Australian Agricultural Economics and Resources Economics Society 55TH Annual Conference-Melbourne, Australia 8-11 February 2011

Empirical Analysis of Agricultural Productivity: Growth in Benin and Mainly Factors which Influence Growth

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Abstract:

This study examined changes in agricultural productivity at Benin in the context of diverse institutional arrangements using Data Envelopment Analysis (DEA).A time series data which consists of information on agricultural production and means of production were obtained from World Research Institute database, INSAE and rainfall data from AMMA database. The information was for a 43-year period (1961-2003); DEA method was used to measure Malquist index of total factor productivity to evaluate technical change efficiency and technological efficiency change across the country's 12 provinces. A decomposition of TFP measures revealed whether the performance of factors productivity is due to technological change or technical efficiency change over the reference period. The study further examined the effect of land quality, agriculture labor, and selected governance indicators such as government effectiveness and openness on productivity growth. All the variables included in the model are significant effect on the TPF and the country agriculture growth. They equally performed well in terms of expected relationship with TFP except land quality index which unexpectedly had an inverse relationship with TFP.

Keywords: Data Envelopment Analysis, Efficiency, Productivity, Benin
JEL Codes: N57,C01,C23.

Introduction

Like many developing economies, agriculture is the dominant sector in Benin for growth, poverty alleviation, contribution to GDP, employment and incomes. The sector represents 70% of the workforce and contributes at 39% of the Country Gross Domestic Product (GDP). It provides 90% of export earnings and participates in 15% of state revenue. As a result, it occupies a prominent place in the economy household income source.

Benin agriculture growth and total agriculture factor of productivity growth rate has know several variation with aggregate of 1,9% of increase from 1961-1980 and 2,93% from1981-2001(Flavio Avila; Robert Evenson,2001) compare to over sustainable agriculture growth country still very low(seeTable1,annex).The sector growth were also very instable and influenced by his political administration such colonial (before 1960), freedom (1960-1972) and revolutionary (Marxist-Leninist) (1972-1990) and liberal from 1990.

During the colonial period, the principal culture was the palm oil and from 1940-1960, the country exported average of 43614 tones of palm kernel with 12426 tones oil palm per year and that accounted for 75% of the country's export(Modest and al,2000). Food producing cultures have got low interest during that period.

After the freedom in 1960, was created rural land management perimeter to growth palm grove and the management was guide by some cooperative and farmers own land was restitute to those cooperative who also contribute to the labor forces (Dissou,1983).During that period the country total export was essentially agriculture products and palm oil still be the first priority culture and 48% of the country agriculture investment was allocated to this culture(1966-1970)(Dissou,1983) whatever others cultures such(coffee, cashew, pineapple, cocoa, groundnuts and Shea nuts) has retain interest. Modest Hougbedji (2009) has noted that the national budget allocate to the agriculture sector variation was very low with 1,71%-2,84% fro 1960-1968(INSAE, 1960-1968).

After 1972, the Marxism politically regime has fixe food security as purpose and has negligee the oil palm and the cotton. That has reduce cotton and oil palm production and exportation but from 1982,the Sectorial strategic of development policies has also abandoned in favor to integrated rural development project and from 1985 cotton production has past 85000tones and food producing cultures has also know a significant growth.GDP growth was low(less than 2,6%)(Modest et al, 2009) and contract(6,6% for agriculture sector,1,7% for industry and 0,7% for trade and service).

During 1990,agriculture sector exportation profit has increased by more than 50% of total exportation of the country(MAEP,2000).From 1990-1991, the agriculture sector has become liberalized and government has decline his engagement from that sector due to the economic crisis of that time and the private sector and other multilateral start the business with freedom. Modest et al (2009) from their analysis has contacted that it is from that period has really know a good agricultures policies with the "Lettre de Déclaration de Politique de Développement Rural (LDPDR)" that help to put in place the "programme de restructuration du secteur agricole (PRSA)" and roundtable on rural sector in 1995(Modest and al, 2000). The LDPDR has started to be implemented from 1999/2000 with precision on why the state has disengaged its responsibility (disengaged from production, transformation and commercialization of agricultures cultures).This document has fixed the role of each such as: state, local collectivity of farm and rural cooperative, technical and financial partner. In September 2001 Benin has adopted politic of women farmer promotion in agricultures sector and in rural area (Politic of Women Promotion in Agriculture Sector and in Rural area (PPFR,PWPAR)) that was the implementation of National Political of Women Promotion ((PNPF,NPWM)). With the recent food crisis in 2008, the government has initiated food security policies called Strategic Plan of Agriculture Sector Reflate (PSRSA in French) to make Benin a powerful food security country in Sub-Sahara Africa.

Since, the sector has become liberal the production is focusing on export crops (cassava, bean, yam, sorghum, maize, millet and rice) and especially the main export crop cotton. The country is also a leading cotton producer in Africa and giving income to 2 million of the population. From 1990 to 2003, the "white gold" has contributed to over 14% of GDP. Such other culture like oil palm, cashew and limited supply of coffee, cashew, pineapple, cocoa, groundnuts and Shea nuts are also produced. The cultures of pineapple and cashew nuts are respectively 110000 tons and over 40 000 tones in the crop year 2004-2005 and some familiar emergence alongside cotton. The palm oil production also increase from 130 000 tones of oil in 1994 to around 280 000 tones in 2005. These levels of production are largely insufficient to satisfy a national and regional market with high demand. While relatively developed animal husbandry, practiced mainly in the north, is still insufficient to meet demand, flocks of cattle, sheep (3.4 million goats and sheep) and pigs (297 000 animals) cover only 60% of the needs and the sector is subject to strong competition from imports of frozen products from the European Union. Fishing, practiced for three quarters of freshwater is mainly artisanal and sustains approximately 300 000 people. Annual production varies from 7 000 to 10 000 tones for marine fisheries and 30 000 to 40 000 tones for inland fisheries. It represents only 2% of GDP and provides only half of domestic demand.

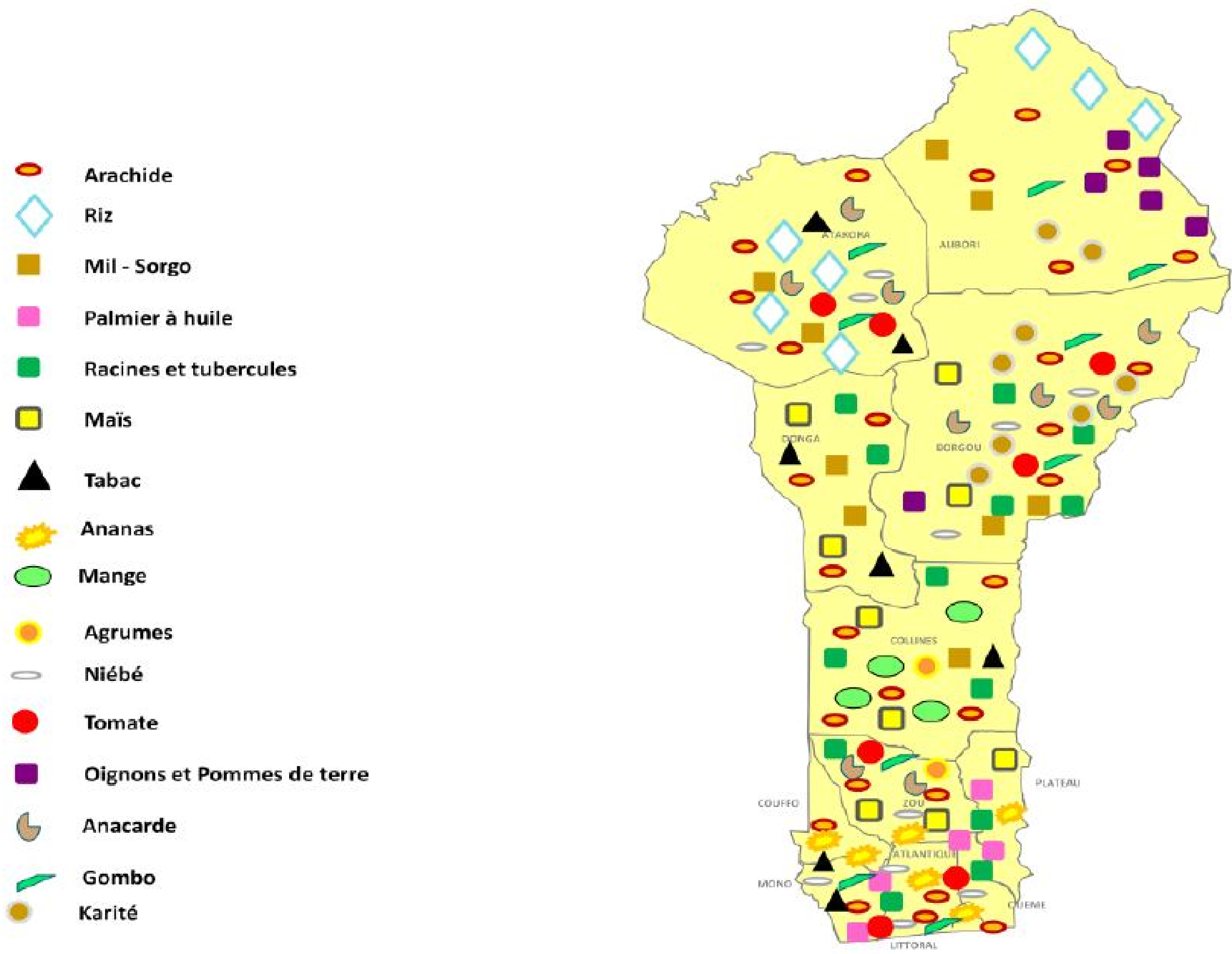
Benin has great potentiality of production with a lot of variety of agriculture production(see picture1) but fails to achieve food self-sufficiency when a large proportion of arable land is still not under cultivation, incomes and productivity are low and the labor force is only partially recovered, which makes it very uncompetitive agricultural products. Farmers are still using low yielding Agricultural technologies, which lead to low productivity and most operators have very little use of inputs and engage in mining practices that emphasize natural resource degradation .The same sector is characterized by the predominance of small farms, which are subjected to financial difficulties, technology and the vagaries of climate and they not very competitive because of high input costs and low mechanization. The country is classified into 12 provinces that have great agro-climatic condition but could not maximize their production (the production repartition also is not uniform).

