Religious faith and agricultural growth: exploring some correlations in Africa

Nkamleu, Guy Blaise

Center for the study of African Economies - Oxford University

2007

Center for the study of African Economies – Annual Conference Oxford 18th- 20th March 2007

RELIGIOUS FAITH AND AGRICULTURAL GROWTH: EXPLORING SOME CORRELATIONS IN AFRICA

Guy Blaise NKAMLEU

International Institute of Tropical Agriculture (IITA, Ibadan-Nigeria). c/o LW Lambourn & Co, Carolyn House 26 Dingwall Road, Croydon CR9 3EE, United Kingdom. Tel (234 2) 241 2626 ;
Fax (234 2) 241 2221 ; Email: g.nkamleu@cgiar.org

December, 2006

C\conference\csae\csae07_nkamleu.doc

RELIGIOUS FAITH AND AGRICULTURAL GROWTH: EXPLORING SOME CORRELATIONS IN AFRICA

Abstract

This study investigates the relationship between religious beliefs and agricultural growth in Africa. Empirical analyses are undertaken using panel data of a representative sample of 26 countries, covering the period 1970-2000. The countries analyzed were classified into three groups; countries with a majority of Christian believers, those with a majority of Muslims and those where there are more who follow indigenous beliefs. Results generally indicate a non-neutral effect of religious on agricultural growth. The results accord with perspectives in which classic religions influence traits that enhance agricultural performance, particularly through technological progress. The conclusion draws implications from the findings and highlights areas needing further scrutiny.

Key words : Religion faiths, Agricultural growth, Agricultural productivity, Efficiency, Technology, Africa.

JEL classification: D24; O47; O55; Z12

Introduction

Economic growth is probably one of the most important research topics in modern economics. In recent years, there has been a burgeoning of empirical research into the factors affecting economic growth in both developed and developing countries (O'Connell and Ndulu, 2000). Most of these researches have successfully isolated economic variables that can help to explain why some countries achieve rapid economic growth and some others experience stagnation and even economic regression. The resurgent interest in economic growth has encouraged development economics as economists seek to understand the factors which influence the development process.

Recent literature, however, argued that explanations for economic growth have to go beyond narrow measures of economic variables to encompass cultural forces (Barro and McCleary, 2003). In particular, the relationship between religious beliefs and practices, on the one hand, and economic prosperity, on the other, is still a poorly explored field. The few empirical researches found in the literature suggest that religious beliefs influence economic outcomes by affecting personal traits, such as honesty, thrift, willingness to work hard, and openness to strangers (Mahmud, 2003; Barro and McCleary, 2003; Chen, 2005). This paper improves our understanding by investigating the relationship between religious beliefs and agricultural growth in Africa. This is an issue of particular importance given the strong tie between the agricultural sector and overall economic growth (Uma Lele, 1991; Nyemeck et Nkamleu, 2006), and the seemingly intertwined relationship of agriculture and religion (Falvey, 2005).

Growth in agriculture, particularly in Africa, has been strongly tied to overall economic growth in the literature, given its importance in overall GDP, export earnings, and employment, as well as its strong link to non-agricultural growth (Nkamleu, 2004a). As reported by Uma Lele (1991), broadly based agricultural production has an enormous impact on the patterns of consumption, savings, and investment. These, in turn, determine internal links between growth in the agricultural and non-agricultural markets, and external links between growth in the domestic and international markets. These links govern the pace and robustness of growth. In the other hand, recent work by Falvey (2005), maintains that all scriptures use agricultural references to impart their esoteric concepts of transcendence. The author argues that this occurred with the development of the great religions and writing, both of which relied on agriculture to create stable and stratified civilizations in which agriculture was the everyday preoccupation of the populace.

Africans profess a variety of religious beliefs, with Christianity and Islam being the most widespread. According to Wikipedia (2006), approximately 40% of all Africans are Christians and another 40% are Muslims, while roughly 20% primarily follow indigenous African religions. Because specific aspects of agriculture are embedded in such teachings (Falvey, 2005), such as those concerning land distribution, agronomic practices, mortgage management, the role of work and technology, and off-community responsibilities, religions could have an influence on the outcome of the agricultural sector. This study explores the impact that different religious beliefs might have had on agricultural growth in Africa in the course of the last three decades.

The rest of the paper is organized as follow: Section two provides a brief literature review on religion and development, section three presents the theoretical framework. The data used are presented in section 4. Section 5 discusses the results and section 6 presents conclusions and some policy lessons.

2. Religion and development

Religion and development is a linking of essential themes that has been neglected until recently. As discussed by Barro and McCleary (2003), one prominent theory in the literature is the secularization hypothesis, whereby economic development causes individuals to become less religious, as measured by church attendance and religious beliefs. The secularization hypothesis also encompasses the idea that economic development causes organised religion to play a less important role in political decision-making and in social and legal processes more generally. The secularization hypothesis remains controversial, and an important competing theory focuses on ‘‘market’’ or ‘‘supply side’’ forces. This approach downplays the role of economic development and other ‘‘demand factors’’ for religion and focuses instead on competition among providers of religion. A greater diversity of religions available in a country or region is thought to promote greater competition, hence, a better quality religious product and, hence, greater participation in religion and increase in believers.

