The potential of internal migration to shape rural and urban populations across Africa, Asia and Latin America

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Abstract

Sub-national divergence in the age and sex structures of populations can have far-stretching consequences for development: from marriage markets to the potential for violence to economic growth. With urbanisation and the demographic transition still underway, rural and urban populations continue to differ across low- and middle-income countries. We examine the extent by which internal migration contributes to these differences, from 1960-2014 using estimates of migration between rural and urban sectors based on census data from 45 countries. We found that despite heavily delineated migration profiles by age and sex, internal migration does not alter sex and age structures of rural and urban populations. All the same, internal migration does increase urban growth in Asia and Latin America and the Caribbean. In contrast, in Africa, internal migration has little leverage with the urban transition. Across the continents there is a potential for de-urbanisation, driven by a rural/urban gap in fertility. As such, the rural population may continue to constitute a significant proportion of national populations, necessitating critical investments to ensure they are not left behind.

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Introduction

The population structure of a country, captured by the age and sex composition of a population, can have far-reaching effects for development. At the national level, population age structure can influence public transfer systems towards health and education, economic growth, and social matters. Young populations require investments in schools for example, while older populations require retirement funds. These needs may change as populations shift. For instance, in high income countries with rapid population aging, public pension arrangements are unsustainable and require major reform (Bongaarts 2004). Both young and old populations also necessitate investments in health systems, with returns differing substantially; health investments in children can translate into a stronger workforce in later periods. Populations with large proportions of working-aged adults, due to declining fertility, have an opportunity for economic growth under the right socio-political and financial conditions (Bloom et al. 2003; Lee and Mason 2006; Mason et al. 2017). Such a demographic dividend is intertwined with improved education particularly of women (Backhaus and Loichinger 2022; Lutz et al. 2019), which increases formal labour market participation, earnings and productivity (Peet et al. 2015). Countries in eastern Asia are considered the forerunners of a first demographic dividend, successful in taking advantage of rapid fertility decline (Bloom and Williamson 1998; Lee and Mason 2012). China, where fertility was strictly limited, has exhausted its demographic dividend (Zhong et al. 2013), while India has been reaping gains in economic growth, despite inequalities in opportunities and slow shifts from agriculture to manufacturing (Joe et al. 2018). Increases in female labour force participation, and revising wage discrimination in India would be needed to achieve a robust dividend (Desai 2010).

Population sex structure also shapes society, albeit in more subtle ways, or in interaction with other factors. Imbalanced sex ratios can lead to a shortage of potential marriage partners (a marriage market squeeze), and can drive changes in the age range of marriage partners, in the proportion of people marrying, and increase intermarriage (Weiss and Stecklov 2020). In 20th century India, a rise in age at first marriage of women resulted not from increased female education or legislative measures against child marriage, but due to declining mortality and insufficient single men at older ages (Bhat and Halli 1999). Additionally, skewed sex ratios at birth due to strong son preference in India are expected to drive a marriage squeeze well into the 21st century (Guilmoto 2012). High sex ratios associated with increased marriage opportunities for women, can also reduce the extent of female labour force participation (Angrist 2002). Skewed sex ratios amongst young adults has further been associated with the occurrence and severity of conflicts (Mesquida and Wiener 1999). In Mexico, where young male migration to the United States has led to an abundance of women, higher risks of violent victimization are common in municipalities with especially imbalanced sex ratios (South et al. 2021).

These socio-economic consequences of age and sex composition of national populations are similarly important to consider sub-nationally. For instance, delayed demographic transition in the rural sector as seen in many African countries, primarily due to lagged and stalled fertility decline (Murthi 2002;

Schoumaker and Sánchez-Páez 2020; Shapiro and Tambashe 1999; White et al. 2005), could increase wage inequalities between the rural and urban sectors (Williamson 2013), and reduce overall economic growth. Sub-national understanding of population structure is therefore essential. Governments and policy-makers need to know for example whether building more schools in the urban sector is necessary if there are more children in the rural sector, or whether investing in a new mine (attracting male migrants) could lead to higher levels of violence in an already volatile region. Overall, sub-national analysis of population structures is essential for highlighting inequalities, and guiding targeted development policies. We focus on rural/urban population structures considering that across low- and middle-income countries (LMICs), roughly half the population live in urban areas (United Nations 2018), and the urban transition is not complete. Moreover, urbanisation is inherently intertwined with both development (Fox 2012), and the demographic transition (Dyson 2011), so that differential rural/urban dynamics in fertility and mortality can lead to divergent rural/urban populations and disparate consequences.

We aim to explore the compositional effects of internal migration on sub-national populations in LMICs over the last 50 years. We firstly examine the differences (and similarities) across Africa, Asia and Latin America and the Caribbean in rural and urban age and sex structure, and whether the role of migration in shaping these structures has changed over time and over the urban transition. We then consider the effect of migration on the tension between current and stable state rural/urban populations.

Internal migration as a determinant of population age and sex structure

At the national level, population structure is determined by births, deaths and international migration. Subrationally, internal migration is also a determining factor. Over the demographic transition, as mortality declines, the increased survival of children leads to a younger population; till fertility falls and populations start to age (Chesnais 1990). Since both mortality and fertility first decline in the urban sector (de Vries 1990; Dyson 2011), divergences in rural and urban age and sex structures are expected. International migration, typically concentrated in young working ages can also alter population structure, often contributing to urban growth (Lerch 2020). However, the impact of international migration on population distribution globally has generally declined since the 1990s (Charles-edwards et al. 2023). Internal migration, between the rural and urban sectors additionally shapes both origin and destination populations. This spatial redistribution of the population is considered the most significant aspect of internal migration (Rees et al. 2017). Although aggregated net migration rates may conceal considerable churning of the populations (Rogers 1990), differences in the composition of in- and out-migration flows could still shape the age and sex structure of the rural and urban populations. For example, rural-to-urban flows concentrated among 15-24 year olds reduces the working population of reproductive ages in the rural population while at the same time boosts them in the urban sector. If urban-to-rural migration flows were at an equivalent level (net migration of zero), but concentrated among 50-64 year olds, the age structure in rural and urban sectors would diverge considerably. Such compositional changes in population structure due to internal migration flows have been noted across sub-Saharan Africa (Menashe-Oren and Stecklov 2018), and in large cities in Latin America (Rodríguez-Vignoli and Rowe 2018).

Internal migration has the potential to underpin changes in population structure since it is much more common than international migration (Bell and Charles-Edwards 2013; Bell and Muhidin 2009; United Nations 2009). Indeed, migration is able to alter populations relatively quickly, without waiting for the slower generational churns associated with fertility and mortality (Billari 2022). The demographic consequences of internal migration are also far-stretching. Migrants tend to be a select group with lower fertility (Chattopadhyay et al. 2006; Choi 2014), and return migrants often spread reproductive norms acquired at destination (Bertoli and Marchetta 2015). At the same time, migrants of reproductive ages shift "future births" from one region to another. Internal migrants are also selected on health, often healthier than non-migrants at origin (Lu 2008; Nauman et al. 2015), while they tend to have lower survival odds at place of destination (Ginsburg et al. 2021). Because migration flows shift over the urban and demographic transitions, from limited circular movement in pre-transition societies, to predominantly rural-to-urban migration, and then to intense intra-urban movement when fertility and mortality levels are low (Dyson 2011; Zelinsky 1971), the consequences of migration will also shift over the course of urbanisation. In the past, migration was the only way cities could grow since death rates were high in urban areas, (Woods 2003). In the future, in countries where fertility is still high, internal migrants are likely to sustain fertility decline.