However it is know for every one that growth and development of this crucial sector is essential for the overall process of socioeconomic development in Benin. It is always argued that, relevant question for agricultural policy makers, is whether the agricultural sector can be made more efficient, by achieving more output with the current input level, or achieving the current output with less input usage than is currently observed.

The objective of this study is to evaluate Benin agriculture productivity since those reforms have been engaged. To achieve that purpose, several questions can be addressed: What is the status of agricultural productivity in Benin? Why the agriculture growth is not sustainable the green revolution accompanied by declining productivity growth? Has Benin agricultural productivity declined sharply as perceived? Are there major differences in Benin productivity growth across provinces? And finally, what are the factors that determine the productivity growth? The broad objective of the study is to examine the performances of the agriculture sector face during those all the reforms that has done.

The remainder of this paper is organized in sections. In section, I provide brief introduction of the concept of productivity and efficiency. In section 2 productivity measurement empirical approaches. In section 3 determination of factor that influencing TPF .In section 4 methodology and data sources. In section5 result and discussion, which are followed by the conclusion and policies in section 6.

Fig1: Presentation of Benin and different crops production in each province



Source; report on operationnalisation and declination plan of sectorial investment for Benin 2025 purpose, December 2008。 “Stractegie d’operationalisation et declinaison en plas d’investissemnets sectoriels de la vision2025”

I-Productivity and efficiency

I-A-Concept of Productivity

Productivity growth is considered necessary to produce higher quality goods in a more efficient manner, which results in lower costs to consumers, and also to raise per capita incomes over time. In the agricultural sector, productivity traditionally has been considered important to the development process, allowing countries to produce more food at lower cost, improve nutrition and welfare, and release resources to other sectors.

A.1. Importance of Productivity

The performance of a firm, converting inputs into outputs, can be defined in many ways. One possible measure of performance is a productivity ratio. By defining the productivity of a firm as the ratio of outputs that it produces to the inputs used, the larger values of this ratio are associated with better performance. Productivity is a relative concept. Therefore, the productivity of a company in the present year could be measured relative to its productivity in the previous year, or it could be measured relative to the productivity of another company in the same year. It is even possible to compare the productivity of an industry over time or across countries.

Our real income and living standards critically depend upon our ability to raise productivity, and as a nation, our objective should be to maximize increases in living standards (broadly defined). Therefore, productivity should always be something that we want to increase as much as possible (O'Neill, Egelton, Hogue 1999). Changes in productivity are of great importance at all levels – national, industrial, company and personal (Kendrick 1993):

- At the national level, productivity is a major element of economic growth and progress.
- At the industrial level, above-average productivity growth leads to relative declines in costs and prices. On both domestic and international markets, this increases the competitiveness of Firms in progressive industries, which consequently tend to grow faster than average.
- At the company level, productivity is fundamental to profitability and survival. Companies with higher productivity than the industry average tend to have higher profit margins. Moreover, if productivity is growing faster than that of the competitors, the margins will rise.
- At the personal level, increasing productivity in all of one's activities is an important aspect of self-fulfilment. The individual serves as a key to advancement since it helps increase the productivity of the organization.

On a global scale, improved productivity is essential to eliminate hunger, disease and poverty. Having established what "productivity" means, it is appropriate to list those subcomponents that determine relative increases in wealth or well-being: (1) new technologies and methodologies; (2) energy utilization; (3) investment; and (4) attitudes (Smith 1993). Therefore, the first element in improving productivity is to develop new ideas and new processes – to do things in a new and better way. The next important component is improved energy utilization. Energy refers to all sources of power, whether from the earth, from the sun, the seas, from animals or people, and most importantly, from the human mind.

Investments in new technology, energy-reducing or labour-saving equipment are necessary components for raising the level of prosperity. The attitudes of managers and employees are fundamental components in improving productivity. The managers must make sure that people and jobs match because employees have the skills and understanding necessary to achieve both the objectives of the company and their own personal goals. In sum, it is possible to increase productivity by managing these four well-being elements.

A.2. Productivity Management

Productivity is one of the major responsibilities of management. By attaining productivity increases, several other management goals are automatically achieved. An increase in the productivity of a firm results in improved product quality and service, decreased production costs as well as improved market share and profit. In the effort to achieve productivity goals, however, management must not lose sight of the other important management responsibilities – ensuring service quality, timeliness, accomplishing the mission and customer satisfaction. Indicators of the performance of these management responsibilities should also be tracked and emphasized by management. It is important to point out that stressing excellence in relation to all these management responsibilities does not present conflicting, but complementary goals (Soniat and Raaum 1993). There are several books by Christopher, W. F. ed. (1993), Sumanth, D. J. (1998), Belasco, K. S. (1990) that provide a methodology for successful application of productivity management.

Success in any productivity enhancement program depends on the leadership, participation and the ongoing support of every manager. So the first activity is a top-level evaluation of management structure and style (Eppolito 2002). Increases in productivity represent one of the key competitive advantages of a company. Unfortunately, companies seldom manage their productivity. The main point of productivity management is to identify area of potential productivity improvement. In order to manage productivity in the true sense of the term, four phases must be linked together (Sumanth 1998):

- Measurement;
- Evaluation;
- Planning;
- Improvement.

These four phases form a continuous productivity process or cycle. The first phase of the productivity cycle is measurement. The present productivity level of the firm must be compared with the target level. This evaluation will provide a vision of the new productivity level for the following period. Depending on the planned level of productivity, improvement must arrive in the subsequent periods. Productivity improvement marks the end of the first productivity cycle, but productivity must be measured again in the next period and this then becomes the beginning of the next new productivity cycle.

A.3 Efficiency

The concept of efficiency is at the core of economic theory. The theory of production economics is concerned with optimization and this implies efficiency. The crucial role of efficiency in increasing agricultural output has been widely recognized by researchers and policy makers alike. It is no surprise; therefore, that considerable effort has been devoted to the analysis of the farm level efficiency in developing countries. An underlying premise behind much of this work is that if farmers are not making efficient use of the existing technology, their efforts designed to improve efficiency would be more cost effective than introducing new technologies as a means of increasing agricultural outputs(Bravo-ureta and Everson,1994).The issue of determining the pattern and the efficiency of resource use in traditional farming arises in the context of formulating development strategies designed not only to raise the productivity of resources already committed to the farming but also to ensure that the newly created resources in the agricultural development efforts are allocated to areas and for enterprises in which their productivities are higher (Awoyemi, et al., 2003).

