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Rural-Urban Population Age and Sex Composition in Sub-Saharan Africa

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ABSTRACT

Population age structures act both to support and constrain key aspects of development, ranging from demographic dividends to civil violence. Despite recognition of the crucial role played by *national* age and sex structures, the rural/urban perspective remains sorely neglected. This study explores how differential rural/urban natural increase, interacting with rural-to-urban migration, creates profound gaps in population age and sex structures across sectors in Sub-Saharan Africa. We calculate sector-specific dependency and sex ratios using United Nations data from 45 Sub-Saharan African countries between 1980 and 2015 to probe the extent of the rural/urban age and sex structure gaps. Results indicate that these gaps are predictable by stage of demographic transition. Rural-to-urban migration of young adults plays an important role in explaining the gaps between the sectors. Our results highlight the value of accounting for *local* age and sex structures to better prepare for the consequences of demographic shifts in Sub-Saharan Africa.

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INTRODUCTION

Rural and Urban Age Structures

The evolution of age structure over the course of the demographic transition is well understood (Chesnais, 1990; Lee, 2003). National age structures first tend to become younger as more children survive with the onset of mortality decline but then populations progressively age as fertility falls. International migration may also affect age structure. When migrants are concentrated in young working ages, as is typical with labour migration, emigration can lead to a decline in average ages in the sending area as working populations are often above the average age early in the transition (Chesnais 1990). Eventually, when populations age through further declines in mortality and fertility, emigration's impact diminishes (Zelinsky 1971). These changes in country-wide population age structures, as well as possible shifts in sex composition, are determined by three factors: fertility, mortality and international migration. These are essentially the proximate determinants of national age structural (and sex compositional) change. The influence of any other factors such as income, female education or marriage, must all operate through their impact on these determinants.

In contrast to the well-studied area of national-level age and sex structures, the extent of within-country variation in age structures occurring over the course of the transition remains sorely neglected. Because the demographic transition is so deeply intertwined with the mobility transition and urbanisation (de Vries 1990; Dyson 2011), the combination of influences may create large divergences in population composition across the urban and rural sectors. Of course, like national age structures, sub-national age structures are also determined by the three core demographic factors. However, two additional factors may also stimulate divergence in age structures across rural and urban sectors. The first is that demographic rates are typically faster to change in the urban sector. Thus, urban mortality will decline first and urban fertility will generally follow the urban mortality more closely (Dyson 2011; de Vries 1990). Mortality and fertility also decline in the rural sector, but the

delayed declines will lead to a divergence between the age structures of urban and rural sectors and will generally push the rural age structure to be younger than the urban once rural mortality decline has begun.

A second factor driving divergence between age structures in the two sectors is rural-urban migration, typically concentrated among the working ages (Rogers et al. 2005; Raymer & Rogers 2006; Montgomery et al. 2003). Because pre-transition urban mortality generally exceeds rural due to higher levels of exposure to pathogens, population density and social ills (Reher 2001; Woods 2003; Fox 2012), rural to urban migration is necessary to maintain pre-transition urban populations (Keyfitz 1980). Once mortality rates begin to fall in the rural sector, increasing child survivorship and rising population density may create pressure for increased rural to urban migration (Zelinsky 1971; Keyfitz 1980). Cities may also become more attractive over time with growing opportunities in the urban sector and information diffusion spreading the appeal of urban migration (Montgomery et al. 2003). The combined effect of rural-urban migration and the diverging pace of mortality and fertility decline will be to extend the gap in age structures. In addition, if rural to urban migrants are predominantly male, substantial gaps in sex ratios may emerge with the male share in the urban sector rising relative to the rural sector.

This study describes the shifting age and sex patterns of populations across sectors in Sub-Saharan Africa (SSA) from 1980-2015. We calculate sector-specific population estimates and, using a variation on the census survival ratio method, estimate net rural to urban age- and sex-specific migration rates across 45 SSA countries. Our analysis focuses both on the general patterns of change in population composition as well as the specific role of rural to urban migration in this process. Much of our attention is concerned with understanding how differences in rural and urban age structures, or the "urban-rural gap," evolve over time. The gap may be measured using a variety of metrics such as the difference in mean ages or the ratio of median ages for the two sectors. We discuss our operationalization of the urban-rural gap in the methodology.

We hypothesise that rural age structures are younger than urban age structures, particularly before the onset of the demographic transition. We expect an initial divergence in age structures as fertility declines first in urban populations and working-age migrants move to

cities, creating an urban sector with fewer dependents. We then expect convergence in the age structures at lower dependency ratios when rural fertility also declines. In a similar vein, age-specific sex ratios are distinct across the urban and rural sectors and shift over the course of the fertility transition. We hypothesize that these differences, largely driven by migration, are largest in the early stages of the fertility transition when rural-urban migration's role is large but diminish once the fertility transition nears its end. Furthermore, we expect that migration plays a key role in creating divergence in the population composition across sectors. In particular, because migrants are highly concentrated by sex and age, we predict that the sex composition and the share of the young working-age population in both sectors, as expressed through the dependency ratio, will be driven most strongly by rural-urban migration rather than vital rates.

Urbanization in Sub-Saharan Africa

Few have yet to consider the extent of differentiation in age structures across the rural and urban sectors and what this means for development although there has been considerable debate in recent years about overall trends in urbanisation in Sub-Saharan Africa (Beauchemin 2011; Potts 2009; de Brauw et al. 2014). Interest in urbanisation in SSA is partly driven by low levels of urbanisation and a weak pace of industrialization. Although the annual rate of urbanisation in SSA was 1.4 percent for the period between 2010-2014[1] – on par with Asia but much higher than in developed regions – the proportion of the population urban in 2014 was only 40% (United Nations 2014c). Historically, SSA's urbanisation rate is not unusually high (Cohen 2004; Kessides 2007; Preston 1979; United Nations 2001), and several studies suggest both that past figures on urbanisation rates were over-estimated and that declines in recent years have been sustained (Bocquier 2004; Potts 2009).

In fact, a decline in the urbanisation rate in SSA would not be altogether surprising. Africa's urban transition has been distinctive – notably disconnected from economic growth levels since the 1980s –oft described as 'urbanisation without industrialisation' (Fay & Opal 2000). Although the income gap between urban and rural wage earners, which can drive rural-urban migration, narrowed considerably since the mid-1970s in Sub-Saharan Africa (Jamal & Weeks 1993), urbanisation from the 1980s has become virtually disassociated with growth

in incomes (Fay & Opal 2000). More recently, economic declines eroded the incomes of a large portion of the urban population, exacerbated by structural adjustment programmes which specifically targeted the rural/urban income gap (Potts 1995). Urbanization rates have slowed as a consequence - spurred by rural-urban migration becoming less attractive and urban-rural migration increasingly common (Amis 1989; Beauchemin 2011; Beauchemin & Bocquier 2004; Potts 1995; Chen et al. 1998). Countries in SSA that do experience rapid urbanisation with slow-growing economies are characterised by rural-urban migrants being "pushed" rather than "pulled" due to agricultural stress (Buckle & Clarke Annez 2009).

Consequences of a Rural and Urban Age Structure Gap to Development

In light of the low levels of urbanisation, decoupled from industrialisation, as well as high levels of poverty and an AIDS crisis which contributes to higher mortality (Hosegood et al. 2004; Blacker 2004), the extent of differentiation in age structures across rural and urban sectors may be critical for development, especially as SSA remains in the midst of a fertility transition (McNicoll 2011). Spatial heterogeneity in population composition may mean states can and should be more locally responsive – considering demographic structure at the sub-national level - to effectively research and plan for development. Although the relationship between a rural/urban age structure gap and development has not been studied, age structure has been shown to impact development at the national level in numerous ways.

Age structure is a direct product of past and ongoing demographic processes and as such reflects those development-related factors that determine mortality, fertility and migration. Complex interactions can make it difficult to isolate the discrete role of age structure on its own. Nonetheless, shifting distributions of population by age and sex can prove to be an additional hindrance or boon for development. We highlight three dimensions through which age structure may impact development including its impact on, 1) the fiscal balance of benefits and costs of population change; 2) the demographic dividend; and 3) social and political conflict.

