IFAD
Investing in rural people

Population age structure and sex composition in sub-Saharan Africa

A rural-urban perspective

by

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Department of Sociology and Anthropology, Hebrew University of Jerusalem

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Abstract

Urbanization in sub-Saharan Africa, occurring despite relatively low levels of industrialization, has driven concerns over future development in the region. We explore how the differential timing and levels of natural increase in rural and urban areas, interacting with rural-urban migration, create profound gaps in population age and sex structures across the urban and rural sectors of sub-Saharan Africa. Population age structures establish critical parameters for understanding development, ranging from the potential to reap demographic dividends to civil violence. We argue that a sectoral perspective on both age structure and development can be beneficial. We calculate dependency ratios and sex ratios using United Nations data from 45 sub-Saharan African countries between 1980 and 2015 to probe the extent of the age and sex structure gaps across stages of the demographic transition. Results indicate that age and sex structure gaps are predictable by the stage of transition. Both descriptive analyses and linear country fixed-effects models show that rural-urban migration of young adults plays a key role in explaining dependency ratio and sex compositional gaps between the sectors. The results highlight the value of taking into account local age and sex structures to better prepare for the demographic dividend and other consequences of demographic shifts in sub-Saharan Africa.

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Introduction

The annual rate of urbanization in sub-Saharan Africa, defined as the average rate of change in the proportion of the urban population, was 1.4 per cent for the period between 2010 and 2014 (United Nations, 2014a), not unusually high in historical terms with rates having been reported to reach as high as 5.2 per cent between 1950 and 1955 (Cohen, 2004; Kessides, 2007; Preston, 1979; United Nations, 2001, 2015). Several studies, however, suggest both that past figures on urbanization rates were overestimated and that declines in recent years have been sustained (Bocquier, 2004; Potts, 2009). While Africa's urbanization levels remain lower than other world regions (United Nations, 2014a), a decline in the urbanization rate is not altogether surprising. Africa's urban transition has been distinctive – notably disconnected from economic growth levels since the 1980s – and often described as "urbanization without industrialization" (Fay and 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 and Weeks, 1993), urbanization from the 1980s has become virtually disassociated with growth in incomes (Fay and 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 and Bocquier, 2004; Potts, 1995). Alongside these demographic changes, non-agricultural income diversification among the rural sector has led to the increasing deagrarianization of sub-Saharan Africa (Bryceson, 1996, 2002; Temudo and Abrantes, 2013).

One way to make sense of Africa's urbanization trends is to put more emphasis on past demographic patterns and their variation across the rural and urban sectors, which can play a key role in urbanization (Dyson, 2011). In fact, demographic forces may have been critical in propelling African countries to relatively rapid urbanization from the 1960s until the 1980s (Bocquier, 2004; Chen, Valente and Zlotnik, 1998). Demographic changes – first mortality and then fertility decline – generally commence in the urban sector prior to reaching the rural sector. These changes cause population age structures to shift over time from predominantly young to increasingly old. Once mortality decline reaches the rural sector, increasingly large cohorts in the rural sector attain working ages and form migrant pools that can become a powerful force for urbanization. The role of a large rural population in rural-urban migration will be particularly pronounced where rural poverty offers few economic alternatives (Bilsborrow, 1992). However, once fertility begins to fall in the rural sector and rural populations begin to age, demographic momentum for urbanization loses steam and urbanization trends become more variable.

Shifting population age structures over the course of the demographic transition produce fundamental implications for society as a whole. Youth bulges may emerge sometime after mortality declines – before fertility declines and ageing becomes a more dominant influence. Such youth bulges may lead to economic gain under favourable conditions, with studies showing that economic growth rates substantially increase through the first demographic dividend as fewer dependents enable resources to be freed up for investments (Bloom and Canning, 2011; Lee and Mason, 2006, 2011). In fact, some estimates suggest output per effective consumer for sub-Saharan Africa might be increased by a third if the first demographic dividend is successfully captured (Mason, 2005). Alongside these positive impacts, other studies have highlighted the potentially negative influences of age structural shifts – with youth bulges producing violence and social conflict under certain social, economic and political conditions (Cincotta et al., 2003; Goldstone, 2002; Staveteig, 2005; Urdal and Hoelscher, 2009).

Most of the existing evidence is nationally focused. Yet, while transitions of age structure at the national level are well understood (Bongaarts, 2009; Lee, 2003), the meaning and extent of within-country variation in age structures occurring over the course of the transition remains neglected. In particular, because the demographic transition is so deeply intertwined with the mobility transition and urbanization (de Vries, 1990; Dyson, 2011), their combination may create large divergences in population composition across the urban and rural sectors – driven, as well as accentuated, by rural to urban migration flows. The causes and consequences of these divergent age structures need to be better understood in order to clarify the implications of shifting demographic trends for development.

This study describes the shifting age and sex patterns of populations across sectors in sub-Saharan Africa (SSA) from 1980 to 2015 – roughly the period when urbanization began to decouple from economic growth. We examine the relationship between the slowdown in urbanization and rural urban age structure gaps as well as the evolution of the gap over the fertility transition. We then use a variation on the census survival ratio method, enabling estimation of age-specific net rural to urban migration rates for this same period for all countries in our data. This allows us to examine the relationship between age-specific net rural to urban migration and changing age structures across SSA. This approach allows us to shed light on the role of migration and other demographic influences on age and sex compositions across the rural and urban sectors of sub Saharan Africa.

Rural and urban age structure in development

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: (i) the fiscal balance of benefits and costs of population change; (ii) the demographic dividend; and (iii) 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 (Bloom et al., 2003; Higgins and Williamson, 1997). 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 and 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 rural to urban 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 violent unrest (Buhaug and Urdal, 2013; Cincotta et al., 2003; Goldstone, 2002; Mesquida and Wiener, 1999; Staveteig, 2005), and even breakdowns in democratic systems (Weber, 2013). While not a direct cause for conflict, youth bulges are an enabling factor to violent conflict due to their being more easily mobilized, with fewer family responsibilities and low opportunity costs of political violence (Macunovich, 2000; Mesquida and Wiener, 1999).

Rural and urban age structures over the course of the demographic transition

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. Eventually, when populations age through further declines in mortality and fertility, emigration's impact diminishes. These changes in countrywide 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 a similar manner, subnational age structures are also determined by these three 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 (de Vries, 1990; Dyson, 2011). Mortality and fertility also decline in the rural sector, but the delayed decline in mortality and then fertility 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, at least 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 (Montgomery et al., 2003; Raymer and Rogers, 2006; Rogers et al., 2005). Because pre-transition urban mortality generally exceeds rural due to higher levels of exposure to pathogens, population density and social ills (Fox, 2012; Reher, 2001; Woods, 2003), 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 (Keyfitz, 1980; Zelinsky, 1971). 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. If rural to urban migrants are predominantly male, substantial gaps in the sex ratios may emerge with urban sectors becoming more heavily male relative to the rural sector.

