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Benin Agriculture Productivity and Profitability Measurement

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Abstract: This study explored the Benin agricultural productivity and profitability under occurred reform since 1961-2008. Productivity and profitability has been evaluated using the new approach developed by O'Donnell. In the approach, productivity is obtainained using Hick Moorsteen Index decomposition into technical change, mix efficiency change and scale efficiency change while profitability is obtain using productivity and term of trade product. To achieved the purpose of this study, agricultural output-input quantity and prices data have been collected from FAO stat, Benin Country FAO stata and Benin National Agricultural Institute Database during the period 1961-2008. All data are computing using the DPIN software developed by O'Donnell. It is found that since the country national independency in 1961, Benin agriculture productivity has decreased. The decreased has been more significant after the sector liberalization while the term of trade has been much improved and profitability increased. This situation explains that after the liberalization, competiveness has decreased and monopolization increased. It can be conclude that most private stakeholder involve in the sector during post liberalization has earn more profit than invest to contribute at the sector productivity growth. The study indentify that the country does not improved agricultural productivity after the sector liberalization in opposite to the normal figure that liberalization will stimulate technology transfer and development which will improve productivity. The situation will then highlight policies maker to identify news strategy which can help to optimize the production and agriculture resources efficiency.

Key words: Agricultural productivity, profitability, Benin, reform, case study, China

INTRODUCTION

Like most sub-Sahara economies in Benin agricultural is a dominant sector for economic growth, food security and to poverty alleviation. Its contributes >20% of country's Gross Domestic Product growth (GDP) and employs at least 60% of country's population (OCDE, 2008), mostly women's who have access to small pieces of land (1.7 ha per 7 peoples) provides 90% of export earnings and participates in 15% of state revenue. Over decades, the country's agricultural growth was on downward trend.

However, comparing to developed countries agriculture growth which have been increased highly substantially over several decade, Benin agriculture growth has decreased. This situation generates polarized debate regarding the real impact of agricultural sector growth decreased on the country poverty alleviation goals.

Moreover, Benin's has undergone several reforms under different political regimes since 1961. However, the important reform started from 1990 with the country openness economy and agriculture liberalization in purpose to stimulate the country economic growth. There is evidence that agricultural as key sector for the country economic growth will certainly been affected. The productivity question in Benin is not new topic but very little empirical study has been done in this field to evaluate the whole country agricultural productivity. Most study are sectorial studies focused only in cotton productivity or cassava productivity (Adekambi *et al*., 2010).

This study aims to explore the Benin's agricultural productivity and profitability from 1961-2008 and evaluate the variation over that period.

Productivity and profitability measurement: Productivity is defined as the relationship between output generated by production and service and the input provided to produce this output. According to the researcher, productivity means resources (labor, capital, material, energy and information change) efficient use. Chambers

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(1988) argued that productivity measurement is an approach to measure the production rate of technical change and can be conceptualized as comprising two main components.

The first component is Partial Factor Productivity (PFP) and expressed as the ratio of total output Y and any X_i input used to produce that output. The second component is the total output Y ratio with summation of all input X_i. However, it is very complex most of time to quantify the exact input used to produce a certain amount of output. When the input is visible, it is in form of good and invisible when it is in form of service (Gboyega, 2000). From this point of view, it seems that various components are involved in output production and this makes more complex the exact description of input components. To overcome this complexity, a common approach is to consider labour (human resources), capital (physical and financial assets) and material as input components with time becoming the denominator of output with the assumption that capital, energy and other factors are regarded as aids to individual productivity. Furthermore, there are several methods to aggregate inputs and outputs for productivity measurement.

Grosskopf (1993) conclude that there are four productivity measurement methods which could be base on frontier output or on non-frontier output: Econometric production models; total factor productivity indices; Data Envelope Analysis (DEA) and stochastic frontiers (Coelli *et al*., 1998) (Fig. 1).

The econometric methods are based on the determination of the production function or dual/cost profit function. The important benefit of this approach is that its econometric implementation yields parameter estimates of the production technology in the process of measuring productivity advancement.

But it request to know the production function (ex: the Cob-Douglas Production Function) base on Solow

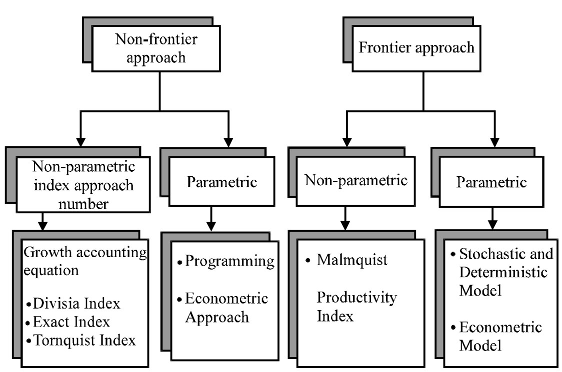

Fig. 1: Methods to aggregate input and output for productivity measurement

Growth Model. Nonetheless, the Malmquist Index base on Caves *et al*. (1982) research and using the distance function are very good tools to measure and analyse productivity. Indeed Fare *et al*. (1994) proposed use of the distance function approach first proposed by Shepherd (1970) and Fare *et al*. (1994) to calculate the Malmquist TFP as geometric mean of output Malmquist Index and input Malmquist Index. They found that the TFP can be decomposed as a product of two forms of efficiency factors which are technical change and technical efficiency change. Fare *et al*. (1994) utilize the Data Envelopment Analysis (DEA) approach. This is a non-parametric approach based on linear programming to compute these two efficiency factors. The non-parametric Malmquist Index became very popular as it is easy to compute. Furthermore, the approach does not require information on cost or revenue shares to aggregate inputs or outputs, consequently, it less demanding in terms of data. Furthermore, the approach allows into changes in efficiency and technology to be broken down (Hsu *et al*., 2003; Alejandro and Bingxin, 2008).

In addition, the method does not attract any of the stochastic assumption restrictions. Despite this, it is susceptible to the effects of data noise and can suffer from the problem of unusual shadow prices when degrees of freedom are restricted (Coelli *et al*., 2005a). The issue of shadow prices is important and is one that is not well understood among researcher who apply the Malmquist DEA Methods. By contrast, DEA Methods in measuring productivity growth which differ from pure Index approach such as Fisher and Tornkvist Indexes do not require any price data. The concept is more evident in agriculture where input price data are seldom available and could at any times be distorted by the government policies.

The productivity evaluation Malmquist TFP approach based on DEA Method has been applied by several scholars to evaluate several countries, regions and provinces in terms of both overall productivity and in various individual sectors over the past decades (Fare *et al*.,1994; David and Elliott, 1998; Hsu *et al*., 2003; Linh, 2003; Coelli and Walding, 2005; Masterson, 2007; Carlos, 2010). Indeed, Fare *et al*. (1994) has applied the method to analysis productivity growth in 17 OECD countries over the period 1979-1988. They found that US productivity growth is slightly higher than an average country in the OECD region and it was due to technical change in the US agriculture sector while Japan's productivity growth is highest with almost half due to efficiency change. Michael A. Trueblood used the method to evaluate intercountry agricultural productivity growth over the period of 1961-1991. It was the most comprehensive sample of countries in the world to date. The study found that globally, productivity declined during the 1960 and 1970's but rebounded in the 1980's. Developing economies' productivity declined over 1961-1991 while developed economies exhibited positive production growth, demonstrating a widening productivity gap.

North America and Western Europe registered high growth while Asia and sub-Sahara Africa registered negative growth. Differences were attributed toward policies of greater economic openness and the effectiveness of the green revolution.

Carlos (2010) used the method to evaluate Latin America and Caribbean agricultural productivity in comparison to the rest of the world during the period 1961-2007.

It was found that among developing regions, Latin America and the Caribbean had the highest agricultural productivity growth during the last 2 decades due particularly to improvements in efficiency and the introduction of new technologies. This has been achieved through strong land allocation and agriculture policies. This was the case in Brazil and Cuba which policies that do not discriminate against agricultural sectors and that remove price and production distortions were considered to have helped improve productivity growth.