The first and most obvious influence is through the impact of shifting age structure on continued demographic growth. As population composition is altered through variation in vital rates over the demographic transition, the stream of births and deaths in the

population is also affected. Under a range of assumptions regarding fertility trends, the overall count of births in the population will increase until a relatively late stage of the transition (Coale 1964; Keyfitz 1971). Continued growth in births arising from age structural shifts, often described in terms of population momentum (Keyfitz 1971), means that states must continue to deal with costs associated with rapidly growing numbers of children in spite of declining levels of childbearing. This is particularly apparent with public transfer systems (Lee 1994). Less developed countries with younger populations focus on downward public transfers, particularly health and education investments for children (Lee et al. 2000; Soyibo et al. 2010). In more developed aging countries, the rise in old age dependency ratios means that pension schemes become increasingly burdensome (Bongaarts 2004; Harper 2014; Lee and Mason 2010). Both very young and very old population age structures can impose heavy burdens on public sector budgets.

A second and related economic implication of age structure is through its impact on economic growth (Bloom et al. 2003). Changes in age structure over the course of the demographic transition create the potential for a substantial demographic dividend for economic growth (Bloom and Canning 2011; Lee and Mason 2006). The demographic dividend depends directly on the timing of age structure shifts and on the capability of capital markets to support this growth (Bloom et al. 2007; Bloom and Canning 2011; Crenshaw et al. 1997; Kögel 2005; Lee and Mason 2012; Lee and Mason 2007; Prskawetz et al. 2007). Evidence shows that falling dependency ratios have contributed substantially to economic growth in a number of East Asian countries (Higgins & Williamson 1997; Bloom et al. 2003). Sub-Saharan African countries are demographically primed to enter the first demographic dividend, but questions abound as to whether their legal and market structures are equipped to take advantage of the dividend and if greater human capital levels could help expand the growth dividend (Bloom et al. 2007; Canning et al. 2015; Eastwood & Lipton 2011).

Social and political effects offer a third dimension through which large proportions of young adults in a population may impact development. These so-called “youth bulges” are often driven by a combination of low mortality, declining fertility and high rates of working-aged migration. States often face difficulties in providing services and opportunities for youth

bulges and the job market and economy may struggle to keep up with incoming migrants. Such conditions may lead to increased poverty (UNFPA 2007), violent unrest (Staveteig 2005; Mesquida & Wiener 1999; Cincotta et al. 2003; Goldstone 2002; Buhaug & Urdal 2013) and even breakdowns in democratic systems (Weber 2013). While not a direct cause for conflict, youth bulges are an enabling factor to violent conflict since they are more easily mobilised, with fewer family responsibilities and low opportunity costs of political violence (Macunovich 2000; Mesquida & Wiener 1999).

DATA AND METHODS

In order to evaluate rural and urban age structures and the role of rural-urban migration, population counts by sex and age for the rural and urban sectors are required for two separate points in time, such as ten years apart. This is no small challenge in SSA, where censuses are not carried out regularly and access to existing census data tends to be highly restrictive. The United Nations Department of Economic and Social Affairs' (UN-DESA) Population Division produces country-level estimates of Urban and Rural Populations by Age and Sex (URPAS) for every five year interval over the period of 1980 to 2015 (United Nations 2014b). We use these data for 45 Sub-Saharan African countries to estimate and examine the differentials in age composition by sex between rural and urban areas.

The URPAS data of the United Nations are based on observed changes in the proportion of population living in urban areas, by sex and five-year age groups. It is important to recognize that each country uses its own definition of urban making cross country comparisons somewhat fragile (Buettner 2014). The population estimates are taken from censuses and population registers. The proportion urban is interpolated or extrapolated for the period 1980 to 2015 in five year intervals following a linear path. Estimates are matched to the total proportions urban from the World Urbanisation Prospects (WPP) to guarantee consistency. For countries that lack observed empirical data, estimates are imputed based on sub-regional proportions urban by age and sex. Fourteen countries in SSA have no data by age and sex – almost a third of the countries in our analysis (United Nations 2014a).[2]

Our analysis focuses on sex and sector-specific dependency ratios, which are particularly useful indicators for summarizing population composition. Total dependency ratios

(henceforth dependency ratios) measure the number of children (aged 0 to 14) and older adults (aged 60 plus) in the population divided by the size of the working-age population (15-59 year olds). Youth dependency ratios measure the proportion of 0-14 year olds to the working-age population. For our purposes, the dependency ratio should be seen as a purely demographic summary statistic. It includes no information on age-specific consumption, production or employment status – in contrast to more complex measures such as economic dependency ratios (Loichinger et al. 2014). In a similar sense, the dependency ratio ignores the fact that dependents in one sector may be supported through remittances across sectors or that one sex may depend on the other. Notwithstanding these limitations, the dependency ratio is a transparent demographic summary measure capturing important features of age structure and is easy to interpret.

While we focus here on the dependency ratio, we also assessed the age structure gap using other measures including differences in the median ages and the dissimilarity index. Neither alternative was found to add much to what we learned using the dependency ratio. The median age is transparent but less meaningful. The dissimilarity index is informative but less intuitive and less specific as it treats shifts in age structure similarly regardless of which age groups change. However, we note that results using these alternative measures were consistent with our main findings. Urban median ages are higher, especially among men where the urban-rural gap is greater. The index of dissimilarity also suggests less uniform distribution among men between rural and urban populations by age. The index increases over time, indicating a growing gap in age structure across sectors.

We use total fertility rate (TFR) estimates from the UN, estimated for every five-year period from 1980 to 2015, to assess each country's stage within the demographic transition (United Nations 2013b). We use a modified categorization of fertility transition stages based on national TFR levels (Bongaarts, 2003), shown in Table 1. Given that all countries experienced substantial declines in mortality prior to 1980, the pre-transition stage refers to pre-*fertility* transition. The limited number of countries in SSA with TFR's below 4 children leads us to aggregate the later stages of transition into a single "advanced" stage. This advanced stage is used to represent the mid-late, late and post transition stages, and while a TFR cut-off of four is high, it is representative of the progression of the fertility transition in SSA where the average TFR is still above five (United Nations 2013a; Bongaarts 2016).

Table 1: TFR Ranges Assigned to Stages of Fertility Transition

Transition Stage	TFR Range
Pre	7+
Early	6-6.9
Early-mid	5-5.9
Mid	4-4.9
Advanced	< 4

Regression models are used to examine the role of each of the three components shaping rural and urban age structure: fertility, mortality and migration. Country fixed effects (FE) models are used to account for between-country sources of heterogeneity that are both observed as well as differences that are fixed but unobserved. A key advantage of the FE specification is in overcoming *fixed* differences in urban definitions across countries. A series of models test the effect of fertility, mortality and migration, evaluated separately for the urban and rural sectors of each country and measured over time, on the dependency ratio. Sector-specific data on fertility and child mortality are not widely available, so we rely on estimates from the Demographic and Health Surveys (DHS) (ICF International 2014). However, inclusion of variables from the DHS survey data sharply reduces our sample sizes.

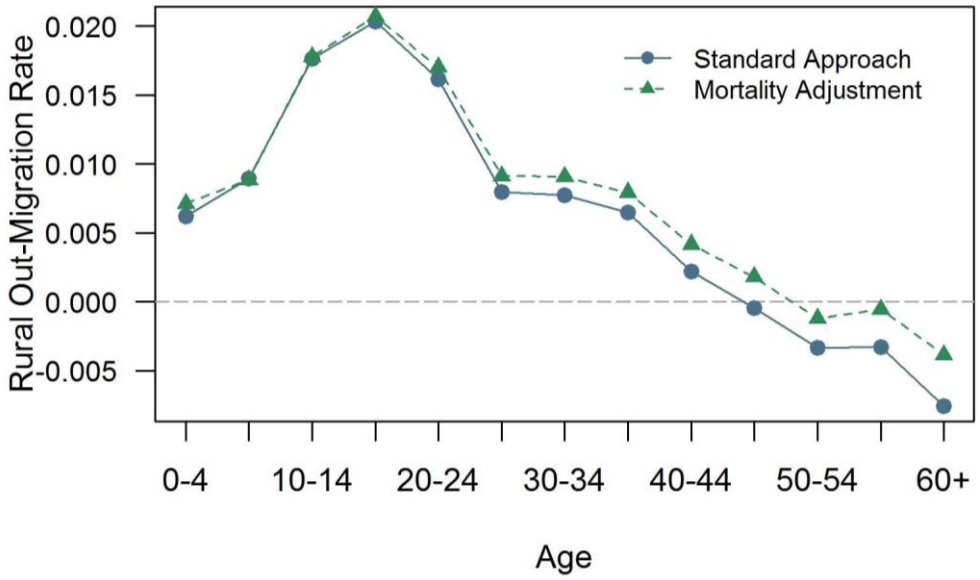
Estimating Net Rural-Urban Migration Flows by Age and Sex

Despite widespread availability of national estimates of vital rates, data on rural-urban migration for Sub-Saharan Africa are sorely lacking (de Brauw et al. 2014; Bell et al. 2015).[3] Estimates of migration flows can be obtained using the Census Survival Ratio Method (CSRM) (Hamilton & Henderson 1944; Preston 1979). Our estimated migration rates are based on slight variations on the UN approach (United Nations 2001). Rather than using census data, we work with the URPAS database indicated above (United Nations 2014b). Furthermore, in our variation on the traditional CSRM approach, rural rather than urban populations are used as the basis for estimating inter-sectoral migration flows. Thus, when the rural population is smaller than anticipated based on cohort survival estimates, the difference is attributed to rural to urban migration. Instead of focusing on the survival at the migrants' destination this approach focuses on survival at the source. When urbanisation levels are relatively low, as in SSA, this approach may be preferable due to the larger and

typically more stable population base. Also, this approach may be more robust to international migration if the likelihood of international migration from urban areas is greater (Liu 2013; Bocquier 2004).