While there has been considerable debate in recent years about overall trends in urbanization in sub-Saharan Africa (Beauchemin, 2011; de Brauw et al., Mueller and Lee, 2014; Potts, 2009), particularly given the weak pace of industrialization and high levels of poverty, few have yet to consider the extent of differentiation in age structures across the rural and urban sectors and what this means for development. In addition, sub-Saharan Africa remains in the midst of both a fertility transition and an HIV/AIDS crisis – factors that create complex demographic differences across the rural and urban sectors. We build on data for the period 1980-2015 to study the patterns and gaps in age structure between rural and urban sectors both over time and by sex. This allows us to estimate net rural to urban age- and sex-specific migration rates across all countries in our sample. Our analysis focuses both on the general patterns of change in population composition and on the specific role of rural to urban migration in this process. We hypothesize that:

i. Rural age structures are younger than urban age structures, particularly before the onset of the demographic transition. Over the course of the fertility transition, we hypothesize an initial divergence in age structures. This divergence is driven both by fertility decline starting earlier in the urban sector and by flows of rural working-age migrants to cities. The combination of factors creates an urban sector with fewer dependents. We then expect convergence in the age structures at lower dependency ratios across the two sectors when rural fertility also declines.

ii. 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 diminishes once the fertility transition nears its end.

iii. 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 share of the young working-age population in both sectors, as expressed through the dependency ratio, and the sex composition will be driven most strongly by rural-urban migration rather than vital rates.

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 sub-Saharan Africa, where there is only a limited number of available census data. The United Nations Department of Economic and Social Affairs (UN-DESA) Population Division produced country-level estimates of urban and rural populations by age and sex (URPAS) for every five-year interval over the period 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. It is important to recognize that these data are not based on a universal definition of urban. Each country uses its own definition, making cross-country comparisons somewhat fragile (Buettner, 2014). For example, rural-urban migration in Ethiopia where urban is defined as a locality with over 2,000 inhabitants may be different in scale to migration in Senegal where urban is defined as places with over 10,000 inhabitants. However, to the best of our knowledge, rural and urban population data by age and sex using a standardized definition across countries do not exist.

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). 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 – a limitation not found in more complex measures (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.

We use total fertility rate (TFR) estimates from the United Nations, estimated for every five-year period from 1980 to 2015, to assess each country's stage within the demographic transition (United Nations, 2013). 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 sub-Saharan Africa with TFRs below four children leads us to aggregate the last three stages into a single "advanced" stage.

Table 1: Total fertility rate ranges assigned to stages of fertility transition

Transition stage	Total fertility rate range
Pre	7+
Early	6-6.9
Early-mid	5-5.9
Mid	4-4.9
Advanced	< 4

The role of each of the three components shaping rural and urban age structure – fertility, mortality and migration – is decomposed using regression models. Country fixed-effects (FE) models are used to account for between-country sources of heterogeneity that are observed as well as differences that are fixed but unobserved. The FE models can be helpful in overcoming differences in urban definitions across countries, at least when similar definitions are maintained within a country over time. The 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). Models that include variables taken from the DHS data sharply reduce our sample sizes.

Estimating net rural-urban migration flows by age and sex

While national estimates of vital rates are widely available, data on rural-urban migration for sub Saharan Africa are sorely lacking (de Brauw et al., 2014). Estimates of migration flows can be obtained using the Census Survival Ratio Method (CSRM) (Hamilton and Henderson, 1944; Preston, 1979). Our estimated migration rates are based on slight variations of the United Nations approach (United Nations, 2001). Rather than using census data, we work with the URPAS database, which provides best estimates of rural and urban populations by age, building on census data, where available, as well as adjustments from available surveys and demographic modelling (United Nations, 2014b). Furthermore, in our variation on the traditional CSRM approach, the rural rather than the urban population is used as the basis for estimating intersectoral 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. Essentially, instead of focusing on survival at the migrants' destination, this approach focuses on survival at the source. When urbanization 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 (Bocquier, 2004; Liu, 2013).

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 per cent lower than urban survival ratios (an assumption tested in the robustness section below). These ratios predict the expected number of people in each rural cohort at the time of each 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 provides 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).

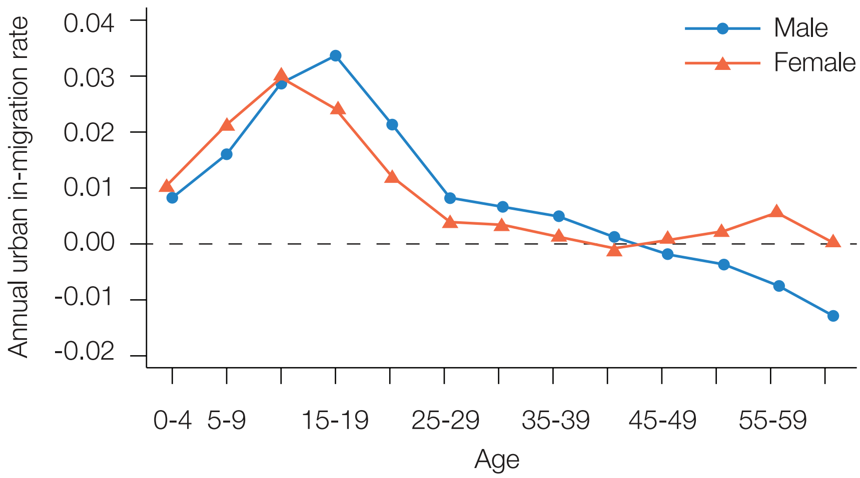
The CSRM produces rural to urban migration estimates for all 45 SSA countries for every five-year interval between 1980 and 2015. Annual net urban in-migration rates are calculated as the number of net rural-urban migrants over the urban population; annual net rural outmigration rates are calculated as the estimated (negative) number of net rural-urban migrants over the rural population for each age group.[1]

A number of important limitations with the CSRM approach, equally valid for our modified version, have been raised (Moultrie et al., 2013; Preston, 1979). CSRM migration estimates do not directly account for international migration or reclassification. The rural to urban migration estimates may be biased depending on international migration, which is not distinguished from the survival ratios. In contexts where international migration is high, use of the rural-based approach shown here may reduce biases in estimates of net rural to urban migration, although the extent of bias depends on whether international migrants come primarily from the rural or urban sectors. Also, reclassification is not possible to distinguish using the cohort survival approach. Thus, our migration estimates are a combination of *both* net rural to urban migration and reclassification. The robustness discussion below clarifies why the migration estimates by age are likely conservative – at least in terms of the relative propensity to migrate at the young adult ages.

Estimated age-specific net rural to urban age-migration profiles averaged across all countries in our SSA sample are shown in Figure 1. 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 consistent with evidence on such migration patterns for youth (Beauchemin, 2011; Gultiano and Xenos, 2006; Heckert, 2015). Furthermore, these migration patterns are consistent with existing evidence on the extent of fostering in SSA (Isiugo-Abanihe, 1985; Madhavan, 2004). 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 proportion of the population in these older ages is much lower – only 24.8 per cent of the population of SSA is between ages 30-59 and merely 4.9 per cent aged 60 and older. 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, notwithstanding trends at the older ages, the overall impression is 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.

