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Estimating Time Trends in Life Expectancy in Sub-Saharan Africa

Authors: Guglielmo Maria Caporale and Luis A. Gil-Alana

Affiliations: Brunel University London, UK (Caporale); University of Navarra, Pamplona, Spain (Gil-Alana)

Corresponding author: Professor Guglielmo Maria Caporale, Department of Economics and Finance, Brunel University, London, UB8 3PH, United Kingdom;
email: Guglielmo-Maria.Caporale@brunel.ac.uk

Abstract

This paper analyzes time trends in life expectancy at birth in sub-Saharan Africa, allowing the errors to be $I(d)$, where d is a fractional value, instead of making the usual, more restrictive assumptions of $I(0)$ or $I(1)$ errors. The results indicate that the order of integration of the series varies across countries: some are $I(d)$ with d significantly below 1 (which implies mean-reverting behavior), some are $I(1)$ and the remainder exhibit orders of integration significantly above 1. The time trend coefficients are in some cases substantially different from those estimated under the assumptions of $I(0)$ or $I(1)$ errors. There is evidence of a positive trend in most countries, the highest coefficients being those for Gambia, Ethiopia, Mali, Liberia and Cape Verde.

Keywords

Time trends, life expectancy, sub-Saharan Africa, fractional integration

JEL classification

C22, J11

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Introduction

This paper analyzes time trends in life expectancy at birth in sub-Saharan Africa. Most existing studies on this measure of longevity (two other main measures of longevity are median and modal age at death) rely on simple plots over time of the calculated life expectancy at birth (or alternatively maximum, modal or median age at death) and comment on its evolution (Canudas-Romo, 2010), or linearize trends over time using a logistic transformation (Bulatao et al., 1989, Oeppen and Vaupel, 2002 and Cheung and Robine, 2007). The assumption underlying such models based on simple linear least squares (OLS, GLS) regressions for either the levels or the first differences of the series examined is that the errors are stationary $I(0)$ or non-stationary $I(1)$ respectively. However, many series are $I(d)$, where d is a fractional value, and are said to be fractionally integrated, and for them the standard approach is clearly inappropriate.

The present study addresses this issue by adopting a fractional integration specification to estimate linear trends in life expectancy at birth in a group of 48 sub-Saharan countries. The series examined are total population, as well as males and females separately, the frequency is annual, and in all cases the sample period is from 1960 to 2013. The countries examined are Angola, Benin, Burkina Faso, Botswana, Burundi, Cameroon, Central African Republic, Congo Democratic Republic, Chad, Comoros, Congo Republic, Cape Verde, Djibouti, Eritrea, Ethiopia, Gabon, Gambia, Guinea Bissau, Ghana, Guinea, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, South Africa, Senegal, Sierra Leone, Somalia, South Sudan, Sao Tome, Sudan, Swaziland, Togo, Uganda, Zambia and Zimbabwe. Our coverage is therefore considerably more extensive, both in terms of the sample period and the number of countries, compared to previous studies that have typically focused on fewer countries or on the impact of specific factors on life expectancy (Klasen, 1996, Murray and Lopez, 1997, Mathers et al., 2001 and Bor et al., 2013).

The contribution of this study is twofold. First, it uses a more sophisticated empirical framework that sheds new light on the statistical properties of the series of interest. Second, it analyzes a much more extensive dataset for a region of the world, namely sub-Saharan Africa (SSA), for which thorough studies on the issue of life expectancy are distinctly lacking. Specifically, the analyzes focus on the estimation of the time trend coefficients for the life expectancy at birth in countries in SSA as well as the degree of persistence of the series measured by the fractional differencing parameter by means of $I(d)$ techniques.

The layout of the paper is as follows. Section 2 outlines the econometric approach. Section 3 describes the data and discusses the empirical results. Section 4 offers some concluding remarks.

Econometric methodology

The standard approach to analyze time trends consists in estimating the following model:

$$y_t = \alpha + \beta t + x_t, \quad t = 1, 2, ..., \tag{1}$$

where y_t is the observed time series (in our case, life expectancy at birth), and x_t is the error term that is assumed to be relatively stable across time. The parameter β measures the average yearly increase in life expectancy, which is expected to be significantly positive in the majority of countries. However, in order to make a valid statistical inference about β it is crucial to determine correctly the structure of the error term. The usual assumption is that it is $I(0)$ stationary or $I(1)$ nonstationary. In the first case, if x_t is a random variable independently drawn from a Gaussian distribution with zero mean and constant

variance, the OLS estimates are unbiased, and inference based on the F and t statistics is valid (Hamilton, 1994, Chapter 16, and Draper and Smith, 1998). Still, under the assumption of $I(0)$, if the series display some degree of dependence this is usually modelled as an AutoRegressive process of order 1, AR(1), defined as

$$x_t = \rho x_{t-1} + \varepsilon_t, \quad t = 1, 2, ..., \tag{2}$$

with $| \rho | < 1$ and white noise ε_t. This model has been widely employed in the literature because of its relation with the stochastic first-order differential equation. One can use the Prais-Winsten (1954) transformation to obtain a t-statistic which converges in distribution to a N(0, 1) random variable. However, as noted by various authors, such as Park and Mitchell (1980) and Woodward and Gray (1993), this test statistic exhibits significant size distortions when the AR coefficient ρ in (2) is close to 1.

By contrast, if the detrended series is assumed to be nonstationary $I(1)$ the process is said to be integrated of order 1 (and denoted as $x_t \sim I(1)$), and statistical inference should be based on its first differences, $(1 - L)x_t = x_t - x_{t-1}$. Combining now (1) and (2) (with $\rho = 1$) the model becomes:

$$(1 - L)\, y_t = \beta + \varepsilon_t, \quad t = 1, 2, ..., \tag{3}$$

where L is the lag-operator ($Ly_t = y_{t-1}$) and one can construct another t-statistic for β.

The above discussion implies that it is essential to determine if the de-trended process x_t in (1) is stationary $I(0)$ or nonstationary $I(1)$ before proceeding to the estimation. However, it could also be $I(d)$, where d is a number between 0 and 1 or even above 1. The $I(d)$ approach is more general and it includes the two special cases of $d = 0$ and $d = 1$ respectively. It is used in the present study, since different estimates for the time trend may be obtained depending on the assumptions made about the order of integration of the de-trended series.

For our purposes we assume x_t in (1) to be an $I(d)$ process of the following form:

$$(1 - L)^d x_t = u_t, \quad t = 0, \pm 1, ..., \tag{4}$$

with $x_t = 0$ for $t \leq 0$, and $d > 0$, where L is the lag-operator ($Lx_t = x_{t-1}$) and u_t is $I(0)$. Thus, the parameter d refers to the degree of differencing required to make a series stationary $I(0)$. By allowing d to be fractional, we introduce greater flexibility in the dynamic specification of the series compared to the classical approaches based on integer differentiation. Processes with $d > 0$ in (4) display the property of "*long memory*", and are characterized by a spectral density function which is unbounded at the lowest (zero) frequency. They are called long-memory processes because they exhibit high dependence between observations which are far away in time. The fractional differencing parameter provides information about the degree of persistence of the series: the higher the value of d, the higher the degree of dependence between observations is. If d is smaller than 1, shocks will have transitory effects, which die away at a faster rate the lower the value of d is.