In order to collectively raise productivity, country, global and regional productivity growth in agriculture has been the focus of intense research in the past few decades. Economists (e.g. Block,) 1995) have examined the sources of productivity growth over time and the productivity differences in country, among countries and regions over this period. Productivity growth in the agricultural sector is considered important in some Sub-Saharan country and if agricultural sector output is to improve at a rate equal to or greater than the population growth rate to meet the demand for food and raw materials. Also, productivity performance in the agricultural sector is critical to improvement in the economic well being of the country. Unlike previous studies that have measured agricultural productivity in Benin which have been motivated by a variety of issues including identifying the primary sources of productivity growth and analysis the structural and productivity compare to other to evaluate the growth problem.

For agricultural sector to achieve these objectives, government and various institutions have sought strategies that would lead to higher levels of production and a key factor for a sustained increase of agricultural production is improvement of productivity, which is carried out through technological change and efficiency change. Hence, increasing agricultural productivity in Sub-Sahara Africa as Benin has received a wide spread attention in the literature on economic development and poverty alleviation. Since agricultural growth is linked to farm profit, there had been considerable research that examined the performance of this crucial sector in the Sub-Sahara region (e.g. Moock, 1973 and Lipton, 1988).

II- Productivity Measures

II-A-Empiric Approach

Productivity growth is generally defined in terms of the improvement and technical change with which inputs are transferred into outputs in the production process; see e.g. Shih-Hsun et al., 2003. Indexes of productivity can therefore be simply referred to as the ratio of aggregate output index to an index for total factor use. In assessing growth, sustainability, and competitiveness in the agricultural sector, proper identification and measurement of agricultural productivity growth, particularly when technical change in the sector is factor-biased rather than Hicks-neutral is very important.

Broadly based empirical analyses in agriculture have focused on global (e.g. Rao and Coelli, 1998), regional (e.g. Fulginiti et al., 2004) and country level performance (e.g. Alabi, 2005). At the beginning of examining cross-country agricultural productivity, cross-sectional data were used to estimate a Cobb-Douglas production technology using regression methods e.g. Hayami and Ruttan, (1970), and Capalbo and Antle (1988). The focus of these earlier studies were generally on the estimation of the production elasticities and investigation of the contributions of farm scale, education and research in explaining cross-country labour productivity differentials(Coelli and Rao, 2003).

There are different methods for estimating the total factor productivity (TFP) growth e.g. Malmquist and Tornquist indexes. The former had gained popularity in recent years since Fare et al., (1994) apply the linear programming approach to calculate the distance functions that make up the Malmquist index. According to Shih et al, (2003), since Data Envelopment Analysis (DEA) type of analysis can be directly applied to calculate the index, the Malmquist index has the advantage of computational ease, does not require information on cost or revenue shares to aggregate inputs or outputs, consequently, less data demanding and it allows decomposition into changes in efficiency and technology. This method does not attract any of the stochastic assumptions restriction, however, it is susceptible to the effects of data noise, and can suffer from the problem of 'unusual' shadow prices, when degrees of freedom are limited (Coelli and Rao, 2003).

The issue of shadow prices is important and is one that is not well understood among authors who apply these Malmquist DEA methods; also, DEA methods in measuring productivity growth which made it distinct from pure index approach such as Fisher and Tornkvist indexes is that it does not require any price data, more so that agricultural input price data are seldom available and could a times be distorted by the government policies. According to Chambers (1988), productivity can be used to measure rate of technical change in production and can be conceptualized as two main components; partial factor productivity (PFP) and total productivity. Partial factor productivity is the ratio of output to a specific input. Denoting Y as the output and X_i as any individual input factor, then partial factor productivity of input X_i is

$$PFP = \frac{Y}{X_i}$$

This only measures the contribution of one particular input to technical change, ignoring the effects from other input factors; while total factor productivity (TFP) is the partial product of all input factors. It is the ratio of output to an index of inputs.

If X denotes the index of all inputs, then TFP is

$$TFP = \frac{Y}{X} = \frac{Y}{\sum \beta_i X_i}$$

Where β is the weight of input X_i and can be measured using indexes.

Farrell, (1957) identifies two types of efficiency: Technical efficiency that evaluates a farmer's ability to obtain maximum possible output from a given set of inputs and allocative efficiency which measures marginal revenue of products with marginal cost of inputs. Traditionally, econometric procedures were used to measure technical and allocative efficiencies given the technology and process. However, this requires the specification of production technology. In the late 1970s, a mathematical programming approach known as Data Envelopment Analysis (DEA) was developed to measure technical efficiency by comparing the individual firm's production to the best practice frontier (Charnes, Cooper and Rhodes, 1978).

In DEA the envelopment of decision-making units (DMU) is estimated through the linear programming methods to identify the "best practice" for each DMU. The efficient units are located on the frontier and the inefficient ones are enveloped by it. The DMUs can be company, farms, country and so one.

The contribution of Farrell was path breaking as noted by Forsund and Sarafoglou (2000) in their article "On the Origin of Data Envelopment Analysis".

Efficiency measures were based on radial uniform contractions or expansions from inefficiency observations to the frontier. Thomson and Thrall (1993) observed Farrell seminal paper was followed by a relatively large number of refinement and extensions, which may be broadly classified into three schools of thought and identified as Afriat School, Charnes School and Shepherd School. Afriat School covers econometricians' parametric estimation approach, while the last two may more accurately be termed axiomatic production theory school.

The 1978 paper "Measuring the efficiency of decision making unit (DMU)" by A. Charnes, W.Cooper and E. Rhodes (CCR) is quite similar to Farrell concept of efficiency measurement. As pointed out with interest by Forsund and Sarafoglou (2000), the one unique contribution of CCR is the explicit connection made between a productivity index in the form of a weighted sum of outputs on a weighted sum of inputs, and the Farrell technical efficiency measurement in the case of constant returns to scale (CRS). This was the starting point in CCR: finding weight by maximization of such productivity ratio subject to best practice and normalization constraints. The so called ratio form of CCR, corresponds to the natural science engineering concept of micro productivity ratios and economists' concept of efficiency making explicit the interpretation of primal and dual solutions. It shows how to calculate useful features like marginal productivity, and in the later development when the constant returns to scale format of CCR was extended to variable returns to scale, and also scale elasticity (Banker, Charnes and Cooper, 1984).

Vu Hoang Linh(2003) to evaluate the Vietnam agriculture productivity has applied the nonparametric output-oriented Malmquist DEA method based on a panel data of 60 provinces in the period 1985-2000.He has estimated the total factor productivity (TFP) by Malmquist DEA method that is chosen in preference to the Tornqvist TFP index method, because inputs prices were not available in recent Vietnamese agricultural data. However David K. Lambert and Elliott Parker(1998) has also used the DEA method to evaluate the Productivity in Chinese Provincial Agriculture from 1979 open reform of China to 1995 and has included crop prices in his model. He applied constant crops price of 1994 in his study. Over time best practice are natural and to include frontier shifts, that is, technical change, the Malmquist productivity index is a well established measure

II-B- Malmquist Index determination by DEA method

DEA is linear-programming methodology, which uses data on input and output quantities of a Decision Making Units (DMU) such as individual firms of a specific sectors to construct a piece-wise linear surface over data points. In Vu Hoang(2003) and David&Paker(1998) study DMUs are provinces. Fare *et al.*, (1994) used Data Envelopment Analysis (DEA) methods to estimate and decompose the Malmquist productivity index.

The Malmquist indices can be decomposed into technological change and technical efficiency. Calculated values of the Malmquist indices are then regressed against several possible explanatory factors in a second step. Factors affecting productivity and efficiency include: an index of the implementation of the household responsibility system, the share of land affected by severe natural disasters, the development of rural industry, and grain prices relative to the general provincial price level.

The Malmquist index has become increasingly popular in analyzing changes in MFP when panel data are available. Fare et al. (1994) measured gross domestic output for 17 OECD countries resulting from two factors, capital stock and employment. Bureau, Fare and Grosskopf (1995) used a similar Malmquist index in measuring differences in MFP for the agricultural sectors of nine European Union countries and the United States. Price and Weyman-Jones (1996) examined efficiency and total productivity gains in the United Kingdom's gas industry before and after its 1986 privatization.