1. 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 size of the migrant population relative to the rural/urban/national population but we maintain the term "rates" for consistency.

Figure 1: Country mean net rural-urban migration age profile by sex (UN-DESA URPAS data for 45 sub-Saharan African countries, 2010-2015)



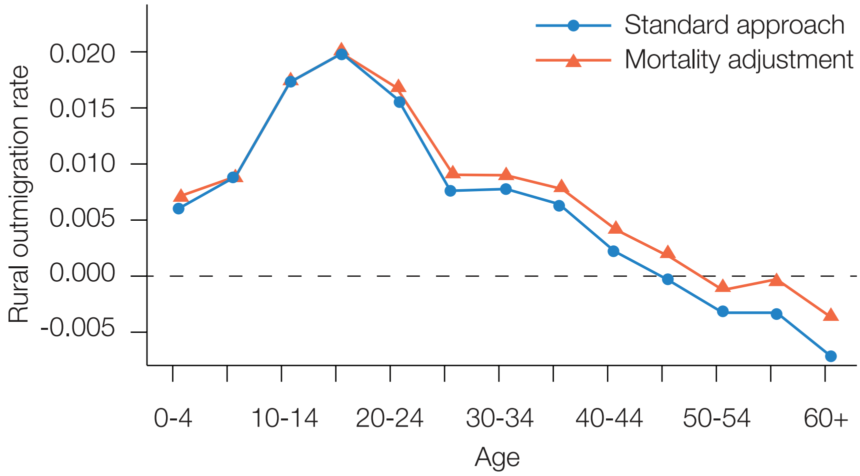
Robustness of migration estimates

Our robustness analyses explore three separate potential biases: (i) sensitivity to the standard assumption that rural mortality rates are 25 per cent higher than urban; (ii) likely impact of international migration on our qualitative findings; and (iii) whether reclassification is largely driving the age patterns of our migration estimates.

i. The 25 per cent higher rural mortality assumption is broadly consistent with evidence that rural child mortality levels generally exceed those in the urban sector (Akoto and Tambashe, 2002; Bocquier et al., 2011; Buckley, 1998; Cai and Chongsuvivatwong, 2006). However, there is surprisingly little evidence regarding rural-urban mortality differentials for adults in developing countries (Menashe-Oren and Stecklov, 2016). We tested the sensitivity of our estimates to variations in the mortality differential. Based on our own calculations on adult mortality from DHS data, and using DHS macro data on rural and urban child mortality (ICF International, 2014), we estimated a gradient of rural-urban mortality differentials under the assumption that urban mortality exceeds rural by 29 per cent for the youngest survivors but only by 3 per cent for adults. As seen in Figure 2, use of the graduated profile for rural-urban mortality differences ("mortality adjustment") had little impact on our migration age profiles up to age 30. 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 per cent mortality differential assumption ("standard approach").

ii. The rural-based approach makes our rural-urban migration estimate patterns more robust to international migration. This is both because the rural sector in SSA likely provides a substantially smaller share of international migrants (Bocquier, 2004; Liu, 2013) and because in most SSA countries the rural population is larger in an absolute sense so that the proportional effect of an international migrant on cohort

Figure 2: Country mean net rural-urban migration age profile by sex (UN-DESA URPAS data for 45 sub-Saharan African countries, 2010-2015)



survival estimates will tend to be smaller. However, we also employ an additional 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 any individual country. Existing empirical evidence, though limited, suggests that about half of international migration from African countries is *within* Africa (Abel and 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 stay urban. Migration estimates are compared to the average profile for all SSA countries in Figure 3, where the "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.

There is an impressive degree of similarity for the two profiles with both peaking at the same young ages, although the country average profile is slightly lower at the younger ages and slightly more negative at the later ages. Overall, these profiles share a similar basic pattern and offer more support for the robustness of our estimated rural-urban migration patterns to the effects of international migration.

iii. A long-standing and well-recognized limitation in the CSRM approach is the inability to distinguish between reclassification and migration, making it difficult to ascertain the effects and potential bias from reclassification on our rural-urban age profiles of migration. The few existing estimates that are available offer only limited guidance. Estimates suggest that 28 per cent of urban growth in the Philippines and Thailand is due to reclassification (United Nations, 2001) – roughly 50-60 per cent of all migrants. Estimates for Africa between 1950 and 1980 indicate that reclassification is responsible for 26.4 per cent of urban growth (Beauchemin and Bocquier, 2004), although reclassification may have been more substantial in this earlier period and there are few estimates of the scale of reclassification in current SSA data.

Despite ambiguity due to the lack of data on reclassification, reasonable assumptions on age structures of reclassified populations enable us to gain some clarity on our migration estimates. Because the age and sex structure of areas that are reclassified are essentially similar to the national or urban populations – both being heavily weighted towards younger ages – one can estimate the sensitivity of the age profile of migration under various assumptions on the proportion of total migration due to reclassification. In Figure 4, the average SSA net migration profile is shown to shift under different assumptions about the relative scope of reclassification (calculated at 30, 50 and 70 per cent of migration). 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 the age heaping grows as the relative magnitude of reclassification is increased.

Figure 3: Country mean male net rural-urban migration age profile comparison with sub-Saharan African aggregate (UN-DESA URPAS data for 45 sub-Saharan African countries, 2010-2015)

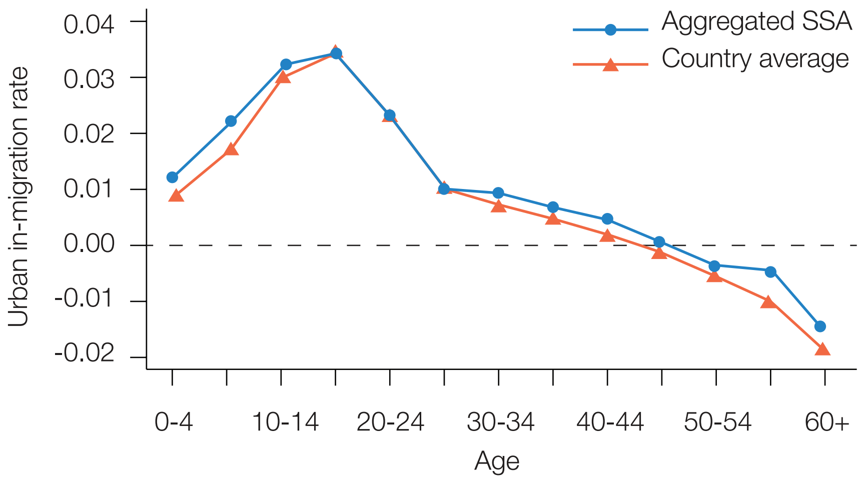
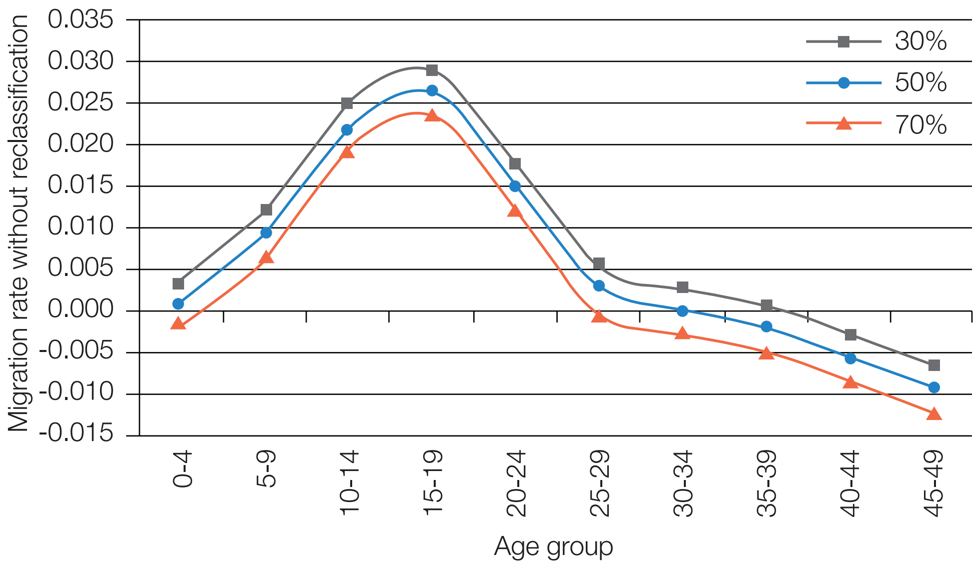