Recent empirical works focus on various themes. B. Burnham (1986) reviews several studies of IQ and religiosity and concludes that more intelligent people tend not to believe in religion. A more recent poll, "The Gallup International Millennium survey 1995" (http://www.gallup-international.com/) shows the same negative correlation between education and religion, and also between intelligence and religion. Seyed Javad (2004) questions the usual approaches used to link intelligence and religious thinking. He argued that neither within the modern paradigm nor the traditional framework have the issues of intelligibility and religiously thinking been fundamentally addressed.

Barro and McCleary (2003) investigated the effects of religiosity on aggregate economic performance and found that economic growth responds positively to the extent of religious beliefs, but negatively to church attendance. That is, growth depends to the extent of believing relative to belonging. Chen (2005) studied the causal impact of economic distress on Koranic study and Islamic school attendance and found that those who are hit harder by economic distress will increase their religious intensity. Mahmud (2003) studied nation building by fusing Islam, pluralism, democracy, and modernity, and concluded in the case of Malaysia that religious tolerance and adherence to Western development models had fostered economic growth since its independence.

In the agricultural field, recent writings use sustainability as the meeting point of science, agriculture, and religion (Falvey, 2005). Religion is a powerful expression of culture that is most obviously expressed in our relationships with nature. As our major meeting point with nature is food, agriculture and religion seem to have been intertwined since their respective invention (Falvey, 2005). It is, therefore, expected that the replacement of indigenous religious structures in Africa by Western and Eastern religions may well have accompanied fundamental changes in attitudes to agriculture.

In summary, previous studies wanted to know how religiosity affects economic variables, but also explored the reverse effects from economic development to religion. According to Barro and McCleary (2003), this reverse channel has been the focus of a substantial amount of literature in the sociology of religion.

3. Theoretical framework

The focal interest of our analysis is to analyze the correlation between religiosity and parameters of agricultural growth. The main issue is to derive different measures of aggregate agricultural growth and then correlate these measures with religion and religiosity.

The Malmquist index method described in Fare et al. (1994), Coelli et al. (1998), Nkamleu (2004b) is used to measure total factor productivity, technology, and efficiency change in African agriculture. The method calculates total factor productivity indexes using efficiency measures. This approach, when has panel data, uses DEA-like linear programs and the Malmquist total factor productivity (TFP) index to measure productivity change and to decompose this productivity change into technical change and technical efficiency change. The Malmquist TFP index is defined using distance functions (Rao and Coelli, 1998). Input distance functions and output distance functions can be defined. An input distance function characterizes the production technology by looking at a minimal proportional contraction of the input vector, given an output vector.

An output distance function considers a maximal proportional expansion of the output vector, given an input vector.

A production technology, satisfying standard axioms, may be defined using the output (possibility) set, P(x), which represents the set of all output vectors, y, which can be produced using the input vector, x [P(x)={y, x can produce y}]. The output distance function is defined on the output set P(x), as (Input distance function can be defined in a similar manner):

$$d_0(x, y) = \min\{\theta : (y/\theta) \in P(x)\},$$

Where θ is the coefficient dividing 'y' to get a frontier production vector given 'x'.

The distance function $d_o(x,y)$ is a measure of how far the production point is from the frontier. The distance measure will take a value which is less than or equal to one if the output vector, y, is an element of the feasible production set, P(x). Furthermore, the distance function will take a value of unity if y is located on the outer boundary of the feasible solution set, and will take a value greater than one if y is located outside the feasible production set.

Extensive discussion on Malmquist indices can be found in Fare et al. (1994), Coelli (1998), Nkamleu (2004b). Following Fare et al. (1994), the MI TFP change between a base period 's' and a period 't' can be written for the single-output, single-input and output-oriented case as:

$$m_0(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)}\left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)}\frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)}\right]^{1/2}, \qquad \text{(Eq 1)}$$

where the notation $d_0^s(y_t, x_t)$ represents the distance from the period t observation, to the period s technology. A value of '*m*' greater than one will indicate positive TFP growth from period s to period t.

In (1), the term outside the square brackets measures the Farrell efficiency change between period s and t, and the term inside measures technical change, which is the geometric mean of the shift in the technology between the two periods. Thus, the two terms in equation (1) are:

$$\textit{Efficiency change} = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)} \qquad \text{(Eq 2)}$$

$$\textit{Technical change} = \left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)} \right]^{1/2} \qquad \text{(Eq 3)}$$

The efficiency change component is equivalent to the ratio of the Farrell technical efficiency in period t to the Farrell technical efficiency in period s, under constant return to scale ($EFFCH_{crs}$). This efficiency change component can be separated into a scale efficiency and pure technical efficiency change. The pure technical efficiency is obtained by re-computing efficiency change under variable return to scale ($EFFCH_{vrs}$). The scale efficiency is, therefore, the ratio of efficiency under constant return to scale and the same efficiency under variable return to scale ($EFFCH_{crs}/EFFCH_{vrs}$).