Data and methods

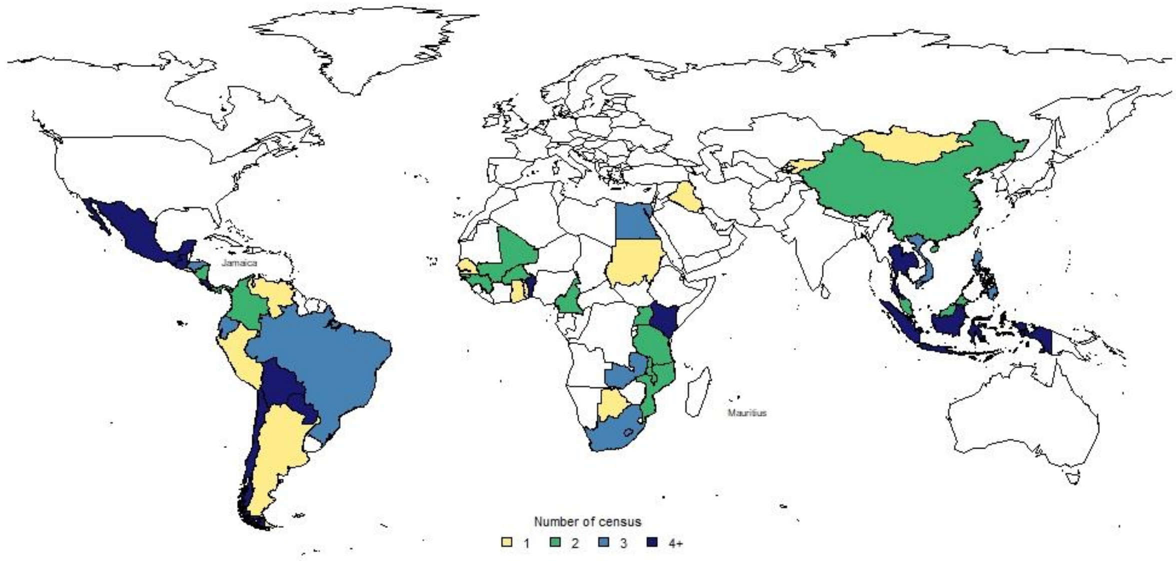
Census samples for directly estimating internal migration

We employ the IPUMS-International census samples (Minnesota Population Center 2020) to estimate migration flows between the rural and urban sectors in LMICs. Censuses were excluded from the analysis when the proportions urban were especially high (as more recently in Latin American countries) and no rural regions identified, or alternatively where only rural regions were identified (most frequently in Africa). Censuses were also excluded where we found a high proportion of unknowns, or when regional boundaries at the time of migration were not the same as boundaries at the time of census, or where some critical information (like place of origin residence, or time since migration) was missing. We ended up with 26 censuses from Asian countries (covering 9 countries between 1970 to 2010), 41 censuses from African countries (covering 19 countries between 1979 to 2014), and 46 censuses from Latin America and the Caribbean (covering 17 countries between 1960 to 2012).[2] As seen in Figure 1, most of the countries in Latin America and the Caribbean[3] are covered by the census (though many island states are missing), and a reasonable proportion of South-East Asian countries are represented in the census. However, substantial sub-regions of Africa are not well represented in the data, namely central and northern Africa. Although

[2] A full list of all census used is available in Appendix Table A1.
[3] For simplicity, below we refer to Latin America and Caribbean simply as Latin America, and in figures as LAC.

the census data only represents a sample of countries, a comparison of the average internal migration rates and proportions urban at the continent level suggests that the sample of countries is in line with continental averages from other sources (Bocquier et al. 2023), and can be used to generalise about each continent.

<u>Figure 1</u> Census data used across LMICs



We estimate migration based on questions of residence one-year or five-years ago, or previous residence (for which we use the most reliable period, the last 2.5 years). The five-year migration questions are most commonly asked in Latin America and the Caribbean censuses, and about half of the censuses in Asia also rely on a five-year threshold. One-year migration questions are only found in censuses in Africa, although generally one-year estimates are more accurate since within a single year return migration is negligible and resulting under-estimation unlikely. We standardize the rates to five-year migration rates assuming that one-year rates are roughly five times the five-year rates, and 2.5-year rates are double the five-year rates.[4] In- and out-migration rates are produced for each sex and five-year age-group using survival-time analysis. We use sample weights provided by IPUMS-International to ensure representativeness, since the census samples are mostly 10% of the national population.

Each census records current (destination) residence as rural or urban according to the national definition of urban. This can differ dramatically between countries. For instance, in Zambia an urban area is considered a locality of 5,000 or more inhabitants where the majority of whom depend on non-agricultural activities, while in Ecuador urban areas are the capitals of provinces and cantons, and in Indonesia a vague definition of satisfying certain criteria (population density, urban facilities, etc.) is given to urban. Although this cross-country heterogeneity in what is considered urban make comparisons somewhat precarious, there is no

[4] Empirically, in Africa and Asia, this assumption holds quite well, with five year rates being 1.7 and 5.2 times the 2.5 and one-year rates respectively (Bocquier et al. 2023).

alternative.[5] Moreover, and importantly, country-specific definitions of urban are more meaningful as they account for the context of each country. For example, an urban definition based on a low population density of 200 per square kilometre would make sense in Mongolia where land area is large and the population is small, but the same definition in Vietnam would define all of the country as urban (though it is currently less than 50% urban to date according to their own definition).

The census data rarely record whether origin place of residence was rural or urban. Therefore, we identify rural/urban origin residence by region, using the rural/urban classification of the region of residence at the time of the census, and assuming that the region has not shifted from rural to urban (or vice versa) over this period. Regions are determined as urban based on a 50% threshold, which inevitably means that regions with large cities are considered urban, while those with a small number of secondary cities are considered rural. As such, the urban continuum is used to its extreme, as dichotomous. This method of approximating regions as urban has previously been found to be reasonably consistent at the continental level with the UN World Urbanisation Prospects' (WUP) proportion of people living in large cities (Bocquier et al. 2023). However, by classifying regions as rural or urban, internal migration is somewhat under-estimated (though a lot of migration is across neighbouring provinces albeit over short distances (Hoffmann et al. 2023)), with possible rural-urban movements within regions not included in our migration rates.

Smoothing migration estimates to be representative at continental level

We use Poisson models by continent to smooth the migration estimates, accounting for the differential timing of the censuses and stages of the urban transition, and correcting for biases in measurement of migration associated with the different census questions. The dependent variable is a count of migrants (standardized to five-year estimates), and covariates include sex, five-year age groups (from 0 to 80+), period (in four categories: pre-1970, 1970-1984, 1985-1999 and 2000-2014), proportion urban (taken from the WUP (United Nations 2018), a correction factor for under-five year old migration (possible only in African model where we have one-year migration estimates), in- or out-migration flow, and rural/urban origin and destination. The covariates of age and sex are interacted in the model with in/out and rural/urban origin-destination factors so that each migration flow follows its own age and sex pattern. Since both in- and out-migration are included in the same model, it is possible to estimate net migration based on the marginal effects of the in- minus the out-migration rates.[6] Predicted estimates of migration based on the model provide average migration rates for each continent.

[5] Standardised definitions of urban have been attempted, particularly using satellite imaging (see for example (Balk et al. 2018; Dorélien et al. 2013), but such definitions have not been globally adopted, or are not applicable to historical data.

[6] This is done in Stata using the *dxdy()* option in the *margins* commands.

Measures of population structure

We employ two indicators to summarise the population structure –dependency ratios and sex ratios – for the rural and urban sectors separately. Total dependency ratios of migration are estimated as the number of child migrants under age 15 and older adult migrants above age 65, as a proportion of working-aged migrants aged 15-64. We do not interpret the dependency ratio as an economic measure, but purely as a demographic measure summarising the age pattern of migration. Sex ratios of migration are examined as the proportion of male to female migrants, for each age group.