Figure 4: Effect of various levels of reclassification on age-specific migration estimates assuming reclassified settlements have urban age structures



Results

We first consider the extent of change in urbanization rates, growth rates of the urban population, in SSA over time. Extensive urbanization in SSA over the past 35 years has raised urban shares from 25.8 per cent in 1980 to 41.8 per cent in 2015. While substantial, the pace of urbanization appears to have slowed down in recent decades. The average urbanization rate for countries in SSA shown in Figure 5 highlights a sharp slowdown from about 2.2 to 1.1 per cent over the past 30 years, consistent with prior studies (Cohen, 2004; de Brauw et al., 2014; Potts, 2016).

Assessing the rural-urban age and sex composition gap

Given the apparent decline in the pace of urbanization, one might question whether age and sex structures are distinguishable across the two sectors or whether declining rates have led to relatively homogenous age and sex structures across the two sectors. The answer is evident in the two overlaid population age pyramids – one rural and one urban – showing national average age and sex structures for SSA as a whole in 2015 (Figure 6). The rural population is clearly younger, with a greater fraction of males and females at the youngest ages: 46 per cent of the male population in the rural sector is under age 15 compared to 38.7 per cent 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

Figure 5: Declining urbanization rates in sub-Saharan Africa (simple average of country estimates) (UN-DESA URPAS data for 48 sub-Saharan African countries, 1985-2015)

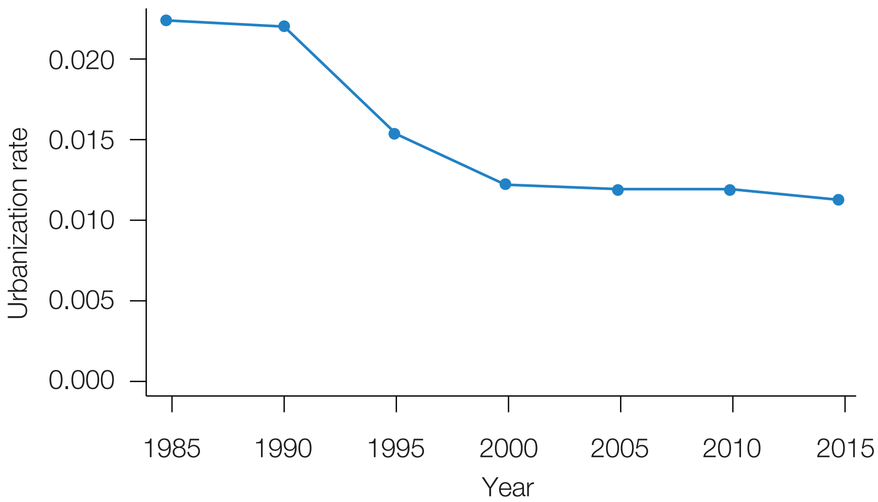
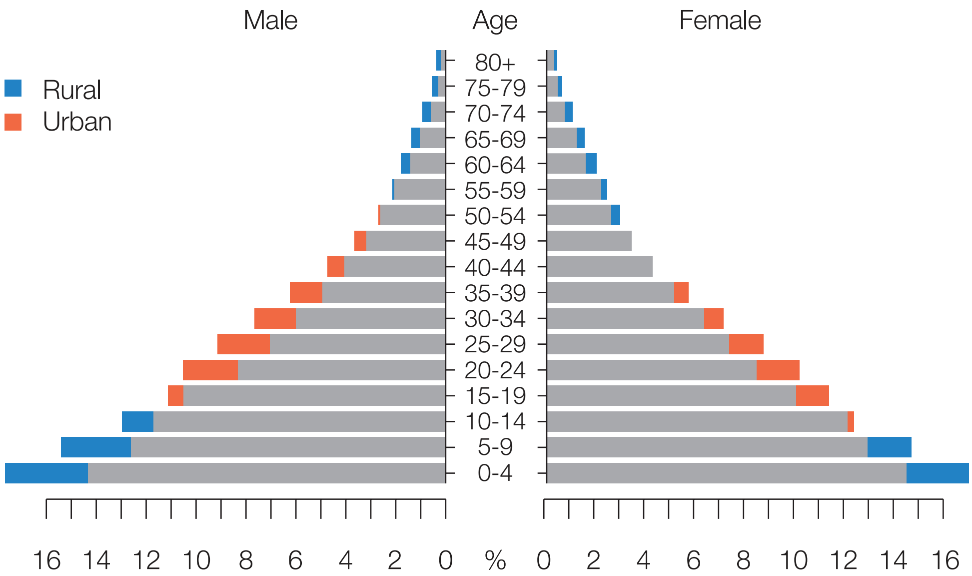


Figure 6: Population pyramid of 45 sub-Saharan African countries based on mean rural and urban population in 2015 (UN-DESA URPAS data)



pronounced for males (57.8 per cent of the population in the urban sector and 49 per cent in the rural sector). At the oldest ages, the rural population is dominant with 5 per cent over age 60 compared to only 3.5 per cent 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 also worth noting that this pyramid hides considerable heterogeneity within SSA in the age structure gap between rural and urban populations. Nonetheless, dependency ratios are higher in urban populations for 93 per cent of our full country-year sample.

A more informative perspective comes from comparing the dependency ratios of urban and rural sectors by sex. In Figure 7, a set of box plots show separate dependency ratios for 2015 for males and females by rural-urban status for the SSA data.[2] 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 among women. This is based both on their closer median dependency ratio values and on the greater proximity of the interquartile ranges. Figure 7 demonstrates how the dependency ratio differs across the sectors and highlights the particularly large gap for males. Furthermore, when 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 1.06 to 0.96.