The overall index in (1) represents the productivity of the production point (y_t, x_t) relative to the point (y_s, x_s), and a value larger than one depicts positive TFP growth between periods s and t. Empirical applications require the computations of the four distance functions in (1). As suggested by Coelli (1996), the distance functions can be recovered by solving the following DEA-like linear programs:

$$
\begin{aligned}
&[d_0^t(x_t, y_t)]^{-1} = Max_{\phi,\lambda}\phi, \\
&subjet\ to \quad -\phi y_{it} + Y_t\lambda \geq 0 \\
&\qquad\qquad\quad x_{it} - X_t\lambda \geq 0' \\
&\qquad\qquad\quad \lambda \geq 0,
\end{aligned}
\qquad \text{(Eq 4)}
$$

$$
\begin{aligned}
&[d_0^{t+1}(x_{t+1}, y_{t+1})]^{-1} = Max_{\phi,\lambda}\phi, \\
&subjet\ to \quad -\phi y_{i,t+1} + Y_{t+1}\lambda \geq 0 \\
&\qquad\qquad\quad x_{i,t+1} - X_{t+1}\lambda \geq 0' \\
&\qquad\qquad\quad \lambda \geq 0,
\end{aligned}
\qquad \text{(Eq 5)}
$$

$$
\begin{aligned}
&[d_0^t(x_{t+1}, y_{t+1})]^{-1} = Max_{\phi,\lambda}\phi, \\
&subjet\ to \quad -\phi y_{i,t+1} + Y_t\lambda \geq 0 \\
&\qquad\qquad\quad x_{i,t+1} - X_t\lambda \geq 0' \\
&\qquad\qquad\quad \lambda \geq 0,
\end{aligned}
\qquad \text{(Eq 6)}
$$

$$
\begin{aligned}
&[d_0^{t+1}(x_t, y_t)]^{-1} = Max_{\phi,\lambda}\phi, \\
&subjet\ to \quad -\phi y_{it} + Y_{t+1}\lambda \geq 0 \\
&\qquad\qquad\quad x_{it} - X_{t+1}\lambda \geq 0' \\
&\qquad\qquad\quad \lambda \geq 0,
\end{aligned}
\qquad \text{(Eq 7)}
$$

where λ is a Nx1 vector of constant and ϕ is a scalar with $1 <= \phi < \infty$.

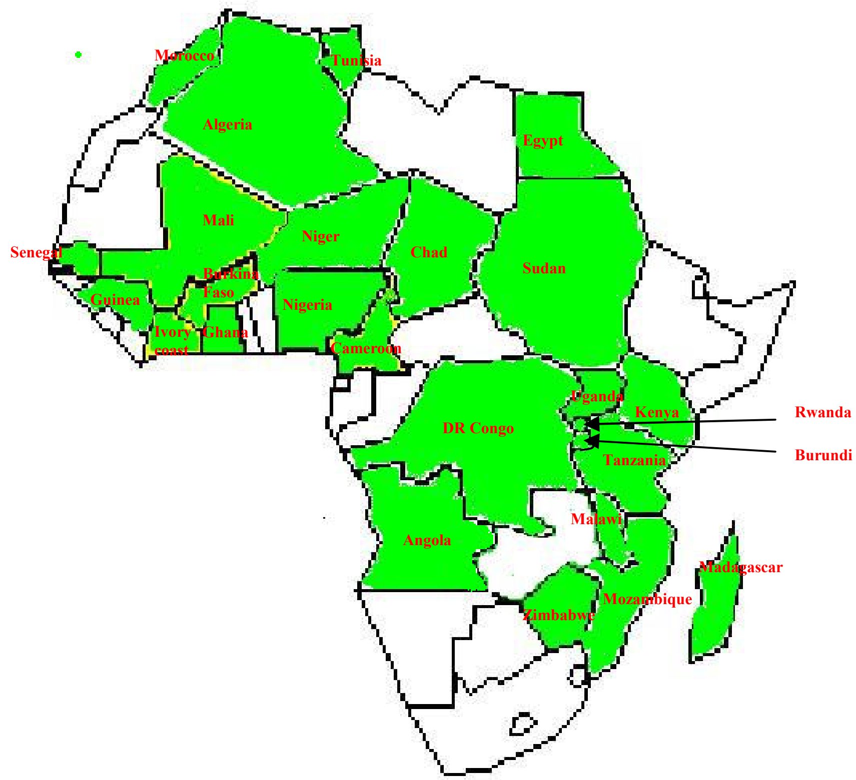
ϕ-1 is the proportional increase in outputs that could be achieved by the i-th unit, with input quantities held constant.

The above programs must be solved for each country in the sample in each period, and an extra three programs are needed for each country to construct the chained index. If we have T time periods, we must calculate (3T-2) LP's. Overall, for N firms and T periods, with the decomposition of the technical efficiency N(4T-2) LPs are solved (3068 LP in the present case).