Stable populations to assess the compositional effects of internal migration on rural and urban populations

We use cohort component projections to "project" *theoretical* future populations,[7] aggregated to the continent-level, and their composition by age and sex, assuming migration, fertility and mortality of the populations at the time of the census will remain unchanged, and that the national populations are closed to international migration. When fertility, mortality and migration are constant, and therefore the age structure unchanging, populations are considered stable. We run parallel projections with either constant internal migration rates and/or with zero migration, allowing us to compare the effect of migration on intrinsic growth rate (Coale 1957), and age and sex structure, in each urban and rural sector.

For the cohort component projections, we rely on Leslie matrices which include fertility rates, survival rates, and net internal migration rates (Preston et al. 2001). This matrix is used on our initial populations, the rural/urban population of each continent. Each matrix leads to a different stable state and corresponding constant (intrinsic) growth rate and age structure. A larger discrepancy between the observed situation and the stable state indicates greater tension between the current state (which is the result of past history) and the intrinsic state entailed by current population movements (mortality, fertility, and migration).

To populate the matrices for each continent (Africa, Asia, Latin America) and each time period (1970-1984, 1985-1999, 2000-2014)[8], by sex, we estimate aggregated net migration rates from the census data. For fertility and mortality, we use continent-level aggregates, including countries that do not have available IPUMS census. For fertility and mortality rates, life table survival ratios (located in the cells below the diagonal in the matrix), and age specific fertility rates (located in the top row of the matrix for women aged 15-49, as fertility contributes to the births in the population i.e. 0-4 year olds) are required. Standardised fertility and mortality data (by age and sex), and by rural/urban sector for each country-year does not exist. We turn to an external data sources matched to the year of census, for national estimates

[7] Although the method is based on projections, we do not truly project future populations, but use this method as a tool to assess the role of internal migration.

[8] For this part of our analysis we exclude censuses from before 1970 since we only have four and they are all in Latin America.

of fertility and mortality at the continent level, the World Population Prospects (WPP) (Gaigbe-Togbe et al. 2022)and then adjust them to rural/urban-specific rates based on factors relying on empirically measured rural/urban differences, using Demographic and Health Surveys (DHS) and previous research (ICF International 2018; Menashe-Oren and Masquelier 2022; Menashe-Oren and Stecklov 2023). Details on the data used to inform the Leslie matrices, and on the methods are available in the Appendix.

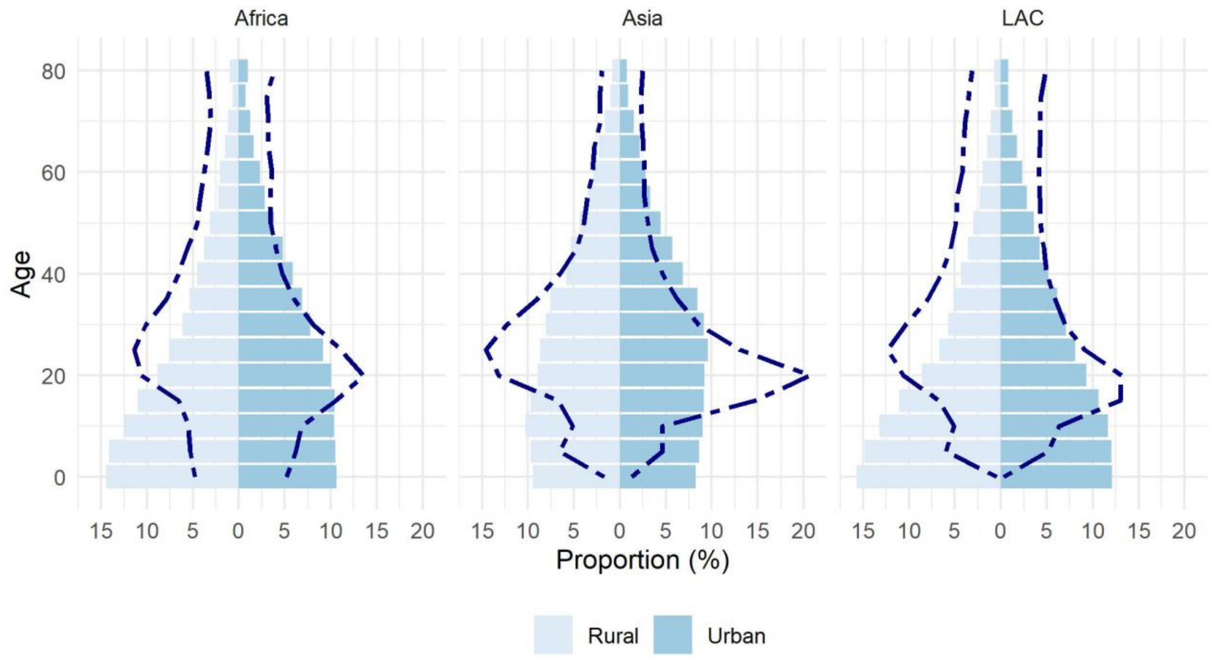
The overall output of the cohort component projections are 72 populations at stable state. We compare the populations using the mean absolute deviation (MAD) between population age and sex structure which allows us to check whether migration contributes to diverging or converging rural/urban population structure, and whether this changes over time. We distinguish stable state populations at a given precision level, when the MAD is less than 1/1000).

Results

Internal migration, and rural/urban population structure across continents

On average between 1960 and 2014, the rural population age structure is younger than the urban age structure in Africa and Latin America, and to a lesser extent in Asia (Figure 2). In Asia, while there are proportionately fewer under-15 year olds in the urban sector than in the rural, there are more adults between ages 20-44 year old in the urban sector. Although these age structures are smoothed over the entire period we examine, they provide a good contrast to the in-migration profiles. Across the continents, a large proportion of in-migration to the urban sector is among young adults: 35.2% of migrants in Latin America, 48.5% of migrants in Asia, and of migrants in 35.1% Africa are aged 15-29 years old. In contrast, in-migration to the rural sector is more evenly distributed across ages, though the bulk of migration remains in young adult ages, with 29.7% of migrants in Latin America, 34.5% of migrants in Asia and 28.6% of migrants in Africa between ages 15-29. A typical minor hump amongst children in migration profiles is also evident in Figure 2 for ages 5-9. Due to under-estimation of under-five year old migration in Asia and Latin America, where census questions do not sufficiently capture migration within this age group, we do not see as high migration rates as we would expect. The under-five migration rates in Africa are also under-estimated but our modelled estimates are able to correct for the bias due to the available census in the continent that capture one-year migration estimates. In Figure 2, the proportion of in-migrants in older adult ages in Latin America is noticeably higher than in Africa and Asia, with 17.7% of urban in-migrants being over 65 years old.