In their approach, the output distance function is defined on the output set

A Distance Function Measure of Productivity Change
Characterizing country Agricultural Production
Consider the production possibilities set S available at time *t*:

$$S^t = \{ (\mathbf{x}, \mathbf{y}) : \mathbf{x} \text{ can produce } \mathbf{y} \text{ at time } t \} \qquad (1)$$

where $\mathbf{x} \in \Re_n$ is a vector of inputs and $\mathbf{y} \in \Re_m$ is a corresponding vector of outputs. S_t is conditional upon the technology available at time *t*.

Output distance functions have been shown to completely characterize technology (Färe et al. 1994). The output distance function is defined at time *t* as:

$$D_o^t(\mathbf{x}, \mathbf{y}) = \inf\{\theta : (\mathbf{x}, \mathbf{y}/\theta) \in S^t\} \qquad (2)$$

$$= (\sup\{\theta : (\mathbf{x}, \theta\,\mathbf{y}) \in S^t\})^{-1} .$$

The output distance function is the reciprocal of the maximum proportional expansion in output **y** given **x** and s^t 。 Values of D_o^t less than 1 will lie within the boundary of s^t, implying that a proportional increase in outputs could occur for the observed level of inputs. A distance function value equal to 1 indicates the observed net-put vector (**x**, **y**) lies on the frontier of s^t. No increase in the observed levels of **y** is possible given **x** and the technology available at *t*. Values of D_o^t greater than 1 indicate that **y** cannot be produced given **x** and s^t. θ would indicate the minimal shrinkage of **y** to be on the boundary of s^t.

Given a set of *K* observations in time period *t*, the output distance function for each decision making unit, be it firm, province, or nation, for example, can be computed by solution of the following linear programming problem:

$$\left(D_o^k(\mathbf{x}^k, \mathbf{y}^k)\right)^{-1} = \text{Max } \theta \qquad (3)$$

$$\text{subject to} \qquad \theta\ \mathbf{y}^k \le \sum_{i=1}^{K} \lambda_i \mathbf{y}^i$$

$$\sum_{i=1}^{K} \lambda_i \mathbf{x}^i \le \mathbf{x}^k$$

$$\lambda_i, \theta \ \ge 0$$

Placing no restrictions on the intensity variables, defines a constant returns to scale technology. The distance function is the reciprocal of Farrell’s (1957) measure of output technical efficiency. The solutions to (3) will thus indicate which provinces define the frontiers of the aggregate country production function and which provinces are inefficient.

Färe et al. (1994) developed techniques to determine improvements in technical efficiency over time. Changes in technical efficiency for an individual province from period *t* to *t+1* is given by:

$$\text{Efficiency change} = \frac{D_o^{t+1}(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})}{D_o^t(\mathbf{x}^t, \mathbf{y}^t)}, \qquad (4)$$

where the notation for province k is suppressed for notational convenience. If the province is on the frontier of the production frontier in both periods, the efficiency change measure will equal 1. Movements towards (away from) the frontier will be measured by values greater (less) than 1.

Technical change presumes the frontier of the production possibilities set shifts over time (Solow, 1957). The frontier in each period is determined by solution of problem (3). Changes in the frontier between period t and $t+1$ is determined by comparing the observed period t production bundle for province k with the frontier in period $t+1$. Changes in the calculated distance function that are not explained by changes in technical efficiency are attributed to shifts in the production frontier. Rather than selecting an arbitrary reference technology, such as t or $t+1$, Färe et al. (1994) recommend comparing period t observations with the $t+1$ frontier and period $t+1$'s net-put bundle with the period t frontier. Technical change can then be calculated as:

$$\text{Technical change} = \left[\frac{D_o^t\left(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}\right)}{D_o^{t+1}\left(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}\right)} \times \frac{D_o^t\left(\mathbf{x}^{t}, \mathbf{y}^{t}\right)}{D_o^{t+1}\left(\mathbf{x}^{t}, \mathbf{y}^{t}\right)} \right]^{1/2} \tag{5}$$

The output distance function associated with province k's production bundle in period t with the $t+1$ frontier is obtained by solution of the following linear programming model:

$$\left(D_o^{t+1}\left(\mathbf{x}^t, \mathbf{y}^t\right)\right)^{-1} = \text{Max } \theta \tag{6}$$

$$\text{subject to} \quad \theta \, \mathbf{y}^t \le \sum_{i=1}^{K} \lambda_i \mathbf{y}^{i,\,t+1}$$

$$\sum_{i=1}^{K} \lambda_i \mathbf{x}^{i,\,t+1} \le \mathbf{x}^t$$

$$\lambda_i \,, \theta \ \ge 0$$

Output distance function $\left(D_o^t\left(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}\right)\right)^{-1}$ is found by reversing the roles of t and $t+1$ in problem (6).

Considerable use has been made of the Malmquist productivity index since Caves et al.'s (1982) derivation of the theoretical properties of the index and Färe et al.'s (1994) empirical applications. The Malmquist index is a primal index based solely on observed input and output quantities. Cost and revenue shares need not be calculated for the Malmquist index, yet the index does yield multifactor productivity changes in a multiple-output setting (Färe et al., 1994). The Malmquist index can be decomposed into changes from period to period resulting from changes in a province's technical efficiency (4) times movements in the production frontier resulting from technical change (5).

Consequently, the Malmquist output-based index for an individual province can be expressed:

$$M_o\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \frac{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)}{D_o^t\left(x^t, y^t\right)} \times \left[\frac{D_o^t\left(x^{t+1}, y^{t+1}\right)}{D_o^{t+1}\left(x^{t+1}, y^{t+1}\right)} \times \frac{D_o^t\left(x^t, y^t\right)}{D_o^{t+1}\left(x^t, y^t\right)}\right]^{1/2} \quad (7)$$

III-Determination of Main Factors influencing the TPF

Understanding factors that influence growth in the country can be used to formulate policies that will enhance productivity. Several factors have been identified in the literature as the most important sources of productivity change in agriculture: research and development, extension services, education, infrastructure and government program but ignores institutional quality.

Benin like most of African Sub-Sahara has witnessed structural adjustment in recent times to promote rural development through the introduction of 'modern technologies (e.g. hybrid maize, fertilizer and other inputs) and 'modern' public institutions like co-operatives, marketing boards and parastatals. The introduction of modern technologies was attempted largely on the basis of the public provision of seasonal credit. Co-operatives, marketing boards and parastatals were frequently granted crop-marketing monopolies partly in order to allow credit recovery through crop sales.

Ajao (2003), to determine majors factors that have influenced TPF across sub-Sahara African, he used Ordinary Least Square (OLS) estimation techniques to examine the effect of the above selected variables such as xi on agricultural productivity growth.

The model used is explicitly as follows: The first two objectives were achieved by solving equation (iv)-(vi) and for the last objective, an Ordinary Least Square (OLS) estimation techniques was used to examined the effect of the above selected variables on agricultural productivity growth

Y = f(Xi, e)……………………………………………………………………(x)
Where Y is the TFPCH index, that is, Malmquist Productivity Index and; i = 1, 2………9
X1 represents conflict
X2 represents corruption (corruption transparency index)

X3 represents land quality

X4 water resources use intensity in agriculture

X5 represents Agriculture labor force

X6 represents education

X7 represents government effectiveness
X8 represents life expectancy at birth
X9represents openness

IV-Methodology and data sources

To achieve the purpose of this study, I will first applied David & Paker(1998) methodology that has been used to evaluate the productivity in Chinese provincial agriculture. That method will help us to evaluate the agriculture productivity at Benin across all provinces by determination of each provinces agriculture TPF by DEA Malmquist Index.

In this study, Benin has 12 provinces and available time series data is collected from several sources (PP/MAEP, INSAE, Benin FAO Stata, etc…) during the period 1999-2003. Output data from each province are: grain production; cash crops production; animal production and other crops production for each province and each year from 1999-2003 and Input data are irrigated proportion ;labor proportion; draft animal ; fertilizer; and power. Land is measured in sown hectares, which adjusts cultivated land for the prevalence of multiple crops per year in many of the agricultural production areas. In addition, sown land is differentiated between irrigated and dryland. Cultivated land area is adjusted from Benin country Stata estimation.Labor is measured as the number of provincial agricultural workers at year-end. Draft animals are reported in number of head. Fertilizer is measured in tons of effective content for nitrogenous, phosphate, potash, and complex fertilizers. The machinery input is measured in kilowatts of engine power capacity.