4. Data

We began our research by constructing a cross-country dataset of 26 African countries (Fig 1). Panel data on the top 26 African agricultural producers, from 1970 to 2000, are analyzed. Table 3.2 in Rao (1993) contains the ordering of 103 countries which account for more than 99% of the world's agricultural output. We first considered the 29 African countries appearing in that list. We later excluded Somalia and Ethiopia due to data-related problems, and also dropped South Africa to minimize outlier problems. Most recent studies on aggregated agricultural production in Africa analyze the same sample countries (Nkamleu et al., 2006; Coelli and Rao, 2005 ; Rao and Coelli, 1998). The data gathered include information on aggregate agricultural input and output variables and data on religious beliefs. Data on religiosity is still a scarce commodity, and this is especially true for African countries where basic statistics are difficult to obtain. Each year, CIA Factbook (https://www.cia.gov/cia/publications/factbook/) provides information on religiosity in different countries. This source of information was used to assemble limited data on religiosity as from 1989. Data collected are the percentages of believers of the three main religious groups in Africa, Christianity, Islam, and indigenous beliefs (Table 1). Data series on religiosity from 1989 to 1999 in sampled countries show very little variation of the percentages of the population belonging to each group as shown in Table 2.

Figure 1: Selected countries included in the analysis.



Agricultural data were drawn from FAOSTAT (http://faostat.fao.org) system of statistics used for the dissemination of statistics compiled by the Food and Agriculture Organization (FAO). Our approach involves non-parametric estimations of aggregate production functions. Data used in the analysis consisted of panel data from 1970 to 2000 and included agricultural production, agricultural labor, number of tractors in use, quantity of fertilizer used, agricultural land, and livestock. Specification of output and inputs used is as follows:

Agricultural output

Agricultural production: To construct the output series, we followed the methodology suggested in Rao and Coelli (1998). Output aggregated for the year 1990 was used to compute the output series. These 1990 aggregated outputs were computed using international average prices (expressed in US dollars) derived using a Geary-Khamis method (see Rao, 1993). The aggregates are based on the sum of price-weighted quantities of different agricultural commodities produced after the deduction of quantities used as seed and feed, weighted in a similar manner. The resulting aggregates represent, therefore, disposable production for any use, except as seed and feed. The 1990 output series were then extended to cover the study period, 1970-2000, using the FAO production index number series.

Means of production

- *Labor:* Refers to the economically active population in agriculture for each year, in each country. The economically active population in agriculture is defined as all persons engaged or seeking employment in agriculture, forestry, hunting, or fishing sectors, whether as employers, own-account workers, salaried employees, or unpaid workers. Since it was not possible to have information on differentials in skill levels and the number of hours worked on the farm, the economically active population in agriculture is the best proxy of labor input into the agricultural sector.

- *Agricultural land*: Is the sum of the areas under *arable land* (land under temporary crops, temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow), *permanent crops* (land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber), and *permanent pastures* (land used permanently for herbaceous forage crops, either cultivated or growing wild).

- *Fertilizer*: Fertilizer consumption is often viewed as a proxy for the whole range of chemical inputs and more (Mundlak et al., 1997). Different countries use a large number and type of fertilizers. Following other studies (Hayami and Ruttan, 1970; Rao et al., 2003), the sum of nitrogen (N), potassium (P_2O_2) and phosphate (K_2O) expressed in thousands of tones, that are contained in the commercial fertilizers consumed, is used as the measure of fertilizer input. There were four observations with fertilizer input equal to zero. These observations were replaced by the means of adjacent years.

- *Tractors*: Data on agricultural capital is very scarce. Commonly, crude data on tractors and machinery have been used in cross-country analyses of agricultural production functions. We used data on the number of tractors, which refer to total wheel and crawler tractors (excluding garden tractors) used for agricultural production.

- *Livestock*: Following Hayami and Ruttan (1971) who advocated the use of livestock as input in aggregated agricultural production function (see for example, on p.140), the livestock input variable used in this study is the sheep-equivalent of five categories of animals. The categories of animals considered are buffaloes, cattle, pigs, sheep, and goats. Data on the number of these animals are converted into sheep-equivalents, using the following conversion factors as suggested in the literature (Hayami and Ruttan, 1971; Fulginiti et Perrin, 1997; Kudaligama et Yanagida, 2000 ; Rao et al., 2003): 8 for buffalo and cattle; and 1 for sheep, goats, and pigs.

Table 1: Percentage of population belonging to each religion in sampled countries.

	Christians (%)	Muslim (%)	Indigenous beliefs and others (%)	Predominant religion
Algeria	1	99	0	Islam
Angola	53	0	47	Christianity
Burkina Faso	10	50	40	Islam
Burundi	67	1	32	Christianity
Cameroon	33	16	51	Indigenous
Chad	25	50	25	Islam
Congo, Dem Republic	70	10	20	Christianity
Côte d'Ivoire	22	60	18	Islam
Egypt	6	94	0	Islam
Ghana	24	30	46	Indigenous
Guinea (Conakry)	8	85	7	Islam
Kenya	66	7	27	Christianity
Madagascar	41	7	52	Indigenous
Malawi	75	20	5	Christianity
Mali	1	90	9	Islam
Morocco	1.1	98.7	0.2	Islam
Mozambique	30	20	50	Indigenous
Niger	10	80	10	Islam
Nigeria	40	50	10	Islam
Rwanda	74	1	25	Christianity
Senegal	2	92	6	Islam
Sudan	5	70	25	Islam
Tanzania	45	35	20	Christianity
Tunisia	1	98	1	Islam
Uganda	66	16	18	Christianity
Zimbabwe	75	1	24	Christianity

Source: CIA Factbook, 1999

Table 2: Evolution of religious adherence (percentage of the total population).

