid maize is still less expensive than fertilizers, and some farmers have continued to grow more hybrid maize rather than local maize, even if they could not apply any fertilizer to it. International Fertilizer Development Center (IFDC 2003) also reported that production of hybrid maize has jumped from 43% in 1992 to 61% in 2002. Moreover, regardless of the size of the land, those farmers who applied fertilizer on their farms had used sub-optimal rates, averaging between 25 – 50 kg per hectare while the economically optimal level of fertilizer application in Malawi ranges from 35-92 kg per ha depending on the area (Benson, 1999). Therefore, taking in to account the limited application of fertilizer by the few farmers who can afford it, coupled with incorrect method of application (mostly top dressing when small amount is used) and timing of application might have contributed to the marginal effects of fertilizer on maize production.

Another striking result is the relative land versus labor scarcity. Labor is marginally affecting maize production as both model estimates suggest. The elasticity for labor implies an inelastic response for maize production, i.e. for a unit person-day increase in labor would result in a 0.25 unit increase in maize production implying the decline in maize productivity is a consequence of sub-optimal labor use on the small farms.

On-farm labor shortages are obviously not caused by technical factors, since households have more labor than is necessary to cultivate their small landholdings that average less than 1.5 ha (Ministry of Agriculture, 1995/2000). However, the well-being of these farmers relies critically on the functioning of factor and product markets. According to the National Economic Council (NEC 2000), casual labor (*ganyu*) accounts for about 67% of total income, and *ganyu* serves as a major source of income to maintain household cash and food balances. Thus the results may imply that the marginal effect of labor are due to marginal agricultural returns caused by unaffordability fertilizer, soil infertility and unfavorable weather conditions. Furthermore, the shortage of labor on the farms also might have been caused due to economic reform related shocks (market liberalization) that had resulted in reduced purchasing power of the majority of households and especially led most smallholder farmers to be food insecure. To cope with such unwarranted shocks and constraints such as inaccessibility of seasonal agricultural credit, the majority of the farmers have sought off-farm income-generating activities, which in most cases involves selling their labor in critical times of the farming season. Obviously, the households that engaged heavily in *ganyu* market in early farming months to meet consumption expenses and to purchase farm inputs end up planting and weeding untimely, which in effect reduces their maize production significantly. Therefore, the cash or liquidity constraint causes smallholder farmers to experience on-farm labor shortages as also reported in Table 2 (labor requirement fell from 97.3 days/ha/year to 84.1 days/ha/year in post-liberalization). These constraints usually have led to sub-optimal and inefficient farming activities. Instead, neither the low rural wage

they receive from off-farm employment nor the low agricultural returns them to get out of the vicious poverty cycle.

To complement the estimates of the C-D and frontier production functions, using equation [5], we have also examined the extent of technical efficiency (or inefficiency) of maize production in Malawi. Technical efficiency (TE) refers to a farmer's success to operate on the production frontier, and technical efficiency of Malawi's maize production was found to be on average 61% during pre-liberalization period (1985-1994). After market liberalization, farmers' success to produce maize declined to 55%, with an average decline rate of 1.4% per annum, which is again attributed to many factors including labor market that induced failure of the farmers to operate efficiently on their farms and hence lower maize productivity. These are the implications that the sustainability of maize production has generally been eroded leading to shortage of food, which aggravate the level of poverty in the country.

Having examined maize production and technical efficiency, in the next section we investigate the total factor productivity indices of maize in order to understand the annual growth rates for all traditional inputs in both pre- and post-liberalization periods.

Total Productivity Growth: Divisia Index Approach

Results of application of equation [7] on various agricultural data from NSO and Ministry of Agriculture are presented in Table 5. The Table presents the growth in input use, output and total factor productivity in Malawi's maize production from 1985-2000.

All traditional inputs (labor, land, fertilizer and seed) declined over the whole period (pre- and post-liberalization periods) as shown in the last column (Table 4). Although the absolute quantity of land input use slightly increased (61 to 63), the land input share (or production elasticity) in total input use remained constant (at 0.2). The use of modern inputs including seed technology and fertilizer has decreased implying that Malawi's maize production is generally undergoing a downward transformation mainly due to inaccessibility and unaffordability of fertilizers to most smallholder farmers. The decline was also partially complemented by the droughts Malawi had experienced in 1987, 1992 and 2000/01 growing seasons.