Available data on Benin agriculture as most south Sahara Africa data is very difficult and I just focus on the period 1999-2003. I start from 1999 as the LDPDR has started to be implemented from 1999/2000 with precision on why the stat has been disengage his responsibility (disengaged from production, transformation and commercialization of agricultures cultures) and from 2001 was been adopted politic of women farmer promotion in agricultures sector and in rural area (Politic of Women Promotion in Agriculture Sector and in Rural area (PPFR,PWPAR)) that was the implementation of National Political of Women Promotion ((PNPF,NPWM)).This was very important as in Benin women occupied more than 70% of agriculture labor force and got only less than 1% of agriculture available land. As there is no such available input and output already computed data, I will computer that for collected available data from each province. Constant crop prices of 2000 will be used to compute output data.

I will then use that data to evaluate the Efficient Change (EC) and Technical Change (TC) for each province. The DEAP (Data Envelopment Analysis Program 3.2 version) Comparative analysis will be made across province and comment the variation.

In the second part, I will use regression method to examine the major factor that influence the TPF at Benin and impact of political economy on agricultural productivity, the study considered the following variables: Conflict (International Peace Research Institute, Oslo); corruption and government effectiveness (Governance Matter II); Land Quality (Peterson, 1987); Public health and Education which was used as a proxy for quality of labor (Center of International Development, Harvard University), available water resources (rainfall data will be collected from AMMA database). Data also will be collected from the FAO web site (AGROSTAT) and it covers a period of 43 years (1961-2008).The data consists of information on agricultural production (Crop and Livestock index) and means of production such as total rural population and total agricultural area were get from world resources institute (WRI) database. In that case output is : **Y**= TFP and input are:(a) Total agricultural area (1000ha);(b) Total rural population (1000);(c) Rainfall (weighted);(d) Irrigation (1000ha),(e) Total agriculture production index. To evaluate the reason for significant decline and factors that limit the TPF, I will use regression method.

With available data, I have focus on 5 variables**, X3, X5, X7, X9.**

V-Results and Discussion

The result from data computed for each province output and input are summarized in Annex1,Annex2. Average gross output per hectare and output shares for 1999 - 1993 are presented. Percent of sown acres that is irrigated is listed in table2. Finally, average input usage per hectare over the period is presented.

Output data analysis show that for 1999 to 2003 the agriculture output value per hectare has considerable varieties across all the 12 provinces at Benin , where Atacora has with high output value at 1999/2000; Littoral in 2000/2001and 2001/2002. However the input variation during all the period show that Atacora has the larges irrigated area, Mono the large agriculture labor force, Couffo with high draft animal and fertilizer used and littoral high power used. The agriculture potential across all provinces is not the same and the region of Oueme is known as the agro-ecological potentiality region of Benin.

Using the Malmquist index function approach to calculate year-by-year and province-by-province Malmquist indices for both technological progress and technical efficiency, I was able to calculate a measure of MFP by using the DEAP model .Malmquist productivity indexes were calculated for the 12 Beninese provinces in our data set, for each year from 1999 through 2003. The result of the DEAP result is in Annex4.

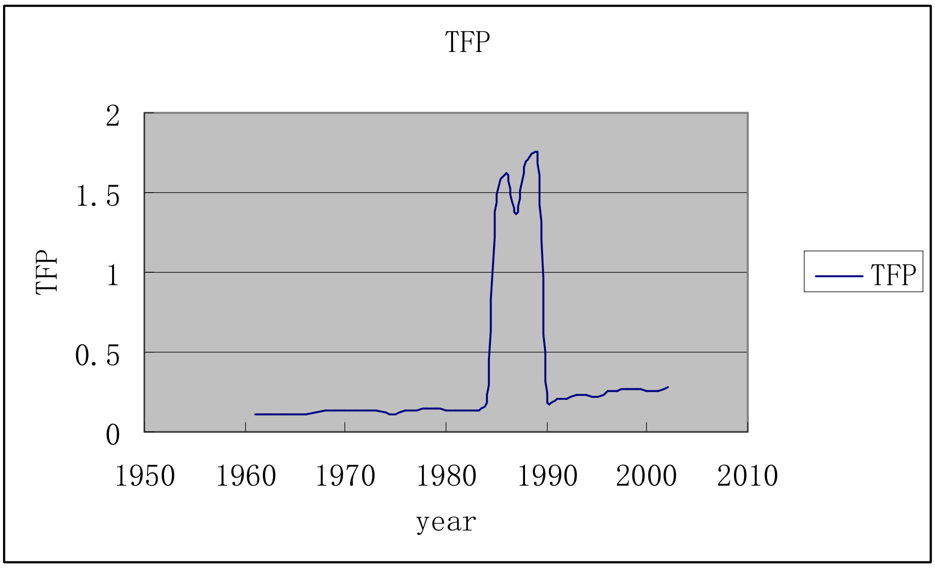
The analysis of provincial total productivity change form 1999 to 2003 show that just after the reform implementation in 1999, the technical and productivity change was high at Borgou and and lowers at littoral and fall with the high rate at Colline and lower rate at littoral region. general the mean of technical efficient change and technical efficient change has increase across all Benin. After the reform and start of implementation, local collectivity of farm and rural cooperative, technical and financial partner effort has been increase in the country and more in vulnerable area. The Colline region is know as very limited natural resources and limited agro-climatic facilities, and with climate change effect is one of vulnerable area and effort has been improve in most vulnerable region across all the country. Efficient agriculture resources have been allocated to produce output. That is not the case of such regions like Oueme, Plateau where the annual agriculture rainfall, land quality are able to produce.

However, the phenomena was uniform across the country and the analysis of Benin total productivity factor since 1960 to 2003 The analysis of Benin TFP have significant variation from 1961 to 2003.The first period is from 1961 to 1985 where the productivity was low with average 0, 12 and from 1983 increase significantly (rise rapidly) to max1=1, 52 and then decrease to min1=1, 47.This first period (1961-1990) high growth production can be explain by the "green revolution'' short run positive impact. During this period many developing country like Benin had target agriculture modernization policies and many effort had done as well by government, multinational and other's to increase the growth and achieve food security.

At the second period is the Total productivity increase from 1, 47 to another max2=1, 75 and then decrease to min2=min1 and rise from 1990 start to rise slowly.

Comparing this variation Benin TFP since the significant decreasing at 1990 after "the green revolution" the productivity still very low with average 0,240 and low compared to other developing countries that TFP was also very low and decreasing the Benin productivity is low (Michael A.Trueblood and Jay Coggins, 1990) (See table1).Some researcher has said that is the long run negative impact of the green revolution. However Benin available resources input facilities is very high that the contract. Which factors have influenced Benin growth during this period?

Table1: Benin TFP variation from 1961-2003



Own graph

The regression method used to evaluate the reason of significant decreases of the Benin Agriculture TPF and mainly factor that influence the TFP, show us:

The first regression give (see Annex5).The equation is given by:

Y= -8.05 -1.30E-6 X3+ 8.33 E-6 X5+ 0.55X7 -2.22X9

R=0.77 DW=1,056

The analysis of the graph of Annex 6 show as that the residue is positive and there is correlation between the TFP and the land quality, agriculture labor force, government effectiveness and the country openness. That means that the technical efficient change and technological efficient change optimization across provinces and the inefficiency observe in such province is due to non sufficient land use, lack of agriculture labor force used optimization, insufficiently government policies implementations by the liberalization of agriculture sectors.

VI-Conclusion

This study presents some important findings on level and trends in Benin agricultural productivity and further examined in one the technical efficient change and technological efficient change across all Benin province and in another hand the political economics of agricultural productivity in Benin between 1961 and 2003.

The findings revealed firstly that technical and technological change has increased across all Benin provinces after the reform but not efficient in potential agriculture available resources area. That means that the agriculture output is still not optimized because the agriculture resources allocated to produce output are not used efficiently. This is the case of such region like Oueme, Plateau, Borgou, Zou, and Mono where the agriculture input are sufficient.The contract is that the productivity is more efficient in low agriculture available resources are climate change vulnerable region. The growth was found to be technological progress rather than efficiency change.

However, after the open market, the state government has allowed the agriculture sector management more to private sector and the analysis of the impact of the political economy on the productivity change revealed that activities of rural development has not really transformed into effective action, hence, policy implication of these findings are significant in Benin and foreign aid agencies should channel their resources in such a way that an average rural dweller will have access to unfettered and quality education to improve the existing man power and capacity building. The regression method show that the land quality, agriculture labor force, government effectiveness and the country openness has considerable influence on Benin agriculture TPF so on technical change and technological efficiency change.