David and Elliott (1998) have also applied the Malmquist DEA Method to evaluate change in Chinese provincial agriculture productivity after the China's agricultural reform opening. They found significant variation in productivity change from year-to-year and from province-to-province. They concluded that de-collectivization in the early 1980's accounted for a significant expansion of agricultural productivity while rural industrialization registered the opposite effect. In addition, they found that productivity was also sensitive relative grain prices, to natural disasters including flood and drought and the proximity of a given province to coastal areas.

Hsu *et al.* (2003) has also applied the Malmquist productivity indexes and it decomposition using DEA approach to evaluate China's 27 provinces agricultural productivity to analyze then the productivity growth in China's agricultural sector over the period 1984-1999. He found that over all the considered period TFP growth remains sluggish in China's agricultural. Similarly, Linh (2003) applies Malmquist Productivity Index method to measure Total Factor Productivity (TFP) growth in Vietnamese agriculture using panel data from 60 provinces in Vietnam over the period 1985-2000. His study indicated that most of the early growth in Vietnamese agriculture (1985-1990) was due to TFP growth in response to incentive reforms. He also found that during the period 1990-1995, the growth rate of TFP fell and Vietnam's agricultural growth was mainly caused by drastic investment in capital while in the last period 1995-2000, TFP growth increased again though still much lower than the period 1985-1990. Overall, TFP growth rate in the whole period is estimated 1.96% contributing to 38% of Vietnam's agricultural growth.

However, the Malmquist Index uses to evaluate productivity has two limitations and there remains a polarized debate about the different approach employed. First, there might be cases where the distance function takes on the value of -1 in which case the Malmquist Index is not well defined.

Second, there might be a reallocation factor bias in the measure where there is movement of unallocated inputs from one activity to the other rather than technical growth.

O'Donnell (2008) has made great contribution to the literature by founding that any multiplicatively-complete TFP Index can be exhaustively decomposed into the product of measures of technical change and several meaningful measures of efficiency change. The class of multiplicatively-complete TFP Indexes includes the well-known Paasche, Laspeyres, Fisher, Tornquist and Hicks-Moorsteen Indexes but not the Malmquist TFP Index of caves.

O'Donnell (2008) decomposes the Hicks-Moorsteen TFP Indexes into economically-meaningful measures of technical change (movements in the boundary of the production possibilities set), technical efficiency change (movements towards the boundary) and scale and mix efficiency change (movements around the boundary to capture economies of scale and scope). This is the real advantage compare to Mamlquist TFP which identify the productivity to technical change only.

Unlike some other TFP decomposition methodologies, the O'Donnell (2008) methodology does not depend on any assumptions concerning the technology, firm behavior or the level of competition in input or output markets. These constitute one important limitation of the method as firm behavior and market variation can significantly affect the productivity. Indeed, very few scholars applied this new approach (O'Donnell, 2010a; Laurenceson and O'Donnell, 2011) but form recently more scholars start given attention.

O'Donnell (2010b) shows how Data Envelopment Analysis (DEA) methodology can be employed to compute and decompose the distance-based Hicks Moorsteen TFP Index. He developed linear programming software called DPIN to compute all input and output to obtain all available productivity and profitability components. O'Donnell has evaluated this new approach of TFP Indexing based on Moorsteen Hicks Index with DEA computation approach to revaluate the TFP calculated by Coelli *et al.* (2005b).

His new TFP Index alleged to be different from the famous TFP based on Malmquist Index but it is not the case as he used previous technical change and scale efficiency change index evaluated by Coelli *et al.* (2005a) to compute his new result under variable return scale. Laurenceson and O'Donnell (2011) applied this new approach to evaluate new estimation and decomposition of provincial productivity change in China from China reform opening to 2008. They found that TFP growth during the first half of the reform period (1978-1993) can be attributed to both technical change and efficiency improvement.

However in the second half of the reform period (1994-2008), it can be attributed to technical change alone. Indeed, they also found that average levels of technical and scale efficiency fell during the second half of the reform period, particularly in inland provinces. They attribute these lower efficiency estimates to an especially high rate of technical change not to a decline in the ability of Chinese producers to transform inputs into outputs. They conjecture that Chinese producers have been increasing their productivity levels but at a rate that leaves them lagging behind a rapidly shifting frontier.

MATERIALS AND METHODS

To achieve the purpose of this study, I will first part evaluate Benin's total aggregate output and input variation over the period 1961-2008. This will help us to quantify the amount of input use to produce a quantity of output and also the growth rate. Common classifiers of agriculture aggregated inputs (per ha) are utilized in five categories: capital (K); Labor (L); Energy (E); Material inputs (M) and purchased Services (S). In this study:

- There physical capital and financial capital. Here, only physical capital (X1) is consider and this include agriculture land area
- Labor (X2) include number of man day in agricultural
- Energy is use for annual agriculture energy consumption (Power), however it is neglected component in agriculture sector in Benin
- Materiel input here is defined as total numbers of agricultural tractor per 100 km^2 (X3) and the quantity of fertilizer (X4) used per unit of land
- An agricultural purchase service is indentified to farmers' wholesaler services and it is very mostly characterized by traditional purchased services which are not regulated and difficult to be quantified

Input quantity and prices: All input data are collected from FAO statistical database while input prices of 2008 have been considered a proxy for all the period considerate and collected computing from MAEP (MAEP is Benin Agricultural Ministry.

The land prices have been computed for MAEP rapport on prices proposition report), Moussaratou and INRAB (INRAB is Benin National Agricultural Research Institute) Statistical Data. Ouput data include:

- Grain (Y1) included all cereal (Maize, sorghum, wheat, rice paddy, millet)
- Vegetables and fruit (Y2) (All vegetable and fruit)
- Animal husbandry (Y3) (Beef, mutton, chicken)
- Cash crop (Y4) (cotton, oil palm)

Output quantity and prices: All output quantity and prices data are collected from Benin National Institute of Agricultural Research (INRAB), FAO statistical database and FAO Benin country Statistical database. In second part, researchers evaluate Benin agriculture Total Productivity Factor (TFP), Profitability Efficiency (PROFE) and Term of Trade (TT) to see major endogen factors of Benin's agriculture productivity analyzing the same period between 1960-2008. TPF, PROFE and TT will be calculate based on the decomposition method propose by O'Donnell (2008).

Indeed, O'Donnell measures a firm n productivity mathematically so-called TFP_{nt} which is the product of firm maximum TFP denote TFP_t* and other measure of efficiency. It is express as (Fig. 2 and 3):

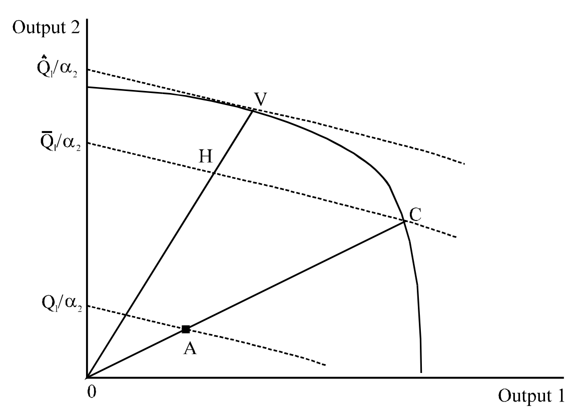

Fig. 2: Output-oriented technical efficiency

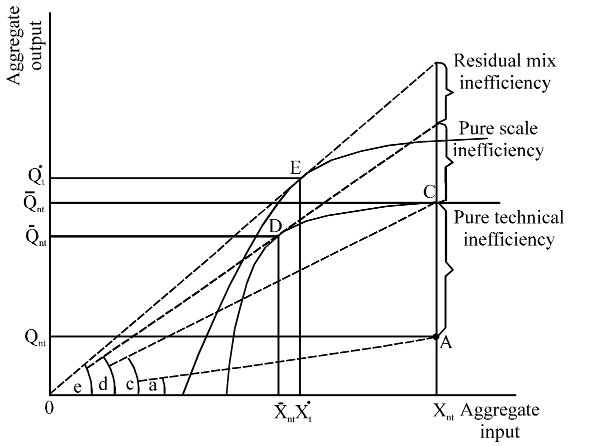

Fig. 3: Output-oriented measures of efficiency

$$\text{TFP}_{nt} = \text{TFP}_t^* * (\text{OTE}_{nt} * \text{OME}_{nt} * \text{ROSE}) \quad (1)$$

or;

$$\text{TFP}_{nt} = \text{TFP}_t^* * (\text{OTE}_{nt} * \text{OSE}_{nt} * \text{RME}_{nt}) \quad (2)$$