Sex ratios capture another key dimension of population composition, and age-specific sex ratios for each sector in 2015 are presented in Figure 8. Sub-Saharan Africa is characterized 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

2. The thick line inside the box represents the median value, while the box captures the interquartile range and the dashed lines reach until values that are 1.5 times beyond interquartile range. Finally, outliers are represented by individual circles.

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. The analysis below indicates 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 7: Urban and rural dependency ratios by sex for 2015 (UN-DESA URPAS data for 45 sub-Saharan African countries)

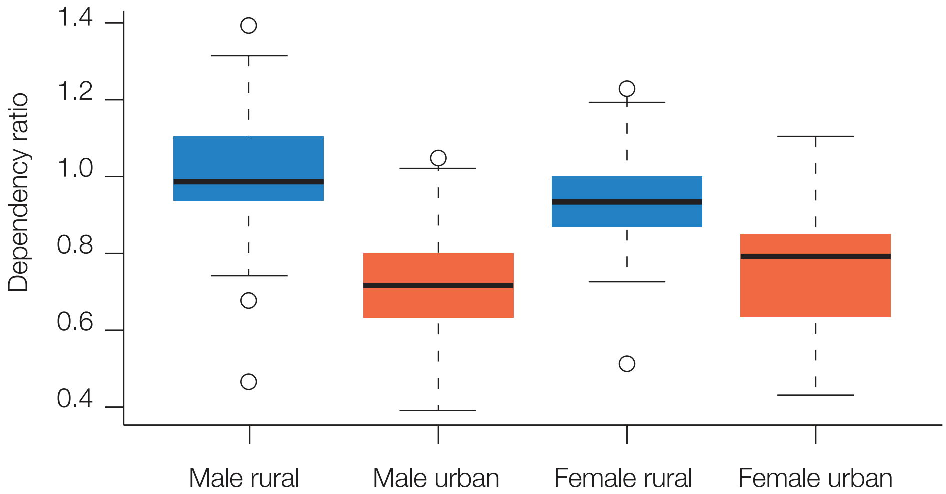
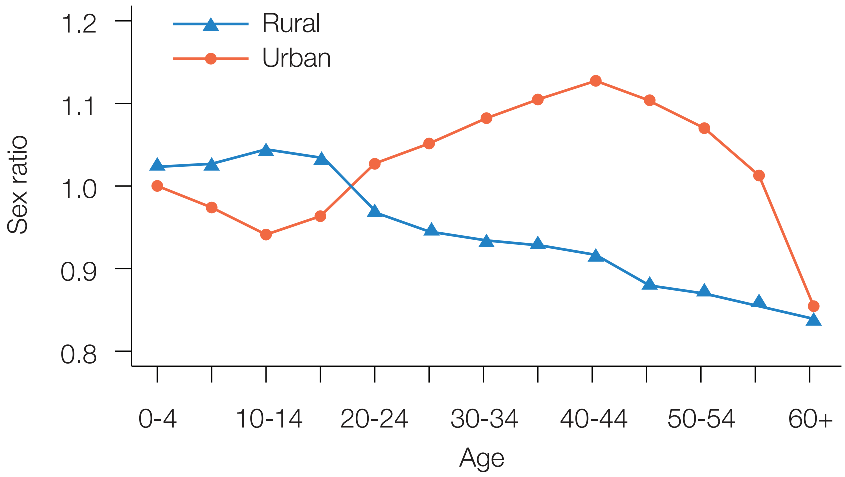


Figure 8: Urban and rural mean sub-Saharan African sex ratios (males/females) in 2015 (UN-DESA URPAS data for 45 sub-Saharan African countries)



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. Because the United Nations data begin in the 1980s after the onset of the mortality transition, they only allow us to examine patterns of shifting age structure over the complete course of the fertility transition – for most countries – though not pre-mortality transition (see Figure 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 the growing gap between fertility levels in rural and urban sectors (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 four 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 stage suggests that the gap is closing but the timing is highly variable. Interestingly, the pre- and advanced stages both show the greatest variability in dependency ratios: in the pre-fertility stage it is within the urban sector, and in the advanced stage within the rural. 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.

Our examination of sex ratio patterns supports this same basic description of gaps shifting systematically over the course of the fertility transition. The box plots in Figure 10 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.

In addition to examining how the age structural gaps shift over the course of the transition, we also explore their evolution as urbanization levels increase. Since the demographic transition is intrinsically linked to urbanization, it should not be surprising to find a link between the gap and urbanization. Figure 11 provides evidence of this relationship in sub-Saharan Africa, with the gap between male rural and urban age structures high when urbanization levels are low and declining to smaller gaps at the highest levels of urbanization. In addition to the general decline with urbanization, the figure also suggests extensive heterogeneity between countries with the greatest variance in the age structure gap clearly seen in the low to mid-range of urbanization. Most countries during this period are only about one third urban.

Figure 9: Rural and urban age dependency ratios over the fertility transition stages seen at the national level (UN-DESA URPAS data for 45 sub-Saharan African countries, 1980-2015)[3]