YEARS	Christian	Muslim	Traditional beliefs
1989	32.20	42.68	25.12
1990	32.20	42.68	25.12
1991	32.20	42.68	25.12
1992	32.20	42.68	25.12
1993	32.20	42.68	25.12
1994	32.20	42.68	25.12
1995	32.35	44.99	22.55
1996	32.35	44.99	22.55
1997	32.35	45.37	22.16
1998	32.35	45.37	22.16
1999	32.73	45.41	21.85
Total	32.30	43.84	23.82

Source: CIA Factbook, 1999.

5. Results

We first look at the evolution of aggregate agricultural output in different groups of countries. We first relied on the FAO production index numbers which are used widely around the world by agricultural economists. The FAO indices of agricultural production, calculated by the Laspeyres formula, show the relative level of the aggregate volume of agricultural production for each year in comparison with the base period 1999-2001. Figure 2 shows the comparative evolution of the nominal agricultural production index by predominant religion. Countries are classified into three groups; countries where most are Christians (this included Catholics, Protestants and other churches centred on Jesus of Nazareth), countries where most are Muslims and those where indigenous believers are most numerous (this included African religions and those not classified in the Christian or Muslim groups). From the graphic, it is apparent that countries that are primarily Muslim have realized a better improvement of the agricultural production. The index of agricultural production for Muslim countries which was equal to 45% in 1970, increased to 100% in 1999/2001. In other words, the nominal agricultural production has more than doubled in those countries during the three last decades. Although this performance is well below the tripling of the agricultural production achieved on average by all the developing countries (http://faostat.fao.org), it is more than the performance achieved by Christian countries and countries dominated by traditional believers (Fig. 2). From 1970 to 2000, agricultural production has grown by more than 125% in Muslim countries. As shown in Table 3, this growth has been partly driven by an extensification of land cultivation.

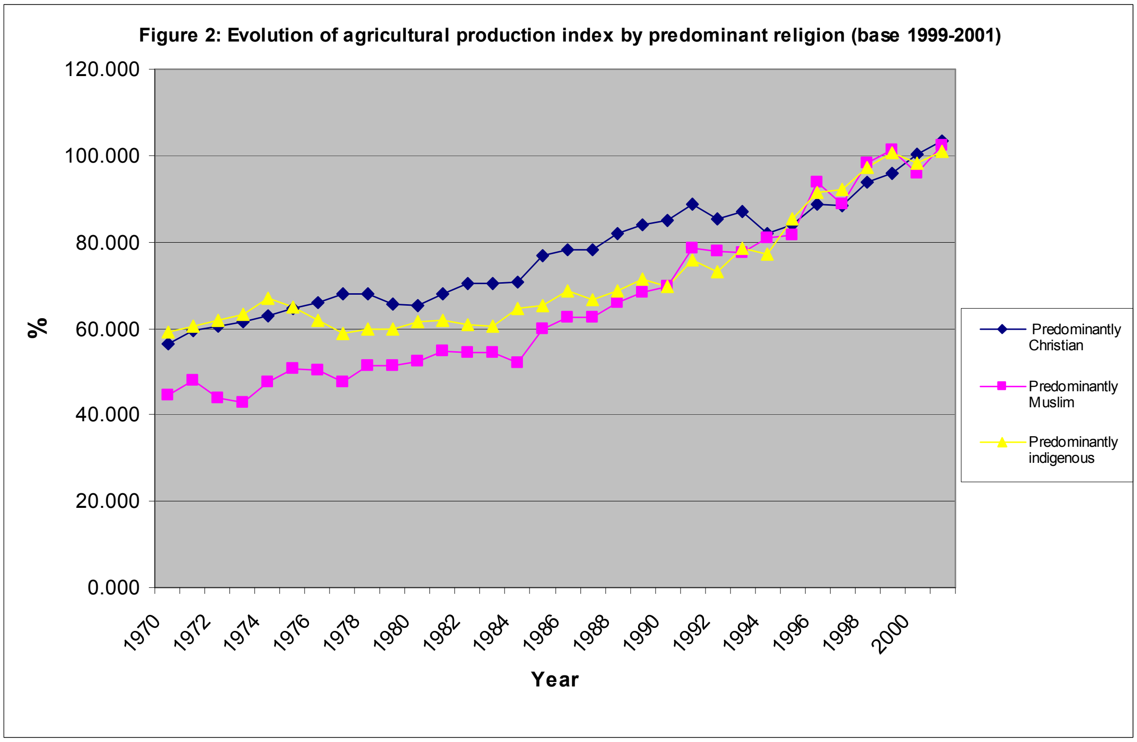


Table 3: Agricultural output and agricultural land by predominant religion.