VII-Recommendation

With the climate change effect the land value change is more and lower and effort policies should be implemented to help rural farmers to mitigate climate change negative effect on land. New land valorization technical should be used and transfer to farmers. The north part of Benin is very vulnerable whatever the country has sufficient agriculture land available; however effort should be manage essentially in north for land revalorization and increase to farmers land use facilities. Local farmers climate change adaptation methods should be developed or improve to limited the high input cost and maximize the agriculture resources allocated to produce output More policies should be implemented for sufficient agriculture resources use in each province. This is the case of Zai technical at Burkina-Faso that is local farmers technical for land revalorization.

This can not be achieving without investment and public as private investment is needed. For that, government should be engaged more in agriculture sector by collaborating with private sectors. Government should manage agenda with private sector to implement more policies in rural area by rural infrastructure building (solicit their contribution), Public investment (rural roads, marketplaces and storage facilities; irrigation infrastructure; soil fertility improvement anti-erosion measures, mechanism fertilizer substitutes and research by providing more technical support to rural farmers with technology transfer.

Investment to increase competitiveness of agriculture and other non-resource based sectors and ensure social stability and cohesion.

Government should target more sustainable development project in agriculture sector and increase investment in agriculture sector. In Benin as most of sub-Sahara country government spending in agriculture sector is less than 10% of annual GDP growth that was recommended to achieved MDG goals and poverty reduction in 2015.More investment in climate change mitigate effect research should be addressed to increase available land for more agriculture growth.

The government openness should be more sufficient by elaborate more policies that could encourage more private investment in agriculture sector but also should control flow of agriculture trade across the country and abroad.

Government effectiveness should target more regions with participative approach. Government action in agriculture or rural development project should target more needy people and without corruption. The real implementation of decentralizations will be a good issue of central government objectives.

Policies should be put in place for agriculture market (largely due to a frail private sector), efficient investment in infrastructure, reduce high transportation costs, improve information systems and a poor regulatory framework have hampered proper remuneration of producers and deterred indeed, increase capacitated from investing and specializing in new and high value products. Policies to control highly volatile agriculture products prices and there put in place mechanisms that can help minimize or share the risk borne by producers.

With the human capital available at Benin more policies should be addressed to use this labor and reduce the stubble clearing. More policies need to control rural migration that contribute to cities overpopulation:This is the case of Cotonou population rising in recent years, by the number of motto driver<Zemidjan man>. This situation has considerably reduced rural area labor forces and the agriculture production potential could not be maximized. Their migration also increases also other social problems in Benin. Policies such as household responsibilities should be addressed to stop this migration. Evaluate this class of society by background, classify them and integrate those who are more qualified to public administration and private sector.

The migration has also increased pressure on the land subside in some province such Atacora. The use of the land nowadays indicates that in remote mountainous villages, where land is scarce, hills are being cultivated. Land reform policies should also be improved.

Government should work with the private sector to use more the local labor force and promote more employment. Government should also manage effort to create in all local area “public labor” labor force that could be use for public work in agriculture and others rural development sector.

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Annex1: Input data

Province	Irrigated proportion	Labor	Draft Aninal	Fertilizer	Power
Atakora	0.72	0.14	0.068	0.054	0.5
Donga	0.64	0.18	0.12	0.1	0.3
Borgou	0.67	0.16	0.23	0.1	0.4
Alibori	0.31	0.11	0.03	0.04	0.2
zou	0.56	0.67	0.017	0.36	0.2
Colline	0.31	0.22	0.05	0.08	0.1
Mono	0.66	1.32	0.006	0.4	0.3
Couffo	0.62	1.28	0.58	0.48	0.8
Atlantic	0.17	0.1	0.43	0.42	1.5
Littoral	0.2	0.4	0.17	0.014	1.5
Oueme	0.75	0.36	0.1	0.11	1.2
plateau	0.56	0.12	0.1	0.2	0.9

Annex2: Output data from 1999 to 2003 for each province

1999/2000					
provinces	output value/ha	Grain	cash crops	Animal	other
Atakora	7912294	0.76	0.1	0.02	0.12
Donga	2370420	0.32	0.35	0.02	0.31
Borgou	1817658	0.55	0.31	0.1	0.13
Alibori	3225703	0.47	0.22	0.05	0.26
zou	2494280	0.51	0.24	0.03	0.22
Colline	2339801	0.44	0.25	0.02	0.28
Mono	2072058	0.4	0.2	0.3	0.1
Couffo	2942044	0.5	0.17	0.3	0.03
Atlantic	1436647	0.11	0.27	0.13	0.49
Littoral	3832827	0.03	0.14	0.82	0.4
Oueme	1589144	0.13	0.31	0.21	0.35
plateau	1420555	0.14	0.4	0.04	0.42

2000/2001					
provinces	output value/ha	Grain	cash crops	Animal	other
Atakora	3159458	0.34	0.28	0.04	0.33
Donga	2793621	0.34	0.32	0.02	0.32
Borgou	1893529	0.63	0.34	0.01	0.02
Alibori	3099582	0.42	0.24	0.05	0.29
zou	2382818	0.5	0.24	0.03	0.23
Colline	2046353	0.52	0.32	0.03	0.12
Mono	1912381	0.38	0.21	0.3	0.11
Couffo	2595621	0.39	0.21	0.36	0.4
Atlantic	1164815	0.12	0.28	0.16	0.44
Littoral	4220901	0.01	0.04	0.01	0.94
Oueme	1555441	0.11	0.3	0.22	0.37
plateau	1237794	0.15	0.37	0.05	0.43

2001/2002					
provinces	output value/ha	Grain	cash crops	Animal	other
Atakora	2795676	0.36	0.29	0.01	0.33
Donga	2673791	0.32	0.3	0.02	0.36
Borgou	2441182	0.46	0.26	0.01	0.27
Alibori	3221388	0.39	0.23	0.09	0.29
zou	2041728	0.46	0.26	0.03	0.25
Colline	2214333	0.46	0.3	0.03	0.21
Mono	2166625	0.37	0.2	0.33	0.1
Couffo	2554568	0.45	0.17	0.33	0.05
Atlantic	1421108	0.1	0.25	0.14	0.51
Littoral	5112934	0.01	0.1	0.01	0.98
Oueme	2600324	0.49	0.17	0.14	0.2
plateau	1194974	0.16	0.4	0.05	0.39

2002/2003					
provinces	output value/ha	Grain	cash crops	Animal	other
Atakora	3170353	0.36	0.28	0.01	0.35
Donga	3047256	0.28	0.28	0.02	0.42
Borgou	2517202	0.64	0.28	0.02	0.25
Alibori	3093517	0.44	0.22	0.09	0.25
zou	1667406	0.57	0.34	0.05	0.04
Colline	2472524	0.45	0.28	0.02	0.25
Mono	2090021	0.36	0.2	0.32	0.1
Couffo	2374663	0.41	0.18	0.35	0.06
Atlantic	1606647	0.11	0.24	0.12	0.53
Littoral	5300368	0.02	0	0.01	0.98
Oueme	2538256	0.48	0.18	0.15	0.19
plateau	1444060	0.13	0.46	0.04	0.37

Annex3

Results from DEAP Version 2.1

Instruction file = eg23-ins.txt

Data file = eg23-dta.txt

Output orientated Malmquist DEA

DISTANCES SUMMARY

year = 1

firm crs te rel to tech in yr vrs

no. *********************** te**

	t-1	t	t+1	
Atacora	0	1	5.941	1
Donga	0	1	1.792	1
Borgou	0	1	2.337	1
Alibori	0	1	4.103	1
Zou	0	1	7.836	1
Colline	0	1	2.304	1
Mono	0	1	37255	1
Couffo	0	1	5.379	1
Atlantic	0	1	2.244	1
Littoral	0	1	14.331	1
Oueme	0	1	2.589	1
Plateau	0	1	2.342	1

Mean	0	0.999	7.371	1

year = 2

firm crs te rel to tech in yr vrs

no. ********************** te**

	t-1	t	t+1	
Atacora	2.592	1	2.494	1
Donga	1.212	0.92	1.079	1
Borgou	7.685	1	7.28	1
Alibori	1.323	1	1.436	1
Zou	2.535	1	3.017	1
Colline	2.474	1	1.943	1
Mono	5.944	1	22.222	1
Couffo	10.917	1	17.3	1
Atlantic	0.871	1	1.156	1
Littoral	0.853	1	0.9	1
Oueme	1.074	1	1.75	1
Plateau	1.108	1	0.944	1
Mean	3.216	0.993	5.127	1

year = 3

firm crs te rel to tech in yr vrs

no. ********************** te**

	t-1	t	t+1	
Atacora	2.235	1	0	1
Donga	1.693	0.847	0	1
Borgou	1.876	1	0	1
Alibori	4.337	1	0	1
Zou	7.067	1	0	1
Colline	2.62	1	0	1
Mono	38.578	1	0	1
Couffo	2.866	1	0	1
Atlantic	2.169	1	0	1
Littoral	3.259	1	0	1
Oueme	2.283	1	0	1
Plateau	2.342	1	0	1

