An Assessment of the Age Reporting in the IPUMS-I Microdata

Johanna Fajardo-González[1], Laura Attanasio[2], and Jasmine Trang Ha[3]

Minnesota Population Center

University of Minnesota

Paper submitted for presentation at the 2014 Annual Meeting of the Population Association of America.

Abstract

The objective of this paper is to provide data users with a global assessment of the age reporting in the Integrated Public Use Microdata Series-International (IPUMS-I) data. We investigate the consistency of the demographic data from 23 countries in Africa and Asia using various statistical procedures to identify systematic irregularities in the reporting of ages. In our analysis, we consider both single and multiple censuses, when available, to obtain age-ratios, sex-ratios, and other summary measures such as the United Nations Age-Sex Accuracy Index, the Whipple's index, and the Myer's blended index. Our results indicate that overall there are some anomalies in the reported age data from these countries over time. In most cases, the reported age statistics show a strong preference for terminal digits 0 and 5. In similar analyses stratified by sex, we found that in some samples, this preference is stronger among females than among males.

Introduction

Age is an important demographic variable because it is utilized for description and analysis of a population structure and to forecast population growth. However, reporting of age is very susceptible to errors, and both the nature and quality of data varies greatly between countries and over time (Moultrie, 2012).

There are many potential sources of error in age-reporting. One common issue is either under-reporting of children less than one year of age or over-statement of age at very advanced ages. There is also a tendency to provide an exact age of some legal significance such as voting age or marriage age (United Nations, 1956). Heaping on ages ending at 0, 5, or at other digits is also common due to cultural preference for or avoidance of certain digits (Nagi, Stockwell & Snawley, 1973). Other issues include ignorance of the true age, low numeracy, and problems in the collection of data (Crayen & Baten, 2008). Several methods and indices for evaluating the accuracy of age-reporting have been developed and widely employed for a more complete understanding of data structure and anomalies. Analysis of age- and sex- ratio, the Whipple's Index, the Myer's Blended Index, and the United Nations (UN) Age-Sex

[1] Ph.D. Student in Applied Economics. E-mail: fajar016@umn.edu
[2] Ph.D. Student in Health Services Research, Policy and Administration. E-mail: attan002@umn.edu
[3] Ph.D. Student in Sociology. E-mail: haxxx132@umn.edu

Accuracy Index are among the most commonly used strategies for evaluating accuracy of age reporting (Moultrie, 2012).

Nevertheless, the true challenge is to separate inaccuracies from structural anomalies. Methods to detect problems with the reports of age usually involve either the calculation of expected values (frequencies, proportions or ratios) or the calculation of summary indices (Pullum, 2005). Such methods typically have an underlying assumption of a "normal" age-sex distribution. Hence, the indices are only capable of informing us how the data at hand diverge or conform to the assumed "normal" distribution. For cases where the actual age-sex distribution is indeed atypical due to social or structural reasons such as war, out-migration of a certain sex or age group, or sex-selective abortions, the inaccuracies flagged by those evaluative indices should not be automatically considered to be data errors.

The goal of our analysis is to investigate the consistency of the demographic data from 23 countries in Africa and Asia based on patterns in age-sex distribution. Some irregularities in age data from African and Asian samples have been noted by previous studies (Caldwell, 1966; Caldwell & Igun, 1971; Nagi et al., 1973; Byerlee & Terera, 1981; Ewbank, 1981; Jowett & Li, 1992; Denic et.al, 2004 Palamuleni, 2012). According to the most popular measures of accuracy, the quality of census in terms of age-reporting has improved pronouncedly in Asia, but less so in African countries (Cleland, 1996). We replicate the various statistical procedures that are commonly used to identify systematic patterns of age-misreporting, including age ratios by sex, Whipple's Index, Myer's Blended Index, and the UN Age-Sex Accuracy Index. At the same time, utilizing the availability of multiple censuses for the same countries provided by the Integrated Public Use Microdata Series-International (IPUMS-I) project, we are also able to explore changes and continuities in various countries' age-sex structure over time. We conclude by considering the strengths and weaknesses of several summary measures of age-reporting quality.

Data and Methodology

Data

This paper uses data from the Integrated Public Use Microdata Series-International (IPUMS-I) project. The IPUMS-I has compiled the world's largest collection of population microdata, currently containing individual-level information on 544 million people from 238 censuses in 74 countries (Minnesota Population Center, 2013). Most IPUMS-I samples represent 5% or 10% of the national population and have a uniform weight. For samples with more complex weighting schemes, we use sample weights in our analysis to make inferences about the population. In this paper, we analyze data from 17 African countries (Burkina Faso, Cameroon, Egypt, Ghana, Guinea, Kenya, Malawi, Mali, Morocco, Rwanda, Senegal, Sierra Leone, South Africa, South Sudan, Sudan, Tanzania, and Uganda), and 6 Asian countries (Bangladesh, Kyrgyz Republic, Malaysia, Indonesia, Mongolia, and Thailand).

Analysis

We begin by replicating the various statistical procedures that are commonly used to identify systematic patterns of age-misreporting while keeping in mind their assumptions about the data structure. As mentioned above, statistical methods for age-reporting evaluation usually involve either the calculation of expected values (frequencies, proportions or ratios) or the calculation of summary indices (Pullum, 2005). The calculation of expected values usually entails an estimation of the

distributions of the population by age and sex, as well as sex-ratios and age-ratios (United Nations, 1956; U.S. Bureau of the Census, 1985).

The age-ratio (AR_{nx}) for a given age group between ages *n* and *x* is the ratio of the population in that age group (N_{nx}) to half the sum of the population in each of the immediately preceding (N_{nx-5}) and following (N_{nx+5}) age groups. Algebraically, $AR_{nx} = N_{nx} / 0.5 * (N_{nx-5} + N_{nx+5})$. If no irregularities are to be identified in the census data, the age-ratio should be approximately equal to 1.

The sex-ratio is usually defined as the number of males per 100 females in the population. This ratio can be disaggregated by age as the ratio of male population between ages *n* and *x* (N_{nx}^{m}) to the female population in the same age group (N_{nx}^{f}), which is $SR_{nx} = 100 * N_{nx}^{m} / N_{nx}^{f}$. The overall ratio is conditioned by the age structure of the population as well as patterns of mortality and migration by gender. We do not report sex ratio results separately, but they are a component of the UN Age-Sex Accuracy Index described below.