We use a procedure that jointly estimates the linear trend coefficients (α and β) and the fractional differencing parameter d, and is based on the Whittle function in the frequency domain (Dahlhaus, 1989). In addition, we also employ a Lagrange Multiplier (LM) test (Robinson, 1994) that tests the null hypothesis *Ho:* $d = do$, in (1) and (4) for any real value do. The main advantages of this approach are that it remains valid even in nonstationary contexts ($do \geq 0.5$) and the fact that the limit distribution is standard normal. Moreover, it is the most efficient test in the Pitman sense against local departures from the null. Other methods (e.g. maximum likelihood in the time domain – see Sowell, 1992, and Beran, 1995) were also employed, and the results were very similar to those reported in the paper.

Data and empirical results

The series examined are life expectancy at birth of the total population (for males and females separately) for the 48 countries belonging to the sub-Saharan African region. The frequency is annual and the time period is from 1960 to 2013. The data source is the World Bank (Health Nutrition and Population Statistics) database (http://databank.worldbank.org/data).

Tables 1a, 1b and 1c present disaggregated (males and females), descriptive statistics for the total population. For total population, the lowest life expectancy is found in Rwanda (27 in 1992 and 1993, at the time of the genocide in that country), followed by Mali (28 in 1960), while the highest is found in Cape Verde (75) and Mauritius (74). As for the growth rate for the whole period (1960 – 2013), the highest increase occurred in Mali (96.42%), followed by Gambia (84.375) and Liberia (74.28%), while Botswana is the only country with a decrease (-7.84%), probably as a consequence of the scourge of AIDS affecting it (see table 1 in the Appendix) (*all tables are in the Appendix*).

In the case of the male population, the lowest values are found for Rwanda (25) and Mali (27), and the highest ones for Cape Verde and Mauritius (71). The percentage increase over the sample is 103.7% for Mali, and above 87% for Liberia and Gambia. Once gain the value for Botswana is negative (-2.04%). Finally, for the female population, life expectancy is slightly higher (79 for Cabo Verde and 78 for Mauritius), but the percentage increase is lower than for the male population (for instance 81.81% in Gambia and 89.65% in Mali).

Next we focus on the joint estimation of the time trend coefficient and the fractional differencing parameter. For this purpose, we consider a model as the one given by equations (1) and (4) under the assumption that the errors in (4) are a white noise process. In other words, the estimated model is:

$$y_t = \beta_0 + \beta_1 t + x_t, \qquad (1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots,$$

with white noise u_t.[1]

Table 2 displays the estimated values of d (along with their corresponding 95% confidence intervals) as well as the associated time trend coefficient (with the corresponding t-values) for each series. We also report the estimate of the $\beta_1$coefficients under the assumption of $I(1)$ and $I(0)$ errors (see table 2a),

For total population (see table 2a) the lowest estimates of the fractional differencing parameter are those for Guinea Bissau (0.46), South Sudan (0.66), Comoros (0.69), Sudan (0.70) and Equatorial Guinea (0.71). For all these countries (and some others such as Ghana, Mauritius, Madagascar, Mozambique, Benin, Mali and Chad), the null hypothesis that d is smaller than 1 cannot be rejected, which implies mean reverting behavior, with the effects of shocks disappearing in the long run though at a slow rate. For another group of countries (Somalia, Congo Democratic Republic, Eritrea, Angola, Cape Verde, Djibouti, Nigeria, Sao Tome, Burundi, Mauritania, Liberia, Burkina Faso, Niger, Gambia, Cameroon and Malawi), instead the unit root null hypothesis (i.e., $d = 1$) cannot be rejected. Finally, for the remaining countries the null that d is higher than 1 cannot be rejected, the highest values being estimated for Rwanda (2.13), Zimbabwe (1.68) and Lesotho (1.55) (see table 2a).

[1]AR models could also be considered for the error term. However, we have decided to describe the time dependence through a fractional differencing polynomial and have not included them to avoid the competition between the two structures (AR and fractional).

The estimates of the time trend coefficients for total population are also shown in table 2a. They differ substantially depending on whether $I(d)$, $I(0)$ or $I(1)$ errors respectively are assumed. In the $I(d)$ case, most of them are significantly positive, ranging from 0.165 (Congo Democratic Republic) to 0.517 (Mali). Insignificant trends are found for Botswana, Namibia, South Africa, and Swaziland (countries affected by AIDS epidemics); Congo Republic, Ivory Coast, Sierra Leone, Lesotho (countries where there have been civil wars respectively since 1996, in 2002-2004, in 1991-2002, and military coups until 1998); and Rwanda, Zambia and Zimbabwe (countries where there have been genocides respectively in 1994, 1995 and 1982-83).

Tables 2b and 2c report the estimates for males and females in turn. In the former case, mean reversion (i.e., values of d significantly below 1) occurs in Benin (0.78), Comoros (0.61), Equatorial Guinea (0.61), Guinea Bissau (0.62), Ghana (0.76), Mozambique (0.73), South Sudan (0.68) and Sudan (0.70). For the remaining countries, the estimated values of d are equal to or higher than 1. The highest time trends coefficients are estimated for Mali (0.532), Liberia (0.531) and Gambia (0.508), whilst the trends are insignificant in Botswana, Lesotho, Namibia, Rwanda, South Africa, Sierra Leone, Swaziland, Zambia and Zimbabwe – the same countries as before with the exceptions of the Congo Republic and the Ivory Coast where the trends are now found to be significant (see tables 2b and 2c).

In the case of the female population, estimates of d significantly below 1 are found for Comoros (0.80), Equatorial Guinea (0.79), Guinea Bissau (0.61), Ghana (0.81), Madagascar (0.82), Mali (0.84), South Sudan (0.66) and Sudan (0.68). In the other countries the estimated values of d are significantly equal to 1 or higher than 1, which implies that shocks have permanent effects. The highest estimates of the time trends coefficients are those for Cape Verde (0.556) and Gambia (0.507), whilst they are insignificant for Botswana, the Central African Republic, the Congo Republic, Ivory Coast, Kenya, Lesotho, Namibia, Rwanda, South Africa, Swaziland, Uganda, Zambia and Zimbabwe, that is, for four countries more than in the case of the male population.