Where:

$$\text{OTE}_{nt} = \frac{Q_{nt}}{\bar{Q}_{nt}} \text{(Output – Oriented Technical Efficiency)}$$

$$\text{OTE} = Q_{nt} / \bar{Q}_{ms} = \| OA \| / \| OC \|$$

$$\text{OSE}_{nt} = \frac{\bar{Q}_{nt} / X_{nt}}{\tilde{Q}_{nt} / \tilde{X}_{nt}} \text{(Output – Oriented Scale Efficiency)} \quad (3)$$

$$\text{OME} = \frac{\bar{Q}_{nt}}{\hat{Q}_{nt}} \text{(Output – Oriented Mix Efficiency)} \quad (4)$$

$$\text{OME} = \frac{\bar{Q}_{nt}}{\hat{Q}_{nt}} = \| OH \| / \| OV \|$$

$$\text{ROSE} = \frac{\hat{Q}_{nt} / X_{nt}}{Q_{nt}^* / X_{nt}^*} \text{(Residual Output Oriented Scale Efficiency)} \quad (5)$$

$$\text{RME} = \frac{\tilde{Q}_{nt} / \tilde{X}_{nt}}{Q_{nt}^* / X_{nt}^*} \text{(Residual Mix Efficiency)} \quad (6)$$

Where:

$\bar{Q}_{nt}$ = The maximum aggregate output that is technically feasible

X_{nt} = Used to produce a scalar multiple of q_{nt}

$\hat{Q}_{nt}$ = The maximum aggregate output that is feasible when using X_{nt} to produce any output vector

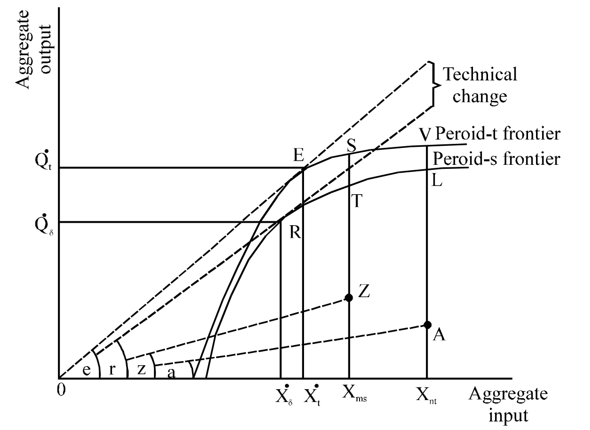

Fig. 4: Technical chnange

$\tilde{Q}_{nt}$ and $\tilde{X}_{nt}$ = The aggregate output and input obtained when TFP is maximized subject to the constraint that the output and input vectors are scalar multiples of q_{nt} and X_{nt}, respectively

A similar equation holds for firm m in period s. It follows that the index that compares the TFP of firm n in period t with the TFP of firm m in period s can be writing:

$$\text{TFP}_{ms,nt} = \frac{\text{TFP}_{nt}}{\text{TFP}_{ms}} = \left(\frac{\text{TFP}_t^*}{\text{TFP}_s^*}\right) \times \left(\frac{\text{OTE}_{nt}}{\text{OTE}_{ms}} \times \frac{\text{OME}_{nt}}{\text{OME}_{ms}} \times \frac{\text{ROSE}_{nt}}{\text{ROSE}_{ms}}\right) \quad (7)$$

$$\text{TFP}_{ms,nt} = \left(\frac{\text{TFP}_t^*}{\text{TFP}_s^*}\right) \times \left(\frac{\text{OTE}_{nt}}{\text{OTE}_{ms}} \times \frac{\text{OSE}_{nt}}{\text{OSE}_{ms}} \times \frac{\text{RME}_{nt}}{\text{RME}_{ms}}\right) \quad (8)$$

Each TFP and other efficiency will be compute applying the DPNI software writing by O'Donnell (2008) base on data envelopment analysis using the country agriculture input and output data collected in first part (Fig. 4). Moreover, the profitability amount firm n in period t and firm m in period s is express as the product of TT and TFP. Mathematically, researchers have:

$$\text{PROF}_{ms,nt} = \frac{\text{PROF}_{nt}}{\text{PROF}_{ms}} = \frac{P_{ms,nt}}{W_{ms,nt}} \frac{Q_{ms,nt}}{X_{ms,nt}} = \text{TT}_{ms,nt} \times \text{TFP}_{ms,nt}$$

PROF is computing directly using the DPIN. From this, it is easy to deduce the terms of trade. There is an inverse relationship between productivity and the terms of trade which holds two interesting implications. First, it provides a rationale for microeconomic reform programs designed to increase levels of competition in agricultural output and input markets-deteriorations in the terms of trade that result from increased competition will tend to drive firms towards points of maximum productivity. Second, it provides an explanation for the observed convergence in rates of agricultural productivity growth in regions, states and countries that are becoming increasingly integrated and/or globalised firms that strictly prefer more income to less and who face the same technology and prices will optimally choose to operate at the same point on the production frontier, they will make similar adjustments to their production choices in response to changes in the common terms of trade and they will thus experience similar rates of productivity change.

RESULTS AND DISCUSSION

Benin has done a great effort since several years to achieve the country food demand. This is showed by the country grain, vegetable and meat output and output per ha variation since 1961.

Grain production: In Benin grain production is characterize by maize, rice, sorghum and millet. Maize is the major grain crop production in Benin and its large number of varieties allows the production under climatic conditions reaching from sub humid to semi-arid. It grows in all parts in the country rotationally depending on the local consumption patterns and comparative advantages of other products (Valerien and Andrew, 2005) mostly grow maize is most grow in the South region.

- Grain output generally has increased slowly from 1960 until today with some fall and maize is the highest output production. While the output per ha has also increase slowly since 1960 with major fall in 1977, 1988 and 2008 (Fig. 5a, b)
- Vegetable and fruit output has also known slow increased from 1961 with the higher pick in 1990 (500000 MT) of fruit. Idem for the output per ha which fall since 1996 until today. Over all the period fruit production output is higher than vegetable (Fig. 6a, b)
- Meat production output rise since 1961 until now-a-days in average but with constant production from 1963-1986 (2000 MT) before to rose while the meat output per capita has decreased from 1966 (13 T ha^{-1}) to 1986 (8 T ha^{-1}) before to rise (Fig. 7a, b)

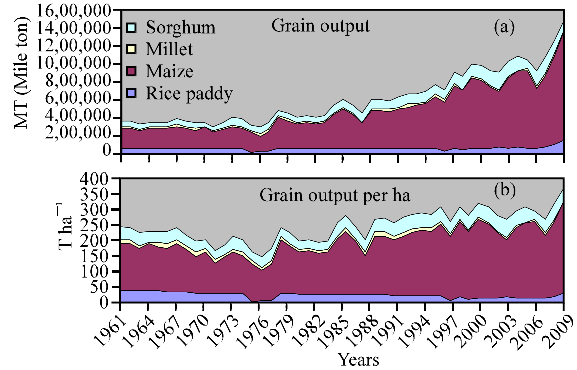

Fig. 5: Benin grain output a) variation between 1961 and 2008 and b) per ha variation between 1961 and 2008 (Emphasize is mine from FAO statistical database)

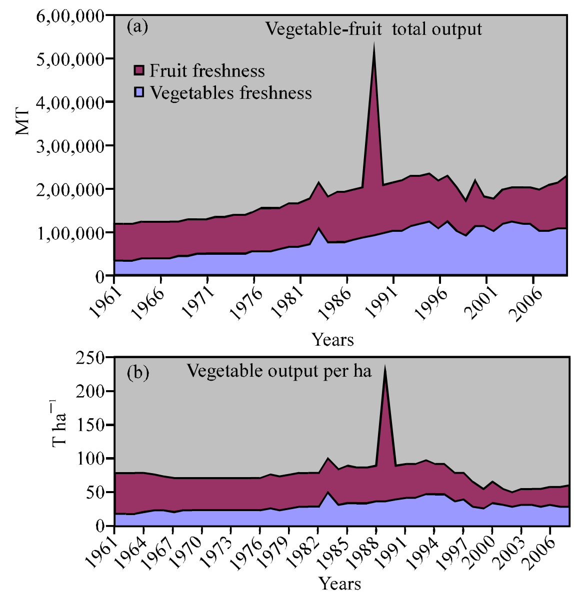

Fig. 6: Benin vegetable output; a) variation between 1961 and 2008 and b) per ha variation between 1961 and 2008 (Emphasize is mine from FAO statistical database)

- Cash crop production has also fluctuate over the whole period with slow rise since 1961, two pick in 1997 and 2005 before to fall since 2005. Cotton seed was more important in term of quantity than palm oil Fig. 8a, b). Indeed, there is inverse relationship between palm kernel and palm oil (Fig. 8c)

However, this cannot be achieved without input improvement. Agriculture labor, land, fertilizer and machines used have fluctuated significantly over the years.