	Predominantly Christian countries	Predominantly Islam countries	Predominantly Indigenous beliefs
Output (Thousands of 1989-91 international dollars)			
1971	1244651	1748834	1273302
2000	2150747	3938704	2181941
Growth rate	72.8%	125.2%	71.4%
Agricultural land (1000 ha)			
1971	19894.67	30818.31	23281.75
2000	20812.44	33644.77	24811.25
Growth rate	4.6%	9.2%	6.6%

Means of the measures of technical change (TECHCH) and total factor productivity change (TFPCH) along with overall efficiency change (EFFCH) for each country are presented in Table 4. Recall that total factor productivity change is the product of efficiency change and technical change (TFPCH = EFFCH*TECHCH). A value greater than unity represents an improvement, while a value less than unity represents a decline. The sample as a whole indicates that the change in total factor productivity of the agricultural sector of the study countries has been positive. On average, total factor productivity has increased by 0.2% annually. This figure appears to be consistent with some of the recent studies (Coelli et *al.,* 2003; Fulginiti *et al*., 2004).

The agricultural sector can improve the level of total factor productivity by improving technical efficiency and/or by improving the technological level (a shift in the production frontier). The component measures of total factor productivity, 'Effchc' and 'TechchC' show that there has been technological progress, though for some individual countries there has been some evidence of technological regression. The overall average annual technological change was 0.4%, while the efficiency change was negative over the period (-0.2% per year).

Table 4: Annual mean technical efficiency change, technical change and TFP change for sampled countries, 1971-2000.

	Overall Efficiency Change (EFFCH)	Technical Change (TECHCH)	Total Factor Productivity Change (TFPCH)
Algeria	0.996	1.016	1.012
Angola	1.014	0.998	1.012
Burkina Faso	0.991	0.998	0.989
Burundi	0.999	0.968	0.967
Cameroon	1	1.001	1.001
Chad	1.001	0.996	0.998
Congo, DR	1	1.009	1.009
Côte d'Ivoire	1	1.011	1.011
Egypt	1	1	1
Ghana	1	1.001	1.001
Guinea	0.997	0.989	0.985
Kenya	1.003	1.008	1.011
Madagascar	0.999	0.999	0.997
Malawi	1.002	1.011	1.013
Mali	0.994	0.999	0.993
Morocco	0.99	1.02	1.011
Mozambique	0.994	1.007	1
Niger	0.989	1.012	1.001
Nigeria	1	1.005	1.005
Rwanda	1	1.013	1.013
Senegal	0.987	1.003	0.99
Sudan	1.001	1.007	1.008
Tanzania	1.004	1.002	1.006
Tunisia	1	1.008	1.008
Uganda	1	1.011	1.011
Zimbabwe	0.983	1.018	1.001
Mean	0.998	1.004	1.002

Source: Author's calculations.

Table 5 provides measures of annual changes in efficiency (EFFCH), technology (TECHCH) and total factor productivity (TFPCH) by different religions groups. Our data show almost no variation in the percentage of the population belonging to each religion in sampled countries. Consequently, in the analysis, we have considered that the religiosity of a country in 1999/2000 has remained the same since 1970.

Primarily, we found that countries dominated by indigenous believers posted the lower rates of TECHCH and TFPCH (the difference was, however, statistically non-significant). This is a very important observation which suggests farmers in those countries have been relatively less able to acquire new technologies and have experienced a regression (negative sign of TFPCH) in overall agricultural productivity. This could be explained by the fact that traditional culture might have negatively influenced agricultural outcome, by affecting farmers' traits such as their acceptance of new technologies and openness to new and efficient ways of managing farms.

On the other hand, we observe that countries that are primarily Christian had the better performance in term of TFP growth, mainly due to a relative better performance of the efficiency change (EFFCH) component, and a good performance of the technology component. Muslim countries seem to perform better in terms of technology change (TECHCH), but have performed poorly in terms of efficiency change, with an 0.41% annual average regression of efficiency level. This suggests that predominantly Muslim countries have increasingly failed to absorb and exploit the full potential of new technologies. An important fact to notice is that, despite their relatively weak performance in raising their TFP, Muslim countries raised their overall agricultural output better than other countries. This again confirms that physical inputs, or factor accumulation, have contributed more to agricultural output growth for Muslim countries during the last three decades.

Table 5: Average 1971-2000 total factor productivity gain by religiosity.

	Predominantly Christian countries	Predominantly Islamic countries	Predominantly Indigenous beliefs
Efficiency Change (EFFCH)	0.06%	-0.41%	-0.19%
Technical Change (TECHCH)	0.42%	0.51%	0.17%
Total Factor Productivity Change (TFPCH)	0.47%	0.09%	-0.02%

The results presented so far treat religion as a dummy variable. Since we also have continuous measures of the fraction of the population adhering to each religion, we also investigated the impact of these religions' measures on productivity growth. We investigated this issue by estimating Tobit type regression models linking productivity growth with a set of exogenous variables. Three regressions were estimated. The dependent variables are EFFCH, TECHCH, and TFPCH respectively. The percentage of Christians and the percentage of Muslims in the country are the two independent religious variables used. The proportion of indigenous believers is used here as the base. Therefore, the Christian and the Muslim variables are compared to the indigenous beliefs.