The United Nations Age-Sex Accuracy Index, the Whipple's Index, and the Myers' Blended Index are some of the summary indices used to evaluate the quality of age reports. The United Nations Age-Sex Accuracy Index is to evaluate the quality of reported age-sex distribution in five-year age groups (United Nations, 1956). This index is calculated as three times the average of sex-ratio differences plus the average of the deviations from 100 of male and female age-ratios. Sex-ratio differences are calculated as the successive differences in sex-ratios between one age-group and the next one. The accuracy ratio is usually interpreted by categorizing the results (see Table 2), as the index is regarded as an "order of magnitude" rather than a precise measurement.

The Whipple's Index is the ratio of the total number of persons between ages 23 and 62 who report ages ending in 0 and 5 to one-fifth of the total population in the same age group, multiplied by 100. A score of 100 indicates no age heaping on 0 or 5, whereas a score of 500 indicates that every age reported ends in 0 or 5. The Whipple's Index scores can be also summarized through categories (see Table 1) proposed by the United Nations (1973).

The Myers' Blended Index is similar to the Whipple's Index, except that it considers preference (or avoidance) for ages ending in any number from 0 to 9. The index is calculated by first computing a "blended" population in which almost equal sums are expected for each digit (United Nations, 1956, pp.41). The "blended" totals for each of the ten numbers should be nearly 10 percent of their grand total, in the absence of any irregularities in the reporting of ages. We then obtain the absolute deviations of each sum from 10 percent and add them together. The value of the Myers' Index is one-half the sum of the absolute deviations. The theoretical range of the index is from 0 to 90, where 0 indicates no age heaping and 90 indicates every age reported ending in the same digit.

Results

Age-ratios analysis

Age ratios by sex are presented in Figure 1 (Asian countries) and Figure 2 (African countries). Our results indicate that most Asian and African countries have irregularities in all age groups. In Bangladesh, for the 1991, 2001 and 2011 censuses, we observe over-representation in the 60-64 group for both males and females whereas the 15-19 group is usually under-represented. In the 20-24 group, males are under-represented and females are over-represented in the two most recent census years, which may be related to patterns of work migration. Mongolian samples for 1989 and 2000 tell the

same story for the 40-44 and 50-54 age-groups: there are deviations from the expected smoothed trend lines for both males and females.

In some African countries, the age ratio graphs also clearly indicate differences by sex, particularly in earlier samples. In samples from the 1980s and 1990s from Egypt, Guinea and Cameroon, the age ratios for males are noticeably smoother than for females. In the Malawi 1987 sample, on the other hand, age ratios for females are smoother than for males, particularly after age 40.

United Nations Age-Sex Accuracy Index

The analysis of the UN Age-Sex Accuracy Index (Table 3) is complemented by the sex-ratios statistics (see Figures 4 and 5). Results from this index ranged from 14.4 to 65.8. While the majority of countries exhibited a trend of decreasing index scores over time, very few samples had low enough scores to meet the threshold for the "accurate" category. Those that were categorized as "accurate" were South Africa 1996 and South Africa 2001, Indonesia 2010, and all four samples from Thailand.

Whipple's Index

Many of the samples examined had Whipple's Index scores that indicate significant heaping on the 0's and 5's (Table 3). Some African countries also had Whipple scores that, when broken down by sex, revealed substantially more heaping in the age reports for females than for males (Table 4). In certain cases, this results in sex-specific index scores falling into different categories. For example, in Cameroon 1987 and 2005, and Mali 1987 and 1998, the Whipple's Index for males was categorized as "rough," whereas for females it was "very rough." In Morocco 2004, the score for females fell into the "approximate" category, while the male score was "fairly accurate." As with UN Age-Sex Accuracy Index scores, many countries had decreasing Whipple's Index scores over time, indicating a decrease in the tendency to report ages with 0 or 5 as the terminal digit.

Myers' blended index

Myers' Blended Index scores ranged from 0.98 to 36.72 (Table 3). Examination of the index components rather than the blended score showed that most digit preference, when it occurred, was for 0 and 5. Generally, the preference for 0 was far stronger than the preference for 5. A few samples had preferences for other digits as well. The Malawi 1998 and 2008 censuses had a digit preference for 8 that was over similar magnitude to the preference for 5. The Morocco 1994 and 2004 samples had preference for 0 and 4, but no preference for 5. In the Senegal 1988 sample, there is a preference for 4 and a strong preference for 9, while in 2002, there is a preference for 0 and 5. This may be an anomaly of data collection or processing that is particular to the 1988 census. Similar to the Whipple's Index results, many samples had Myers' Blended Index scores that indicated exaggerated age heaping among females compared to males.

Discussion

In this study, we examined the quality of the age reported in census data from 17 African countries and 6 Asian countries. We evaluated the distributions of the population by age and sex, as well as age ratios by sex. We also calculated Whipple's and Myers' indices of digit preference and the United Nations Age-Sex Accuracy Index.

Our results indicate that some irregularities in the age distribution are observed in all countries. In some cases, such irregularities may reflect a real social disturbance, or patterns of labor migration that tend to occur at certain ages. Because the UN Age-Sex Accuracy Index is based on assumptions about the age distribution of populations, samples that are flagged as "inaccurate" may have true anomalies in the population structure rather than errors in age-reporting. For example, according to the UN Age-Sex Accuracy Index, the Bangladeshi data is categorized as "very rough" for all three census years. However, the sex-ratio figures (see Figure 4) for age group 20-29 is consistently low for all three censuses (more female than male). This could potentially be explained by male out-migration for employment. Large waves of out-migration in Bangladesh have indeed been noted in previous studies. Scholars estimated that between five to seven million Bangladeshis are currently working abroad (Gamlen, 2010; Van Hear, Bakewell and Long, 2012). Examining the age-sex distribution for multiple census years allows us to see patterns of the country's age-sex structure that are not reflected by the summary indices. Similar patterns could be found with Mali, Kyrgyz Republic, Cameroon, and Kenya (see Figure 4). As such, it is probably important to consider possible explanations for the continuities and changes in the age-sex structure of those populations in addition to the summary indices. While the consistency of the pattern in the sex ratios at age 20-29 across all three censuses in Bangladesh suggests that this is a true structural anomaly, other irregularities in the sex ratios by age could represent different anomalies or age reporting inaccuracies; additional investigation – and detailed country-specific knowledge – would be necessary to disentangle these factors.