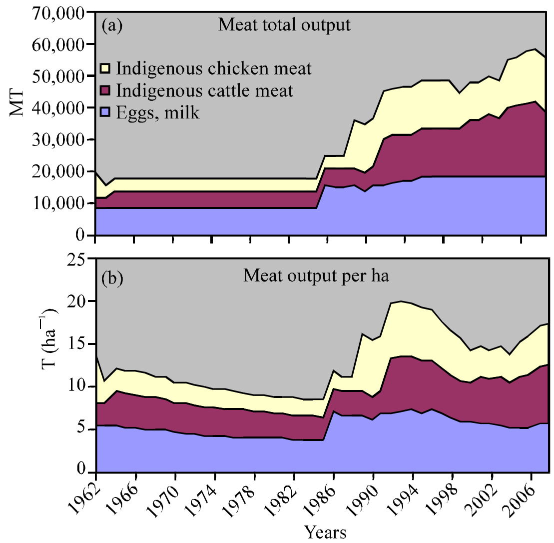

Fig. 7: Benin meat output a) variation between 1961 and 2008 and b) per ha variation between 1961 and 2008 (Emphasize is mine from FAO statistical database)

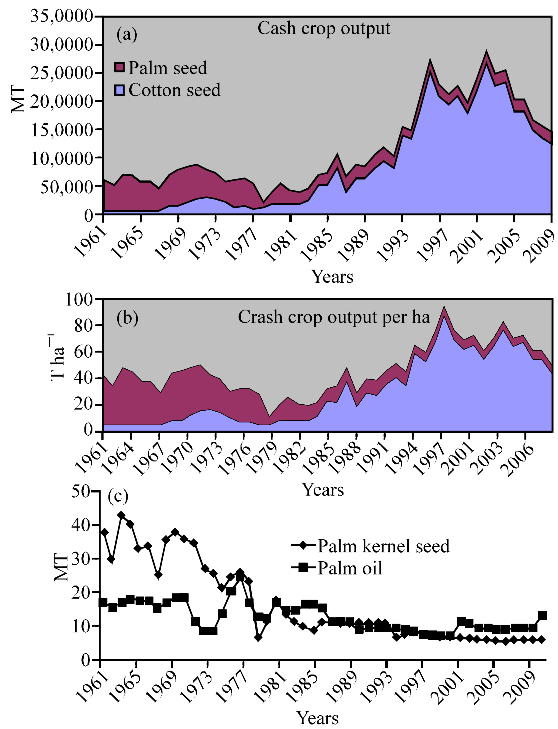

Fig. 8: a, b) Benin cash crop output variation between 1961 and 2008 and c) Benin kernel-plam oil output variation between 1961 and 2008 (Emphasize is mine from FAO statistical database)

- Agricultural lands have considerably increased from 1961 to 2005 and fall slowly since 2009 (Fig. 9)

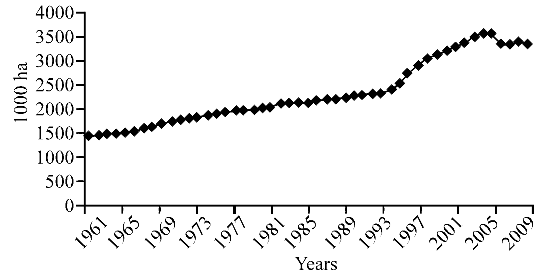

Fig. 9: Benin agricultural land variation between 1961 and 2008 (Emphasize is mine from FAO statistical database) Land 1000 ha

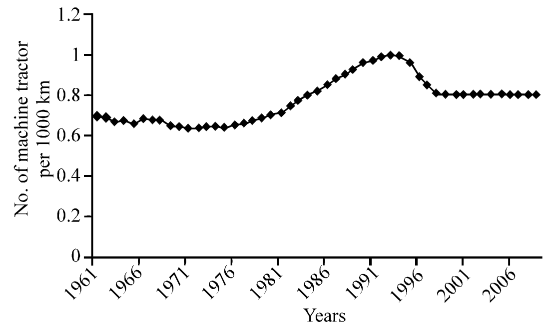

Fig. 10: Benin agricultural machine used variation between 1961 and 2008 (Emphasize is mine from FAO statistical database) Machine tractor 100 km^2

- Agriculture machine has significantly decreased from 1961 (0.75 tractor per 100 km) to 1978 (0.65 tractor per 100 km) and increased from 1978 to his pick in 1 tractor per 100 km in 1996 before to fall until 2000 to his constant level (Fig. 10)
- Fertilizers used over all the period varied in switchback (Fig. 11a, b)
- Labor in general has increased considerably over the period (Fig. 12)

In general, it is fund that over decades Benin agriculture grain has increased while vegetable output per hectare decreased and livestock per ha increased. Look at the variation of Benin agriculture input, it could be concluded that all the production has been achieved using very intensive labor. Land expansion increased but the mechanization is still very archaic with high punt of fertilizer used. Moreover, indexes that measure change in Benin agricultural profitability (PROF), productivity (TFP) and Term of Trade (TT) variation between the review period has been very remarkable presented (Fig. 13 and 14). Figure 13 and 14 are obtained using the DPIN result shown in Table 1 and 2.

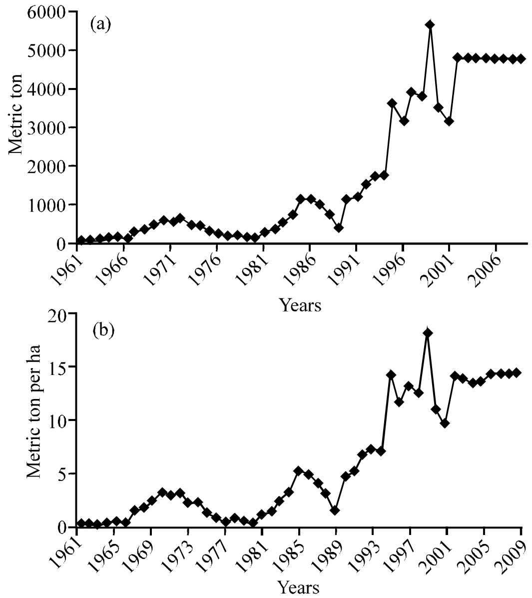

Fig. 11: Benin fertilizer used a) variation between 1961 and 2008; b) per ha variation between 1961 and 2008

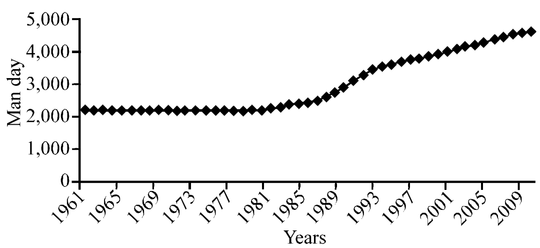

Fig. 12: Benin agricultural labor forces variation between 1961 and 2008

The analysis of Fig. 6, analysis showed that profitability decreased by 77, 55% from 1961-1990 before the agriculture liberalization and increased by 22.67% between 1990 and 2008 after the liberalization. However,