In our modified approach survivorship is calculated for each age group across every five year interval for the population as a whole. These total survival ratios (the fraction of each age group alive after five years) are the backbone upon which the estimates are based. Cohort survival ratios are generated by assuming that rural survival ratios are 25% lower than urban survival ratios for all age groups (United Nations 2001). This assumption is broadly consistent with evidence that rural child mortality levels exceed those in the urban sector (Akoto & Tambashe 2002; Bocquier et al. 2011; Buckley 1998; Cai & Chongsuvivatwong 2006). However, considering rural-urban adult mortality differentials in developing countries may differ (Menashe-Oren & Stecklov 2016; Günther & Harttgen 2012), we tested the sensitivity of our estimates to variations in the mortality differential. Based on our own calculations on adult mortality from DHS survey data, and using DHS macro data on rural and urban child mortality (ICF International 2014), we estimated a gradient of rural/urban mortality differentials. The resulting gradient for countries in our analysis was based on rural mortality exceeding urban by 29 percent for the youngest survivors but only by three percent for adults.[4] Use of this graduated rural-urban mortality profile had little impact on our migration estimates up to age 30 (Figure 1). The impact is larger for the older age groups, with the adjusted mortality rates producing higher estimates of net rural to urban migration. For the purposes of simplicity and consistency, and because much of our interest in this study is ultimately focused on the younger ages, who comprise a larger share of the population, we maintain the 25% mortality differential assumption.

Figure 1: Country Mean Male Net Rural-Urban Migration Age Profile Comparison with Mortality Adjustment, UN-DESA URPAS Data for 48 SSA Countries, 2005-2015



The survival ratios are then used to predict the expected number of people in each rural cohort at the time of every five year period by multiplying the number of people in each rural age group (at the start of the period) by the rural age-specific survival ratios. The difference between the expected cohort size and the actual number at the end of the period provide an estimate of rural to urban migration (and reclassification - where rural areas are redefined as urban) over the five year window. In order to estimate the number of child migrants from ages 0 to 4 (those not born at the start of the five-year period), the number of female migrants and the distribution of childbearing by age (proportionate fertility rates) are used. Urban migrants, a self-selected group likely adapting quickly to their new environment, are given urban fertility rates (Chattopadhyay et al. 2006; Lee and Pol 1993).

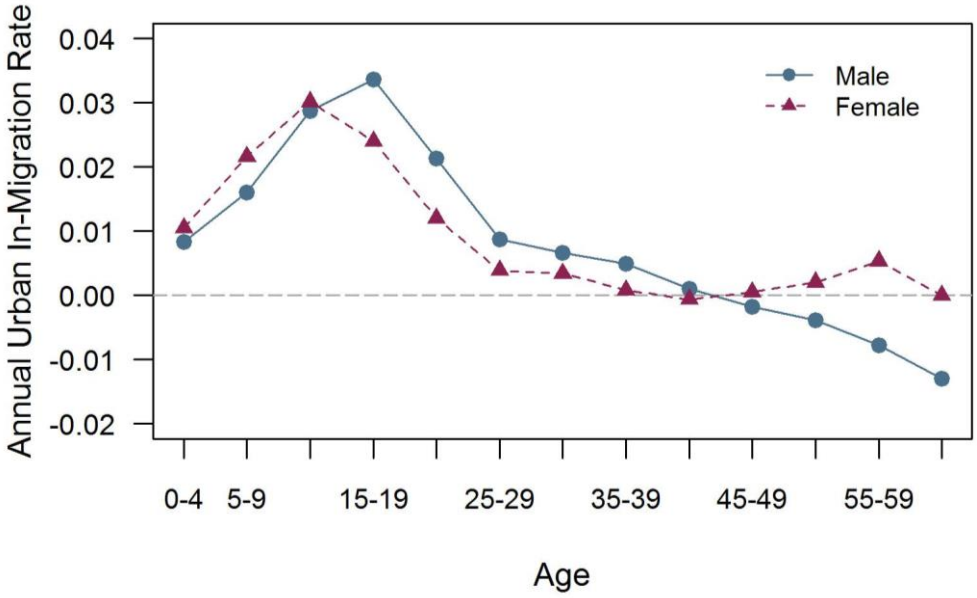
The CSRM produces rural to urban migration estimates for all 45 SSA countries for every five year interval between 1980 and 2015. Annual net urban in-migration rates are calculated as the number of net rural-urban migrants over the urban population; annual net rural out-migration rates are calculated as the estimated (negative) number of net rural-urban migrants over the rural population for each age group.[5] Calculation of net migration rates is specified in Equation 1 where *M* indicates the estimated number of net rural-urban migrants- that is, the balance of the number of rural-urban and urban-rural migrants; *P*

indicates the exposed population (the average size over 5 years); *x* the five year age group; *t* time; and *i* indicates either rural or urban based.

[Eq. 1] $$Net\ Migration\ Rate_{i,x} = \frac{2*M_{x,t}}{5*(P_{i,x,t}+ P_{i,x,t+5})}$$

Estimated age-specific net rural to urban age-migration profiles between 2010-2015 averaged across all countries in our SSA sample are shown by sex in Figure 2. These migration profiles present a peak in younger ages with male migration reaching its highest levels of about 3.3 per 100 at ages 15-19, while female migration peaks at 3 per 100 at ages 10-14. These peaks are relatively young, but broadly consistent with evidence on migration patterns for youth (Beauchemin 2011; Heckert 2015; Gultiano & Xenos 2006; Bernard et al. 2014a). These peak migration ages generally mirror life-course transitions including education and entry to the labour force, especially among women (Bernard et al. 2014b). Furthermore, the youthfulness of the migration patterns may be driven by fostering in SSA (Madhavan 2004; Isiugo-Abanihe 1985). The overall patterns for each sex are quite similar but male migration rates exceed female rates from age 15-19 up until age 45-49. From age 50-54 onwards, net male migration reverses direction going from urban to rural areas. While there is growing evidence on substantial urban to rural migration, particularly in older ages (Beauchemin 2011; Potts 1995), these data points should be treated cautiously. The rural-urban mortality differential (25%) assumption used in the CSRM is probably less applicable to older age groups (Menashe-Oren & Stecklov 2016; Günther & Harttgen 2012). When this assumption is adjusted the negative migration rates for older adults become smaller, as seen in Figure 2. Furthermore, the proportion of the population in these older ages is much lower – only 24.8% of the population of SSA is between ages 30-59 and merely 4.9% aged 60+. While the smaller size of these age groups makes it more difficult to accurately estimate rates for these ages, it also means they play a smaller role in determining overall migration levels. Thus, the overall impression remains that of a strong shift of young adults (and youths) from rural to urban sectors leading to their relative paucity in the rural sector and their relative abundance in the urban sector.

Figure 2: Country Mean Annual Net Rural-Urban Migration Age Profile by Sex between 2010-2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries.