Summary of the results

Tables 3a – 3c summarize the estimation results for the fractional differencing parameter and the time trend coefficient in the case of total population, males and females respectively. For the former, we distinguish the cases of mean reversion ($d < 1$), unit roots ($d = 1$) and explosive behavior ($d > 1$), while for the latter we consider insignificant ($\beta = 0$) and significant positive trends ($\beta > 0$).

Whether shocks have temporary (as in the case of mean reversion, $d < 1$) or permanent effects ($d \geq 1$) is clearly very important from a policy perspective. For instance, in the event of a negative shock (i.e. the AIDS or Ebola crisis), if its effects are transitory and disappear over time, the series will revert to its original trend in the long run without any need for policy intervention. By contrast, active policies will be necessary in the case of a shock with permanent effects (without mean reversion). As can be seen from the top panels of table 3, only approximately one fourth of the countries in our sample exhibit mean reverting behavior. These include Guinea Bissau, South Sudan, Sudan, Comoros, Equatorial Guinea, Ghana and Mozambique for all three series examined. Evidence of mean reversion is obtained in five countries: for the female and total population in Madagascar and Mali, for the male and total population in Benin, and for total population in Chad and Mauritius (though in Chad and Mauritius the upper confidence bands are very close to 1). It is also noteworthy that in all cases except one (Guinea Bissau for total population) the estimated values of d are above 0.5, which implies nonstationary

behavior. Therefore, first differencing is required prior to the estimation of the parameters in order to draw valid statistical inference [12] (see tables 3b and 3c).

As for the time trend coefficients, these are not significantly different from zero for all three series in seven countries, namely Lesotho (where there were military coups until 1998), Rwanda, Zimbabwe and Zambia (where there were genocides in 1994, 1982-83, and 1995 respectively), and Swaziland, Namibia and South Africa (all three countries heavily affected by AIDS). They are also insignificant in Botswana, Congo Republic, Sierra Leone and Ivory Coast in the case of total population; Benin and Sierra Leone for the male population, and Congo Republic, Central African Republic, Ivory Coast and Kenya for the female population. The highest estimated coefficients are those for Gambia (for all three series); Ethiopia and Mali (for total population), Mali and Liberia (males) and Cape Verde (females). In all these cases they are above 0.50.

Finally, it is noteworthy that the estimates of the time trend coefficients are in some cases substantially different from the corresponding ones under the assumptions of $I(0)$ or $I(1)$ errors. For example, for total population, the time trend coefficient for the Central African Republic is 0.136 with I(0) errors, 0.264 with the $I(1)$ specification and 0.336 in the fractional case. Similarly, for Kenya it is equal to 0.157, 0.301 and 0.446 respectively for $I(0)$, $I(1)$ and $I(d)$ errors. In Senegal, instead, the estimate falls from 0.555 (under $I(0)$) and 0.471 ($I(1)$) to 0.395 with the fractional differencing approach.

Conclusions

This paper analyzes time trends in life expectancy at birth in sub-Saharan Africa, allowing the errors to be $I(d)$, where d is a fractional value. This is in contrast to previous studies based on the standard assumptions of either $I(0)$ or $I(1)$ series, which might not be appropriate for the series of interest and therefore might have produced biased results.

Our findings indicate that the orders of integration differ substantially across countries. Some series are $I(d)$ with d significantly below 1 (which implies mean reverting behavior), some are $I(1)$ and the remainder exhibit orders of integration significantly above 1. The most interesting category includes countries where mean reversion occurs and the effects of shocks disappear in the long run. This is the case in Guinea Bissau, South Sudan, Sudan, Comoros, Equatorial Guinea, Ghana and Mozambique. Some evidence (for at least one of the three series) is also found in Madagascar, Mali, Benin, Chad and Mauritius. The fact that the estimated value of d is different from 1 (either below or above) in at least 31 of the 48 cases examined confirms that the results obtained under the assumption of $I(0)$ or $I(1)$ can be very misleading. Finally, the estimates of the time trend coefficient (based on the appropriate specification for the error term) suggest that this is not significant in Lesotho, Rwanda, Zimbabwe, Zambia, Swaziland, Namibia and South Africa. The highest coefficients are those for Gambia, Ethiopia, Mali, Liberia and Cabo Verde. In most cases, the observed (lack of) trends can plausibly be interpreted in terms of well-known events occurring in the countries being examined, such as genocides, (civil) wars or AIDS epidemics.

The present paper has focused on the estimation of the time trend coefficients and the degree of persistence measured by the fractional differencing parameter. An interesting extension would be to generate predictions not only of the series examined (life expectancy at birth) but also of the mortality

[2] Note, however, that the time trend coefficients here were estimated under the assumption of a d_o-differenced process, which exhibits short memory ($d = 0$) under the null.

trends in the SSA countries. For this purpose, multivariate analysis should be conducted using fractional cointegration techniques (Hualde and Robinson, 2003; Johansen, 2008; Johansen and Nielsen, 2010; among others).

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Appendix

Table 1a: Descriptive statistics for "life expectancy at birth": total population (years)

Country	1960	2013	Minimum	Maximum	% growth rt.
ANGOLA	33	52	33	52	57.57%
BENIN	37	59	37	59	59.45%
BURKINA F.	34	56	34	56	64.70%
BOTSWANA	51	47	46	63	-7.84%
BURUNDI	41	54	41	54	31.70%
CAMEROON	42	55	42	55	30.95%
C AFRICAN R	36	50	36	50	38.88%
CONGO D.R.	41	50	41	50	21.95%
CHAD	38	51	38	51	34.21%
COMOROS	43	61	43	61	41.86%
CONGO R.	49	59	49	59	20.40%
COTE D'IV.	37	51	37	53	37.83%
CABO VERDE	49	75	49	75	53.06%
DJIBOUTI	44	62	44	62	40.90%
EQ. GUINEA	37	53	37	53	43.24%
ERITREA	37	63	37	63	70.27%
ETHIOPIA	38	64	38	64	68.42%
GABON	40	63	40	63	57.50%
GAMBIA	32	59	32	59	84.37%
GUINEA B.	42	54	42	54	28.57%
GHANA	46	61	46	61	32.60%
GUINEA	35	56	35	56	60.00%
KENYA	46	62	46	62	34.78%
LESOTHO	47	49	44	60	4.25%
LIBERIA	35	61	35	61	74.28%
MADAGASCAR	40	65	40	65	62.50%
MALAWI	38	55	38	55	44.73%
MALI	28	55	28	55	96.42%
MAURITANIA	43	62	43	62	44.18%
MAURITIUS	59	74	59	74	25.42%
MOZAMBIQUE	35	50	35	50	42.85%

(cont.)