Similarly, over- and under-representation of various age groups identified in the age ratio graphs can be a result of true trends in the population or issues with the reporting of age. Even if there is some age heaping, age ratios should be smoothed by categorizing ages in 5-year intervals, as we do in the figures. When looking at age ratio graphs, "spikiness" was a reasonably good indicator that the index scores would reveal issues such as age heaping; thus, a simple visual examination of the age ratios by sex can be a useful first step in determining whether there are irregularities that merit further exploration.

The Myers' Index scores identified several cases where there was heaping on digits other than 0 and 5. The most common pattern was heaping on a terminal digit that was the same as the terminal digit of the census year (e.g. Malawi 1998 and 2008 showed digit preference for 8). One likely reason for this pattern of results is that, if age in the census is calculated from birth year, reporting a birth year that ends in '0' would produce a digit preference for the final digit of the census year in the age variable. While we were unable to determine the reason for heaping on 4 and 9 in the Senegal 1988 sample, this case illustrates the benefits of calculating the Myers' index in addition to the Whipple's index. The magnitude of the heaping is in fact greater in 2002 than in 1988; however, the component Myers' scores clearly show that there was some significant heaping in 1988, which would be missed by the Whipple's Index.

Our results also indicate substantial sex differences in the degree of age heaping in some samples. We speculate that this could be caused by sex differences in literacy rates, education, or other factors. For example, women may be more likely to have their information reported by a proxy (such as the head of the household) than men; past research has linked proxy reports of age to age heaping (West, Robinson and Bentley, 2005). Future research is needed to examine factors leading to more inaccurate age reporting among females than males.

One of the advantages of the IPUMS-I as a data source is that it facilitates comparisons across many countries and years. However, measures such as age ratios and the indices that we present in this paper are merely a first step in identifying whether there may be a problem with the quality of age

reporting in the data. Determining whether anomalous findings represent an issue with age reporting (and if so, why) or a true pattern in the population that may be caused by factors such as migration or war requires country- and year-specific knowledge and exploration. Additionally, users should be aware that IPUMS-I microdata samples have undergone different levels of processing and editing at the country's statistical office before being disseminated.

References

Byerlee, D. & Terera, G. (1981). Factors Affecting Reliability in Age Estimation in Rural West Africa: A Statistical Approach. *Population Studies,* 35(3):477-90.

Caldwell, J. (1966). A Study of Age Misstatement among Young Children in Ghana. *Demography,* 3(2):477-490.

Caldwell, J. & Igun, A.A. (1971). An Experiment with Census-type Age Enumeration in Nigeria. *Population Studies*, 25(2):287-302.

Cleland, J. (1996). Demographic Data Collection in Less Developed Countries 1946-199. *Population Studies,* 50(3): 433-450.

Crayen, D., & Baten, J. (2008). Global trends in numeracy 1820-1949 and its implications for long-run growth. *CESifo working paper, No. 2218.* Leibniz Institute for Economic Research at the University of Munich.

Denic, S., Khatib, F. & Saadi, H. (2004). Quality of age data in patients from developing countries*. Journal of Public Health*, 26(2): 168-171.

Ewbank, D.C. (1981). *Age Misreporting and Age-Selective Underenumeration: Sources, Patterns, and Consequences for Demographic Analysis, Committee on Population and Demography*. National Academy Press, Washington, D.C.

Gamlen, A. (2010). *People on the Move: Managing Migration in Today's Commonwealth.* London: The Ramphal Centre.

Van Hear, N., Bakewell, O. & Long, K. (2012). *Drivers of Migration*. "Migrating out of Poverty" Research Programme Consortium, Working Paper 1.

Jowett, J. & Li, Y.Q. (1992). Age heaping: China Contrasting Patterns from China*. GeoJournal,* 28(4):427-442.

Minnesota Population Center. (2013). *Integrated Public Use Microdata Series, International: Version 6.2* [Machine-readable database]. Minneapolis: University of Minnesota

Moultrie, T.A. (2012). *General assessment of age and sex data. Published on Tools for Demographic Estimation*. Available at http://demographicestimation.iussp.org

Nagi, M.H., Stockwell, E.G. & Snavley, L.M. (1973). Digit Preference and Avoidance in the Age Statistics of Some Recent African Censuses: Some Patterns and Correlates*. International Statistical Review*, 41(2):165-174.

Palamuleni, M.E. (2012). *Age reporting in the North West Province, South Africa, 1996- 2007*. Paper presented at the 20013 Annual Meeting of the Population Association of America, New Orleans, April 11- 13.

Pullum, T.W. (2005). *A statistical reformulation of demographic methods to assess the quality of age and date reporting, with application to the Demographic and Health Surveys*. Paper presented at the 2005 Annual Meeting of the Population Association of America, Philadelphia, March 31-April 2.

United Nations. (1956). *Manuals on Methods of Estimating Population. Manual II: Methods of Appraisal of Quality of Basic Data for Population Estimates*. Sales No. E.56. XIII.2. Available at: http://www.un.org/esa/population/pubsarchive/migration_publications/UN_1955_Manual2.pdf

United Nations. (1973). *Demographic Yearbook 1973, 25th Issue, Special Topic Population Census Statistics III*. Sales No. E/F.74.XIII.1

U.S. Bureau of the Census. (1985). *Evaluating Censuses of Population and Housing. Statistical Training Document ISP-TR-5*. Washington, D.C. Available at: http://www.census.gov/srd/papers/pdf/rr85-24.pdf

West, K.K., Robinson, J.G., & Bentley, M. (2005). Did Proxy Respondents Cause Age Heaping in the Census 2000? *ASA Section on Survey Research Methods,* [Internet] 2005:3658–65. Available at: http://www.amstat.org/sections/srms/Proceedings/y2005/Files/JSM2005-000443.pdf

Appendix

Table 1. Degree of Accuracy of the Age Reporting using the Whipple's index

Whipple's index	Category
< 105	Very accurate
105–110	Fairly accurate
110–125	Approximate
125–175	Rough
> 175	Very rough

Table 2. Degree of Accuracy of the Age Reporting using the United Nations Age-Sex Accuracy Index

United Nations Age-Sex Accuracy Index	Category
< 20	Accurate
≥ 20 and ≤40	Inaccurate
> 40	Highly inaccurate