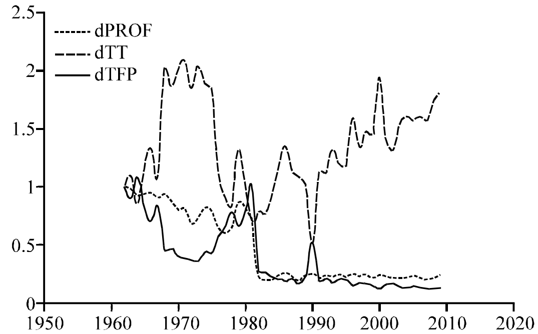

Fig. 13: Indexes measuring changes in profitability, TFP and the terms of trade in Benin agricultural

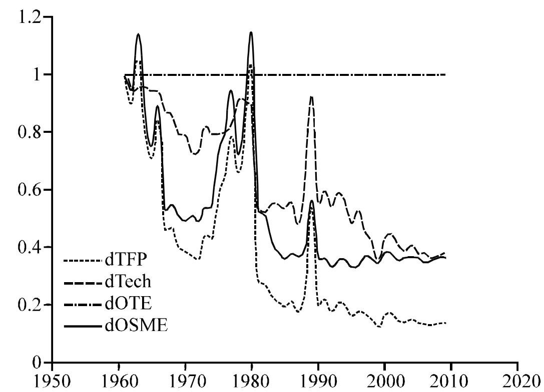

Fig. 14: Output-oriented components of TFP change

Table 1: Benin country's agricultural input-ouput quantiy and prices

Obs i	Period t	Firm n	REV	COST	PROF	OTE	OSE	OME	ITE	ISE	IME	Hick-Moorsteen Indexes: firm n in period t relative to firm n in period t-1 MaxTFP	dPROF	dTT
1	1	1	902840.8	336582.0	2.6824	1	1	1	1	1	1	1.7386		
2	2	1	889906.9	338577.0	2.6284	1	1	1	1	1	1	1.6432	0.9799	1.0914
3	3	1	841278.7	340566.1	2.4702	1	1	1	1	1	1	1.6591	0.9398	0.7774
4	4	1	876907.8	348574.1	2.5157	1	1	1	1	1	1	1.6603	1.0184	1.3609
5	5	1	884596.0	350578.7	2.5232	1	1	1	1	1	1	1.6374	1.0030	1.1550
6	6	1	882393.1	365560.1	2.4138	1	1	1	1	1	1	1.6300	0.9566	0.8140
7	7	1	938636.9	375605.8	2.4990	1	1	1	1	1	1	1.5230	1.0353	1.8560
8	8	1	894027.1	384613.5	2.3245	1	1	1	1	1	1	1.4912	0.9302	0.9215
9	9	1	855726.5	399138.4	2.1439	1	1	1	1	1	1	1.3801	0.9223	1.0713
10	10	1	882904.0	407166.9	2.1684	1	1	1	1	1	1	1.3724	1.0114	1.0511
11	11	1	765996.7	418142.5	1.8319	1	1	1	1	1	1	1.2725	0.8448	0.8838
12	12	1	836534.5	427153.0	1.9584	1	1	1	1	1	1	1.2775	1.0690	1.0986
13	13	1	960256.4	435105.1	2.2070	1	1	1	1	1	1	1.4160	1.1269	0.9282
14	14	1	934105.9	444104.1	2.1033	1	1	1	1	1	1	1.3834	0.9531	0.9644
15	15	1	786938.9	454038.4	1.7332	1	1	1	1	1	1	1.3873	0.8240	0.6187
16	16	1	748577.4	469022.4	1.5960	1	1	1	1	1	1	1.3945	0.9209	0.8199
17	17	1	839565.6	477994.5	1.7564	1	1	1	1	1	1	1.4401	1.1005	0.9076
18	18	1	1148943.0	492012.3	2.3352	1	1	1	1	1	1	1.5877	1.3295	1.5844
19	19	1	1075995.0	499994.4	2.1520	1	1	1	1	1	1	1.5778	0.9216	0.7597
20	20	1	986640.9	517978.5	1.9048	1	1	1	1	1	1	1.5464	0.8851	0.6964
21	21	1	315248.4	530026.2	0.5948	1	1	1	1	1	1	0.9415	0.3123	1.1173
22	22	1	305762.8	554334.4	0.5516	1	1	1	1	1	1	0.9107	0.9274	0.9832
23	23	1	317010.8	570393.0	0.5558	1	1	1	1	1	1	0.9614	1.0076	1.1955
24	24	1	382117.9	586443.3	0.6516	1	1	1	1	1	1	0.9492	1.1724	1.2667

Table 1: Continued

Obs i	Period t	Firm n	REV	COST	PROF	OTE	OSE	OME	ITE	ISE	IME	Hick-Moorsteen Indexes: firm n in period t relative to firm n in period t - 1 MaxTFP	dPROF	dTT
25	25	1	417708.8	603542.1	0.6921	1	1	1	1	1	1	0.9323	1.0622	1.1542
26	26	1	397781.1	624517.6	0.6369	1	1	1	1	1	1	0.9668	0.9203	0.8428
27	27	1	325293.7	640499.1	0.5079	1	1	1	1	1	1	0.8353	0.7974	0.9575
28	28	1	428669.3	656454.5	0.6530	1	1	1	1	1	1	1.0747	1.2858	0.9254
29	29	1	460208.6	672388.1	0.6844	1	1	1	1	1	1	1.6134	1.0481	0.4875
30	30	1	416979.2	692567.2	0.6021	1	1	1	1	1	1	0.9672	0.8797	2.2893
31	31	1	453919.3	702599.8	0.6461	1	1	1	1	1	1	1.0411	1.0730	0.9946
32	32	1	451256.5	716190.6	0.6301	1	1	1	1	1	1	0.9387	0.9753	1.1785
33	33	1	483576.2	727733.0	0.6645	1	1	1	1	1	1	1.0268	1.0546	0.9073
34	34	1	472107.8	747713.1	0.6314	1	1	1	1	1	1	0.9754	0.9502	0.9899
35	35	1	519070.5	769062.2	0.6749	1	1	1	1	1	1	0.8349	1.0690	1.3441
36	36	1	504734.0	796895.2	0.6334	1	1	1	1	1	1	0.9220	0.9384	0.8401
37	37	1	540764.0	823987.7	0.6563	1	1	1	1	1	1	0.7924	1.0362	1.1003
38	38	1	503717.9	851919.3	0.5913	1	1	1	1	1	1	0.7363	0.9010	0.9898
39	39	1	541398.0	858211.3	0.6308	1	1	1	1	1	1	0.6123	1.0669	1.3401
40	40	1	534391.2	866347.4	0.6168	1	1	1	1	1	1	0.7510	0.9778	0.7213
41	41	1	516135.8	873271.5	0.5910	1	1	1	1	1	1	0.7776	0.9582	0.9344
42	42	1	518617.5	883502.9	0.5870	1	1	1	1	1	1	0.7071	0.9932	1.1654
43	43	1	536795.1	893678.8	0.6007	1	1	1	1	1	1	0.6731	1.0233	1.0475
44	44	1	564805.9	903656.6	0.6250	1	1	1	1	1	1	0.7101	1.0406	0.9806
45	45	1	528395.2	898974.3	0.5878	1	1	1	1	1	1	0.6594	0.9404	1.0161
46	46	1	489260.6	880533.5	0.5556	1	1	1	1	1	1	0.6565	0.9453	0.9832
47	47	1	522205.0	881036.9	0.5927	1	1	1	1	1	1	0.6294	1.0667	1.0992
48	48	1	576988.9	886524.9	0.6508	1	1	1	1	1	1	0.6425	1.0981	1.0464
49	49	1	647854.4	877058.8	0.7387	1	1	1	1	1	1	0.6582	1.1349	1.1165