NAMIBIA	47	64	47	64	36.17%
NIGER	36	58	36	58	61.11%
NIGERIA	37	52	37	52	40.54%
RWANDA	42	64	27	64	52.38%
SOUTH AF.	49	57	49	62	16.32%
SENEGAL	38	63	38	63	65.78%
S. LEONE	30	46	30	46	53.33%
SOMALIA	37	55	37	55	48.64%
SOUTH SUDAN	32	55	32	55	71.87%
SAO TOME	50	66	50	66	32.00%
SUDAN	48	62	48	62	29.16%
SWAZILAND	44	49	44	59	11.36%
TANZANIA	44	61	44	61	38.63%
TOGO	40	56	40	56	40.00%
UGANDA	44	59	44	59	34.09%
ZAMBIA	45	58	41	58	28.88%
ZIMBABWE	52	60	43	61	15.38%

Table 1b: Descriptive statistics for "life expectancy at birth": male population (years)

Country	1960	2013	Minimum	Maximum	% growth rt.
ANGOLA	32	50	32	50	56.25%
BENIN	37	58	37	58	56.75%
BURKINA F.	33	56	33	56	69.69%
BOTSWANA	49	48	46	61	-2.04%
BURUNDI	40	52	40	52	30.00%
CAMEROON	40	54	40	54	35.00%
C AFRICAN R	35	48	35	48	37.14%
CONGO D.R.	40	48	40	48	20.00%
CHAD	36	50	36	50	38.88%
COMOROS	42	59	42	59	40.47&
CONGO R.	47	57	47	57	21.27%
COTE D'IV.	36	50	36	51	38.88%
CABO VERDE	48	71	48	71	47.91%
DJIBOUTI	43	60	43	60	39.53%
EQ. GUINEA	35	52	35	52	48.57%
ERITREA	35	60	35	60	71.42%
ETHIOPIA	37	62	37	62	67.56%
GABON	38	62	38	62	63.15%
GAMBIA	31	58	31	58	87.09%
GUINEA B.	41	53	41	53	29.26%
GHANA	46	60	46	60	30.43%
GUINEA	34	55	34	55	61.76%
KENYA	44	60	44	60	36.36%
LESOTHO	45	49	43	58	8.88%
LIBERIA	32	60	32	60	87.50%
MADAGASCAR	39	63	39	63	61.53%
MALAWI	37	55	37	55	48.64%
MALI	27	55	27	55	103.70%
MAURITANIA	43	60	43	60	39.53%
MAURITIUS	57	71	57	71	24.56%
MOZAMBIQUE	34	49	34	49	44.11%

(cont.)

NAMIBIA	45	62	45	62	37.77%
NIGER	36	58	36	58	61.11%
NIGERIA	36	52	36	52	44.44%
RWANDA	41	62	25	62	51.22%
SOUTH AF.	47	55	47	59	17.02%
SENEGAL	37	62	37	62	67.56%
S. LEONE	29	45	29	45	55.17%
SOMALIA	35	53	35	53	51.42%
SOUTH SUDAN	30	54	30	54	80.00%
SAO TOME	49	64	49	64	30.61%
SUDAN	47	60	47	60	27.66%
SWAZILAND	42	50	42	58	19.04%
TANZANIA	42	60	42	60	42.85%
TOGO	39	56	39	56	43.59%
UGANDA	42	58	42	58	38.09%
ZAMBIA	44	56	40	56	2.72%
ZIMBABWE	50	59	43	59	18.00%

Table 1c: Descriptive statistics for "life expectancy at birth": female population (years)

Country	1960	2013	Minimum	Maximum	% growth rt.
ANGOLA	35	53	35	53	51.42%
BENIN	38	61	38	61	60.52%
BURKINA F.	36	57	36	57	58.33%
BOTSWANA	51	47	46	63	-7.84%
BURUNDI	43	56	43	56	30.23%
CAMEROON	43	56	43	56	30.23%
C AFRICAN R	38	52	38	52	36.84%
CONGO D.R.	42	52	42	52	23.81%
CHAD	40	52	40	52	30.00%
COMOROS	45	62	45	62	37.77%
CONGO R.	50	60	50	60	20.00%
COTE D'IV.	38	52	38	55	36.84%
CABO VERDE	50	79	50	79	58.00%
DJIBOUTI	45	63	45	63	40.00%
EQ. GUINEA	38	55	38	55	44.73%
ERITREA	39	65	39	65	66.66%
ETHIOPIA	40	65	40	65	62.50%
GABON	41	64	41	64	56.09%
GAMBIA	33	60	33	60	81.81%
GUINEA B.	43	56	43	56	30.23%
GHANA	46	62	46	62	34.78%
GUINEA	36	57	36	57	58.33%
KENYA	48	64	48	64	33.33%
LESOTHO	48	50	45	61	4.16%
LIBERIA	37	62	37	62	67.56%
MADAGASCAR	41	66	41	66	60.97%
MALAWI	38	55	38	55	44.73%
MALI	29	55	29	55	89.65%
MAURITANIA	44	63	44	63	43.18%
MAURITIUS	61	78	61	78	27.86%
MOZAMBIQUE	36	51	36	51	41.66%

(cont.)

NAMIBIA	49	67	49	67	36.73%
NIGER	35	59	35	59	68.57%
NIGERIA	38	53	38	53	39.47%
RWANDA	44	66	28	66	50.00%
SOUTH AF.	51	59	51	66	15.68%
SENEGAL	39	65	39	65	66.66%
S. LEONE	32	46	32	46	43.75%
SOMALIA	39	57	39	57	46.15%
SOUTH SUDAN	33	56	33	56	69.69%
SAO TOME	52	68	52	68	30.77%
SUDAN	50	64	50	64	28.00%
SWAZILAND	46	48	46	61	4.34%
TANZANIA	45	63	45	63	40.00%
TOGO	41	57	41	57	39.02%
UGANDA	46	60	46	60	30.43%
ZAMBIA	47	60	41	60	27.66%
ZIMBABWE	53	61	42	63	15.09%

Table 2a: Estimates of d and the time trend coefficients (total population)