Mean	5.944	0.987	0	1

[Note that t-1 in year 1 and t+1 in the final year are not defined]

MALMQUIST INDEX SUMMARY

year = 2

province	effch	techch	pech	sech	tfpch
Atacora	1	0.661	1	1	0.661
Donga	0.92	0.857	1	0.92	0.789
Borgou	1	1.813	1	1	1.813
Alibori	1	0.568	1	1	0.568
Zou	1	0.569	1	1	0.569
Colline	1	1.306	1	1	1.036
Mono	1	0.399	1	1	0.399
Couffo	1	1.425	1	1	1.425
Atlantic	1	0.623	1	1	0.623
Littoral	1	0.244	1	1	0.244
Oueme	1.009	0.641	1	1.009	0.647
Plateau	1	0.688	1	1	0.688

Mean	0.994	0.697	1	0.994	0.692

year = 3

province	effch	techch	pech	sech	tfpch
Atacora	1	0.947	1	1	0.947
Donga	0.92	1.306	1	0.92	1.202
Borgou	1	0.508	1	1	0.508
Alibori	1	1.738	1	1	1.738
Zou	1	1.531	1	1	1.531
Colline	1	1.161	1	1	1.161
Mono	1	1.318	1	1	1.318
Couffo	1	0.407	1	1	0.407
Atlantic	1	1.37	1	1	1.37
Littoral	1	1.903	1	1	1.903
Oueme	1	1.142	1	1	1.142
Plateau	1	1.575	1	1	1.575

Mean	0.993	1.141	1	0.993	1.133

MALMQUIST INDEX SUMMARY OF ANNUAL MEANS

Year	effch	techch	pech	sech	tfpch
2	0.994	0.697	1	0.994	0.692
3	0.993	1.141	1	0.993	1.133

Mean	0.993	0.892	1	0.993	0.886

MALMQUIST INDEX SUMMARY OF FIRM MEANS

province	*effch*	*techch*	*pech*	*sech*	*tfpch*
Atacora	1	0.791	1	1	0.791
Donga	0.92	1.058	0.92	0.92	1.058
Borgou	1	0.959	1	1	0.959
Alibori	1	0.993	1	1	0.993
Zou	1	0.933	1	1	0.933
Colline	1	1.097	1	1	1.097
Mono	1	0.725	1	1	0.725
Couffo	1	0.761	1	1	0.761
Atlantic	1	0.924	1	1	0.924
Littoral	1	0.681	1	1	0.681
Oueme	1	0.856	1	1	0.86
Plateau	1	1.041	1	1	1.041

Mean	0.993	0.892	1	0.993	0.886

[Note that all Malmquist index averages are geometric means]

Annex4:

Table:Benin Agriculture production index, irrigated land ,total agriculture area, rural population, rainfall and Total productivity factors data from 1961 to 2003

Year	Agriculture production index	Land irrigated(ha)	Land irrigated as % of total agriculture area	Total agriculture area(ha)	Rural Population	Rainfall data(mm)	Ln Rainfall	TFP
1961	243338	0	0	0	2101000. 3	1500	7. 31322	0. 11582
1962	227587	0	0	0	2101000. 3	1150	7. 047517	0. 108323
1963	227666	0	0	0	2101000. 3	1400	7. 244228	0. 10836
1964	239015	2000	0. 1	20000	2101000. 3	1510	7. 319865	0. 112583
1965	252898	2000	0. 1	20000	2215000. 9	950	6. 856462	0. 113052
1966	241847	2000	0. 1	20000	2215000. 9	1150	7. 047517	0. 108112
1967	273261	2000	0. 1	20000	2215000. 9	1175	7. 069023	0. 122155
1968	299430	2000	0. 1	20000	2215000. 9	1290	7. 162397	0. 133853
1969	290255	2000	0. 1	20000	2215000. 9	1300	7. 17012	0. 129751
1970	308167	2000	0. 1	20000	2365000	1250	7. 130899	0. 129102
1971	314404	3000	0. 2	15000	2365000	1000	6. 907755	0. 131936
1972	321878	3000	0. 2	15000	2365000	1080	6. 984716	0. 135072
1973	331633	3000	0. 2	15000	2365000	1250	7. 130899	0. 139166
1974	301482	3000	0. 2	15000	2365000	1200	7. 090077	0. 126513
1975	290680	4000	0. 2	20000	2508000. 6	1250	7. 130899	0. 114802
1976	340969	6000	0. 3	20000	2508000. 6	1100	7. 003065	0. 134557
1977	327800	6000	0. 3	20000	2508000. 6	925	6. 829794	0. 12936
1978	365490	8000	0. 4	20000	2508000. 6	1225	7. 110696	0. 14412
1979	386425	8000	0. 4	20000	2508000. 6	1350	7. 20786	0. 152375
1980	360348	10000	0. 5	20000	2695000. 1	1100	7. 003065	0. 132237

1981	351623	10000	0.5	20000	2695000.1	950	6.856462	0.129036
1982	361813	10000	0.5	20000	2695000.1	1000	6.907755	0.132775
1983	371849	10000	0.5	20000	2695000.1	725	6.586172	0.136458
1984	495406	10000	0.5	20000	2695000.1	1075	6.980076	0.1818
1985	498912	10000	0.5	20000	304000.4	1200	7.090077	1.493715
1986	542266	10000	0.5	20000	304000.4	950	6.856462	1.623516
1987	456249	10000	0.5	20000	304000.4	725	6.586172	1.365986
1988	565512	10000	0.5	20000	304000.4	1400	7.244228	1.693111
1989	581779	10000	0.5	20000	304000.4	1100	7.003065	1.741815
1990	629809	10000	0.4	25000	3392000.5	1100	7.003065	0.183778
1991	691842	10000	0.4	25000	3392000.5	1300	7.17012	0.201879
1992	700392	10000	0.4	25000	3392000.5	1475	7.296413	0.204374
1993	788455	10000	0.4	25000	3392000.5	1225	7.110696	0.230071
1994	799692	10000	0.4	25000	3392000.5	1215	7.102499	0.23335
1995	892219	10000	0.4	25000	3920000.4	1450	7.279319	0.225592
1996	989800	10000	0.4	25000	3920000.4	1300	7.17012	0.250265
1997	1035625	12000	0.4	30000	3920000.4	1100	7.003065	0.261389
1998	1054114	12000	0.4	30000	3920000.4	975	6.882437	0.266056
1999	1065350	12000	0.4	30000	3920000.4	1200	7.090077	0.268891
2000	1161964	12000	0.4	30000	4435000.2	1325	7.189168	0.25954
2001	1152645	12000	0.4	30000	4435000.2	1105	7.007601	0.257459
2002	1269981	12000	0.4	30000	4435000.2	1110	7.012115	0.283667
2003	1288774	12000	0.3	40000	4435000.2			

Sources:Own computation with data collecting from World resources institute database, AMMA project work paper and database

Table: Benin land quality, agriculture labor force, government effectiveness and the country openness from 1961 to 2003