TABLE 4
TOTAL FACTOR PRODUCTIVITY INDEX OF MALAWI
MAIZE PRODUCTION, 1985 = 100

	1985	1990	1995	2000	annual growth rate %			
					1985-90	1990-95	1995-00	1985-00
Labor index	100.0	90.0	86.0	72.0	-2.0	-0.9	-3.3	-1.9
Land index	100.0	61.0	60.0	63.0	-7.8	-0.3	1.0	-2.5
Seed index	100.0	90.0	83.0	92.0	-2.0	-1.6	2.2	-0.5
Fertilizer index	100.0	41.0	40.0	37.0	-11.8	-0.5	-1.5	-4.2
Labor share	0.3	0.3	0.3	0.2	-2.7	0.8	-6.7	-2.7
Land share	0.2	0.2	0.2	0.2	1.0	1.9	-3.5	-0.3
Seed share	0.5	0.4	0.2	0.3	-4.0	-10.0	10.0	-2.7
Fertilizer share	0.2	0.2	0.2	0.2	-4.3	1.1	-4.2	-2.3
Production index	100.0	88.0	87.0	91.0	-2.4	-0.2	0.9	-0.6
TFP index	100.0	105.0	106.0	103.0	1.0	0.2	-0.6	0.2

Sources: Calculations based on farm technologies and crop budgets, Ministry of Agriculture and Irrigation (1985-2000), IFDC (1990-2000), NSSA (1994) data from NSO and National Economic Council Reports (various issues).

Total factor productivity increased by 0.2% per annum from 1985 to 2000. Prior to market liberalization (1985–1995), productivity increased at an average annual growth rate of 2.0%. However, we observe a sharp decline in maize productivity after 1995, implying that market liberalization had a significant impact on maize production efficiency. The sharp maize productivity decline could be attributed to sharp decline in the input use, i.e. labor (-6.7%), fertilizer (-1.5%) and land (-3.5%). Though production grew on average at 0.9% per annum during 1995-00 period, productivity declined by 2.8% per annum in the post-liberalization era.

The largest contributing factor to the maize productivity decline comes from the decrease in farm labour input (-6.7%), which is largely affected by policy reforms. The policy reform had directly or indirectly shifted allocation of labour from own farm to other farms or non-farm activities that resulted to less technical efficiency and productivity of maize in Malawi.

Having examined the relationships among maize production, productivity, various inputs and policy reforms, we have summarized, concluded and outlined some policy implications. However, the current study has some limitations, which should be borne in mind when generalizing results and perform future research. The first limitation is the crop coverage. Only one crop is included in this study, which may have caused an underestimation of the effects of the policy reforms on rural labour market efficiency and

rural poverty which could also be affected by the changes in other crops (for example, the repeal of the Special Crops Act, which enabled smallholder farmers to grow burley tobacco). The second limitation is the firm level efficiency concept has been applied to national level data. If the individual farms were used, the results could be more effective. The last limitation is policy reforms may induce technological changes (usage of affordable seed varieties) in the long run while the current study only covers a relatively short post-liberalization period (1995-2000). Nonetheless, effects of the labor market liberalization estimated from this study are still fairly large, even when these effects may be underestimated. Therefore, the general conclusions of the study are unlikely to be affected.

VII. SUMMARY AND CONCLUSIONS

Since 1981 a number of major policy changes and investment projects have been implemented in Malawi with the aim of improving the overall economic structure and sectoral productivity. The Structural Adjustment Program (SAP) which began in 1981 and market liberalization, implemented in 1994 are the major national level policy changes. This paper has specifically examined the effects of market liberalization on rural labour market, and in turn on maize production and productivity in the country.

This study has established conceptual link among various factors and quantified separate effects of labor, land, fertilizer, technological change (hybrid maize use) and policy reform (pre- and post liberalization) on maize productivity in Malawi. Measurement of both total factor productivity and technical efficiency from the estimated C-D and frontier production functions, complemented with descriptive analysis, indicated that labor market liberalization contributed to the decline of maize productivity through its impact on labour availability at crucial times of cultivation, as well as unaffordability and decline in fertilizer use among most smallholder farmers.