Country	d (95% conf. intv)	β (t-value) (I(d) case)	β (t-value) (I(0) case) 0.35 β (t-value) (I(1) case) 0.35	β (t-value) (I(1) case) 0.35 β (t-value) (I(1) case) 0.35
ANGOLA	0.92 (0.81, 1.06)	**0.354 (7.25)**	0.318 (30.50)	0.358 (5.49)
BENIN	0.83 (0.73, 0.96)	**0.421 (11.62)**	0.429 (45.23)	0.415 (6.19)
BURKINA F.	1.01 (0.91, 1.14)	**0.415 (5.98)**	0.391 (30.00)	0.415 (6.19)
BOTSWANA	1.41 (1.32, 1.52)	0.057 (0.16)	-0.142 (-3.03)	-0.075 (-0.67)
BURUNDI	0.97 (0.85, 1.14)	**0.242 (3.63)**	0.188 (3.30)	0.245 (3.30)
CAMEROON	1.04 (0.96, 1.15)	**0.247 (3.09)**	0.208 (12.01)	0.245 (3.53)
C AFRICAN R	1.24 (1.16, 1.35)	**0.336 (1.85)**	0.136 (5.54)	0.264 (3.13)
CONGO D.R.	0.90 (0.78, 1.07)	**0.165 (4.14)**	0.131 (16.08)	0.169 (2.95)
CHAD	0.85 (0.73, 0.99)	**0.239 (7.07)**	0.207 (26.26)	0.245 (4.18)
COMOROS	0.69 (0.60, 0.81)	**0.340 (16.39)**	0.331 (46.25)	0.339 (5.27)
CONGO R.	1.16 (1.06, 1.29)	0.220 (1.61)	0.072 (4.05)	0.188 (2.37)
COTE D'IV.	1.32 (1.22, 1.45)	0.382 (1.53)	0.162 (5.21)	0.264 (2.86)
CABO VERDE	0.92 (0.80, 1.07)	**0.497 (9.77)**	0.535 (50.56)	0.490 (7.21)
DJIBOUTI	0.92 (0.83, 1.03)	**0.334 (6.94)**	0.293 (25.21)	0.339 (5.26)
EQ. GUINEA	0.71 (0.56, 0.89)	**0.296 (13.59)**	0.286 (49.31)	0.301 (4.83)
ERITREA	0.90 (0.81, 1.02)	**0.490 (10.00)**	0.506 (41.19)	0.490 (7.21)
ETHIOPIA	1.15 (1.06, 1.27)	**0.511 (4.56)**	0.414 (21.48)	0.490 (7.21)
GABON	1.26 (1.16, 1.40)	**0.431 (2.47)**	0.430 (16.08)	0.434 (5.62)
GAMBIA	1.03 (0.94, 1.15)	**0.507 (6.71)**	0.535 (32.38)	0.509 (7.48)
GUINEA B.	0.46 (0.31, 0.67)	**0.233 (25.97)**	0.238 (62.18)	0.226 (3.97)
GHANA	0.76 (0.63, 0.94)	**0.286 (10.26)**	0.283 (40.43)	0.283 (4.23)
GUINEA	1.13 (1.00, 1.30)	**0.380 (3.39)**	0.455 (33.66)	0.396 (5.53)
KENYA	1.34 (1.24, 1.47)	**0.446 (1.69)**	0.157 (5.90)	0.301 (3.22)
LESOTHO	1.55 (1.43, 1.71)	0.128 (0.24)	-0.022 (-0.54)	0.037 (0.30)
LIBERIA	0.99 (0.86, 1.17)	**0.490 (7.46)**	0.459 (47.28)	0.490 (7.21)
MADAGASCAR	0.80 (0.69, 0.93)	**0.468 (14.37)**	0.459 (51.73)	0.471 (6.94)
MALAWI	1.11 (0.98, 1.27)	**0.323 (3.22)**	0.270 (22.40)	0.320 (4.66)
MALI	0.83 (0.74, 0.96)	**0.517 (14.21)**	0.537 (52.48)	0.509 (7.48)
MAURITANIA	0.97 (0.88, 1.09)	**0.356 (6.07)**	0.336 (25.10)	0.358 (5.49)
MAURITIUS	0.75 (0.57, 0.98)	**0.276 (11.04)**	0.261 (44.26)	0.283 (4.61)

MOZAMBIQUE	0.82 (0.70, 0.96)	**0.280 (8.82)**	0.260 (36.77)	0.283 (4.61)

(cont.)

Table 2a: Estimates of d and the time trend coefficients (total population)

Country	d (95% conf. intv)	β (t-value) (I(d) case)	β (t-value) (I(0) case)	β (t-value) (I(1) case)
NAMIBIA	1.41 (1.28, 1.56)	0.388 (1.13)	0.208 (7.99)	0.320 (3.27)
NIGER	1.01 (0.92, 1.12)	**0.414 (5.96)**	0.464 (31.47)	0.415 (6.19)
NIGERIA	0.95 (0.84, 1.06)	**0.279 (5.66)**	0.231 (22.80)	0.283 (4.61)
RWANDA	2.13 (1.94, 2.40)	1.170 (0.92)	0.239 (3.41)	0.415 (1.69)
SOUTH AF.	1.36 (1.23, 1.50)	0.246 (0.78)	0.085 (2.66)	0.151 (1.45)
SENEGAL	1.29 (1.17, 1.46)	**0.395 (2.00)**	0.555 (29.39)	0.471 (6.08)
S. LEONE	1.31 (1.19, 1.47)	0.364 (1.58)	0.208 (9.38)	0.301 (3.51)
SOMALIA	0.87 (0.73, 1.06)	**0.338 (7.76)**	0.332 (39.47)	0.339 (4.87)
SOUTH SUDAN	0.66 (0.55, 0.81)	**0.434 (22.13)**	0.440 (66.75)	0.434 (6.43)
SAO TOME	0.95 (0.85, 1.08)	**0.299 (5.72)**	0.264 (24.17)	0.301 (4.83)
SUDAN	0.70 (0.56, 0.87)	**0.255 (12.67)**	0.233 (41.21)	0.264 (4.40)
SWAZILAND	1.36 (1.26, 1.49)	0.217 (0.64)	0.042 (1.02)	0.094 (0.81)
TANZANIA	1.27 (1.16, 1.42)	**0.322 (1.85)**	0.231 (12.78)	0.320 (4.35)
TOGO	1.11 (1.03, 1.22)	**0.315 (3.00)**	0.257 (12.24)	0.301 (4.14)
UGANDA	1.32 (1.23, 1.45)	**0.359 (1.79)**	0.153 (6.70)	0.283 (3.69)
ZAMBIA	1.43 (1.34, 1.54)	0.334 (0.90)	0.016 (0.44)	0.245 (2.13)
ZIMBABWE	1.68 (1.57, 1.80)	0.202 (0.29)	-0.129 (-2.82)	0.151 (0.95)

Table 2b: Estimates of d and the time trend coefficients (male population)