Figure 2 *Rural and urban population age structures, and the age profile of in-migration flows between the sectors, both sexes, on average across continents, based on IPUMS census data 1960-2014*



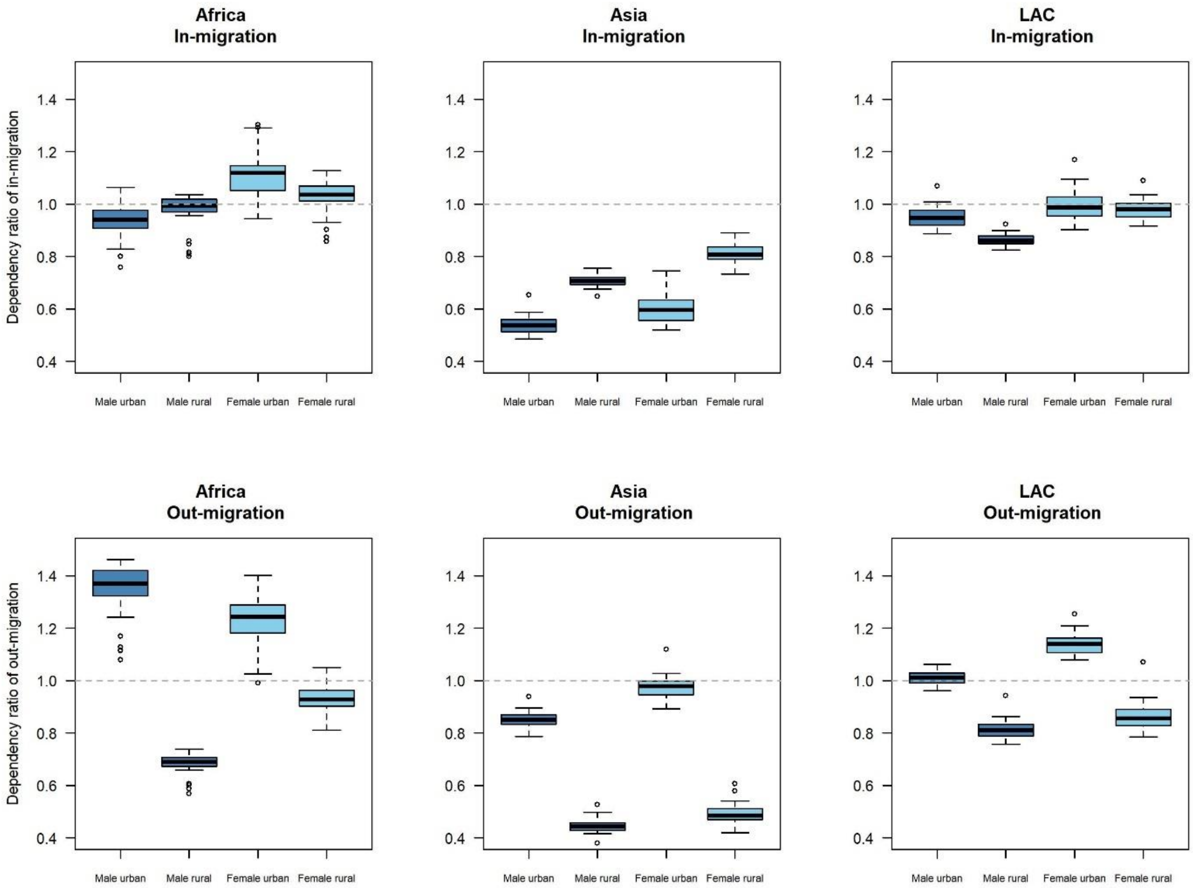
Note: Proportions are of the population within each sector, or of in-migration rates to each sector. Lines depict migration, bars population. LAC is short for Latin America and the Caribbean.

The age and sex distribution of migration

Overall, Figure 2 demonstrates that urban in-migration is mostly composed of working-aged adults. To further examine the age structure of migration flows we utilise dependency ratios of model-predicted internal in- and out-migration (Figure 3). In-migration flows in Africa and Latin America are relatively balanced between the working-aged (15-64 year old) and dependent population (0-14 and 65+ year olds), and the differences between the sexes quite narrow. In contrast, in-migration dependency ratios in Asia are considerably lower than in the other two continents, and below equity for both sexes in both sectors, indicating that very few children or old-aged adults migrate. At its extreme, the median dependency ratio of male urban in-migration is 0.54, meaning that for every 100 male migrants to the urban sector, only 54 under 15-year olds and over 65-year olds migrate. It is important however to note here that these dependency ratios are based on census estimates of migration which under-estimate under-five migration flows (or do not capture them when questions on residence five years ago are posed). Since we do not correct for this under-estimation in Asia and Latin America, it is likely that the dependency ratios in these regions are lower than what they should be. All the same, even if we were to adjust the under-five migration rates in Asia, it is unlikely that they would be much closer to one. As seen in Figure 2, migration of children aged 5-14 in the region is also relatively low so we expect 0-4 migration to be within this range. Across the continents the dependency ratios of female in-migrants tend to be a little higher than of male in-migrants, suggesting that women migrate over a wider age range.

Female dependency ratios of out-migrants are also higher than male dependency ratios, except for Africa urban out-migration flows. Urban out-migration in Africa has the highest dependency for both sexes, with the median at 1.37 for men and 1.24 for women, though the variation between censuses is greater than with other migration flows (as evident by wider inter-quartile ranges of the boxes). Moreover, the difference between rural and urban out-migration flows is particularly divergent. The age structure of out-migration flows in Asia too are starkly contrasting according to sector of origin: rural out-migrants are primarily of working ages, while urban out-migration flows are more balanced.

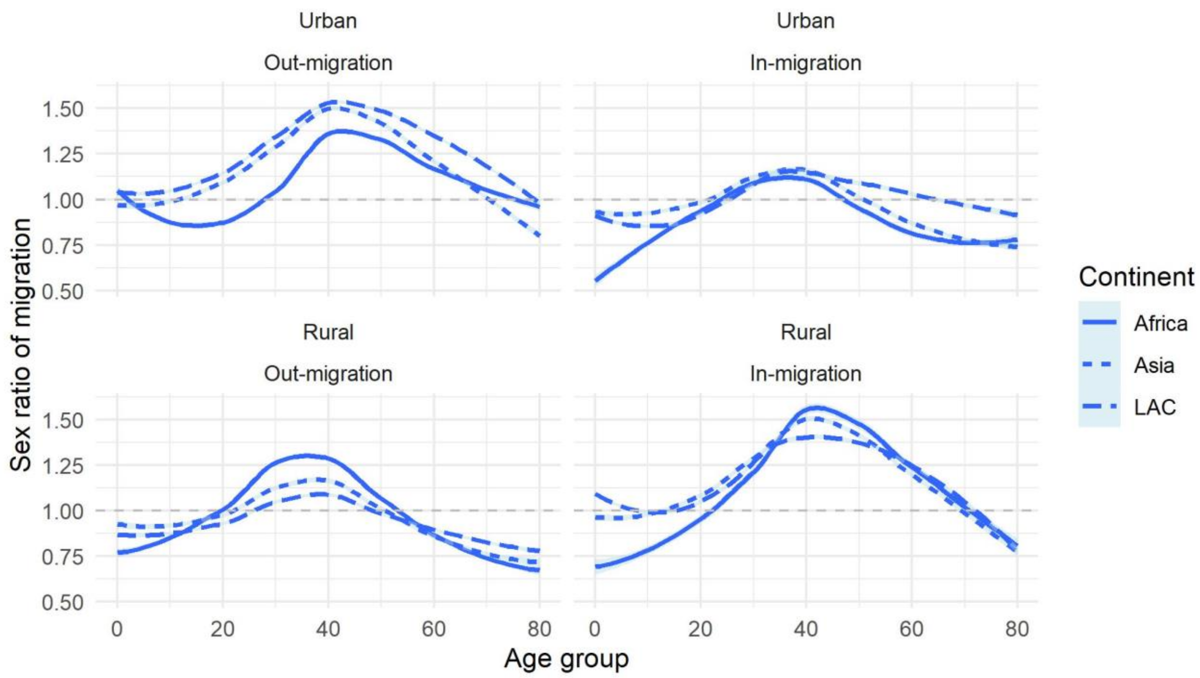
<u>Figure 3</u> Dependency ratios of in-migrants to rural and urban sectors, by sex, based on IPUMS census data (all periods)



Notes: LAC is short for Latin America and the Caribbean. Asia and LAC dependency ratios do not include under-five year old migrants

The differentials we see in Figure 3 demonstrate that migration patterns differ by age dramatically between continents, and to some extent by sex too. In examining sex ratios of in-migrants over each five-year age group (Figure 4), the sex ratios of migrants in Africa appear more extreme than in the other continents. Sex ratios of migrants below age 20 are especially negative in Africa. Moreover, more men migrate in and out of the rural sector during working ages than women, to a greater extent than in Asia and Latin America. In Africa, women also dominate rural-to-urban migration flows from age 50 on. In Latin America however, the sex ratios of urban out-migrants over age 50 are above one, indicating higher proportions of men moving even at these older ages. Indeed, urban-to-rural migration flows appear to be strongly dominated by males between ages 30 to 49 across continents, even reaching proportions of over 150 male migrants for every 100 female migrants. Urban in-migration flows appear to be the most balanced between the sexes.