Apart of religious variables, the models also included several socio-institutional and geographical variables that may supposedly have an impact on productivity. The variables included are the percentage of irrigated land, the illiteracy rate, a dummy variable to characterize countries that are located in the Sahel versus those located in the forest, two dummy variables for French-speaking and English-speaking countries, and 4 dummy variables that index the geographical location of the country.

The models show a positive and significant association between the proportion of Christians and TFP growth and also a positive association with technology change (Table 6). This suggests, as hinted in Table 5, that the higher the proportion of Christians in a country compared to indigenous believers, the higher the growth of agricultural productivity will be. The positive and significant coefficient of Christianity in the Tobit regression for technical change suggests that technological progress is the component that makes the difference between Christians and indigenous believers. Globally, the coefficient of the variable indexing the proportion of Muslims is positive (although non-significant) in all three regressions. These results agree with perspectives in which classic religious beliefs influence individual traits that enhance agricultural performance, particularly through technology adoption. These findings appear to be consistent with the recent study of Barro and Mccleary (2003) who found that economic growth responds positively to the extent of religious beliefs.

Table 6: Tobit model of the determinants of efficiency and productivity change in Africa.

	Efficiency change		**Technical change**		**Total factor productivity change**	
Variables	Coefficient	t-statistics	Coefficient	t-statistics	Coefficient	t-statistics
Constant	1.0030	23.10 ***	1.03524	20.58 ***	1.0327	16.33 ***
% of Irrigated land	-0.0001	-0.46	-0.0003	-0.71	-0.0003	-0.77
Illiteracy rate	0.00003	0.06	-0.0011	-2.17 **	-0.0011	-1.75 *
Sahel	0.0076	0.28	0.0396	1.28	0.0458	1.18
French speaking	-0.0063	-0.14	-0.0824	-1.57	-0.0906	-1.38
English speaking	0.0007	0.02	-0.0895	-1.71 *	-0.0914	-1.39
North	-0.0033	-0.08	0.0462	0.98	0.0496	0.84
West	0.0019	0.05	0.0602	1.40	0.0712	1.31
Central	0.0013	0.04	0.0335	0.96	0.0419	0.95
East	0.0033	0.14	0.0403	1.46	0.0482	1.39
% of Christian	-0.00003	-0.04	0.0014	1.98 **	0.0015	1.60 *
% of Muslim	0.00005	0.11	0.0005	0.94	0.0006	0.82
Sigma	0.1339	37.31 ***	0.1551	37.31 ***	0.1950	37.31 ***
	Log likelihood= 309.60 Total Sample = 696		Log likelihood= 309.60 Total Sample = 696		Log likelihood= 150.28 Total Sample = 696	

* = significant at 0.10; ** = significant at 0.05; *** = significant at 0.01.

6. Conclusion

Recent studies have demonstrated that growth depends more on productivity (technological change and the acquisition of knowledge) than on the traditional factors of production (land, labor, and physical capital). Consequently, there is a resurgent interest in agricultural growth as economists seek to understand the factors which influence productivity growth in the agricultural sector. However, past studies have paid little attention to social forces as determinants of agricultural growth.

This paper improves our understanding by investigating the relationship between religious beliefs and agricultural growth in Africa, using panel data on 26 countries, from 1970 to 2000. Countries are classified into three groups; predominantly Christian, predominantly Muslim, and countries with predominantly indigenous beliefs. A certain number of findings emerge from our analysis:

1 – Observation of the evolution of the agricultural production shows that countries that are predominantly Muslim have realized a better improvement of their agricultural production during the study' period.

2 – The results show an overall average annual growth in total factor productivity of 0.2%, mainly attributable to the technical change (or frontier shift) growth of 0.4%, while technical efficiency change (managerial ability) has experienced a negative evolution over the 30 years.

3 – Countries dominated by indigenous believers had the lower rates of growth of total factor productivity and technological progress.

4 – A positive association was evidenced between the degree of Christianity and the growth of total factor productivity, mainly due to relatively better technological progress in those countries.

5 – Finally, we find that factor accumulation associated with low capital absorption is more apparent in Islamic countries.

Findings suggest that the performance of the agricultural sector across religious groupings varies, thus, should have important implications for policy targeting. These religious differences show the type and extent of interventions needed to be put in place in each group to enhance productivity. The methodology followed in this paper assumes homogenous inputs and outputs across countries. It may, however, be argued that the location of Islamic and Christian influences was not random, but determined by patterns of settlement and conquest which, in turn, were closely linked to productivity and trade. The extent of bias induced by such an endogeneity problem will also need further scrutiny. Moreover, more research is needed to identify particular religious traits and precepts that are capable of influencing agricultural performance. We should encourage more socioeconomic and anthropological researches on judgment and decision making, to make inroads into psychological understanding of cognition and choice (Ohlmer et al., 1998; Nuthall, 2001). This will help clarify our knowledge on how different religions observe information, how information is stored and retrieved, how it is processed, and, how it interacts with religious teachings.