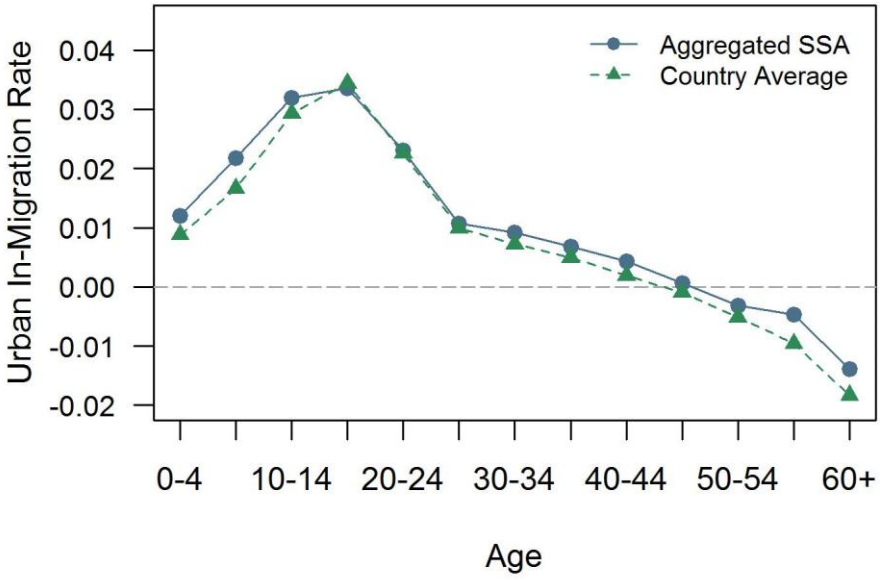


Limitations associated with the role of International migration and reclassification – both inherent in use of the CSRM approach to estimate rural-urban migration and equally valid for our modified version - have been raised previously (Preston 1979; Moultrie et al. 2013). Robustness checks for each of these limitations are presented below and help clarify why the migration estimates by age are likely conservative – at least in terms of the relative propensity to migrate at the young adult ages.

International migration is not distinguished from the survival ratios in the CSRM approach, generating a possible bias in rural to urban migration estimates. We employ a test of the effects of international migration by comparing our estimates with those obtained when the SSA migration profile is calculated for SSA as a whole rather than for any individual country. This test relies on existing empirical evidence which, though limited, suggests that about half of international migration from African countries is *within* Africa (Abel & Sander 2014; Adepoju 2011). The rural and urban population counts by age and sex in this scenario are the total urban and rural populations across all SSA countries. According to this approach, cross-border migration will not affect our migration estimates under the assumption that rural populations stay predominantly rural and urban remain urban. Comparison of the migration estimates with the average profile for all SSA countries shows they are highly

consistent (Figure 3).[6] Both profiles peak at the same young ages, although the country average profile is slightly lower both at younger and older ages.

Figure 3: Country Mean Male Net Rural-Urban Migration Age Profile Comparison with SSA Aggregate, UN-DESA URPAS Data for 45 SSA Countries, 2010-2015



Another longstanding and well-recognized limitation in the CSRM approach is the inability to distinguish between reclassification and migration. Few existing estimates of reclassification are available, offering only limited guidance on the extent of reclassification. Estimates suggest that 28% of urban growth in the Philippines and Thailand is due to reclassification (United Nations 2001) – roughly 50-60% of all migrants. Estimates for Africa for the 1980s and before indicate that reclassification was responsible for about 25% of urban growth (Beauchemin & Bocquier 2004; Chen et al. 1998), although reclassification may have been more substantial in this earlier period.

Despite ambiguity due to the lack of data on reclassification, the age structures of reclassified populations do offer some clarity on our migration estimates. Because the age and sex structure of areas that are reclassified are likely similar to the national or urban populations – both being heavily weighted towards younger ages - one can assess the sensitivity of the age profile of migration under varying proportions of total migration due to reclassification. As the role of reclassification grows, migration rates decline at all ages. However, while the magnitude of migration might be affected, the emphasis on young

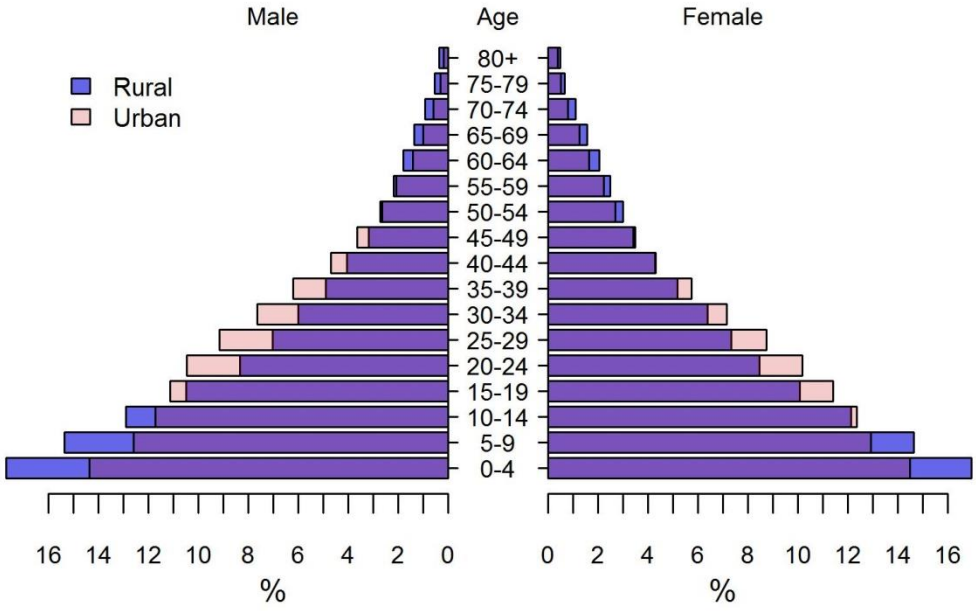
working-age populations is likely underestimated due to reclassification, and age heaping tends to *grow* as the relative magnitude of reclassification is increased.[7]

RESULTS

Assessing the Rural/Urban Age and Sex Composition Gap

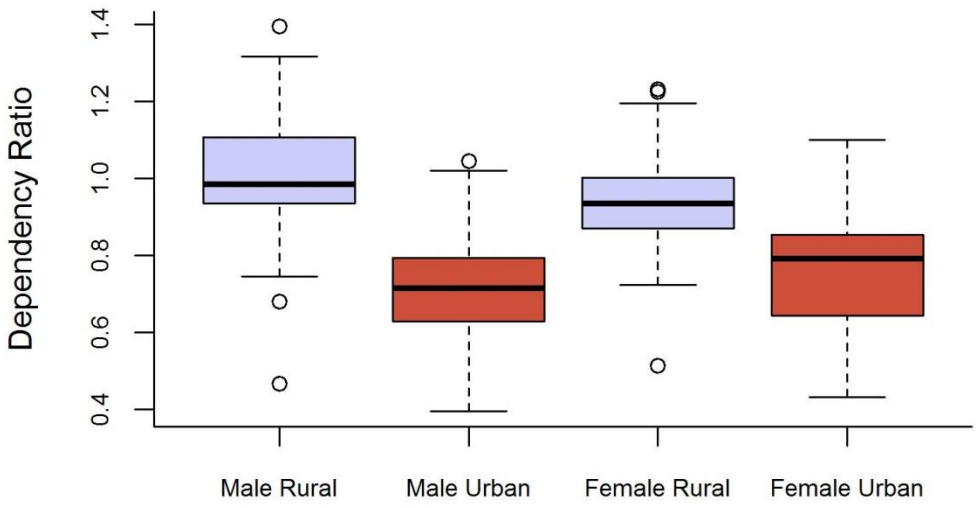
Despite the slowdown in urbanisation in SSA (Cohen 2004; de Brauw et al. 2014; Potts 2016), age and sex structures differ across rural and urban sectors. This is evident in the two overlaid population age pyramids– one rural and one urban - showing average national age and sex structures for SSA as a whole in 2015 (Figure 4). The rural population is clearly younger, with a greater fraction of males and females at the youngest ages – 46% of the male population in the rural sector is under age 15 compared to 38.7% in the urban sector. In contrast, the urban population has higher proportions in the working ages. The urban advantage in the working ages is obvious for both sexes although more pronounced for males (57.8% of the population in the urban sector and 49% in the rural sector). At the oldest ages, the rural population is dominant with 5% over age 60 compared to only 3.5% in the urban sector. Thus, for both males and females for SSA as a whole, the population in rural sectors is proportionally larger at the youngest and oldest ages but smaller in the middle working-age groups. It is worth noting that this pyramid hides considerable heterogeneity within SSA in the age structure gap between rural and urban populations. Nonetheless, urban dependency ratios are lower than rural for 93% of our full country-year sample.