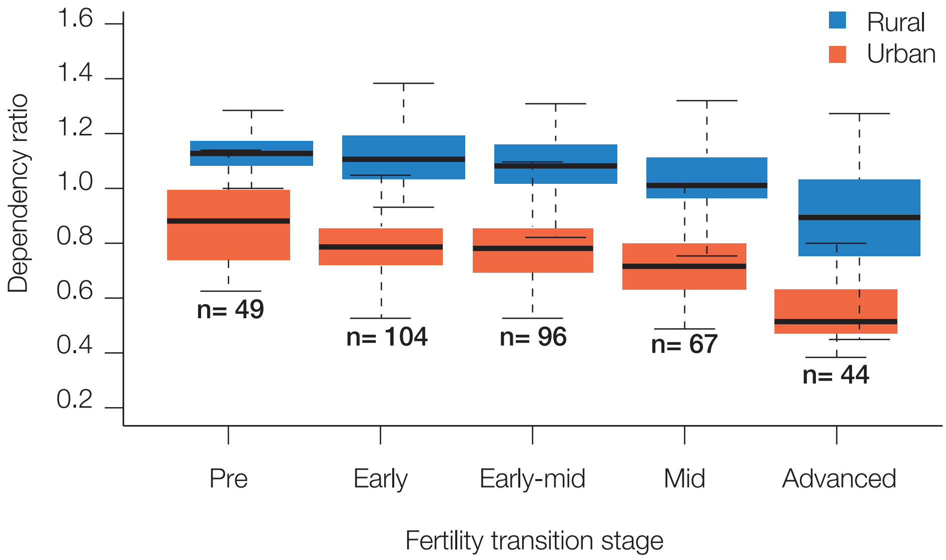
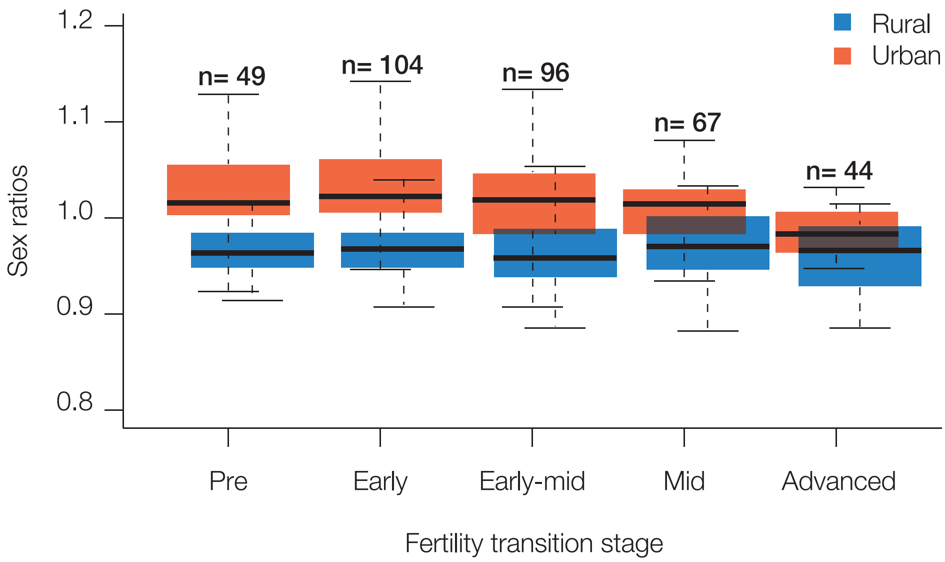
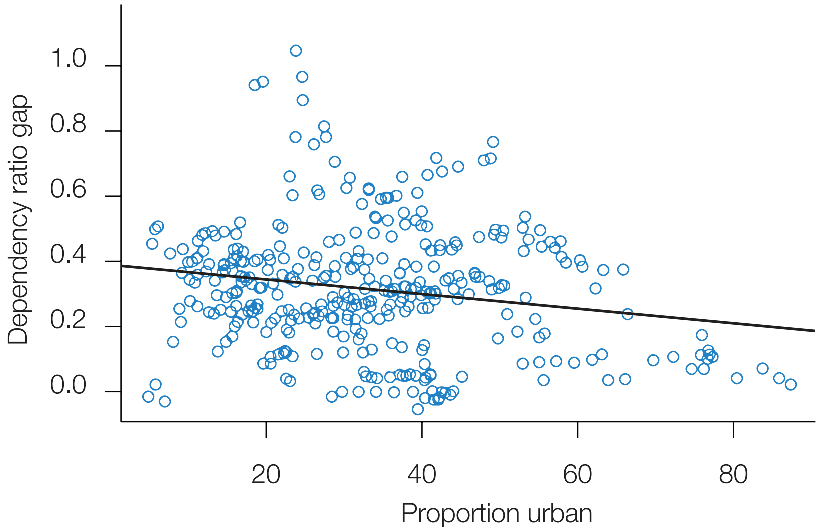


Figure 10: Rural and urban sex composition shifts over fertility transition seen at the national level (United Nations data for 45 sub-Saharan African countries, 1980-2015)



3. For purposes of exposition, Figures 9 and 10 do not include box-plot outliers.

Figure 11: The rural-urban dependency ratio gap for men and urbanization (UN-DESA URPAS data for 45 sub-Saharan African countries, 1980-2015)



We continue to explore the relationship between the fertility transition and sector-specific population composition with the help of multivariate statistical models. 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 = 1,440). 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 urbanization 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 urbanization rise. Model 4 suggests that the gap between rural and urban dependency ratios is relatively small but increases with the onset of the fertility transition. According to the OLS model, 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, 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 sub-Saharan African 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 (-0.01)	-0.003 (-0.01)	-0.004 (-0.01)	-0.145** (-0.01)	-0.147** (-0.01)	-0.141** (-0.01)
Urban	-0.247** (-0.01)	-0.247** (-0.01)	-0.247** (-0.01)			
Per cent urban	-0.002** (0.000)	0.001** (0.000)	0.000 (0.000)	-0.002** (0.000)	-0.004** (0.000)	0.002* (0.000)
Early		-0.046** (-0.01)	-0.009 (-0.01)		0.081** (-0.02)	0.036** (-0.01)
Early-mid		-0.089** (-0.01)	-0.044** (-0.01)		0.110** (-0.02)	0.044** (-0.01)
Mid		-0.157** (-0.01)	-0.104** (-0.02)		0.149** (-0.02)	0.011 (-0.02)
Advanced		-0.330** (-0.01)	-0.255** (-0.02)		0.209** (-0.03)	-0.037 (-0.02)
Constant	1.100** (-0.01)	1.110** (-0.01)	1.102** (-0.02)	0.383** (-0.02)	0.339** (-0.02)	0.241** (-0.02)
R-squared	0.425	0.616	0.595	0.171	0.239	0.491
No. of cases	1 440	1 440	1 440	720	720	720

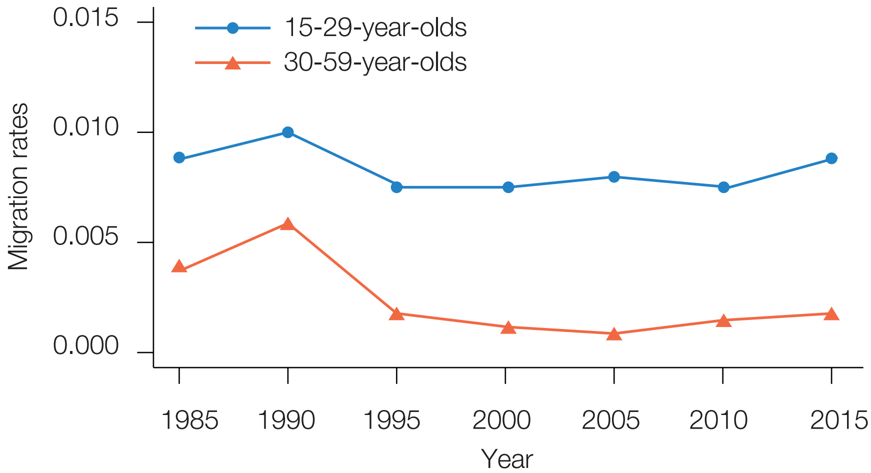
Notes: Standard errors in parentheses; two-tailed test: ** $p < 0.01$; *$p < 0.05$. FE = fixed effects; OLS = ordinary least squares.

Estimating the role of migration in shaping rural-urban age structure gaps

Whereas shifting vital rates in the urban and rural sectors immediately alter their own age structures, rural-urban migration simultaneously alters age structures in both sectors. As working-age migrants shift from rural to urban sectors, the dependency ratio in the rural sector rises and the ratio in the urban declines. The impact of an individual migrant on age structures will depend on the national level of urbanization, 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 and Bocquier, 2004). Over the course of the fertility transition, annual male net rural to urban migration rates first rise – increasing from 1.3 per cent in pre-transition to 1.9 per cent in the early stage and then declining to 1.1 per cent in the advanced stage. In this section, we explore the role of rural-urban migration (including reclassification) in rural and urban age structure differences across 45 SSA countries from 1985 to 2015.