References

Barro Robert J., and Rachel M. McCleary (2003). Religion and economic growth across countries. American Sociological review 25(4): 760-781.

Burnham P. Beckwith (2006). The Effect of Intelligence on Religious Faith. *Free inquiry.* (Spring, 1986).

Chen L. Daniel (2005). Club goods and group identity: Evidence from Islamic resurgence during the Indonesian financial crisis. University of Chicago, Mimeo.

Coelli, Tim J., and D.S.P. Rao (2005). Total factor productivity growth in Agriculture: a Malmquist index analysis of 93 countries, 1980-2000. Agricultural Economics 32 (s1), 115-134, Blackwell Publishing Ltd.

Coelli, T.J., Prasada, R.D.S., and Battese, G. (1998). Introduction to efficiency and productivity analysis. Kluver Academic Publisher, Boston, USA.

Coelli, T.J. (1996). A guide to FRONTIER Version 4.1: a computer Program for Frontier Production Function Estimation. *CEPA Working Paper 96/07*.

Falvey Lindsay (2005). Religion and agriculture: Sustainability in Christianity and Buddhism. Institute for International Development (IID), Adelaide, Australia.

Fare R.S., S. Grosskopf and C.A.K. Lovell (1994). "Production Frontière. Cambridge University Press, Cambridge, UK.

Fulginiti E. L., and Perrin, R. K. (1997). LDC agriculture: nonparametric malmquist productivity index. *Journal of Development Economic* 53: 373-390.

Fulginiti, E.L., Perrin, R.K., and Bingxin, Y. (2004). Institutions and Agricultural productivity in Sub-Saharan Africa. Agricultural Economics 31 (2004) 169-180.

Gallup international Millennium survey (1995). http://www.gallup-international.com/

Hayami, Y., and V. W. Ruttan (1970). Agricultural productivity differences among countries. *American Economic Review* 60: 895-911.

Hayami, Y., and V. W. Ruttan (1971). *Agricultural Development: International perspective.* Baltimore: John Hopkins University Press.

Kudaligama, V.P., and J. F. Yanagida (2000). A comparison of intercountry agricultural production functions: A frontier function approach. *Journal of Economic Development* 25(1): 57-74.

Lele, Uma. ed. (1991). Aid to African Agriculture: Lessons from two Decades of Donors' Experience. Baltimore: Johns Hopkins University Press, USA.

Mahmud Bin Ahmad (2003). Islam and economic growth. Master's thesis, Naval postgraduate school Monterey, California, USA.

Mundlak Yair, Donald F. Larson, and Rita Butzer (1997). The determinants of agricultural production: a cross country analysis. World Bank policy research working paper No 1827, World Bank, Washington DC, USA.

Nkamleu, Guy Blaise. (2004a). L'échec de la croissance de la productivité agricole en Afrique francophone. *Economie Rurale* 279: 55-67.

Nkamleu, Guy Blaise (2004b). Productivity growth, technical progress and efficiency change in African agriculture. *African Development Review* 16(1): 203-222.

Nkamleu, G. B., J. Nyemeck and D. Sanogo (2006). Metafrontier analysis of technology gap and productivity difference in African Agriculture. Agricultural Economic Review (in press).

Nuthall, P.L., (2001). Managerial ability – a review of its basis and potential improvement using psychological concepts. Agricultural Economics 24 (2001) 247-262).

Nyemeck J. and G.B. Nkamleu (2006). Potentiel de Productivité et Efficacité Technique du Secteur Agricole en Afrique. Canadian Journal of Agricultural Economic (In press).

O'connell S. A., and B. J. Ndulu (2000). Africa' growth experience: a focus on sources of growth. AERC/Havard conference on Africa economic growth, Cambridge, MA, March 26-27, 1999, USA.

Ohlmer Bo, Kent Olson, and Brehmer Berndt (1998). Understanding farmers' decision making processes and improving managerial assistance. Agricultural Economics 18 (1998) 273-290).

Rao, D.S.P., O'donnell, J., and Battese, G.E. (2003). Metafrontier functions for the study of inter-regional productivity differences. *Centre for Efficiency and Productivity Analysis Working Paper* 1, Queensland, Australia.

Rao D.S.P. and Coelli T.J. (1998). Catch-Up and Convergence in Global Agricultural Productivity 1980-1995. CEPA Working Paper No 4/98, Queensland, Australia.

Rao, D.S.P. (1993). Inter-country comparisons of agricultural output and productivity. *Social and Economic Development Paper*, No. 156 FAO, Rome Italy.

Seyed Javad (2005). Intelligence and religious thinking: a critical reflection. Transcendent Philosophy 5(2): 141-160.

Wikipedia Free encyclopedia (Accessed April, 2006): http://www.wikipedia.org/

World Bank (2005). Pro-poor growth in the 1990s: Lessons and insights from 14 countries. Washington DC, USA.