Obs i	Hick--Moorsteen Indexes: Firm n in period t relative to firm n in period t - 1 dTFP	dTech	dEff	dOTE	dOSE	dOME	dROSE	dOSME	ITE	dISE	dIME	dRISE	dISME	dRME
1	0.8978	0.9451	0.9500	1	1	1	0.9500	0.9500	1	1	1	0.9500	0.9500	0.9500
2	1.2090	1.0097	1.1974	1	1	1	1.1974	1.1974	1	1	1	1.1974	1.1974	1.1974
3	0.7483	1.0007	0.7478	1	1	1	0.7478	0.7478	1	1	1	0.7478	0.7478	0.7478
4	0.8684	0.9862	0.8805	1	1	1	0.8805	0.8805	1	1	1	0.8805	0.8805	0.8805
5	1.1752	0.9955	1.1805	1	1	1	1.1805	1.1805	1	1	1	1.1805	1.1805	1.1805
6	0.5578	0.9343	0.5970	1	1	1	0.5970	0.5970	1	1	1	0.5970	0.5970	0.5970
7	1.0094	0.9791	1.0309	1	1	1	1.0309	1.0309	1	1	1	1.0309	1.0309	1.0309
8	0.8610	0.9255	0.9303	1	1	1	0.9303	0.9303	1	1	1	0.9303	0.9303	0.9303
9	0.9622	0.9944	0.9677	1	1	1	0.9677	0.9677	1	1	1	0.9677	0.9677	0.9677
10	0.9559	0.9272	1.0309	1	1	1	1.0309	1.0309	1	1	1	1.0309	1.0309	1.0309
11	0.9731	1.0039	0.9693	1	1	1	0.9693	0.9693	1	1	1	0.9693	0.9693	0.9693
12	1.2141	1.1085	1.0953	1	1	1	1.0953	1.0953	1	1	1	1.0953	1.0953	1.0953
13	0.9882	0.9769	1.0115	1	1	1	1.0115	1.0115	1	1	1	1.0115	1.0115	1.0115
14	1.3319	1.0029	1.3281	1	1	1	1.3281	1.3281	1	1	1	1.3281	1.3281	1.3281
15	1.1232	1.0052	1.1174	1	1	1	1.1174	1.1174	1	1	1	1.1174	1.1174	1.1174
16	1.2125	1.0327	1.1741	1	1	1	1.1741	1.1741	1	1	1	1.1741	1.1741	1.1741
17	0.8391	1.1025	0.7611	1	1	1	0.7611	0.7611	1	1	1	0.7611	0.7611	0.7611
18	1.2131	0.9938	1.2207	1	1	1	1.2207	1.2207	1	1	1	1.2207	1.2207	1.2207
19	1.2710	0.9801	1.2969	1	1	1	1.2969	1.2969	1	1	1	1.2969	1.2969	1.2969
20	0.2795	0.6088	0.4591	1	1	1	0.4591	0.4591	1	1	1	0.4591	0.4591	0.4591
21	0.9432	0.9673	0.9751	1	1	1	0.9751	0.9751	1	1	1	0.9751	0.9751	0.9751
22	0.8428	1.0556	0.7984	1	1	1	0.7984	0.7984	1	1	1	0.7984	0.7984	0.7984
23	0.9256	0.9874	0.9374	1	1	1	0.9374	0.9374	1	1	1	0.9374	0.9374	0.9374
24	0.9203	0.9821	0.9371	1	1	1	0.9371	0.9371	1	1	1	0.9371	0.9371	0.9371
25	1.0920	1.0370	1.0530	1	1	1	1.0530	1.0530	1	1	1	1.0530	1.0530	1.0530
26	0.8328	0.8640	0.9638	1	1	1	0.9638	0.9638	1	1	1	0.9638	0.9638	0.9638
27	1.3894	1.2865	1.0800	1	1	1	1.0800	1.0800	1	1	1	1.0800	1.0800	1.0800
28	2.1501	1.5013	1.4321	1	1	1	1.4321	1.4321	1	1	1	1.4321	1.4321	1.4321
29	0.3842	0.5995	0.6410	1	1	1	0.6410	0.6410	1	1	1	0.6410	0.6410	0.6410
30	1.0788	1.0764	1.0023	1	1	1	1.0023	1.0023	1	1	1	1.0023	1.0023	1.0023
31	0.8276	0.9017	0.9178	1	1	1	0.9178	0.9178	1	1	1	0.9178	0.9178	0.9178
32	1.1624	1.0939	1.0626	1	1	1	1.0626	1.0626	1	1	1	1.0626	1.0626	1.0626
33	0.9599	0.9499	1.0106	1	1	1	1.0106	1.0106	1	1	1	1.0106	1.0106	1.0106
34	0.7953	0.8560	0.9291	1	1	1	0.9291	0.9291	1	1	1	0.9291	0.9291	0.9291
35	1.1170	1.1044	1.0114	1	1	1	1.0114	1.0114	1	1	1	1.0114	1.0114	1.0114
36	0.9417	0.8594	1.0957	1	1	1	1.0957	1.0957	1	1	1	1.0957	1.0957	1.0957
37	0.9103	0.9292	0.9796	1	1	1	0.9796	0.9796	1	1	1	0.9796	0.9796	0.9796
38	0.7961	0.8315	0.9574	1	1	1	0.9574	0.9574	1	1	1	0.9574	0.9574	0.9574
39	1.3556	1.2267	1.1051	1	1	1	1.1051	1.1051	1	1	1	1.1051	1.1051	1.1051
40	1.0254	1.0354	0.9904	1	1	1	0.9904	0.9904	1	1	1	0.9904	0.9904	0.9904
41	0.8522	0.9094	0.9371	1	1	1	0.9371	0.9371	1	1	1	0.9371	0.9371	0.9371
42	0.9769	0.9518	1.0263	1	1	1	1.0263	1.0263	1	1	1	1.0263	1.0263	1.0263
43	1.0611	1.0551	1.0057	1	1	1	1.0057	1.0057	1	1	1	1.0057	1.0057	1.0057
44	0.9255	0.9285	0.9967	1	1	1	0.9967	0.9967	1	1	1	0.9967	0.9967	0.9967
45	0.9615	0.9956	0.9658	1	1	1	0.9658	0.9658	1	1	1	0.9658	0.9658	0.9658
46	0.9705	0.9587	1.0123	1	1	1	1.0123	1.0123	1	1	1	1.0123	1.0123	1.0123
47	1.0493	1.0208	1.0279	1	1	1	1.0279	1.0279	1	1	1	1.0279	1.0279	1.0279
48	1.0165	1.0245	0.9922	1	1	1	0.9922	0.9922	1	1	1	0.9922	0.9922	0.9922