Table 3. Whipple's, Myers', and UN Sex-Age Accuracy Ratio Indices

Country	Census year	Whipple's index	Myers's index	UN sex-age accuracy ratio
		Africa		
Burkina Faso	1985	190.50	16.03	35.20
Burkina Faso	1996	162.47	10.07	28.55
Burkina Faso	2006	145.71	8.05	25.07
Cameroon	1976	204.45	17.53	31.32
Cameroon	1987	171.48	12.13	34.13
Cameroon	2005	173.22	12.41	24.77
Egypt	1996	212.07	17.70	36.37
Egypt	2006	196.26	15.71	21.80
Ghana	2000	183.78	15.26	32.18
Guinea	1983	216.95	21.09	65.76
Guinea	1996	207.02	19.33	56.37
Kenya	1969	162.82	11.34	34.53
Kenya	1979	144.53	7.26	27.89
Kenya	1989	147.88	7.82	20.46
Kenya	1999	149.35	7.54	23.62
Kenya	2009	146.58	7.36	21.68
Malawi	1987	138.67	7.13	47.04
Malawi	1998	147.87	10.90	28.13
Malawi	2008	120.51	5.27	30.73
Mali	1987	185.82	14.92	35.70
Mali	1998	180.94	15.47	36.52
Morocco	1982	163.98	13.47	55.07
Morocco	1994	120.10	6.38	38.56
Morocco	2004	112.72	4.99	24.92
Rwanda	1991	100.54	1.49	28.05
Rwanda	2002	106.89	2.39	27.26
Senegal	1988	101.39	9.83	39.89
Senegal	2002	185.27	15.33	35.50
Sierra Leone	2004	242.68	24.37	47.76
South Africa	1996	100.58	2.28	18.41
South Africa	2001	96.96	1.36	19.46
South Africa	2007	95.82	1.31	20.61
South Sudan	2008	174.23	15.92	42.58
Sudan	2008	239.45	23.10	45.27
Tanzania	1988	188.29	16.76	45.39
Tanzania	2002	158.35	13.24	30.50
Uganda	1991	166.74	12.89	36.63
Uganda	2002	134.64	7.74	41.12
		Asia		
Bangladesh	1991	318.12	36.72	60.73
Bangladesh	2001	299.50	33.07	52.06
Bangladesh	2011	262.23	27.38	49.17
Indonesia	1990	160.51	9.97	33.49
Indonesia	2000	151.88	9.14	24.25
Indonesia	2010	114.43	3.40	17.28
Kyrgyz Republic	1999	99.08	1.24	22.83
Kyrgyz Republic	2009	100.25	1.49	23.68
Mongolia	1989	100.02	2.77	28.69
Mongolia	2000	98.75	1.22	23.75
Malaysia	1970	101.54	3.52	29.52
Malaysia	1980	105.80	2.11	25.54
Malaysia	1991	114.24	2.68	20.98
Malaysia	2000	114.97	2.97	21.63
Thailand	1970	104.06	1.71	14.44
Thailand	1980	103.62	1.56	18.29
Thailand	1990	109.80	2.12	19.68
Thailand	2000	104.61	0.98	16.63