Figure 4: Mean Rural and Urban Population Pyramid of SSA Countries in 2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries



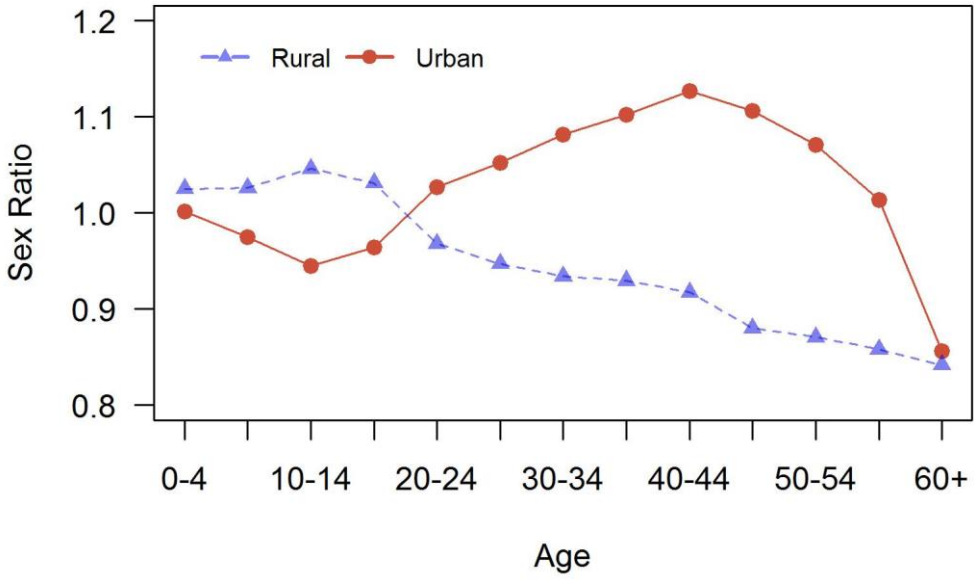
A more informative perspective comes from comparing the dependency ratios of urban and rural sectors by sex. In Figure 5 a set of box plots show separate dependency ratios for 2015 for males and females by rural/urban status for the SSA data.[8] In comparison to the rural population, the urban population is concentrated in working ages with lower levels of dependency. This is true for both sexes; however, the gap between the rural and urban dependency ratios is considerably smaller amongst women. This is based on both their closer median dependency ratio values and on the greater proximity of the interquartile ranges. Figure 5 demonstrates how the dependency ratio differs across the sectors and highlights the particularly large gap for males. The urban-rural gap - seen here using total dependency ratios - is mostly driven by youth dependency (for men the median rural and urban youth dependency ratios are 0.89 and 0.65 respectively). Male old age dependency ratios are much smaller – 0.11 in the rural sector and 0.06 in the urban sector. Both youth and old dependency ratios indicate higher rural dependency. Furthermore, when total dependency ratios are compared over time both sectors show declines across the 35 year period, with average urban dependency ratios dropping from 0.84 in 1980 to 0.72 in 2015 and rural dependency ratios declining from 1.07 to 0.96.

Figure 5: Urban and Rural Dependency Ratios by Sex for 2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries.



Sex ratios capture another key dimension of population composition and age-specific sex ratios for each sector in 2015 are presented in Figure 6. Sub-Saharan Africa is characterised by particularly balanced sex ratios at birth (Garenne 2002) so the primary factor creating divergence in rural-urban age structures will be sex differences in mortality and migration. The role of migration should be accentuated among the working-age population. The data show that sex ratios are near 1.0 at the youngest ages – that is nearly equal numbers of boys and girls – for both rural and urban populations. Sex ratios however begin to diverge at the 5-9 age group with rural ratios rising to 1.05 and urban falling to 0.95 in the 10-14 age group. Until ages 15-19, there are more boys than girls in the rural sector and fewer boys than girls in the urban sector. There is a crossover at ages 20-24 (the rural sex ratio drops to .99 and the urban rises to 1.03) and from then on urban sex ratios exceed rural ratios. Sex ratios in the 60+ age group converge, likely driven by higher male mortality in both rural and urban sectors rather than migration. The analysis below demonstrates that both the preponderance of boys in young ages in the rural sector and the relative abundance of males in the working and older ages in the urban sector is driven by patterns of rural-urban migration.

Figure 6: Urban and Rural Mean SSA Sex Ratios (Males/Females) in 2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries.

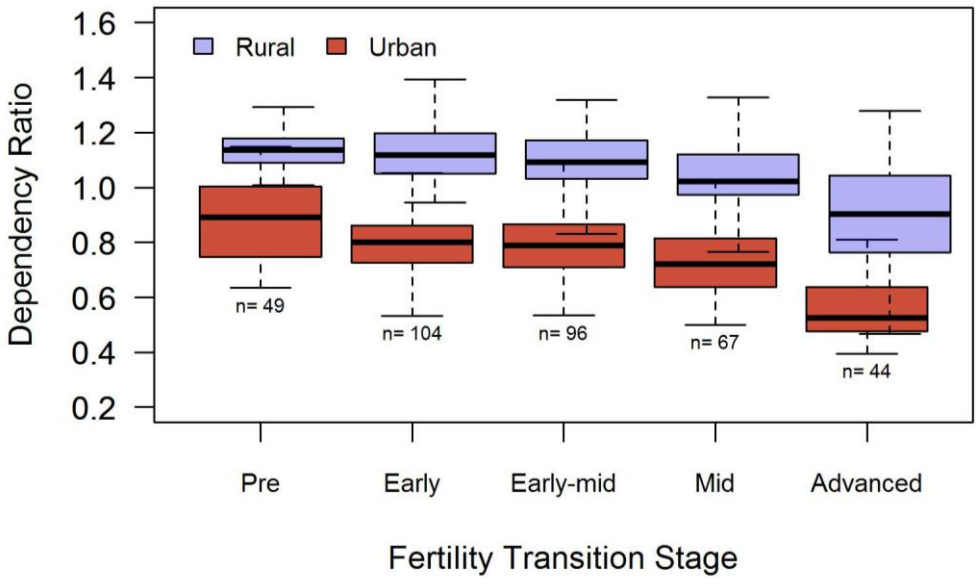


The Rural-Urban Age and Sex Structure Gap over the Fertility Transition

The descriptive results indicate large gaps between rural and urban age structures and sex compositions. We next examine patterns of shifting age structure over the course of the fertility transition (Figure 7).[9] Rural male dependency ratios are found to exceed urban ratios at every stage. The gap is already quite large at the pre-fertility transition stage, with rural dependency ratios exceeding urban by some 0.3 dependents per working adult. Extensive heterogeneity in dependency ratios in the urban sector at this stage – witness the span of the box at the pre stage – means that the gap can be quite narrow for some countries despite the difference between the median values. Earlier work has identified a growing gap between rural and urban fertility levels (Eloundou-Enyegue et al. 2012) – a likely cause of the growing gap in dependency ratios as the urban dependency ratios decline with the onset of the fertility transition. When the transition reaches the advanced stages with TFR levels below 4 children per woman, the gap falls due to large declines in rural dependency ratios. During this last stage both rural and urban dependency ratios are below one. The increased heterogeneity in rural dependency ratios at this advanced stage suggests that the gap is closing but the timing is highly variable. Interestingly, the pre- and advanced stages – opposite ends of the fertility transition - both show the greatest variability in dependency ratios. The high variability in dependency ratios in the pre-fertility stage occurs

within the urban sector while in the advanced stage it is found within the rural. This suggests that both before and towards the end of transition there is heterogeneity in the extent of the gap in SSA countries, probably driven by varying migration intensities. In the pre-fertility stage migration has a larger impact on urban dependency ratios (being a smaller population). In the advanced stage the rural population is smaller so varying intensities of out-migration generate more diversity in rural dependency ratios. While this perspective draws on countries at different stages of the transition at different periods of time, it does offer compelling descriptive evidence for the expansion and contraction of age structure gaps over the course of the transition.

Figure 7: Rural and Urban Male Age Dependency Ratios over the Fertility Transition stages seen at the national level, 1980-2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries.



We turn to multivariate statistical models to further explore the relationship between the fertility transition and sector-specific population composition. Table 2 presents country level ordinary least squares (OLS) and fixed-effects (FE) regression models with the sector-(rural/urban) and time-specific (every five years between 1980 and 2015) dependency ratio for each sex and every country as the outcome variable (n= 1440). Model 1 indicates that dependency ratios are not statistically different for men and women, but the dependency ratio is 0.25 units lower in the urban sector and that increasing urbanisation at the national

levels is associated with lower dependency ratios. Our main findings in Model 2, supported by OLS and country fixed effects alike and consistent with our earlier predictions, emphasize the association of stage of transition with the dependency ratio. Low levels of national fertility are associated with smaller dependency ratios. The dependency ratio is largest at the pre-transition stage (the reference category) with more or less monotonic declines from there. In the within-country models, the coefficients are slightly smaller but remain highly significant and qualitatively similar.