Table 1: Continued

			Hicks-Moorsteen Indexes: Firm n in period t relative to firm n in period t															
Obs i	Period t	Firm n	dPROF	dTT	dTFP	dTech	dEff	dOTE	dOSE	dOME	dROSE	dOSME	dITE	dISE	dIME	dRISE	dISME	dRME
1	1	1	1.0000	1.0000	1.0000	1.0000	1.0000	1	1	1	1.0000	1.0000	1	1	1	1.0000	1.0000	1.0000
2	2	1	0.9799	1.0914	0.8978	0.9451	0.9500	1	1	1	0.9500	0.9500	1	1	1	0.9500	0.9500	0.9500
3	3	1	0.9209	0.8484	1.0855	0.9543	1.1375	1	1	1	1.1375	1.1375	1	1	1	1.1375	1.1375	1.1375
4	4	1	0.9379	1.1546	0.8123	0.9550	0.8506	1	1	1	0.8506	0.8506	1	1	1	0.8506	0.8506	0.8506
5	5	1	0.9407	1.3335	0.7054	0.9418	0.7490	1	1	1	0.7490	0.7490	1	1	1	0.7490	0.7490	0.7490
6	6	1	0.8999	1.0855	0.8290	0.9375	0.8842	1	1	1	0.8842	0.8842	1	1	1	0.8842	0.8842	0.8842
7	7	1	0.9316	2.0148	0.4624	0.8760	0.5279	1	1	1	0.5279	0.5279	1	1	1	0.5279	0.5279	0.5279
8	8	1	0.8666	1.8567	0.4667	0.8577	0.5442	1	1	1	0.5442	0.5442	1	1	1	0.5442	0.5442	0.5442
9	9	1	0.7993	1.9890	0.4018	0.7938	0.5062	1	1	1	0.5062	0.5062	1	1	1	0.5062	0.5062	0.5062
10	10	1	0.8084	2.0906	0.3867	0.7893	0.4899	1	1	1	0.4899	0.4899	1	1	1	0.4899	0.4899	0.4899
11	11	1	0.6829	1.8478	0.3696	0.7319	0.5050	1	1	1	0.5050	0.5050	1	1	1	0.5050	0.5050	0.5050
12	12	1	0.7301	2.0300	0.3596	0.7348	0.4895	1	1	1	0.4895	0.4895	1	1	1	0.4895	0.4895	0.4895
13	13	1	0.8228	1.8843	0.4366	0.8145	0.5361	1	1	1	0.5361	0.5361	1	1	1	0.5361	0.5361	0.5361
14	14	1	0.7841	1.8172	0.4315	0.7957	0.5423	1	1	1	0.5423	0.5423	1	1	1	0.5423	0.5423	0.5423
15	15	1	0.6461	1.1243	0.5747	0.7979	0.7203	1	1	1	0.7203	0.7203	1	1	1	0.7203	0.7203	0.7203
16	16	1	0.5950	0.9218	0.6455	0.8021	0.8048	1	1	1	0.8048	0.8048	1	1	1	0.8048	0.8048	0.8048
17	17	1	0.6548	0.8366	0.7827	0.8283	0.9449	1	1	1	0.9449	0.9449	1	1	1	0.9449	0.9449	0.9449
18	18	1	0.8706	1.3255	0.6568	0.9132	0.7192	1	1	1	0.7192	0.7192	1	1	1	0.7192	0.7192	0.7192
19	19	1	0.8023	1.0070	0.7967	0.9075	0.8779	1	1	1	0.8779	0.8779	1	1	1	0.8779	0.8779	0.8779
20	20	1	0.7101	0.7012	1.0127	0.8894	1.1386	1	1	1	1.1386	1.1386	1	1	1	1.1386	1.1386	1.1386
21	21	1	0.2217	0.7835	0.2830	0.5415	0.5227	1	1	1	0.5227	0.5227	1	1	1	0.5227	0.5227	0.5227
22	22	1	0.2056	0.7703	0.2670	0.5238	0.5096	1	1	1	0.5096	0.5096	1	1	1	0.5096	0.5096	0.5096
23	23	1	0.2072	0.9209	0.2250	0.5529	0.4069	1	1	1	0.4069	0.4069	1	1	1	0.4069	0.4069	0.4069
24	24	1	0.2429	1.1664	0.2083	0.5460	0.3814	1	1	1	0.3814	0.3814	1	1	1	0.3814	0.3814	0.3814
25	25	1	0.2580	1.3462	0.1917	0.5362	0.3574	1	1	1	0.3574	0.3574	1	1	1	0.3574	0.3574	0.3574
26	26	1	0.2375	1.1346	0.2093	0.5561	0.3764	1	1	1	0.3764	0.3764	1	1	1	0.3764	0.3764	0.3764
27	27	1	0.1893	1.0863	0.1743	0.4805	0.3628	1	1	1	0.3628	0.3628	1	1	1	0.3628	0.3628	0.3628
28	28	1	0.2434	1.0053	0.2422	0.6181	0.3918	1	1	1	0.3918	0.3918	1	1	1	0.3918	0.3918	0.3918
29	29	1	0.2552	0.4901	0.5207	0.9280	0.5611	1	1	1	0.5611	0.5611	1	1	1	0.5611	0.5611	0.5611
30	30	1	0.2245	1.1219	0.2001	0.5563	0.3596	1	1	1	0.3596	0.3596	1	1	1	0.3596	0.3596	0.3596
31	31	1	0.2409	1.1159	0.2158	0.5988	0.3605	1	1	1	0.3605	0.3605	1	1	1	0.3605	0.3605	0.3605
32	32	1	0.2349	1.3150	0.1786	0.5399	0.3308	1	1	1	0.3308	0.3308	1	1	1	0.3308	0.3308	0.3308
33	33	1	0.2477	1.1932	0.2076	0.5906	0.3515	1	1	1	0.3515	0.3515	1	1	1	0.3515	0.3515	0.3515
34	34	1	0.2354	1.1811	0.1993	0.5610	0.3553	1	1	1	0.3553	0.3553	1	1	1	0.3553	0.3553	0.3553
35	35	1	0.2516	1.5875	0.1585	0.4802	0.3301	1	1	1	0.3301	0.3301	1	1	1	0.3301	0.3301	0.3301
36	36	1	0.2361	1.3337	0.1770	0.5303	0.3339	1	1	1	0.3339	0.3339	1	1	1	0.3339	0.3339	0.3339
37	37	1	0.2447	1.4675	0.1667	0.4557	0.3658	1	1	1	0.3658	0.3658	1	1	1	0.3658	0.3658	0.3658
38	38	1	0.2204	1.4524	0.1518	0.4235	0.3584	1	1	1	0.3584	0.3584	1	1	1	0.3584	0.3584	0.3584
39	39	1	0.2352	1.9464	0.1208	0.3522	0.3431	1	1	1	0.3431	0.3431	1	1	1	0.3431	0.3431	0.3431
40	40	1	0.2300	1.4039	0.1638	0.4320	0.3792	1	1	1	0.3792	0.3792	1	1	1	0.3792	0.3792	0.3792
41	41	1	0.2203	1.3119	0.1680	0.4472	0.3755	1	1	1	0.3755	0.3755	1	1	1	0.3755	0.3755	0.3755
42	42	1	0.2188	1.5289	0.1431	0.4067	0.3519	1	1	1	0.3519	0.3519	1	1	1	0.3519	0.3519	0.3519
43	43	1	0.2239	1.6014	0.1398	0.3871	0.3612	1	1	1	0.3612	0.3612	1	1	1	0.3612	0.3612	0.3612
44	44	1	0.2330	1.5704	0.1484	0.4084	0.3633	1	1	1	0.3633	0.3633	1	1	1	0.3633	0.3633	0.3633
45	45	1	0.2191	1.5957	0.1373	0.3793	0.3621	1	1	1	0.3621	0.3621	1	1	1	0.3621	0.3621	0.3621
46	46	1	0.2071	1.5689	0.1320	0.3776	0.3497	1	1	1	0.3497	0.3497	1	1	1	0.3497	0.3497	0.3497
47	47	1	0.2210	1.7245	0.1281	0.3620	0.3540	1	1	1	0.3540	0.3540	1	1	1	0.3540	0.3540	0.3540
48	48	1	0.2426	1.8045	0.1345	0.3695	0.3639	1	1	1	0.3639	0.3639	1	1	1	0.3639	0.3639	0.3639
49	49	1	0.2754	2.0148	0.1367	0.3786	0.3610	1	1	1	0.3610	0.3610	1	1	1	0.3610	0.3610	0.3610