Country	d (95% conf. intv)	β (t-value) (I(d) case)	β (t-value) (I(0) case)	β (t-value) (I(1) case)
ANGOLA	0.97 (0.86, 1.12)	**0.339 (5.86)**	0.317 (27.47)	0.339 (5.27)
BENIN	0.78 (0.65, 0.96)	**0.406 (13.61)**	0.428 (60.58)	0.396 (5.95)
BURKINA F.	1.06 (0.95, 1.20)	**0.438 (5.26)**	0.396 (29.88)	0.433 (6.43)
BOTSWANA	1.39 (1.30, 1.51)	0.096 (0.29)	-0.100 (-2.34)	-0.018 (-0.17)
BURUNDI	0.93 (0.80, 1.09)	**0.224 (4.23)**	0.189 (19.93)	0.226 (3.32)
CAMEROON	1.02 (0.93, 1.13)	**0.265 (3.77)**	0.219 (14.11)	0.264 (4.03)
C AFRICAN R	1.21 (1.11, 1.34)	**0.279 (1.69)**	0.136 (6.02)	0.245 (2.94)
CONGO D.R.	0.89 (0.77, 1.07)	**0.149 (4.00)**	0.125 (15.55)	0.151 (2.72)
CHAD	0.86 (0.76, 1.00)	**0.259 (7.20)**	0.224 (25.28)	0.264 (4.40)
COMOROS	0.61 (0.51, 0.74)	**0.332 (21.40)**	0.333 (59.92)	0.320 (5.04)
CONGO R.	1.15 (1.05, 1.28)	**0.223 (1.79)**	0.073 (4.54)	0.188 (2.51)
COTE D'IV.	1.20 (1.11, 1.31)	**0.307 (1.91)**	0.178 (6.61)	0.264 (3.13)
CABO VERDE	0.98 (0.87, 1.13)	**0.435 (6.93)**	0.456 (37.65)	0.433 (6.43)
DJIBOUTI	0.90 (0.81, 1.02)	**0.318 (7.20)**	0.287 (25.45)	0.320 (5.05)
EQ. GUINEA	0.61 (0.45, 0.81)	**0.303 (19.29)**	0.291 (58.11)	0.320 (5.05)
ERITREA	0.98 (0.78, 1.00)	**0.474 (10.82)**	0.499 (44.06)	0.471 (6.94)
ETHIOPIA	1.10 (1.01, 1.22)	**0.479 (4.67)**	0.420 (21.83)	0.471 (6.47)
GABON	1.24 (1.14, 1.37)	**0.457 (2.75)**	0.446 (16.93)	0.452 (5.85)
GAMBIA	1.02 (0.93, 1.15)	**0.508 (6.96)**	0.536 (33.29)	0.509 (7.48)
GUINEA B.	0.62 (0.50, 0.80)	**0.230 (15.75)**	0.242 (47.63)	0.226 (3.97)
GHANA	0.76 (0.62, 0.96)	**0.269 (9.82)**	0.276 (41.79)	0.264 (4.03)
GUINEA	1.16 (1.04, 1.31)	**0.370 (3.22)**	0.472 (34.76)	0.396 (5.95)
KENYA	1.29 (1.19, 1.40)	**0.406 (1.81)**	0.172 (67.76)	0.301 (3.35)
LESOTHO	1.46 (1.34, 1.60)	0.291 (0.64)	0.0008 (0.02)	0.075 (0.61)
LIBERIA	1.06 (0.91, 1.27)	**0.531 (6.34)**	0.488 (48.71)	0.528 (7.77)
MADAGASCAR	0.85 (0.74, 1.00)	**0.452 (11.53)**	0.447 (48.79)	0.452 (6.68)
MALAWI	1.04 (0.92, 1.20)	**0.342 (4.27)**	0.282 (25.49)	0.339 (4.87)
MALI	0.92 (0.82, 1.06)	**0.532 (10.47)**	0.565 (49.71)	0.528 (7.77)
MAURITANIA	0.93 (0.84, 1.04)	**0.321 (6.48)**	0.320 (25.40)	0.264 (4.02)
MAURITIUS	0.86 (0.51, 1.18)	**0.253 (6.40)**	0.228 (41.70)	0.320 (5.04)
MOZAMBIQUE	0.73 (0.60, 0.90)	**0.281 (12.24)**	0.267 (45.81)	0.283 (4.61)

(cont.)

Table 2b: Estimates of d and the time trend coefficients (male population)

Country	d (95% conf. intv)	β (t-value) (I(d) case)	β (t-value) (I(0) case)	β (t-value) (I(1) case)
NAMIBIA	1.38 (1.26, 1.54)	0.402 (1.29)	0.201 (7.84)	0.320 (3.27)
NIGER	1.02 (0.94, 1.12)	**0.413 (5.74)**	0.465 (30.29)	0.415 (6.19)
NIGERIA	0.93 (0.83, 1.06)	**0.298 (6.14)**	0.249 (25.05)	0.301 (4.83)
RWANDA	2.06 (1.87, 2.30)	-0.017 (-0.01)	0.246 (3.49)	0.396 (1.58)
SOUTH AF.	1.31 (1.19, 1.46)	0.243 (0.98)	0.099 (3.75)	0.150 (1.62)
SENEGAL	1.29 (1.16, 1.46)	**0.445 (2.40)**	0.532 (29.80)	0.471 (6.47)
S. LEONE	1.33 (1.22, 1.49)	0.307 (1.23)	0.220 (8.97)	0.301 (3.35)
SOMALIA	0.85 (0.70, 1.05)	**0.337 (8.39)**	0.320 (41.53)	0.339 (4.87)
SOUTH SUDAN	0.68 (0.58, 0.82)	**0.448 (21.32)**	0.449 (64.79)	0.452 (6.68)
SAO TOME	0.98 (0.88, 1.13)	**0.282 (4.93)**	0.249 (22.20)	0.283 (4.61)
SUDAN	0.70 (0.58, 0.87)	**0.242 (12.32)**	0.225 (39.83)	0.245 (4.19)
SWAZILAND	1.42 (1.31, 1.56)	0.324 (0.88)	0.091 (2.33)	0.151 (1.37)
TANZANIA	1.20 (1.09, 1.35)	**0.351 (2.44)**	0.251 (14.87)	0.339 (4.55)
TOGO	1.08 (0.99, 1.21)	**0.331 (3.42)**	0.271 (14.35)	0.320 (4.35)
UGANDA	1.30 (1.20, 1.42)	**0.382 (1.95)**	0.173 (7.69)	0.301 (3.89)
ZAMBIA	1.38 (1.28, 1.50)	0.283 (0.88)	0.030 (0.91)	0.226 (2.09)
ZIMBABWE	1.61 (1.51, 1.74)	0.306 (0.50)	-0.092 (-2.2)	0.169 (1.17)

Table 2c: Estimates of d and the time trend coefficients (female population)