The estimated migration flows enable us to assess the share of urban growth due to migration and reclassification. On average, in SSA between 1985 and 2015, 36 per cent of urban growth can be attributed to rural to urban migration and reclassification, consistent with previous research (Preston, 1979; United Nations, 2001). However, the role of migration is particularly large in key young adult ages (15-29): we estimate that about half (51 per cent)

Figure 12: Net rural-urban rates for men over time by age group (UN-DESA URPAS data for 45 sub-Saharan African countries, 1980-2015)

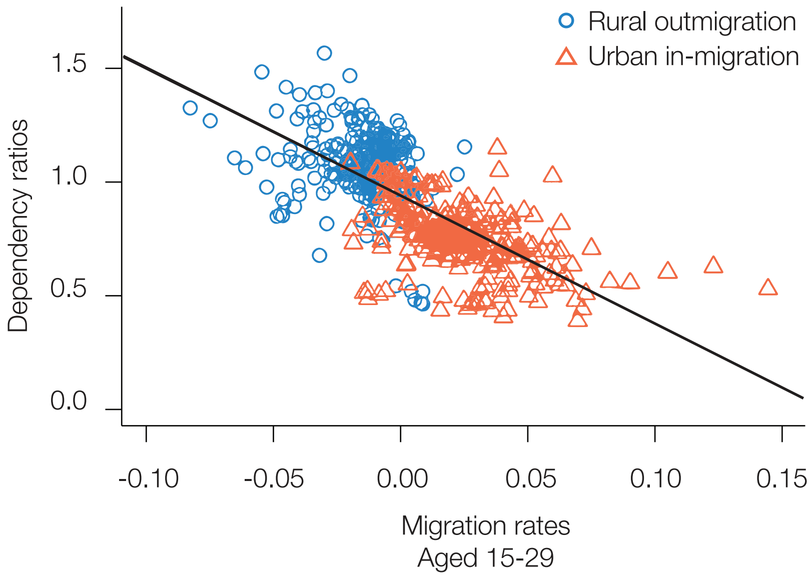


of urban growth for SSA as a whole in this period is due to rural to urban migration (and reclassification). Nonetheless, the slowdown in urbanization described above may be due to lower rural-urban migration. By considering male national-based migration rates – that is the number of net rural to urban migrants divided by the size of the cohort for the entire population – of separate age groups in the past 35 years, we find significant declines in rural-urban net migration of older adults, particularly after 1990 when rates of older adults fall sharply (Figure 12). In contrast, migration of younger adults aged 15-29 has remained more stable at higher levels, while experiencing smaller declines in the early 1990s as well as some increase since then.

We hypothesized that migration rates substantially alter age structures across the two sectors. This is supported by the strong pattern of net migration with age. More importantly, Figure 13 shows the strong association between 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 outmigration. 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 mobilized (Easterlin, 1978; Mesquida and Wiener, 1999; Rogers, Raymer and Willekens, 2002). Our migration estimates for 15 to 29-year-olds, both net rural outmigration and net urban in-migration, show strong negative associations with dependency ratios. In both cases, as the net migration rate becomes more positive, the dependency ratio declines. In the rural sector, the greater the net outmigration, the higher the dependency ratios. In the urban sector, as the net in-migration grows, the dependency ratios decline.

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 and 14), young adult migration (ages 15-29), and older adult migration (ages 30-59).

Figure 13: The impact of male migration between the ages of 15 and 29 on urban and rural dependency ratios (UN-DESA URPAS data for 45 sub-Saharan African countries)



Sector-specific estimates of fertility and child mortality are also included.[4] 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.[5] 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).

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 urbanization 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).[6] The addition of these demographic factors has some impact on the main

4. 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.
5. 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).
6. 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.

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 standardized variables (Model 2: FE Z).[7] 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.[8] Young adult migration has the greatest absolute impact on dependency ratios: a one standard deviation (0.025) increase in migration at ages 15-29 significantly lowers the dependency ratio by 0.12 units.

7. 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.

8. 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 standardized.

Table 3: Regression results decomposing components of dependency ratio (United Nations and DHS data for sub-Saharan African countries)

	Model 0	Model 1	Model 2	Model 2 FE	Model 2 FE Z
	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)
Per cent urban	-0.001**	-0.002**	-0.001**	-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**	-4.826**	-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)
Total fertility rate			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

Notes: Standard errors in parentheses; two-tailed test: ** $p < 0.01$; *$p < 0.05$. FE = fixed effects.

Summary of findings

As states progress through the demographic transition and increasing shares of the population are found in urban areas, age structures undergo fundamental transformations. 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 transition. Our empirical analysis offered convincing confirmation of these predictions. In support of our first hypothesis, 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. This divergence of age structures is mostly explained by faster and earlier declines in vital rates in the urban sector and by migration (de Vries, 1990; Dyson, 2011; Zelinsky, 1971). Convergence of age structures becomes feasible when the sectors share similar vital rates, although migration can continue to create substantial gaps. In addition, supporting our second hypothesis, 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. Using a variation on the traditional census survival methodology, we estimated age-specific net rural to urban migration rates within every country in sub-Saharan Africa from 1980 to 2015 for both men and women. These estimated migration rates include reclassification, which cannot be distinguished using this method (Preston, 1979). Earlier studies have suggested that a substantial share of urban growth in the earlier period, before our study, is due to reclassification (Beauchemin and Bocquier, 2004). This cannot be verified here, yet as shown in the methodology section, there is reason to expect that the main age patterns we identify are robust to reclassification and almost certainly understate the relative importance of young working ages in the migration process. A second major caveat, mentioned earlier, is that international migration – difficult to identify in the best of cases for countries in SSA – cannot be identified from our data. However, robustness testing discussed above helps allay some concerns over the potential impact of international migration on our main findings. We re-estimated migration using data for sub-Saharan Africa as a whole, an approach that subsumes cross-border migration *within* SSA to the extent that it remains within the same sector. This alternative approach produced rural-urban migration age patterns that were qualitatively consistent with those shown here. This is encouraging, particularly given that cross-border migration *within* Africa is estimated to account for about one half of overall international migration for Africa (Abel and Sander, 2014; Adepoju, 2011).

Our results clearly show that migration reaches a peak with young adults – younger among females than males. While surprising and likely in part influenced by reclassification, this young peak is broadly consistent with age-specific patterns seen in other studies within SSA (Beauchemin, 2011; Caldwell, 1969; Callaway, 1967; Heckert, 2015). 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 (Singh and Samara, 1996; Watts, 1984). In addition, as evident from the rural-urban net migration profiles, 15- to 29-year-olds comprise the bulk of migration flows. This broad age group of migrants consists of a cohort of distinct characteristics – a career-starter, family-builder and relatively easily mobilized population (Easterlin, 1978; Mesquida and Wiener, 1999) – with the potential to transform the urban sector. It is also worth emphasizing that despite a substantial slowdown in urbanization, young adult rural-urban migration has remained at relatively high rates over the 1980-2015 period.