Table 2: DPIN results

Obs	Period	Firm	Y1	Y2	Y3	Y4	X1	X2	X3	X4	P1	P2	P3	P4	W1	W2	W3	W4
1	1	1	625.7468	79.75035	13.488210	22.53160	1442	1.506395	0.409847	64	1250	300	5000	1300	100	240	50	3000
2	2	1	627.5646	78.65937	10.841310	21.26678	1462	1.485788	0.408345	64	1250	300	5000	1300	100	240	50	3000
3	3	1	582.8736	77.59784	12.145750	22.06037	1482	1.465737	0.286775	64	1250	300	5000	1300	100	240	50	3000
4	4	1	610.7335	77.89614	11.984020	23.23227	1502	1.446220	0.539281	66	1250	300	5000	1300	100	240	50	3000
5	5	1	618.1110	76.87254	11.826540	22.89446	1522	1.427216	0.722733	66	1250	300	5000	1300	100	240	50	3000
6	6	1	618.1110	75.3866	11.597940	22.42203	1552	1.399628	0.483247	70	1250	300	5000	1300	100	240	50	3000
7	7	1	666.7800	73.49246	11.306530	20.44726	1592	1.364461	1.567211	72	1250	300	5000	1300	100	240	50	3000
8	8	1	626.6451	73.36621	11.097410	25.55677	1622	1.339225	1.840937	74	1250	300	5000	1300	100	240	50	3000
9	9	1	596.8553	71.17750	10.544820	27.36927	1707	1.272538	2.659637	76	1250	300	5000	1300	100	240	50	3000
10	10	1	614.5558	72.37985	10.422700	31.44751	1727	1.257801	3.300521	78	1250	300	5000	1300	100	240	50	3000
11	11	1	526.6697	71.75014	10.129430	27.29800	1777	1.222410	2.982555	80	1250	300	5000	1300	100	240	50	3000
12	12	1	585.7607	72.49585	9.961262	25.21423	1807	1.202115	3.290537	82	1250	300	5000	1300	100	240	50	3000
13	13	1	686.7826	72.63273	9.852217	23.63638	1827	1.188956	2.395183	84	1250	300	5000	1300	100	240	50	3000
14	14	1	666.0470	72.42865	9.693053	24.11790	1857	1.169748	2.466882	86	1250	300	5000	1300	100	240	50	3000
15	15	1	545.7908	71.42857	9.488666	27.56038	1897	1.145083	1.272536	88	1250	300	5000	1300	100	240	50	3000
16	16	1	511.2741	72.13285	9.340944	31.64625	1927	1.127256	1.037883	92	1250	300	5000	1300	100	240	50	3000
17	17	1	593.5894	75.88145	9.197752	22.17362	1957	1.109976	0.562085	94	1250	300	5000	1300	100	240	50	3000
18	18	1	845.2038	75.11381	9.104704	18.75459	1977	1.098747	0.971168	98	1250	300	5000	1300	100	240	50	3000
19	19	1	784.5348	77.36605	9.013520	20.80689	1997	1.087743	0.665999	100	1250	300	5000	1300	100	240	50	3000
20	20	1	708.9096	78.93439	8.880118	24.94079	2027	1.071644	0.425259	105	1250	300	5000	1300	100	240	50	3000
21	21	1	174.5341	79.72776	8.750608	22.62262	2057	1.078972	1.344677	108	1250	300	5000	1300	100	240	50	3000
22	22	1	166.4137	80.86124	8.612440	23.40396	2090	1.084530	1.483254	115	1250	300	5000	1300	100	240	50	3000
23	23	1	164.9459	100.95240	8.571429	28.98894	2100	1.101852	2.571429	120	1250	300	5000	1300	100	240	50	3000
24	24	1	209.4328	85.30806	8.530806	40.06186	2110	1.120326	3.488626	125	1250	300	5000	1300	100	240	50	3000
25	25	1	225.7279	89.20188	11.793430	38.32401	2130	1.134585	5.396244	130	1250	300	5000	1300	100	240	50	3000
26	26	1	201.4338	86.75799	11.333330	48.68825	2190	1.127600	4.940183	135	1250	300	5000	1300	100	240	50	3000

Table 2: Continued

Obs	Period	Firm	Y1	Y2	Y3	Y4	X1	X2	X3	X4	P1	P2	P3	P4	W1	W2	W3	W4
27	27	1	162.3612	88.18182	11.28182	30.36816	2200	1.183081	4.304091	140	1250	300	5000	1300	100	240	50	3000
28	28	1	214.0234	90.04525	16.27149	40.59150	2210	1.241830	3.128507	145	1250	300	5000	1300	100	240	50	3000
29	29	1	212.5297	229.95050	15.55405	36.76231	2220	1.307558	1.486486	150	1250	300	5000	1300	100	240	50	3000
30	30	1	199.9544	91.18943	16.07048	45.63608	2270	1.353402	4.847137	155	1250	300	5000	1300	100	240	50	3000
31	31	1	208.8668	92.54386	19.79386	50.84870	2280	1.419347	5.182895	158	1250	300	5000	1300	100	240	50	3000
32	32	1	212.2904	93.68192	20.00436	44.43623	2295	1.486323	6.677560	162	1250	300	5000	1300	100	240	50	3000
33	33	1	213.2632	97.41379	19.93879	67.75316	2320	1.506226	7.430172	165	1250	300	5000	1300	100	240	50	3000
34	34	1	214.2433	93.33333	19.27417	61.48679	2400	1.490741	7.106250	169	1250	300	5000	1300	100	240	50	3000
35	35	1	236.8759	92.46032	19.04365	76.93790	2520	1.449515	14.285710	172	1250	300	5000	1300	100	240	50	3000
36	36	1	214.7541	79.33579	17.70849	95.34483	2710	1.371464	11.321400	175	1250	300	5000	1300	100	240	50	3000
37	37	1	267.2511	78.27093	16.60554	77.07013	2890	1.306228	13.483740	178	1250	300	5000	1300	100	240	50	3000
38	38	1	251.6255	66.22951	15.73443	69.72698	3050	1.255009	12.362950	182	1250	300	5000	1300	100	240	50	3000
39	39	1	286.9905	54.00322	14.37556	72.75471	3110	1.248660	18.231510	182	1250	300	5000	1300	100	240	50	3000
40	40	1	282.8721	67.50798	14.84632	66.39777	3195	1.235437	11.017210	182	1250	300	5000	1300	100	240	50	3000
41	41	1	263.3530	55.34211	14.50444	75.24594	3265	1.230220	9.525268	182	1250	300	5000	1300	100	240	50	3000
42	42	1	253.7430	51.60297	14.69599	86.52148	3365	1.216774	14.217240	182	1250	300	5000	1300	100	240	50	3000
43	43	1	284.2468	55.48168	13.80387	73.70984	3467	1.203410	13.798960	182	1250	300	5000	1300	100	240	50	3000
44	44	1	298.3115	56.30978	15.31427	75.73249	3567	1.191477	13.412110	182	1250	300	5000	1300	100	240	50	3000
45	45	1	279.6064	55.88182	15.79403	63.96347	3520	1.227904	13.591190	182	1250	300	5000	1300	100	240	50	3000
46	46	1	241.5542	58.98171	17.18441	64.38562	3335	1.317674	14.345130	182	1250	300	5000	1300	100	240	50	3000
47	47	1	278.9782	57.81677	17.40210	53.17436	3340	1.336494	14.323650	182	1250	300	5000	1300	100	240	50	3000
48	48	1	326.4147	60.53019	16.37732	53.01915	3395	1.334479	14.091610	182	1250	300	5000	1300	100	240	50	3000
49	49	1	380.5201	54.37597	16.37732	56.92685	3300	1.391414	14.497270	182	1250	300	5000	1300	100	240	50	3000

productivity increased by 77.99% between 1961 and 1990 and decreased at 31.68% during 1990-2008 while the term of trade increased at 12.19% during 1961-1990 and increased by 79.58% between 1990 and 2008. This is consistent with the inverse relationship between productivity and terms of trade.

The improvement of term of trade in Benin explain the lack of competiveness in the sector and the increased of agriculture profitability while the productivity decreased significantly.

In a related development, it justifies the conclusion that over the period of liberalization of the agriculture sector during 1990, there has been limited private sector involvement and investment. It is also consistent with this finding that the big gap that we can observe result in agriculture output prices that are much higher that agriculture input prices and with the global economic crisis the figures take on a deeper meaning. Moreover, evidence of this type of optimizing duality response can be observed regarding the index of technical change and output-oriented efficiency change shown in Fig. 7. It can be seen that important components of Benin agricultural TFP change have been change in OSME = OME×ROSE but not change in technical change. Meaningful, OME and ROSE have been important index in TFP change index.

Indeed, an average of OME and ROSE has felled since 1961 during the pre reform and felled more during the post reform. OME and ROSE failed by 60.82% between 1961 and 1990 and by 55.7% between 1990 and 2008. Researchers can conclude that the decreased of productivity during the post reform has not been due to any change of Benin agricultural producer production ability but due to multiples lack of good management.

CONCLUSION

It can be said that during the period after independence (1961), Benin's agricultural productivity fell and that fall took on more significance after the beginning of the openness period (economic reform period in 1990). However since 1990, the term of trade has strongly extremely improved due to a lack of competiveness. Indeed, very limited private involvement in the sector has led the sector to be more protectionists with profit taking prominence over developing economic potential in the sector. This explains the low private investment in the agriculture sector and the necessity of urgent policy action to be taken by government in the sector, particularly in light of the recent food crisis in 2008. Agricultural liberalization does not assist Benin to improve food production or to encourage sustainable development of the sector, a sector key to Benin's economic growth.

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