1. Farmer's success to operate on the production frontier was found to be on average 61% during pre-liberalization period (1985-1994). After market liberalization, farmers' success to produce maize declined to 55%.
2. Real minimum wages for agriculture sector fell from MK13.48 to MK4.80 in post-liberalization periods (1994-1999). This directly implies the weakening of purchasing power of the resource poor farmers who became continuously more food insecure, consequently aggravating the poverty levels in the rural areas of Malawi.
3. Total factor productivity declined at 1.2% per annum from 1985 to 2000. Prior to market liberalization (1985 – 1995), productivity increased at 2.0% per annum, but declined after market liberalization in 1995. The sharp maize productivity decline between 1995 and 2000 could be attributed to sharp decline in the input use, i.e. labor (-6.7%), fertilizer (-1.5%) and land (-3.5%). Though production grew on average at 0.9% per annum, productivity was constantly declining from 1995 onwards, and decreased by 2.8% per annum in the post-liberalization era. The negative attributes could imply that the general impact of labor market liberalization, removal of fertilizer subsidies, higher

fertilizer prices and control of maize produce prices might have contributed to low maize productivity in the country.

The agriculture labour market exhibits elements of failure since it has brought about sub-optimal labour use in the smallholder sub-sector. In fact,

1. On-farm labour shortages were obviously not caused by technical factors, since households have more labour (including child labour) than necessary to cultivate their smallholdings given the national average land size for smallholder is less than 1 hectare. However, the well-being of these farmers relies critically on the functioning of factor and produce markets, with Ganyu accounting for about 67% of total income. The low real wage payment for such labour and its inefficient use during the peak farming time is deepening the loss of farm productivity further.

In the final analysis, neither the real wage from off-farm employment nor the low agricultural returns help smallholders to escape the vicious poverty cycle. In fact, the sustainability of maize productivity has been eroded leading to food insecurity and increased poverty.

Moreover, policy related poverty was exacerbated by two major droughts in 1987, 1992 and 2001. Prolonged neglect of tasks intended to restore soil fertility eventually precipitated a drastic fall in output, accompanied by possible soil erosion and environmental degradation. During the pre-liberalization era, the development strategy was largely inward looking and favored the operations of few private monopolies and oligopolies and the semi-public press corporations. There was strict licensing of new enterprises, which constrained the development of a local entrepreneurial class and rural non-farm small, and medium-scale enterprises. With the advent of market liberalization, there has been a proliferation of small businesses with most of them operating in the informal sector.

VIII. POLICY IMPLICATIONS

This paper has demonstrated the effects of rural labour market changes following policy reforms on agricultural productivity, more especially the staple crop maize, and how this impacts on rural poverty and agricultural sustainability in Malawi. From our results, it is imperative that development planners and policy makers should consider broad-based approaches to the rural poverty problem, which is strongly related to smallholder agriculture. The main economic issues that have emerged following market liberalization are:

1. The impact of input market liberalization on the use of fertilizer by smallholder farmers. Because all fertilizers are imported, fertilizer prices are highly sensitive to devaluation. The government should resume fertilizer subsidies for smallholder farmers to boost maize production and productivity in order to increase food security and alleviate poverty in the rural households.

2. A more serious and long-term effort should be followed to improve maize productivity by helping farms to obtain affordable hybrid maize seeds, or devise accessible financial schemes for smallholder farmers in order to be able to buy the maize varieties available in the market. This will also help the farmers to spend their time on their own farm to avoid production inefficiency during the peak farming time; rather than selling their labour to other farmers, which affects the production and productivity on their own land.
3. Within agriculture, the government should encourage agriculture research and extension institutions to focus on crops and farming systems that improve land and labor productivity, especially labor-intensive farming systems that require few purchased inputs and spread labor demands more evenly over the year. Labor-intensive technologies are needed in order to address the weak asset base and related financial position of smallholders.
4. Promote the development of farmers' cooperatives to combine their fragmented small farms so that production and productivity increase, as well as to benefit from economies of scale in marketing their crops at national and international levels. Organizing themselves will reduce the risk of bankruptcy and assist to better access to credit and farm inputs.
5. An integrated approach is needed to improve market infrastructure and information flows, in order to stimulate the demand and supply sides of product markets. Policy makers should realize that wages, finance, food security, access to markets and inputs, and landholding sizes are all intimately related and solutions to one problem cannot be found without addressing the others.

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