Figure 4 Sex ratios of standardised five-year in-migrants to rural and urban sectors, by age, based on IPUMS census data (all periods)

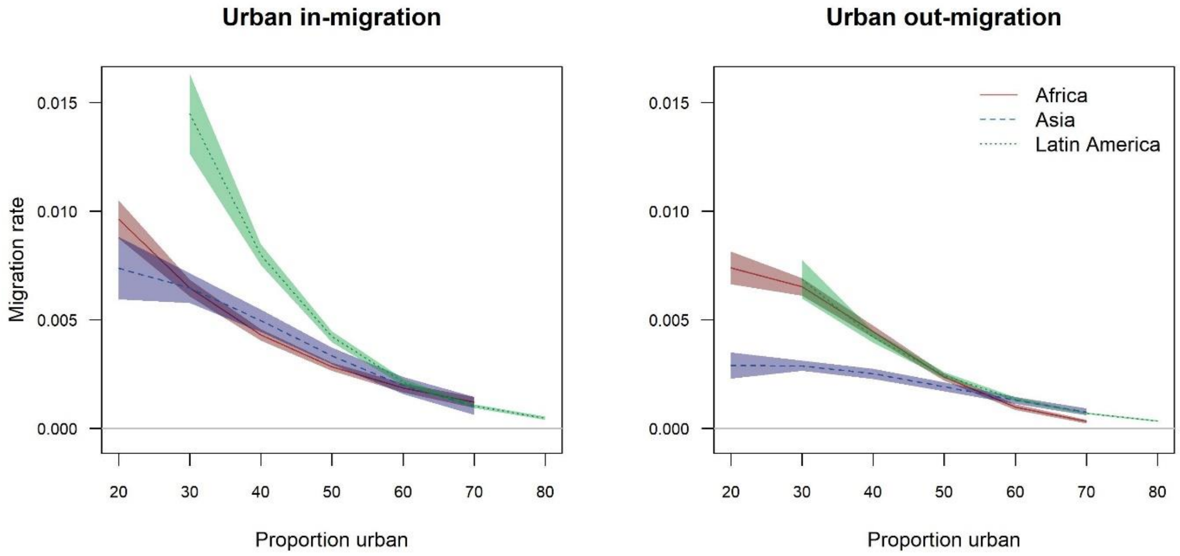


Notes: A sex ratio above one indicates higher male migration rates than female. Smoothed using Loess, with 95% confidence band. LAC is short for Latin America and the Caribbean.

Internal migration over the urban transition

The migration age and sex profiles we have examined across Asia, Africa and Latin America have been averaged out over the period for which we have census data (1960-2014), and regardless of the stage of urban transition. We now consider whether migration patterns shift over the urban transition differentially by continent, rather than changes in migration over time, since previous research has shown that net migration is flat over time (Bocquier et al. 2023; Menashe-Oren and Bocquier 2021). We consider both in- and out-migration patterns in the urban sector, and broadly find that migration rates decline as the proportion urban increases (Figure 5). In-migration rates are mostly higher than out-migration rates (leading to positive net migration), though in Africa net migration is close to zero between 30 to 40% urban, then becomes only slightly positive at higher proportions urban (for net migration over the urban transition see Appendix Figure A4). Indeed, many countries in Africa remain at urbanisation levels below 50% (Appendix Figure A5), and the contribution of migration to urbanisation has been found to be negligible (Bocquier et al. 2023; Chen et al. 1998; Menashe-Oren and Bocquier 2021; Stecklov 2008). In contrast, Figure 5 indicates that Latin America with particularly high urban in-migration levels has higher net migration than seen in other continents. The large gap between in- and out-migration rates in Latin America diminishes over the urban transition, and from around 60% urban net migration is quite flat and only slightly positive.

Figure 5 Shifting in- and out- migration rates over the urban transition, with 95% confidence intervals, modelled IPUMS census samples

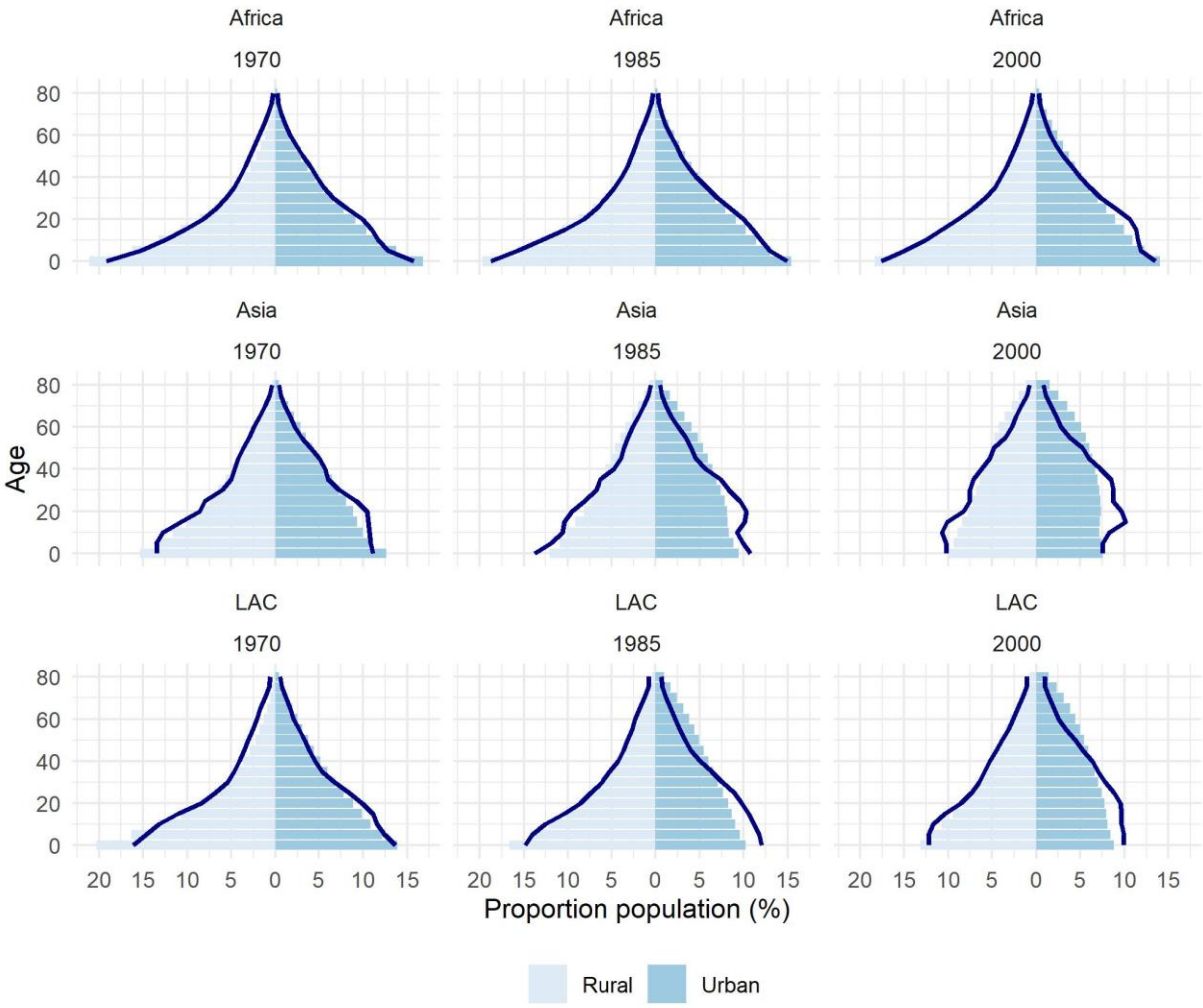


Notes: The trends for Asia and Africa end at 70% urban since we do not have any countries in the census data who have reached this stage of urbanisation, and similarly the trend for Latin America is only plotted from 30% urban since there are no countries in our data with less than this proportion urban.