The subsequent set of models in Table 2 focuses on the dependency ratio gap. There are half as many cases in these models (n=720) because each country has a single measure of the gap at each point in time for each sex. According to Model 3, dependency ratio gaps are smaller for females and the gaps decline as the overall levels of urbanisation rise. Models 4 (FE and OLS) suggest that the gap between rural and urban dependency ratios is relatively small but increases with the onset of the fertility transition. According to Model 4-OLS the gap reaches a maximum in the advanced stage with the gap greater by 0.21 units than where it is at pre-transition. In the country FE specification, Model 4-FE, several coefficients are no longer significant but the main story remains unchanged: the dependency ratio gap between the urban and rural sector grows at the start of the fertility transition but both the coefficient values and their statistical significance indicate that the difference in the gap is no longer different from the pre-transition stage by the mid-transition stage. Thus, the within-country estimates suggest the gap closes earlier – though it is difficult to determine whether this difference is meaningful or due to our limited degrees of freedom. Notwithstanding, the results strongly support our initial hypotheses with both models signalling an initial increase in the gap which subsequently tapers off as the transition proceeds.

Table 2: Regression Models of Dependency Ratio and Dependency Ratio Gap by Stage of Fertility Transition, UN-DESA URPAS Data for 45 SSA Countries, 1980-2015

	Rural-Urban Dependency Ratios			Rural-Urban Dependency Ratio Gap		
	Model 1-OLS	Model 2-OLS	Model 2-FE	Model 3-OLS	Model 4-OLS	Model 4-FE
	b/se	b/se	b/se	b/se	b/se	b/se
Female	-0.006	-0.003	-0.004	-0.145**	-0.147**	-0.141**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Urban	-0.247**	-0.247**	-0.247**			
	(0.01)	(0.01)	(0.01)			
Percent Urban	-0.002**	0.001**	0.000	-0.002**	-0.004**	0.002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Early		-0.046**	-0.009		0.081**	0.036**
		(0.01)	(0.01)		(0.02)	(0.01)
Early-mid		-0.089**	-0.044**		0.110**	0.044**
		(0.01)	(0.01)		(0.02)	(0.01)
Mid		-0.157**	-0.104**		0.149**	0.011
		(0.01)	(0.02)		(0.02)	(0.02)
Advanced		-0.330**	-0.255**		0.209**	-0.037
		(0.01)	(0.02)		(0.03)	(0.02)
Constant	1.100**	1.110**	1.102**	0.383**	0.339**	0.241**
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
R-squared	0.425	0.616	0.595	0.171	0.239	0.491
No. of cases	1440	1440	1440	720	720	720

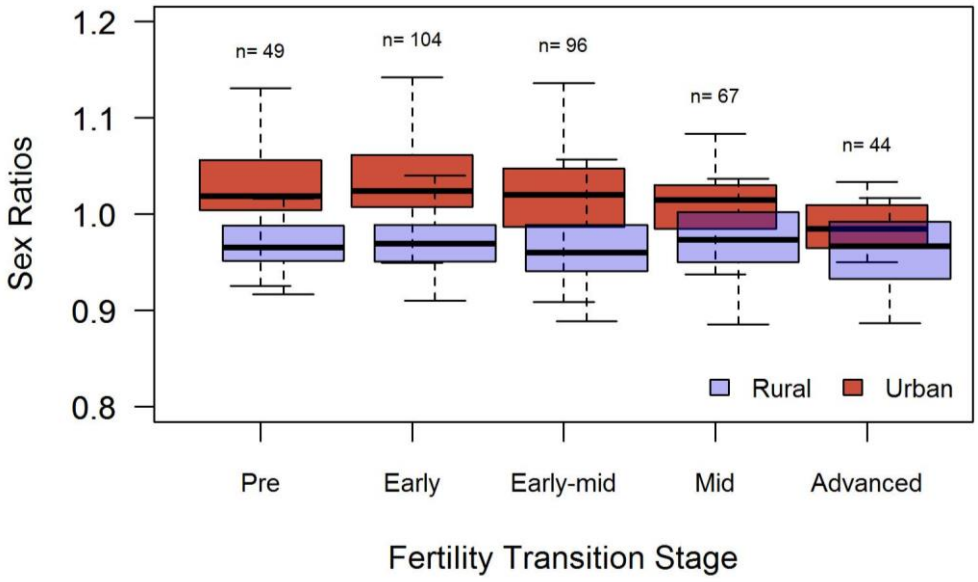
*Standard errors in parentheses; Two-tailed test: ** p<0.01; *p<0.05*

In addition, the models in Table 2 examine the evolution of age structural gaps as urbanisation levels increase. Since the demographic transition is intrinsically linked to urbanisation, it should not be surprising to find a link between the gap and urbanisation. When the models are estimated using OLS, Models 3-OLS and 4-OLS, the results suggest that higher shares of urban populations are associated with lower gaps. However, use of the FE specification, Model 4-FE, shows that the negative relationship is mainly driven by heterogeneity in the sample of countries at different levels of urbanization. In fact, Model 4-FE indicates that higher levels of urbanization are associated with increased gaps – a reversal of the initial finding.

Our examination of sex ratio patterns supports this same basic description of gaps shifting systematically over the course of the fertility transition. The boxplots in Figure 8 indicate that urban sex ratios surpass rural ratios throughout the transition, and remain above one until the advanced stage. On the other hand, rural sex ratios are below one at all stages. The

gaps remain roughly stable and they begin to converge around the mid-transition stage. From then on the differences diminish and the interquartile ranges increasingly overlap, highlighting the proximity of sex ratio levels across the urban and rural sectors of many countries.

Figure 8: Rural and Urban Sex Composition Shifts over Fertility Transition seen at the national level, 1980-2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries.



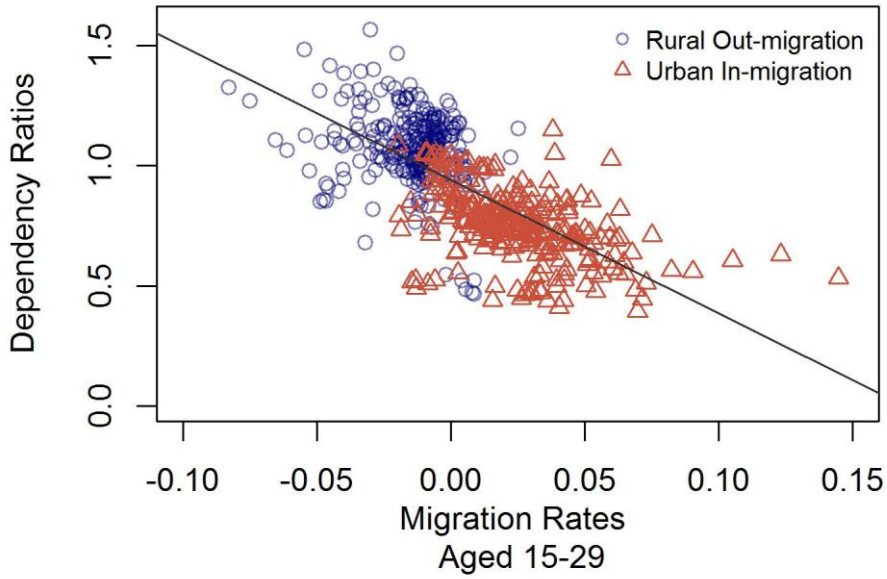
Estimating the Role of Migration in Shaping Rural/Urban Age Structure Gaps

Rural-urban migration simultaneously alters age structures in both urban and rural sectors. The impact of an individual migrant on age structures will depend on the national level of urbanisation with migrant movement imposing a greater impact on their destination's age structure when the share of the population in the destination is smaller (Beauchemin & Bocquier 2004). In this section, we explore the role of rural-urban migration (including reclassification) in rural and urban age structure differences across SSA.