Whipple's index assessment

- Very accurate
- Fairly accurate
- Approximate
- Rough
- Very rough

UN sex-age accuracy ratio assessment

- Accurate
- Inaccurate
- Highly inaccurate

Source: Authors' calculations based on census data from IPUMS-I

Table 4. Whipple's and Myers' Indices by Sex

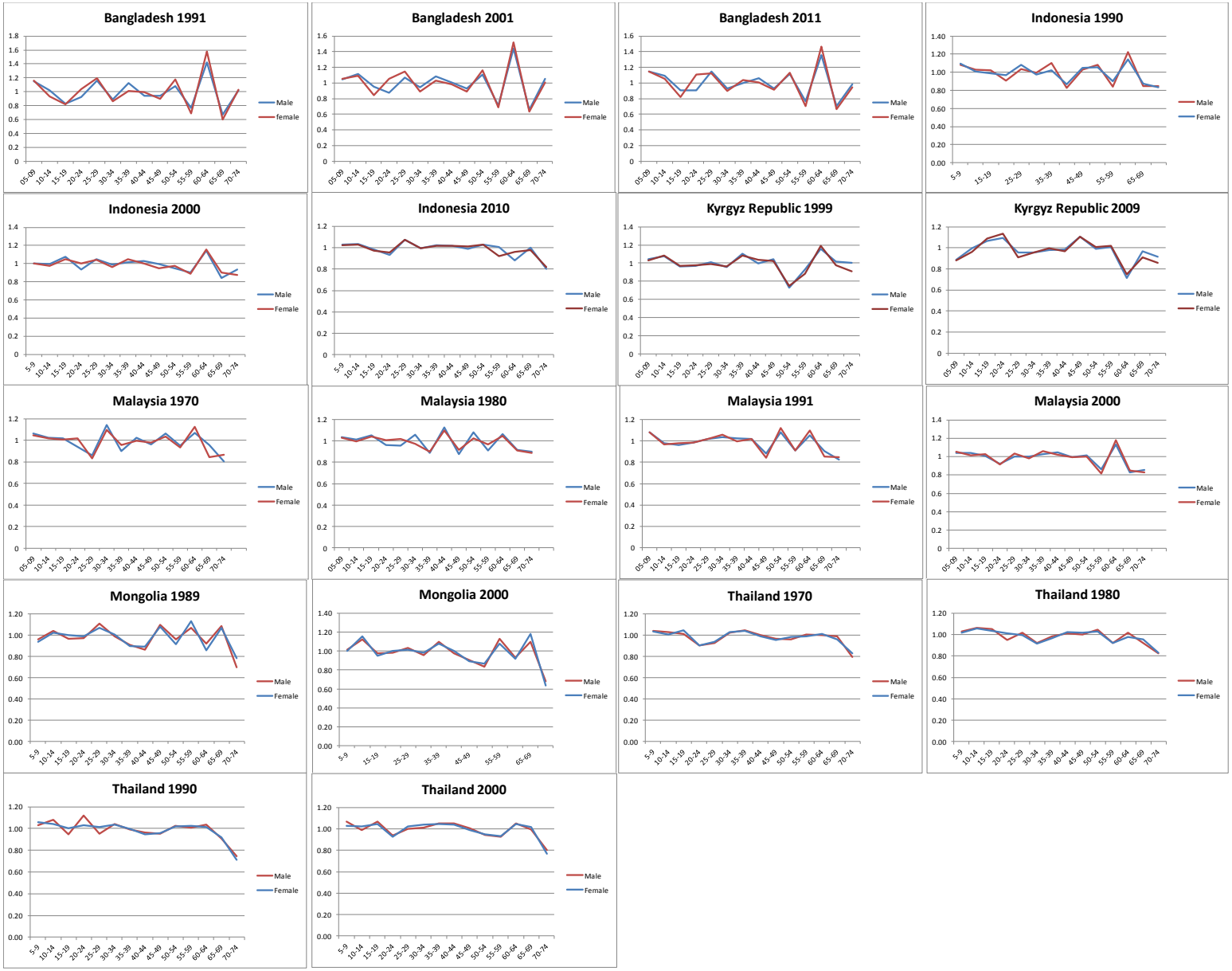
Country	Census year	Whipple's index			Myers's index		
		All	Females	Males	All	Females	Males
Africa							
Burkina Faso	1985	190.50	206.16	173.80	16.03	18.27	13.71
Burkina Faso	1996	162.47	177.75	145.25	10.07	12.34	7.85
Burkina Faso	2006	145.71	154.82	134.82	8.05	9.29	6.60
Cameroon	1976	204.45	215.54	192.06	17.53	19.42	15.47
Cameroon	1987	171.48	185.25	156.23	12.13	14.13	9.92
Cameroon	2005	173.22	180.94	165.03	12.41	13.66	11.08
Egypt	1996	212.07	239.79	184.35	17.70	22.25	13.30
Egypt	2006	196.26	218.02	175.05	15.71	19.20	12.58
Ghana	2000	183.78	191.03	176.04	15.26	16.74	13.71
Guinea	1983	216.95	235.22	195.79	21.09	23.91	17.88
Guinea	1996	207.02	232.26	177.93	19.33	23.13	15.06
Kenya	1969	162.82	165.91	159.93	11.34	12.14	10.64
Kenya	1979	144.53	148.31	140.60	7.26	8.04	6.67
Kenya	1989	147.88	153.45	142.10	7.82	8.86	6.74
Kenya	1999	149.35	153.82	144.61	7.54	8.34	6.74
Kenya	2009	146.58	148.42	144.64	7.36	7.86	6.84
Malawi	1987	138.67	138.45	138.92	7.13	7.64	6.62
Malawi	1998	147.87	146.17	149.60	10.90	11.20	10.57
Malawi	2008	120.51	120.00	121.03	5.27	5.27	5.36
Mali	1987	185.82	196.48	173.77	14.92	16.64	13.01
Mali	1998	180.94	193.98	166.71	15.47	17.68	13.21
Morocco	1982	163.98	179.88	146.84	13.47	16.24	10.71
Morocco	1994	120.10	128.95	110.57	6.38	8.12	4.83
Morocco	2004	112.72	117.19	107.96	4.99	6.11	3.91
Rwanda	1991	100.54	100.15	100.96	1.49	1.85	1.28
Rwanda	2002	106.89	105.87	108.08	2.39	2.29	2.52
Senegal	1988	101.39	100.73	102.11	9.83	11.28	8.30
Senegal	2002	185.27	197.03	172.63	15.33	17.01	13.55
Sierra Leone	2004	242.68	254.89	228.96	24.37	26.38	22.14
South Africa	1996	100.58	100.55	100.61	2.28	2.43	2.19
South Africa	2001	96.96	97.17	96.72	1.36	1.36	1.35
South Africa	2007	95.82	95.19	96.55	1.31	1.45	1.20
South Sudan	2008	174.23	174.06	174.40	15.92	16.15	15.67
Sudan	2008	239.45	249.11	229.33	23.10	24.46	21.77
Tanzania	1988	188.29	201.16	173.90	16.76	18.76	14.54
Tanzania	2002	158.35	163.41	152.74	13.24	14.09	12.30
Uganda	1991	166.74	179.18	153.39	12.89	15.15	10.62
Uganda	2002	134.64	138.03	131.28	7.74	8.51	6.95
Asia							
Bangladesh	1991	318.12	325.81	310.97	36.72	37.15	36.30
Bangladesh	2001	299.50	303.36	295.85	33.07	33.50	32.66
Bangladesh	2011	262.23	267.62	256.79	27.38	28.05	26.79
Indonesia	1990	160.51	163.49	157.42	9.97	10.68	9.23
Indonesia	2000	151.88	152.73	151.04	9.14	9.49	8.79
Indonesia	2010	114.43	114.67	114.19	3.40	3.59	3.29
Kyrgyz Republic	1999	99.08	99.38	98.77	1.24	1.36	1.13
Kyrgyz Republic	2009	100.25	100.54	99.94	1.49	1.75	1.22
Malaysia	1970	101.54	100.54	102.55	3.52	4.34	2.82
Malaysia	1980	105.80	105.28	106.35	2.11	2.40	1.87
Malaysia	1991	114.24	114.59	113.89	2.68	2.83	2.64
Malaysia	2000	114.97	113.65	116.26	2.97	2.86	3.07
Mongolia	1989	100.02	98.25	101.78	2.77	2.31	3.25
Mongolia	2000	98.75	98.71	98.79	1.22	1.08	1.52
Thailand	1970	104.06	104.23	103.90	1.71	1.63	1.95
Thailand	1980	103.62	102.63	104.64	1.56	1.32	1.88
Thailand	1990	109.80	109.72	109.89	2.12	2.10	2.29
Thailand	2000	104.61	105.11	104.08	0.98	0.95	1.06