The contribution of internal migration using stable population comparisons

The overall declining migration rates over the urban transition suggests that the role of internal migration in shaping rural and urban populations will depend on the stage of the urban transition. More so, it will also depend on the stage of the demographic transition. Over the period we examine, rural and urban population structures will in particular reflect declining fertility. We now turn to comparisons of stable populations to quantify the role of internal migration in shaping sub-national populations at different points of the demographic transition (using three broad time periods). In Africa, regardless of period, fertility shapes the age structure (with wide based population pyramids), while in Asia it is clear that fertility decline has narrowed the base of the age pyramid over time (Figure 6 for men, Appendix Figure A6 for women). In Latin America, as in Asia, the urban population has seen fertility decline. In rural Latin America only in 2000-2014 do we start to see a decline in the proportion of children in the rural population.

Figure 6 *Male age structures comparing estimated mid-period population and "projected" age structure at stable state, including internal migration*

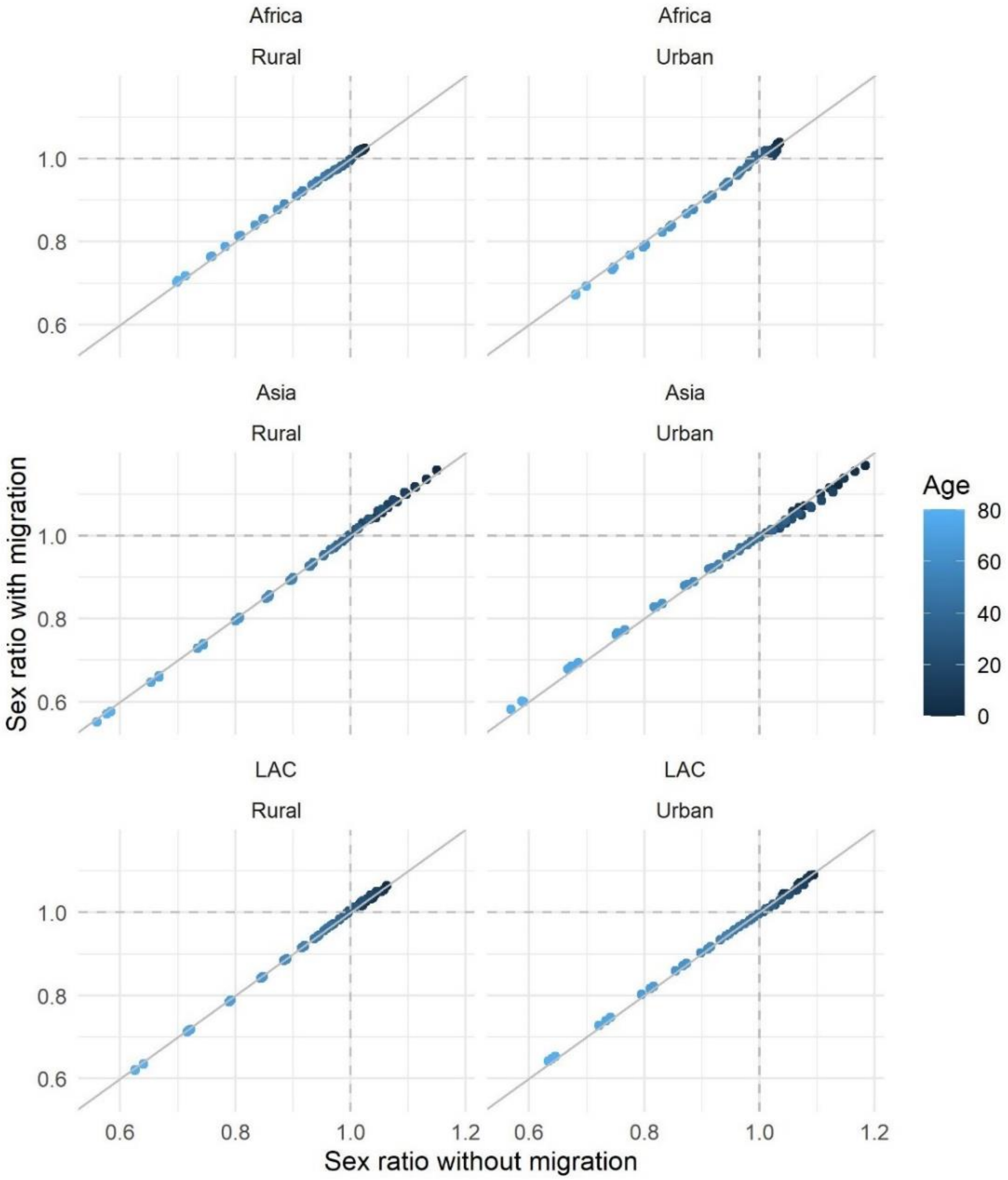


Notes: The lines represent the mid-period initial population (based on URPAS data), and the bars the population at stable state. LAC is short for Latin America and the Caribbean.

Overall from Figure 6 it is clear that the urban population would have faced greater changes in its population structure if mortality, fertility and migration rates were to have continued as they were in each period. When considering the age and sex structure of the rural and urban populations at stable state, we revert to sex ratios and dependency ratios of the population (Figures 7 & 8), and basically find that internal migration does not contribute to rural/urban divergence in population structure. This emerges as quite contrasting to expectations, in light of the strong age and sex patterns of migration (see Figures 3 & 4). Part of this can be explained by net migration, and the balancing out of flows, so that even in the case of high in- and out-migration flows, migrants are replacing each other in each sector. Yet part of this is also related to the stronger forces of the demographic transition.

In Figure 7 it is clear that sex ratios of stable rural and urban populations are remarkably similar whether we account for migration or whether we assume no migration between sectors. The only deviation from the equity line is amongst children in Asia, and in Africa to a lesser extent. Migration in these young ages appears to slightly lower the sex ratios in urban areas. This is probably since urban sex ratios tend to be higher in Asia than rural sex ratios, reflecting stronger urban son preference (Menashe-Oren and Stecklov 2023).