Our hypothesis is that migration rates substantially alter age structures across the two sectors. Figure 9 shows the strong association between male dependency ratios and male migration for each sector in all 45 countries and across time. We use two separate estimates of migration rates in this analysis: urban in-migration and rural out-migration. Our focus is on young adults ages 15-29, who are a critical force in migration, engage in distinct types of

labour, and are relatively easily mobilised (Easterlin 1978; Rogers et al. 2002; Mesquida & Wiener 1999). Both net rural out-migration and net urban in-migration estimates for 15-29 year olds show strong negative associations with dependency ratios. In the rural sector the greater the net out-migration the higher the dependency ratios. In the urban sector, as the net in-migration grows the dependency ratios decline.

Figure 9: The Impact of Male Migration between Ages 15-29 on Urban and Rural Dependency Ratios, 1985-2015; Author calculations based on UN-DESA URPAS Data for 45 SSA Countries.



To determine the role of the proximate determinants of changing dependency ratios, we turn to multivariate models and include fertility, mortality and migration as explanatory factors (see Table 3). The coefficients in Table 3 show the impacts of the determinants of sector-specific dependency ratios between 1985 and 2015 for men and women separately. All told, there are 1,440 observations combining data from each country, by rural/urban sector, sex and year. Rates are aggregated into three broad age groups: child migration (between 0-14), young adult migration (ages 15-29) and older adult migration (ages 30-59). Sector-specific estimates of fertility and child mortality are also included.[10] The baseline model, Model 0, includes basic controls; Model 1 introduces the migration variables; and Model 2 includes other demographic proximate determinants of age structure.[11] Subsequent models include country fixed effects (Model 2: FE) and a model with all

continuous variables standardized to make the magnitudes of coefficients more easily comparable (Model 2: FE Z).

Table 3: Regression Results Decomposing Components of Dependency Ratio, UN and DHS Data for SSA

	Model 0	Model 1	Model	Model 2:	Model 2: FE
	b/se	b/se	b/se	b/se	b/se
1990	0.01	0.016	0.030	0.004	0.004
	(0.013)	(0.011)	(0.021)	(0.022)	(0.022)
1995	-0.009	-0.002	0.019	-0.018	-0.018
	(0.013)	(0.011)	(0.021)	(0.023)	(0.023)
2000	-0.031*	-0.023*	0.007	-0.028	-0.028
	(0.013)	(0.011)	(0.021)	(0.023)	(0.023)
2005	-0.057**	-0.049**	0.017	-0.022	-0.022
	(0.013)	(0.011)	(0.021)	(0.025)	(0.025)
2010	-0.077**	-0.068**	-0.012	-0.045	-0.045
	(0.013)	(0.011)	(0.022)	(0.028)	(0.028)
2015	-0.099**	-0.091**	-0.037	-0.085*	-0.085*
	(0.013)	(0.012)	(0.024)	(0.033)	(0.033)
Female	-0.005	-0.014*	-0.017*	-0.018**	-0.018**
	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)
Urban	-0.247**	-0.176**	-0.040*	-0.121**	-0.121**
	(0.007)	(0.01)	(0.017)	(0.020)	(0.020)
Percent Urban	-0.001**	-0.002**	-	-0.004*	-0.080*
	(0.000)	(0.000)	(0.000)	(0.002)	(0.033)
Migration Rates 0-14		2.453**	0.652	0.590	0.012
		(0.378)	(0.483)	(0.467)	(0.010)
Migration Rates 15-29		-5.111**	-	-4.664**	-0.117**
		(0.227)	(0.226)	(0.211)	(0.005)
Migration Rates 30-59		1.485**	2.228**	2.425**	0.048**
		(0.293)	(0.372)	(0.352)	(0.007)
TFR			0.057**	0.022**	0.031**
			(0.005)	(0.006)	(0.009)
Child Mortality			-0.000	-0.000	-0.011
			(0.000)	(0.000)	(0.007)
Constant	1.111**	1.110**	0.717**	1.079**	1.070**
	(0.011)	(0.01)	(0.036)	(0.070)	(0.026)
R-squared	0.461	0.604	0.858	0.881	0.881
No. of cases	1440	1440	444	444	444

*Standard errors in parentheses; Two-tailed test: ** p<0.01; *p<0.05*

According to Table 3, dependency ratios are shown to decline over time, although these declines are strongest in the later years. The dependency ratio is lower for women than for men. More noticeable is the coefficient on "urban": we find that urban dependency ratios are lower by 0.25 units in the baseline model although the urban effect declines in subsequent models. The national level of urbanisation has a consistently large negative impact across all models.

Migration rates are introduced in Model 1. Child migration is significant and increases the dependency ratio. Older adult migration (30-59) significantly increases the dependency ratio while young adult migration significantly lowers the dependency ratio. In quantitative terms, an increase in the young adult (ages 15-29) migration rate by 0.01 is associated with a decline in the dependency ratio by 0.05 units.

Model 2 includes child mortality and total fertility rates (TFR) by rural/urban sector obtained from DHS data, leaving fewer countries and years, and sharply reducing our sample size (n=444).[12] The addition of these demographic factors has some impact on the main controls, particularly in weaker time effects. The TFR variable in Model 2 is highly significant and positive and indicates, unsurprisingly, that higher fertility is associated with higher dependency ratios. Higher child mortality has no effect on the dependency ratio. The child migration coefficient is weaker and no longer significant in Model 2 (due to the shift in sample composition); nonetheless, the effect of migration rates for younger working-age adults remains consistent and highly significant throughout.

Two variations on Model 2 include a model with country fixed effects (Model 2: FE) and a second FE specification using standardised variables (Model 2: FE Z).[13] According to Model 2 FE, which sheds light on changes within countries over time, adult migration rates and TFR remain significant factors in determining age structure. Furthermore, the effect of older adult migration is amplified. Standardizing the independent variables to Z-scores as in Model 2 FE Z allows us to evaluate which components have a greater impact on age structure in SSA.[14] Young adult migration has the greatest absolute impact on dependency ratio: a one standard deviation (0.025) increase in migration at ages 15-29 significantly lowers the dependency ratio by 0.12 units.

DISCUSSION

Building on prior literature and evidence, our study began with a series of predictions regarding the evolution of the gap between rural and urban age structure and sex composition over the course of the demographic transition. Our empirical analysis offered convincing confirmation of these predictions. The rural age structure during the early stages of transition is younger and the dependency ratio higher when compared to the urban sector. The rural/urban gap in age structures grows before it begins to dissipate once the

mid- or advanced stages of the transition are reached. In addition, sex ratios also go through a similar divergence with rural sectors becoming more female due to high male rural-urban migration rates, and a balance only emerging late in the transition.

Our analysis shows how migration along with differential patterns of natural increase plays a key role in the divergence of age structures across sectors. Migration reaches a peak with young adults – younger amongst females than males. The relatively higher female migration pattern may be driven in part by fostering, with girls more likely to be fostered to cities to take advantage of additional education opportunities (Yaqub 2009), or possibly for early marriage (Watts 1984; Singh & Samara 1996). In addition, as evident from the rural-urban net migration profiles, 15-29 year olds comprise the bulk of overall migration flows. Despite a substantial slowdown in SSA urbanisation, young adult rural-urban migration has remained at relatively high rates over the 1980-2015 period. Broadly speaking, migrants in these ages possess distinctive characteristics - career-starters, family-builders and relatively easy to mobilize (Easterlin 1978; Mesquida & Wiener 1999) – offering the potential to rapidly transform the urban sector.

Our descriptive results show how rural to urban migration rates for males aged 15-29 have a strong negative association with dependency ratios. In urban areas higher in-migration lowers the dependency ratio; in rural areas greater out-migration towards the cities raises rural dependency ratios. These results are reinforced in the multivariate models where migration for young adults is found to bear the largest influence on dependency ratios in each sector - a larger impact than either fertility or mortality. These results strongly support our hypothesis that young adult migration is key in shaping age and sex compositions of the rural and urban sectors.

Migration for older adults (ages 30-59), while not as strong, produces an opposite impact on dependency ratios. While this may seem surprising, it is likely because rural-urban migration rates for these ages have declined in the last 20 years. Migration of older working adults is often in the opposite direction (urban to rural) or at least closer to zero. These estimates of older adult net rural-urban migration however may be biased downwards if urban mortality exceeds rural in these ages. Also, our models do not account for international migration and adult mortality. In these older adult ages higher international migration rates and higher

mortality, particularly from HIV, could be confounding the association between migration and dependency ratios. For example, countries with high HIV prevalence (>10%) have significantly lower rates of 30-59 year old net migration with a mean urban in-migration rate of -0.0001 compared to 0.0045 amongst lower HIV prevalence countries. Such migration rates in high HIV prevalence countries could indicate greater urban-rural migration flows, when ill migrants return home (Clark et al. 2007; Levira et al. 2014). Thus, more complex models accounting for HIV and international migration by rural/urban sector may alter the effect of older adult migration on dependency ratios.