Whipple's index assessment

Very accurate | Fairly accurate | Approximate | Rough | Very rough

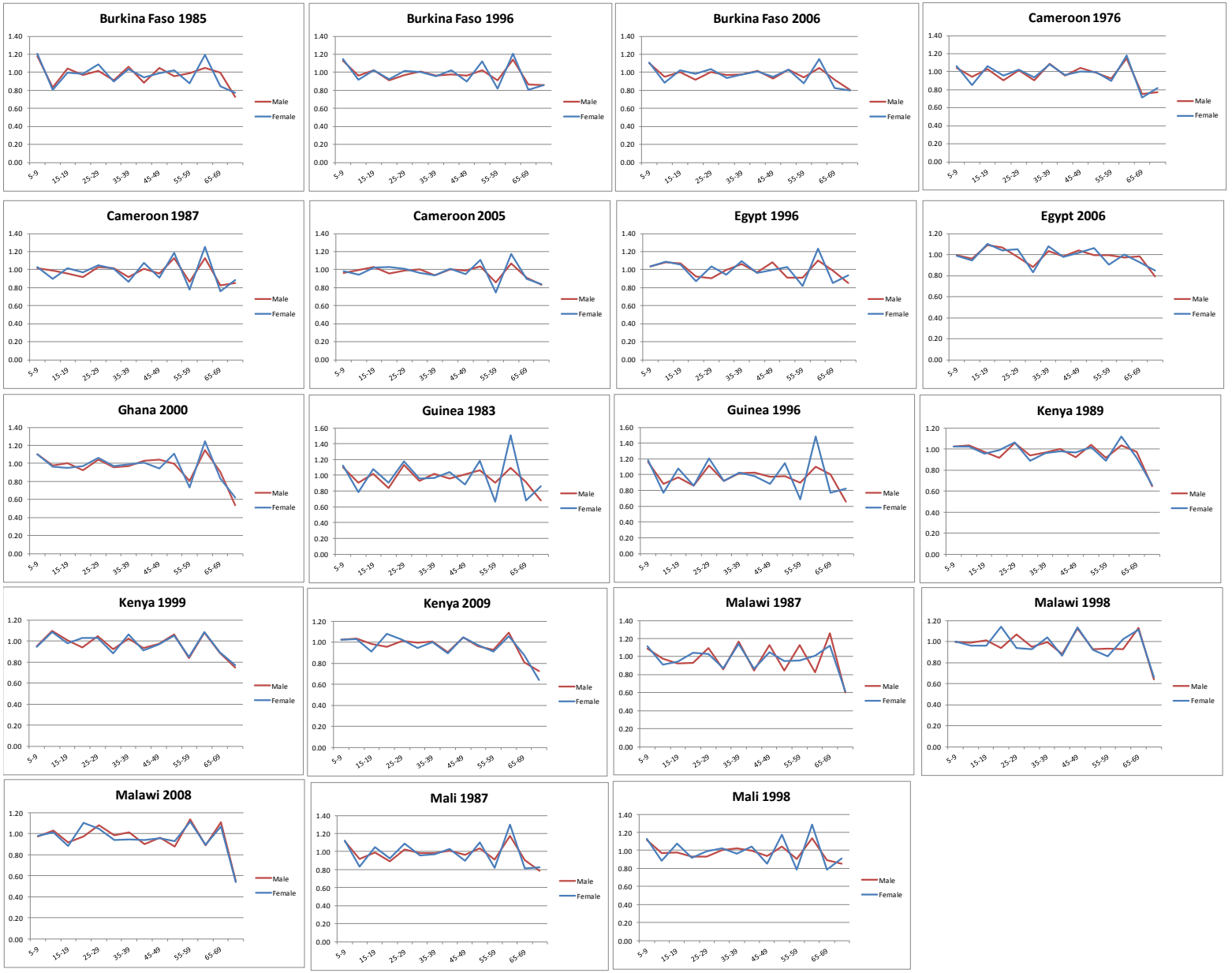
Source: Authors' calculations based on census data from IPUMS-I

Figure 1. Age-Ratios by Sex, selected Asian countries



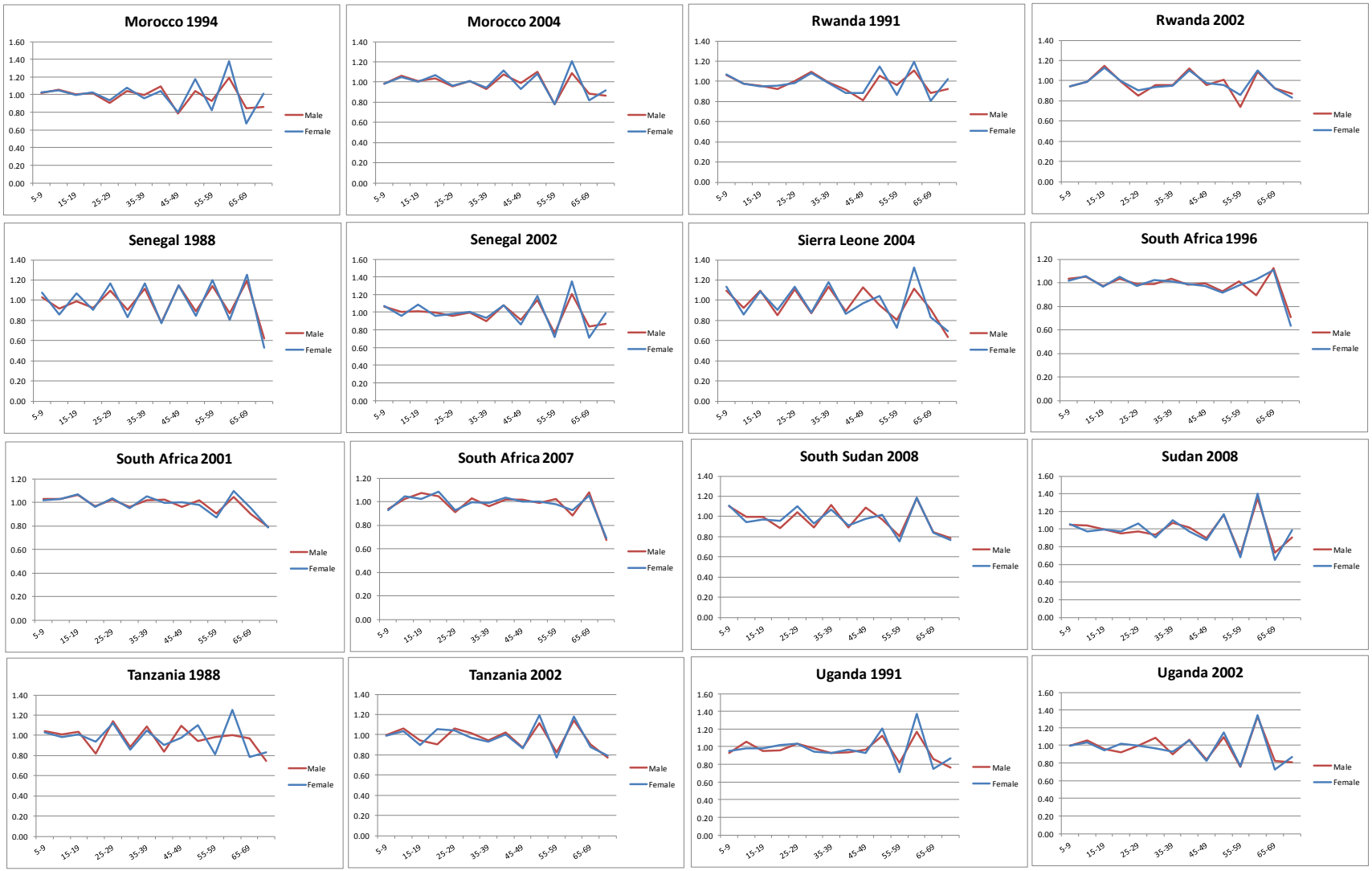
Source: Authors' calculations based on census data from IPUMS-I