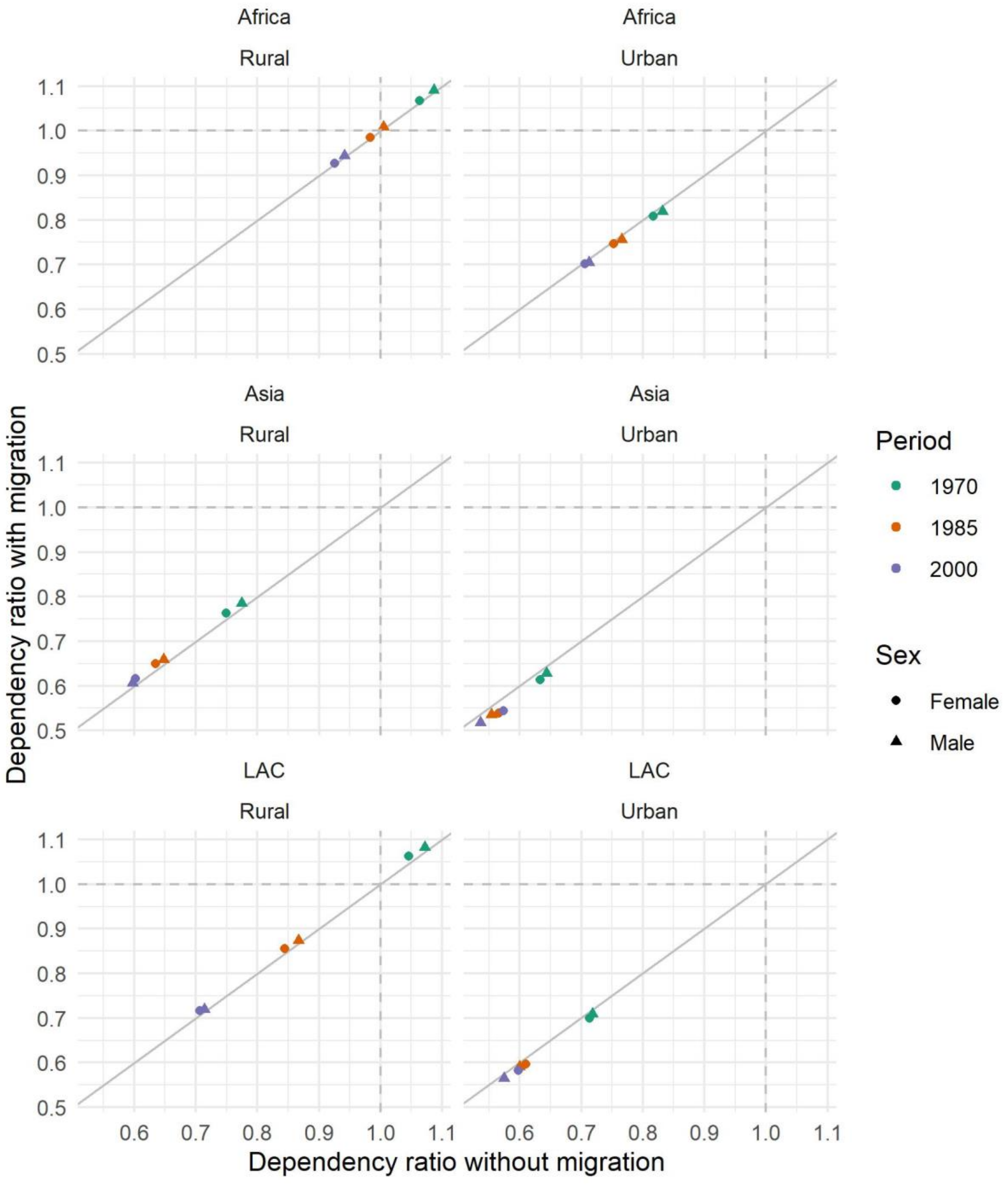
Figure 7 Sex ratios at stable state, accounting for migration or assuming no movement between rural and urban sectors, over all periods



Notes: Diagonal is line of equity. LAC is short for Latin America and the Caribbean.

Dependency ratios are also strikingly similar in the stable rural and urban populations, though again in urban Asia migration seems to marginally lower the dependency ratios (Figure 8). Across continents and sectors dependency ratios have declined over the period examined, or more accurately, based on more recent population dynamics, dependency ratios of stable populations are lower than those based on older rates. All the same, the rural population in Africa will remain considerably young if fertility rates continue as they were between 2000-2014.

Figure 8 Dependency ratios at stable state, accounting for migration or assuming no movement between rural and urban sectors

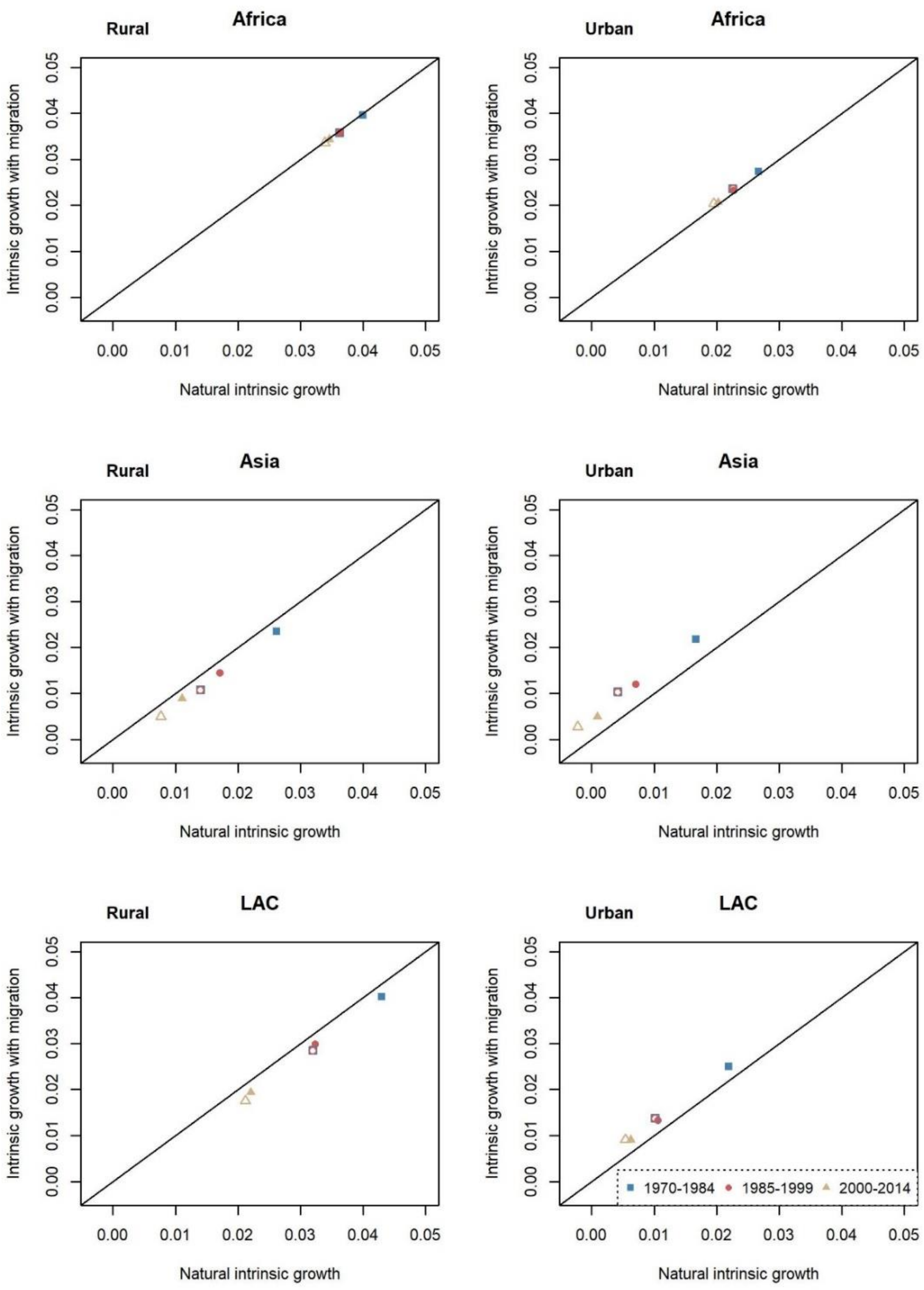


Notes: Diagonal is line of equity. LAC is short for Latin America and the Caribbean.