Year	X3	X5	X7	X9	TFP
1961	920000	1074000	0	0	0.001686
1962	940000	1075000	0	0	0.00168
1963	960000	1078000	0	0	0.001653
1964	980000	1082000	0	0	0.001611
1965	1000000	1086000	0	0	0.001568
1966	1030000	1092000	0	0	0.001546
1967	1070000	1100000	0	0	0.001464
1968	1100000	1086000	0	0	0.001406
1969	1180000	1116000	0	0	0.001339
1970	1200000	1126000	0	0	0.001306
1971	1250000	1124000	0	0	0.00126
1972	1280000	1123000	0	0	0.001231
1973	1300000	1122000	0	0	0.001209
1974	1330000	1121000	0	0	0.00121
1975	1370000	1120000	0	0	0.001189
1976	1400000	1118000	0	0	0.001135
1977	1430000	1117000	0	0	0.001125
1978	1450000	1115000	0.63125	0	0.00109
1979	1470000	1115000	0.63125	0	0.001066
1980	1500000	1115000	0.63125	0	0.001064
1981	1530000	1135000	0.63125	0	0.001053
1982	1550000	1155000	0.63125	0	0.001037
1983	1560000	1177000	0.63125	0	0.001026
1984	1570000	1199000	0.63125	0	0.000961
1985	1580000	1221000	0.63125	0	0.000955
1986	1590000	1242000	0.63125	0	0.000931
1987	1600000	1263000	0.63125	0	0.000966
1988	1610000	1285000	0.63125	0	0.000914
1989	1620000	1308000	0.63125	0	0.000903
1990	1615000	1334000	0.63125	1	0.000886
1991	1620000	1358000	0.63125	1	0.000861
1992	1630000	1385000	0.63125	1	0.000855
1993	1650000	1411000	0.63125	1	0.000817
1994	1700000	1435000	0.63125	1	0.000798
1995	1790000	1455000	0.63125	1	0.000744
1996	1950000	1473000	0.63125	1	0.000679
1997	2100000	1486000	0.62	1	0.000637
1998	2250000	1498000	0.6	1	0.000605
1999	2300000	1510000	0.62	1	0.000594
2000	2380000	1521000	0.63	1	0.000565
2001	2450000	1537000	0.64	1	0.000555
2002	2550000	1553000	0.63	1	0.000524

2003	2560000	1568000	0.65	1	0.000524

Annex5:

TFP data from 1961-1991 for several countries

Country	This study (1961-91)	Arnade (1961-93)	Fulginiti & Perrin (1961-85)	Lusigi & Thirtle (1961-91)
Afghanistan	-1.6	---	---	---
Albania	-0.5	---	---	---
Algeria	-0.4	---	---	2.6
Angola	-2.8	---	---	-0.8
Argentina	-2.6	-1.9	-4.9	---
Australia	0.4	2.2	---	---
Austria	2.6	1.4	---	---
Bangladesh	-0.6	-2.8	---	---
Belgium-Lux.	4.1	3.0	---	---
Benin	1.3	---	---	1.2
Bolivia	0.4	4.7	---	---
Botswana	1.0	---	---	1.3
Brazil	-0.6	-2.1	-0.5	---
Bulgaria	2.0	0.4	---	---
Burkina Faso	-1.5	---	---	0.8
Burundi	-13.9	---	---	3.4
Cambodia	---	2.9	---	---
Cameroon	-0.5	---	---	1.8
Canada	1.3	1.8	---	---
C.A.R.	0.6	---	---	2.7
Chad	-1.5	---	---	0.2
Chile	1.4	1.3	1.1	---
China	1.9	-0.1	---	---
Colombia	1.6	1.8	0.0	---
Congo	-0.6	---	---	1.2
Costa Rica	2.7	3.3	---	---
Cote D'Ivoire	-0.1	---	-6.8	0.9
Cuba	-1.2	---	---	---
Czechoslovaki	1.6	3.8	---	---
Denmark	3.7	2.6	---	---
Dominican Re	-0.4	-1.2	1.0	---
Ecuador	-0.6	-1.0	---	---
Egypt	0.2	0.3	0.9	0.5
El Salvador	0.3	-0.8	---	---
Ethiopia	-1.0	---	---	-1.7
Finland	3.7	0.4	---	---
France	3.1	1.5	---	---
Gabon	-16.7	---	---	-2.3
Gambia	---	---	---	-1.5
Germany	3.6	a	---	---
Ghana	-1.6	---	-5.0	-0.5
Greece	0.2	0.9	---	---
Guatemala	0.9	-0.5	---	---
Guinea	-0.9	---	---	1.2
Guinea-Bissau	---	---	---	-2.1
Haiti	-0.8	---	---	---
Honduras	-1.3	-0.4	---	---
Hungary	3.8	2.3	---	---
India	-1.5	-2.6	---	---
Indonesia	-0.8	-1.0	---	---
Iran	-0.4	-0.5	---	---
Iraq	-2.2	-3.8	---	---
Ireland	1.3	1.2	---	---
Israel	1.3	2.1	---	---
Italy	0.0	0.8	---	---
Jamaica	0.4	---	---	---
Japan	-0.9	0.0	---	---
Jordan	-0.8	---	---	---
Kenya	1.2	-0.7	---	1.9
Korea D.P.R.	0.9	-0.2	---	---
Korea Rep.	-4.6	-4.6	-7.8	---
Lesotho	-1.7	---	---	-1.7
Liberia	-2.5	---	---	0.0
Libya	---	---	---	6.0
Madagascar	0.2	---	---	-0.1
Malawi	-0.1	---	---	0.3
Malaysia	1.7	1.3	0.4	---
Mali	0.3	---	---	0.8
Mauritania	-10.3	---	---	-0.3
Mauritius	0.7	---	---	1.8
Mexico	0.5	1.2	---	---
Morocco	1.4	---	-0.1	2.4
Mozambique	0.5	---	---	0.3
Myanmar	-1.0	-0.7	---	---
Namibia	---	---	---	1.0
Nepal	-0.9	---	---	---
Netherlands	2.2	6.5	---	---
New Zealand	-0.3	1.0	---	---
Nicaragua	-3.6	-2.0	---	---
Niger	-4.4	---	---	1.5
Nigeria	-2.6	-3.8	---	-0.3
Norway	3.1	-0.2	---	---
Pakistan	-1.2	-3.0	-3.6	---
Panama	0.4	---	---	---
Papua N.G.	-2.2	---	---	---
Paraguay	-1.1	0.2	---	---
Peru	-0.1	0.6	---	---
Philippines	1.2	-0.4	-0.3	---
Poland	-1.7	0.2	---	---
Portugal	-1.6	-1.5	0.7	---
Reunion	---	---	---	1.2
Romania	1.2	-1.4	---	---
Rwanda	-10.9	---	---	6.1
Saudi Arabia	0.2	---	---	---
Senegal	-1.3	---	---	1.5
Sierra Leone	1.0	---	---	0.5
Somalia	0.0	---	---	1.2
South Africa	1.0	0.9	---	1.3
Spain	-0.2	1.0	---	---
Sri Lanka	-0.6	-1.5	0.3	---
Sudan	-1.2	2.5	---	0.1
Suriname	1.7	---	---	---
Swaziland	---	---	---	3.3
Sweden	3.1	---	---	---
Switzerland	0.5	---	---	---
Syria	-2.1	---	---	---
Tanzania	1.2	---	---	0.2
Thailand	-1.1	-1.4	-6.4	---
Togo	-5.6	---	---	-1.3
Trinidad & Tob.	-1.0	---	---	---
Tunisia	1.0	---	---	3.8
Turkey	-1.3	-2.0	2.3	---
Uganda	1.8	---	---	7.8
United Kingdom	2.6	1.3	---	---
United States	2.1	1.5	---	---
Uruguay	-0.1	-1.3	---	---
U.S.S.R.	-0.1	-0.6	---	---
Venezuela	0.7	0.2	---	---
Vietnam	---	-0.4	---	---
Yugoslavia	-0.5	---	---	---
Zaire	-1.3	-4.3	---	8.1
Zambia	0.3	-2.7	-0.1	1.5
Zimbabwe	0.9	-1.2	---	2.0

Source: Michael A. Trueblood , Jay Coggins,."INTERCOUNTRY AGRICULTURAL EFFICIENCY AND PRODUCTIVITY:A MALMQUIST INDEX APPROACH"

Annex6: regression statistic result

Dependent Variable: Y
Method: Least Squares
Date: 12/21/10 Time: 13:02
Sample (adjusted): 1961 2002
Included observations: 42 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-8.050636	0.941137	-8.554155	0.0000
X3	-1.36E-06	2.48E-07	-5.457861	0.0000
X5	8.83E-06	1.03E-06	8.577875	0.0000
X7	0.555590	0.175316	3.169078	0.0031
X9	-2.228100	0.223077	-9.988027	0.0000

R-squared	0.776562	Mean dependent var	0.336804
Adjusted R-squared	0.752406	S.D. dependent var	0.469527
S.E. of regression	0.233631	Akaike info criterion	0.041194
Sum squared resid	2.019584	Schwarz criterion	0.248060
Log likelihood	4.134923	Hannan-Quinn criter.	0.117018
F-statistic	32.14849	Durbin-Watson stat	1.056306
Prob(F-statistic)	0.000000