Figure 2. Age-Ratios by Sex, selected African countries



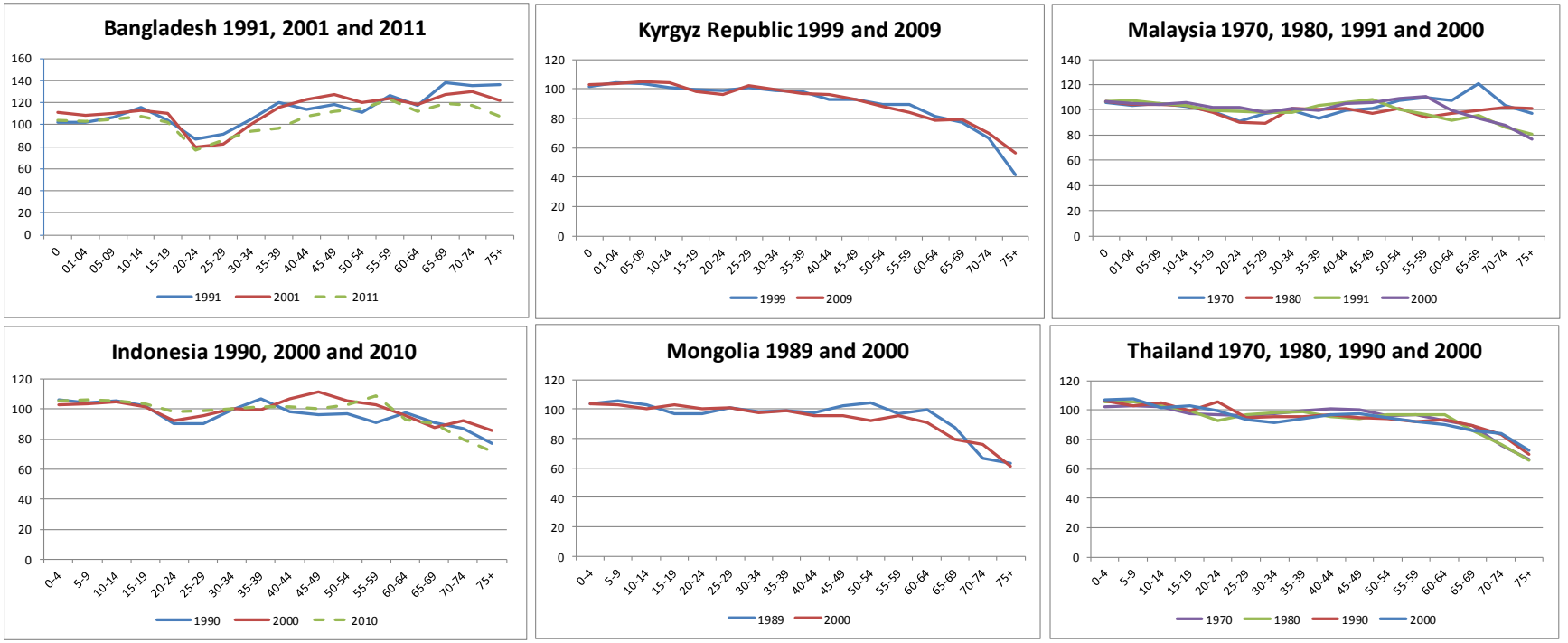
Source: Authors' calculations based on census data from IPUMS-I

Figure 3. Age-Ratios by Sex, selected African countries (continued)