CONCLUSION

There is increasing recognition that urbanisation trends in Africa have followed a distinct path (Potts 2009; Beauchemin & Bocquier 2004), forcing scholars to consider alternative relationships between development and urbanisation (Christiaensen & Todo 2014). Our results indicate that regardless of a slowdown in urbanisation rates, two demographically distinct populations can be identified, driven to a considerable degree by the very young age of rural to urban migrants. One population, in the rural sector, has a far greater share of females and has high levels of dependency with more children and elderly per every working-age adult. A second, in the urban sector, is predominantly male and benefits from far lower dependency rates and a far higher share of working-age adults. These demographic profiles create both challenges and opportunities for development. We focus here on three areas where subnational variation in age structure may prove particularly salient: 1) fiscal implications of changing demography, 2) the demographic dividend, and 3) political and social conflict.

One, residents in the urban sector typically enjoy more services than those in the rural sector (Lipton 1977), accompanied by the inequitable distribution of human capital investments in favour of the urban sector (McEwan 1999; Lemiere et al. 2013; Dussault & Franceschini 2006). This means that when services such as education and health care are at least partly funded by the state, as typical in many SSA countries, state per capita cost outlays may differ substantially across sectors (Stecklov 1999). Thus, from a *purely* fiscal perspective, state spending will grow as urban shares – and more specifically the urban shares of those age groups that are the beneficiaries of state investments - increase. Higher

dependency ratios in the rural sector may be cost saving in the near term. However, expanding investments in the rural sector may be beneficial not only for poverty alleviation and reducing the urban-rural wage gap, but also for greater nonfarm income diversification – which leads to economic growth (Barrett et al. 2001).

Two, the distorted age structures across the rural and urban sectors may also impact the demographic dividend in SSA. The decline in dependency plays a key role in the demographic dividend and calculations regarding Africa's expected gains from the dividend have been somewhat pessimistic (Eastwood & Lipton 2011). Yet, while a national perspective is important, our analyses highlight significant spatial heterogeneity in rural and urban age structures in SSA that may raise the value of focusing on *local* rather than national demographic dividends. Where the market and public sector play a large role in making intergenerational resources flow across age groups, heterogeneity in local age structures may matter less. However, a large share of intergenerational transfers for countries in SSA flow within and between households, rather than through market and public mechanisms (Lee and Mason 2010; Stecklov 1997). Under these conditions, a more local approach may help states plan for changes in the demographic structure of households in the rural sector, before their dependency ratios decline. Such steps could include more intensive investments in human capital as well as encouraging non-farm income diversification and implementing financial services in rural settings to allow savings of remittances (Housen et al. 2013; Barrett et al. 2001). More attention to small or medium sized cities - the "missing middle" sector often have unique characteristics including lower inequality (Christiaensen & Todo 2014) and relatively young populations – also makes them prime candidates for demographic dividends in the relatively near future.

Finally, age structure at the sub-national level may also matter for political stability and social conflict. Violent unrest, such as riots or demonstrations, is often an urban phenomenon in particular because of higher concentrations of young adults in the urban sector (Buhaug & Urdal 2013; Cincotta et al. 2003; Urdal 2008; Urdal & Hoelscher 2009). A higher likelihood of conflict may be reinforced by migration to the urban sector if, as we find, relatively high levels of male versus female migration to cities may produce heavily skewed urban sex ratios (Dyson 2012). High concentrations of 15-29 males in the urban

sector may lead to national instability and breakdowns in democratic institutions. Investing in the urban sector by expanding the formal work sector, providing better access to services, information on job availability, skill training and community building activities may curb urban conflict (Sommers 2010; Banks 2016).

In addition to identifying gaps in age structure across sectors, our findings highlight how sex ratios become distorted. The major cause of these distortions is also migration – both because sex ratios at birth in SSA are not affected by large-scale sex-selective abortion as in parts of Asia (Das Gupta 2010) and because the population remains relatively young (female mortality rates are substantially lower than male rates primarily in older ages). However, where there are imbalanced sex ratios amongst adults, the proportion of those who marry, and in turn fertility rates, may be affected (South 1988; Dyson 2012). High sex ratios (more men than women) amongst young adults may be threatening if it drives young men to engage in violent behaviour, possibly leading to more crime and disorder (Dyson 2012) and undermining national security (den Boer & Hudson 2004). When males are more likely to migrate to cities as in SSA, low sex ratios may affect marriage markets, labour markets and even overall productivity. Investing in female education and autonomy, accompanied by lower fertility, could be beneficial for states as a means of encouraging female rural-urban migration and thus reducing urban sex ratios (Brockerhoff & Eu 1993).

Due to Africa's distinct urbanisation path and the variance of internal migration in other regions of the world (Bell et al. 2015; Potts 2009; Beauchemin & Bocquier 2004), caution must be taken in generalising our results. Higher urban proportions in Latin America where internal migration is moderately intense suggests a possibly smaller urban-rural gap in age structure (Bernard et al. 2017; United Nations 2015). Asian countries – also characterised by urbanisation occurring faster than economic growth and large rural proportions- may have similar age structure gaps as in SSA, though lower migration intensities among the young may narrow the gap (Hoselitz 1957; United Nations 2015; Bell et al. 2015).

The future course of change in Sub-Saharan Africa will depend on future demographic developments. If urbanisation does slow down or even reverse directions, the gaps created between the sectors may be altered. However, both continued urban growth and more importantly, rural to urban migration, is likely to mean that whatever levels of urbanisation

are seen in the near and mid-term future, age structures and the challenges they bring are likely to remain key issues for development policy and planning in SSA.

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ENDNOTES

[1] The annual rate of urbanisation is defined as the average annual rate of change in the proportion of the urban population.

[2] The imputation procedures of the UN will tend to average out differences in age structure and rural-urban migration estimates. Unsurprisingly, when the list of countries based on fully imputed estimates were removed from our analysis the results remained consistent. Change included a small decline in the urban-rural age structure gap for both sexes. Rural dependency ratios rise slightly while urban ratios decline, though both shift by less than ten percent. Migration rates are slightly higher for all ages, particularly between ages 10-29, though the differences are less than 0.01.

[3] For some countries DHS data can also be used to calculate rural-urban migration rates. However these rates are less relevant to our research as they represent lifetime migration, making it hard to establish both the time period of migration as well as whether the destination has been reclassified since migration.

[4] Results are available upon request.

[5] We employ the term "rate" rather than "ratio" for migration estimates since it measures the number of migrants per population (whether rural, urban or national) *during the five-year time period*. In some of these cases, the denominator is not necessarily the population exposed to the event and thus they are not strictly rates. They could be expressed as ratios since they measure the relative size of the migrant population to the rural/urban/national population but we maintain here the use of the term "rates" for consistency.

[6] "Aggregated SSA" is our hypothetical SSA as a whole migration profile and the "Country Average" is the mean migration profile for all countries in SSA included in our analysis.

[7] Details available upon request

[8] The thick line inside the box represents the median value while the box captures the inter-quartile range and the dashed lines reach until values that are 1.5 times beyond inter-quartile range. Finally, outliers are represented by individual circles.

[9] For purposes of exposition, Figures 7 and 8 do not include boxplot outliers.

[10] We also tested adult mortality rates by rural/urban sector (not shown but available upon request). While greatly reducing our sample size, inclusion does not qualitatively impact our findings.

[11] Due to the relatively limited sample size in our analysis, our main models are replicated using robust regression (least absolute deviations or LAD) to estimate Model 2, fully supporting our main findings (available upon request).

[12] We also estimated Model 1 on the sub-sample of 444 cases, restricted to data also available in the DHS sample, to determine whether the observed effects of TFR and child mortality were driven primarily by the sample composition. The change in the child migration coefficient from significant in Model 1 to insignificant in Model 2 arises from the shift to the smaller selective sample of countries where DHS data by sector were available.

[13] We also examined three additional models based on Model 2, which included interaction terms between the components of age structure and urban setting. The significant interactions terms (not shown) indicate that migration rates affect the urban dependency ratio more strongly than the rural.

[14] All (non-dummy) explanatory variables have been rescaled to have a mean of zero and a standard deviation of one; the outcome variable - the dependency ratio - is not standardised.