Our descriptive results, focusing on males, show how higher rural to urban migration rates for males aged 15-29 have a strong negative association with dependency ratios. This is true for urban areas where higher in-migration lowers the dependency ratio. It is also true for rural areas where greater outmigration 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 third hypothesis: young adult migration is key in shaping age and sex compositions of the rural and urban sectors. During the early stages of transition, migration plays a pivotal role in urban growth (Keyfitz, 1980) and helps to maintain the urban population. After rural mortality declines and until rural fertility declines, a larger rural population leads to more young migrants and greater gaps (Zelinsky, 1971).

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 past 20 years. Migration of older working adults is often in the opposite direction (urban to rural), or at least closer to zero. 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 per cent) 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 among 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, Todd and Masanja, 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 urbanization trends in Africa have followed a distinct path as depeasantization and deagrarianization have taken hold in rural sectors (Bryceson, 2002, 2011; Temudo and Abrantes, 2013). Nonfarm employment opportunities appear to be expanding, with increasing diversification of income sources for rural households (Barrett, Reardon and Webb, 2001; Reardon, 1997). These processes are forcing scholars to consider alternative relationships between development and urbanization (Christiaensen and Todo, 2014), just as empirical data paint a clearer picture of declining rates of urbanization in sub-Saharan Africa (Beauchemin, 2011; Potts, 2009).

Our results indicate that regardless of a slowdown in urbanization 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. Notwithstanding the fact that resources may flow across sectors, such as through remittances sent by migrants, the dependency ratios in each sector capture distinct age structures and 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: (i) fiscal implications of changing demography; (ii) the demographic dividend; and (iii) 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 (Dussault and Franceschini, 2006; Lemiere et al., 2013; McEwan, 1999). 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. 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, leading to economic growth (Barrett et al., 2001). Finally, burdensome pension schemes may seem remote, but are likely to expand as African states age and the level of support for the elderly depends on whether they live in cities or in the rural sector. The overall direction suggests that higher dependency ratios in the rural sector may be cost saving in the near term.

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 and Lipton, 2011). Yet, while a national perspective is important, our analyses highlight significant spatial heterogeneity in age structures which may make it important to focus on *local 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, state investments will be more efficient if responsive to the dynamics of local demographic structures. 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 nonfarm income diversification and implementing financial services in rural settings to allow savings of remittances (Barrett, Reardon and Webb, 2001; Housen, Hopkins and Earnest, 2013).

From the perspective of localized demographic dynamics, small or medium-sized cities, which escape are own analyses because of the nature of data employed here, may prove particularly important to monitor. Populations in the "missing middle" sector often have unique characteristics, including lower inequality (Christiaensen and Todo, 2014), so they may be prime candidates for demographic dividends in the relatively proximate future. Their populations are likely young, particularly if recently reclassified from rural. States may need to help these cities develop economically, in part because they are often not as well equipped to engage in international trade and benefit from globalization (Mainet and Racaud, 2015). Investing in secondary towns, where most of the urban live and access to infrastructure is low, may lead to slower economic growth though accompanied by poverty reduction (Christiaensen and Todo, 2014; Dorosh and Thurlow, 2013). Also, secondary cities typically have strong links to the rural sector and are linked to agricultural production which may benefit both (Dorosh and Thurlow, 2013). Investing more heavily in human capital development and effective governance in this category of settlements may be particularly efficient from the dividend perspective by capacitating large cohorts expected to reach labour force ages in the coming one to two decades.

Finally, age structure at the subnational 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 and Urdal, 2013; Cincotta et al., 2003; Urdal, 2008; Urdal and 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 (Banks, 2016; Sommers, 2010). Such investments would be especially effective when focused on young adults in mega cities where income inequality is highest (Christiaensen and Todo, 2014). However, it may be at a price – policies that overinvest in the core urban sector may exacerbate metropolitan bias (Ferre, Ferreira and Lanjouw, 2012).

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 sub-Saharan Africa 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 among adults, the proportion of those who marry, and in turn fertility rates, may be affected (Dyson, 2012; South, 1988). High sex ratios (more men than women) among 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 and Hudson, 2004). When males are more likely to migrate to cities, as in sub-Saharan Africa, low sex ratios may affect marriage markets, labour markets, and even overall productivity. Furthermore, while the increased feminization of agriculture is one consequence of unbalanced sex ratios (Radel et al., 2012), women left behind in the rural sector may remain with less access to capital, reducing their ability to make productive investments (Karamba and Winters, 2015). 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 and Eu, 1993).

Much will depend on future demographic changes. If urbanization does slow down or even reverse directions, the gaps created between the sectors may be altered. However, continued urban growth, and more importantly, rural to urban migration, is likely to mean that, whatever levels of urbanization are seen in the near and midterm future, age structures and their challenges are likely to remain an important element to be contended with in development policy and planning. Also, other forms of population movements, such as rural-rural or urban-urban migration – while not captured in our analysis – may be important for development regardless of their impact on rural urban age structural differences.

Two clear directions for future work emerge from our analyses and findings: (i) increased data collection to add further clarity to the empirical picture on migration; and (ii) empirical analyses to help elucidate the relationship between development investments and migration between urban and rural sectors. First, there is a need for more efforts to collect large-scale, *microlevel* data. While the models used in this study enable us to shed light on patterns of net rural-urban migration by age, they cannot overcome certain limitations of macrolevel data. This includes our inability to distinguish whether small positive net rural-urban migration flows are hiding large but relatively equal-sized migration flows from the urban to rural sector. The estimates shown here will gain credibility or may be revised once microlevel data sources can be used to test at least part of these findings. In a continent saddled by few and irregular rounds of census data collection (Zuberi et al., 2003), and unfortunately weak infrastructure for population registration (AbouZahr et al., 2015; Setel et al., 2007), many of the most vital questions for Africa's future are buried by the limited availability of microlevel demographic data. However, where census data do exist or where efforts have been made to make them more accessible, research to examine the shift in population age and sex structures and the variation in these processes over time would be highly fruitful. Understanding how migration patterns differ within countries, such as by education, labour force status and health status as well as incorporating international migration between countries into this picture, would greatly enhance our understanding of life course dynamics of migration across sectors of a country.

Second, our study's most direct outcome is a set of detailed age-specific rural-urban migration profiles by sex and over time, which offer a means to explore if and how rural development efforts have accelerated or diminished rural-urban migration. A natural next step is to connect these migration flows with data on investments in rural and urban sectors across countries and over time. There are innumerable investment categories, such as those that are targeted towards improvements in human capital or health, others that focus on strengthening credit markets or facilitating agricultural innovation, and also efforts to improve roads, water and sanitation systems and other elements of rural infrastructure. Various dimensions of investment in development may be examined in aggregate to see, for example, whether large rural investments lead to less outmigration, particularly in working-age groups, or whether investments affect male or female migration more strongly (de Brauw, Mueller and Lee, 2014; Todaro, 1997). If the development investment data were to be examined in detail, categorized by type of investments made and by sector, then analyses could be conducted on the differential impact of various development investments on migration by age and sex. Such an approach would make it possible to explore and compare how investments made in each sector affect migration differently across the sectors. It would also provide a better empirical framework to explore the importance of migration in assisting or hindering the success of development policies (Bakewell, 2007).

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