Country	d (95% conf. intv)	β (t-value) (I(d) case)	β (t-value) (I(0) case)	β (t-value) (I(1) case)
ANGOLA	0.87 (0.76, 1.00)	**0.338 (8.44)**	0.315 (33.41)	0.339 (5.26)
BENIN	0.99 (0.90, 1.10)	**0.434 (6.66)**	0.433 (29.00)	0.434 (6.43)
BURKINA F.	1.01 (0.90, 1.16)	**0.396 (5.34)**	0.383 (26.68)	0.396 (5.53)
BOTSWANA	1.36 (1.28 1.47)	0.078 (0.24)	-0.135 (-2.81)	-0.076 (-0.65)
BURUNDI	1.04 (0.93, 1.19)	**0.247 (3.10)**	0.185 (15.80)	0.245 (3.53)
CAMEROON	1.08 (0.99, 1.19)	**0.251 (2.74)**	0.199 (10.80)	0.245 (3.53)
C AFRICAN R	1.30 (1.20, 1.44)	0.360 (1.60)	0.135 (5.05)	0.264 (2.99)
CONGO D.R.	0.91 (0.76, 1.12)	**0.180 (3.84)**	0.133 (15.68)	0.188 (2.90)
CHAD	0.86 (0.74, 1.03)	**0.221 (6.48)**	0.196 (25.89)	0.226 (3.97)
COMOROS	0.80 (0.71, 0.92)	**0.326 (10.67)**	0.323 (35.51)	0.320 (5.05)
CONGO R.	1.16 (1.06, 1.28)	0.224 (1.64)	0.070 (3.95)	0.188 (2.37)
COTE D'IV.	1.38 (1.28, 1.50)	0.435 (1.51)	0.150 (4.30)	0.264 (2.75)
CABO VERDE	0.91 (0.81, 1.05)	**0.556 (11.41)**	0.614 (61.08)	0.547 (8.07)
DJIBOUTI	0.95 (0.85, 1.07)	**0.336 (6.25)**	0.297 (24.16)	0.339 (5.26)
EQ. GUINEA	0.79 (0.65, 0.98)	**0.307 (10.38)**	0.283 (42.91)	0.320 (5.04)
ERITREA	0.92 (0.83, 1.04)	**0.491 (9.65)**	0.507 (39.42)	0.490 (7.21)
ETHIOPIA	1.13 (1.03, 1.26)	**0.481 (4.01)**	0.403 (20.03)	0.471 (6.08)
GABON	1.25 (1.16, 1.37)	**0.464 (2.77)**	0.419 (15.10)	0.433 (5.62)
GAMBIA	1.04 (0.95, 1.16)	**0.507 (6.49)**	0.537 (32.17)	0.509 (7.48)
GUINEA B.	0.61 (0.47, 0.82)	**0.244 (16.76)**	0.244 (50.75)	0.245 (4.19)
GHANA	0.81 (0.68, 0.98)	**0.301 (8.86)**	0.291 (36.32)	0.301 (4.45)
GUINEA	1.13 (1.00, 1.30)	**0.384 (3.43)**	0.437 (32.79)	0.396 (5.53)
KENYA	1.41 (1.30, 1.54)	0.512 (1.59)	0.136 (4.82)	0.301 (3.09)
LESOTHO	1.61 (1.48, 1.76)	0.204 (0.34)	-0.045 (-1.04)	0.037 (0.28)
LIBERIA	0.97 (0.84, 1.13)	**0.470 (7.70)**	0.433 (43.79)	0.471 (6.94)
MADAGASCAR	0.82 (0.71, 0.95)	**0.472 (13.47)**	0.468 (51.05)	0.471 (6.94)
MALAWI	1.14 (1.02, 1.30)	**0.334 (2.80)**	0.257 (19.06)	0.320 (4.35)
MALI	0.84 (0.74, 0.97)	**0.495 (13.11)**	0.507 (49.12)	0.490 (7.21)
MAURITANIA	0.97 (0.88, 1.08)	**0.358 (6.10)**	0.350 (24.86)	0.358 (5.49)
MAURITIUS	0.88 (0.76, 1.05)	**0.316 (7.67)**	0.294 (31.30)	0.320 (5.05)
MOZAMBIQUE	0.84 (0.71, 1.00)	**0.278 (7.44)**	0.254 (32.81)	0.283 (4.23)

(cont.)

Table 2c: Estimates of d and the time trend coefficients (female population)

Country	d (95% conf. intv)	β (t-value) (I(d) case)	β (t-value) (I(0) case)	β (t-value) (I(1) case)
NAMIBIA	1.39 (1.27, 1.55)	0.456 (1.29)	0.224 (8.31)	0.339 (3.12)
NIGER	0.96 (0.88, 1.07)	**0.278 (5.24)**	0.470 (33.31)	0.452 (6.68)
NIGERIA	0.98 (0.88, 1.11)	**0.452 (7.17)**	0.214 (20.32)	0.283 (4.61)
RWANDA	1.92 (1.74, 2.14)	0.031 (0.02)	0.233 (3.31)	0.415 (1.68)
SOUTH AF.	1.44 (1.33, 1.57)	0.288 (0.71)	0.069 (1.75)	0.150 (1.29)
SENEGAL	1.32 (1.21, 1.47)	**0.399 (2.00)**	0.573 (29.90)	0.490 (6.72)
S. LEONE	1.20 (1.09, 1.34)	**0.272 (1.76)**	0.193 (10.14)	0.264 (3.30)
SOMALIA	0.86 (0.71, 1.06)	**0.336 (8.02)**	0.321 (40.67)	0.339 (4.87)
SOUTH SUDAN	0.66 (0.54, 0.82)	**0.430 (21.92)**	0.433 (68.35)	0.433 (6.43)
SAO TOME	0.90 (0.80, 1.03)	**0.300 (6.88)**	0.274 (26.58)	0.301 (4.83)
SUDAN	0.68 (0.55, 0.84)	**0.258 (13.79)**	0.240 (42.53)	0.264 (4.40)
SWAZILAND	1.47 (1.36, 1.61)	0.275 (0.65)	-0.008 (-0.19)	0.037 (0.32)
TANZANIA	1.28 (1.17, 1.42)	**0.398 (1.97)**	0.212 (10.65)	0.339 (4.07)
TOGO	1.15 (1.06, 1.27)	**0.326 (2.58)**	0.243 (10.47)	0.301 (3.89)
UGANDA	1.37 (1.27, 1.48)	0.309 (1.31)	0.122 (5.03)	0.264 (3.30)
ZAMBIA	1.50 (1.41, 1.60)	0.290 (0.67)	-0.009 (-0.23)	0.245 (1.98)
ZIMBABWE	1.66 (1.56, 1.79)	0.627 (0.82)	-0.172 (-3.40)	0.150 (0.85)

Table 3a: Summary results for total population

Estimates of the fractional differencing parameter d		
d < 1	d = 1	d > 1
Guinea Bissau (0.46) South Sudan (0.66) Comoros (0.69) Sudan (0.70) Equatorial Guinea (0.71) Ghana (0.75) Mauritius (0.75) Madagascar (0.80) Mozambique (0.82) Mali (0.83) Benin (0.83) Chad (0.85)	Somalia (0.87) Congo Dem. Republic (0.90) Eritrea (0.90) Angola (0.92) Cabo Verde (0.92) Djibouti (0.92) Nigeria (0.95) Sao Tome (0.95) Burundi (0.97) Mauritania (0.97) Liberia (0.99) Burkina Faso (1.01) Niger (1.01) Gambia (1.03) Cameroon (1.04) Malawi (1.11) Guinea (1.13)	Togo (1.11) Congo Republic (1.15) Ethiopia (1.15) Central African Republic (1.24) Gabon (1.26) Tanzania (1.27) Senegal (1.29) Sierra Leone (1.31) Ivory Coast (1.32) Uganda (1.32) Kenya (1.35) South Africa (1.36) Swaziland (1.36) Namibia (1.41) Botswana (1.41) Zambia (1.43) Lesotho (1.55) Zimbabwe (1.68) Rwanda (2.13)