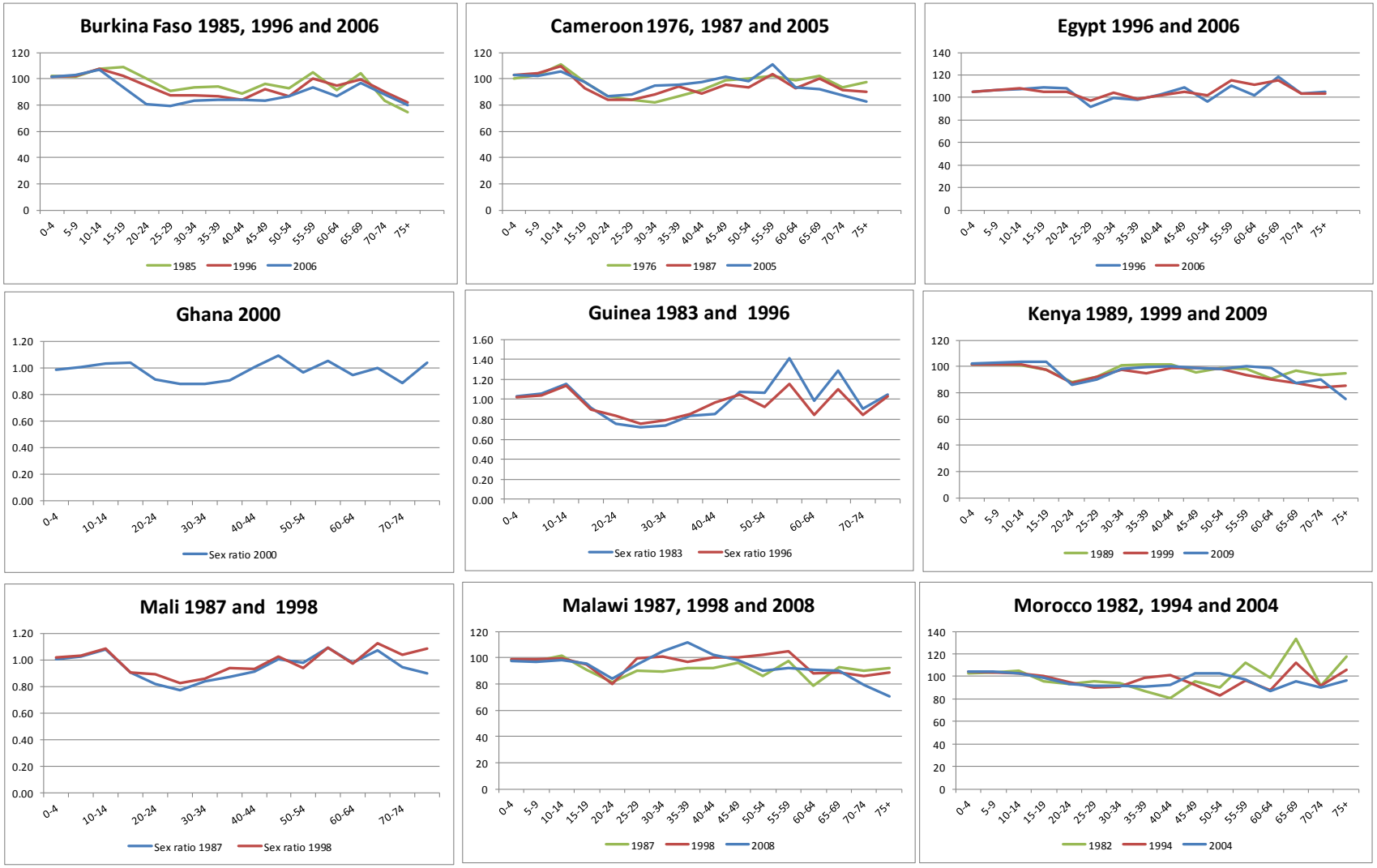
Source: Authors' calculations based on census data from IPUMS-I

Figure 4. Sex-Ratios by Age-Group, selected Asian countries



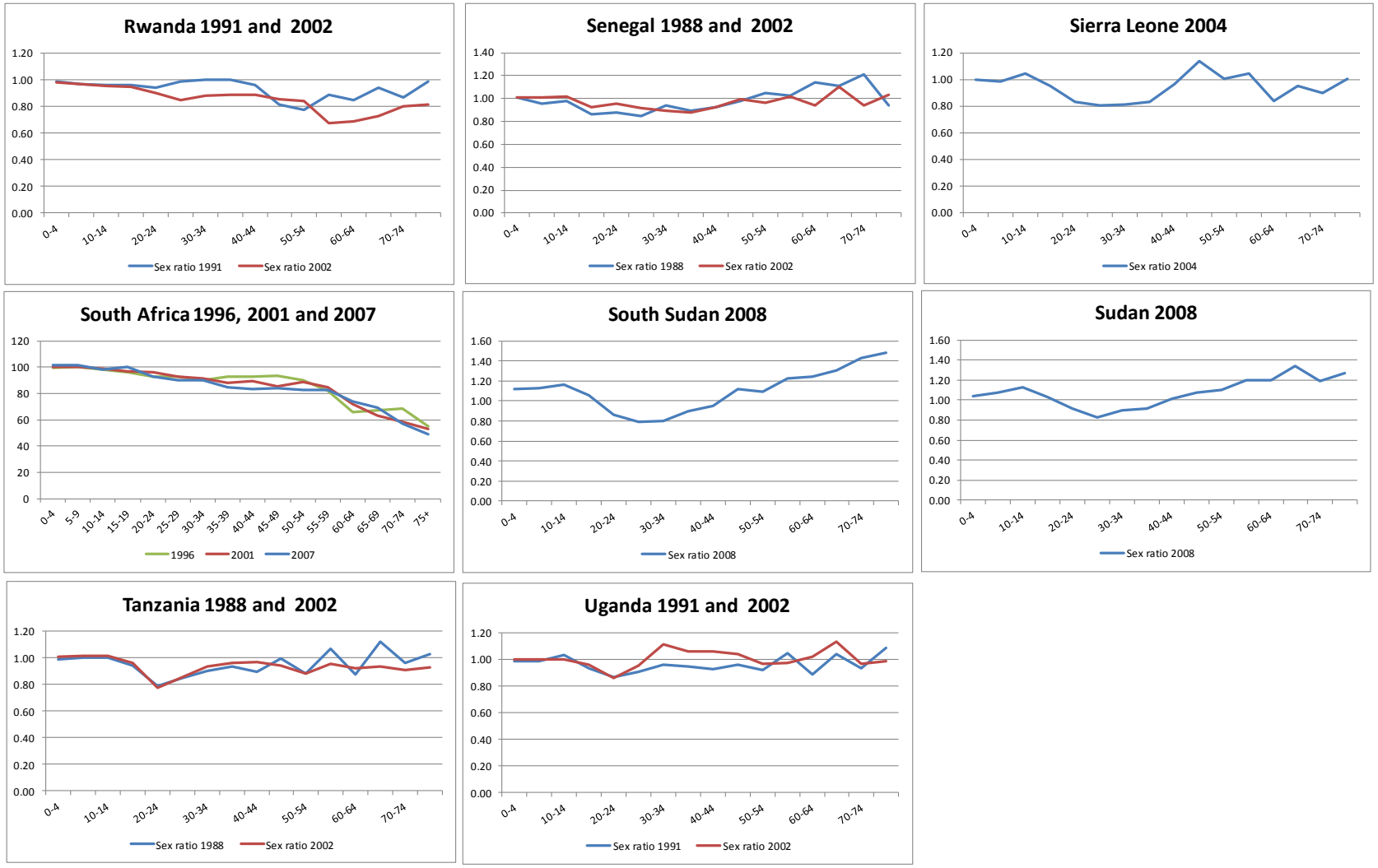
Source: Authors' calculations based on census data from IPUMS-I

Figure 5. Sex-Ratios by Age-Group, selected African countries



Source: Authors' calculations based on census data from IPUMS-I

Figure 6. Sex-Ratios by Age-Group, selected African countries (continued)



Source: Authors' calculations based on census data from IPUMS-I