Estimates of the time trend coefficients	
β = 0	β > 0
Botswana (0.057); Lesotho (0.128); Zimbabwe (0.202); Swaziland (0.217); Congo Republic (0.220); South Africa (0.246); Zambia (0.334); Sierra Leone (0.364); Ivory Coast (0.382); Namibia (0.388); Rwanda (1.170)	Congo Democratic Republic (0.165); Guinea Bissau (0.233); Chad (0.239);Burundi (0.242); Cameroon (0.247); Sudan (0.255); Mauritius (0.276); Nigeria (0.279); Mozambique (0.280); Ghana (0.286); Equatorial Guinea (0.296); Sao Tome (0.299); Togo (0.315); Tanzania (0.322); Malawi (0.323); Djibouti (0.334); Central African Republic (0.336); Somalia (0.338); Comoros (0.340);Angola (0.354); Mauritania (0.356); Uganda (0.359); Guinea (0.380); Senegal (0.395); Niger (0.414); Burkina Faso (0.415); Benin (0.421); South Sudan (0.434); Kenya (0.446); Gabon (0.431); Kenya (0.446); Madagascar (0.468); Eritrea (0.490); Liberia (0.490); Cabo Verde (0.497); Gambia (0.507); Ethiopia (0.511); Mali (0.517)

Table 3b: Summary results for the male population

Estimates of the fractional differencing parameter d		
d < 1	d = 1	d > 1
Equatorial Guinea (0.61) Comoros (0.61) Guinea Bissau (0.62) South Sudan (0.68) Sudan (0.70) Mozambique (0.73) Ghana (0.76) Benin (0.78)	Madagascar (0.85) Somalia (0.85) Chad (0.86) Mauritius (0.86) Congo Dem. Republic (0.89) Djibouti (0.90) Mali (0.92) Burundi (0.93) Mauritania (0.93) Nigeria (0.93) Angola (0.97) Sao Tome (0.98) Cabo Verde (0.98) Eritrea (0.98) Cameroon (1.02) Niger (1.02) Gambia (1.02) Malawi (1.04) Burkina Faso (1.06) Liberia (1.06) Togo (1.08)	Ethiopia (1.10) Congo Republic (1.15) Guinea (1.16) Central Ivory Coast (1.20) Tanzania (1.20) African Republic (1.21) Gabon (1.24) Senegal (1.29) Kenya (1.29) Uganda (1.30) South Africa (1.31) Sierra Leone (1.33) Zambia (1.38) Namibia (1.38) Botswana (1.39) Swaziland (1.42) Lesotho (1.46) Zimbabwe (1.61) Rwanda (2.06)

Estimates of the time trend coefficients	
β = 0	β > 0
Rwanda (-0.017); Botswana (0.096); South Africa (0.243); Zambia (0.283); Lesotho (0. 291); Zimbabwe (0.306); Sierra Leone (0.307); Swaziland (0.324); Namibia (0.402)	Congo Democratic Republic (0.149); Congo Republic (0.223); Burundi (0.224); Guinea Bissau (0.230); Sudan (0.242); Mauritius (0.253); Chad (0.259); Cameroon (0.265); Ghana (0.269); Central African Republic (0.279); Mozambique (0.281); Sao Tome (0.282);Nigeria (0.298); Equatorial Guinea (0.303); Ivory Coast (0.307); Djibouti (0.318); Mauritania (0.321); Togo (0.331); Comoros (0.332); Somalia (0.337); Angola (0.339); Malawi (0.342); Tanzania (0.351); Guinea (0.370); Uganda (0.382); Benin (0.406); Kenya (0.406); Niger (0.413); Cabo Verde (0.435); Burkina Faso (0.438); Senegal (0.445); South Sudan (0.448); Madagascar (0.452); Gabon (0.457); Eritrea (0.474); Ethiopia (0.479); Gambia (0.508); Liberia (0.531); Mali (0.532)

Table 3c: Summary results for the female population

Estimates of the fractional differencing parameter d		
d < 1	d = 1	d > 1
Guinea Bissau (0.61) South Sudan (0.66) Sudan (0.68) Equatorial Guinea (0.79) Comoros (0.80) Ghana (0.81) Madagascar (0.82) Mali (0.84) Mozambique (0.84)	Chad (0.86) Somalia (0.86) Angola (0.87) Mauritius (0.88) Sao Tome (0.90) Congo Dem. Republic (0.91) Cabo Verde (0.91) Eritrea (0.92) Djibouti (0.95) Niger (0.96) Liberia (0.97) Mauritania (0.97) Nigeria (0.98) Benin (0.99) Burkina Faso (1.01) Burundi (1.04) Gambia (1.04) Cameroon (1.08)	Ethiopia (1.13) Guinea (1.13) Malawi (1.14) Togo (1.15) Congo Republic (1.16) Sierra Leone (1.20) Gabon (1.25) Tanzania (1.28) Central African Republic (1.30) Senegal (1.32) Botswana (1.36) Uganda (1.37) Ivory Coast (1.38) Namibia (1.39) Kenya (1.41) South Africa (1.44) Swaziland (1.47) Zambia (1.50) Lesotho (1.61) Zimbabwe (1.66) Rwanda (1.92)

Estimates of the time trend coefficients	
$\beta = 0$	$\beta > 0$
Rwanda (0.031); Botswana (0.078); Lesotho (0. 204); South Africa (0.288); Congo Republic (0.224); Swaziland (0.275); Zambia (0.290); Central African Republic (0.360); Ivory Coast (0.435); Namibia (0.456); Kenya (0.512); Zimbabwe (0.627)	Congo Democratic Republic (0.180); Chad (0.221); Guinea Bissau (0.244); Burundi (0.247); Cameroon (0.251); Sudan (0.258); Sierra Leone (0.272); Mozambique (0.278); Niger (0.278); Sao Tome (0.300); Ghana (0.301); Equatorial Guinea (0.307);Uganda (0.309); Mauritius (0.316); Togo (0.326); Comoros (0.326); Malawi (0.334); Somalia (0.336); Djibouti (0.336); Angola (0.338); Mauritania (0.358); Guinea (0.384); Burkina Faso (0.396); Tanzania (0.398); Senegal (0.399); South Sudan (0.430); Benin (0.434);Nigeria (0.452); Gabon (0.464); Liberia (0.470); Madagascar (0.472); Ethiopia (0.481); Eritrea (0.491); Mali (0.495); Gambia (0.507); Cabo Verde (0.556)