Using the stable state analysis, we find compelling evidence that internal net migration plays a negligible role in shaping age and sex structures, despite migration flows being concentrated in young adult ages, and differential male and female flows. This does not necessarily mean that internal migration is non-consequential. When we consider whether internal migration flows contribute to growth, in Figure 9, we see that in Asia and Latin America intrinsic growth rates are higher in the urban sector when we account for migration, than they would be without migration. In parallel, growth in the rural sector is lower when migration is accounted for. In both continents growth rates for women are lower than for men between 1970-1984. Growth rates in both rural and urban sectors in Africa, during all periods, are not influenced by migration flows. This makes sense when we consider that net migration rates in Africa are close to zero (see Figure A4).

In Africa and Latin America over all periods, we see higher intrinsic growth rates in the rural sector than in the urban (Figure 9). In other words, the urban population grows at a slower pace (the gap between births and deaths is smaller than in the rural sector), and this causes the urban age and sex structure to shift from its original population structure (which captures previous grow rates), as seen in Figure 6. Across the three continents intrinsic growth rates (whether with or without migration) have also declined over time, from 0.029 on average in 1970-1984 to 0.015 in 2000-2014, though with much smaller declines seen in Africa.

<u>Figure 9</u> Comparison of intrinsic growth rates when accounting for migration or assuming no movement between rural and urban sectors



Notes: Female markers are open, male markers are full. LAC is short for Latin America and the Caribbean.

In addition to population growth, we further examine to what extent internal migration contributes to urbanisation. In relation to Figures 5 and A4, we noted that the contribution of net migration to urbanisation was previously found to be negligible, particularly in Africa (Bocquier et al. 2023; Chen et al. 1998; Menashe-Oren and Bocquier 2021; Stecklov 2008). In Figure 10, where we compare the proportions urban at stable state, with migration or assuming no movement between the sectors, we confirm this: indeed in Africa, internal migration appears to have no role in the urban transition.

Figure 10 Proportion urban at stable state, accounting for migration or assuming no movement between rural and urban sectors

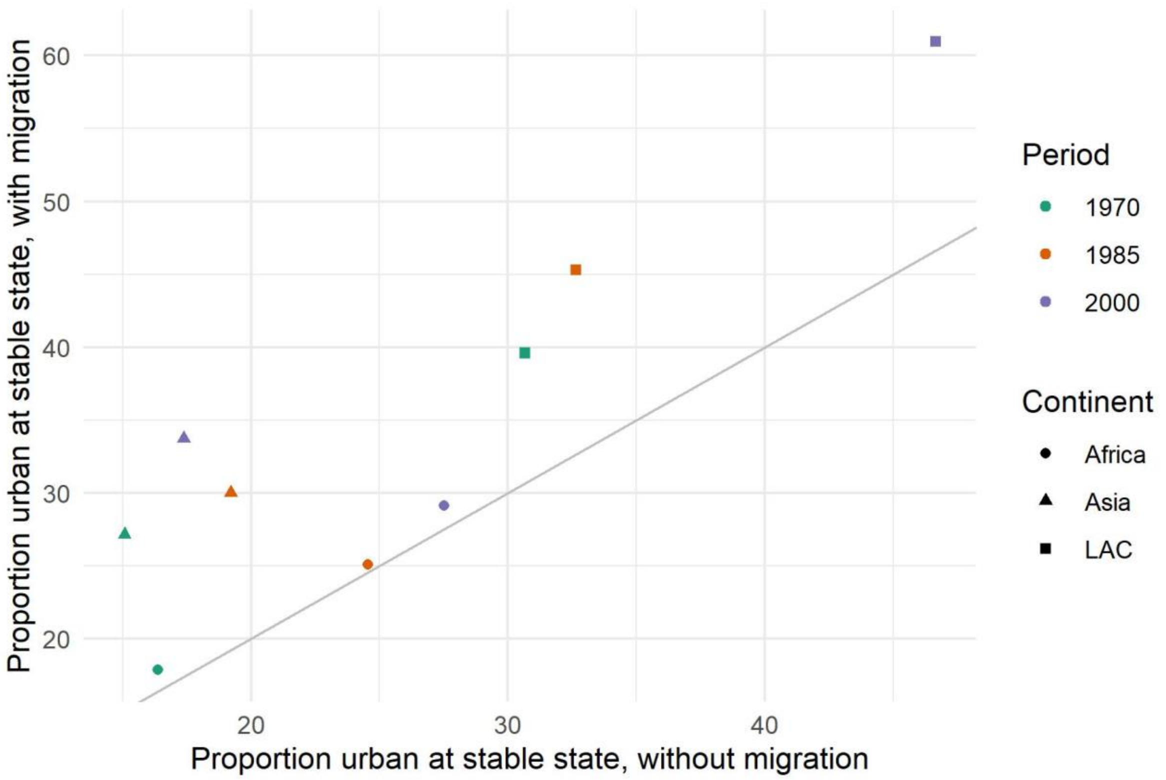


Figure 10 also presents lower levels of proportions urban than we see today across the continents. Essentially, since the rates feeding the cohort component analysis are assumed to be constant – unlike in projections – the proportions urban at stable state only tell us what would have happened had there been no changes. Although the populations at stable state do not account for any changes, these "projections" are useful for comparing the stable populations with no movement between the rural and urban sectors to those with internal migration. Clearly, in Asia, and even more so in Latin America, internal net migration contributes to the urban transition (Figure 10). In Latin America there is also big difference in proportions urban at stable state between the latest period and the earlier two periods. In the 1970-1984 and 1985-1999 periods, the rural population was growing faster than the urban Latin American populations, likely because urban fertility had declined earlier than rural fertility (see Appendix Figure A3). This is also evident from the population pyramids in Figure 6, where the proportion of children in the rural sector was high (wide based) in Latin America, but in 2000-2014 we note a reduction in this proportion.

Discussion

Internal migration flows are effectually different in age and sex distribution to both origin and destination populations, with urban in-migration being most different to the urban population, and young adults migrating at high rates. Although we see this across continents, urban in-migration rates in Asia are extreme, concentrated between ages 15-29. This however does not mean that older adults or children do not migrate. In Latin America, we find a relatively higher proportion of migrants over age 65 (nearly 20%) than in other continents. This is reflected in the dependency ratios of in-migration which are quite balanced in Latin America. In contrast, the dependency ratios of in-migration in Asia are drastically lower, and below equity, suggesting that migration is primarily for marriage or employment. We can be reasonably confident that the dependency ratios are capturing large differences between Asia and Latin America, even with under-estimated under-five year old migration, since this is the case in both continents.

In Africa, slightly higher dependency ratios of in-migration likely reflect child migration related to common fostering practices (Cotton 2021), schooling and adolescent employment such as the employment of young maids (Lesclingand et al. 2017). The exceedingly higher dependency ratios of urban out-migration in Africa are most likely due to "return" migration of families. Indeed, the age profile of urban-to-rural migration flows appears quite different to the more commonly referred to rural-to-urban migration flow. Moreover, we note high migration rates amongst children aged 10-14 in Africa, confirming previous findings (Beauchemin 2011; Bernard et al. 2014), and in particular amongst girls. Sex ratios of both in- and out-migration in rural and urban Africa before the age of 20 are below one, indicating roughly 80 boys migrating for every 100 girls. The dominance of female migration amongst children and adolescents in Africa can partially be explained by girls finishing school earlier and entering the labour force (Hertrich and Lesclingand 2012). From age 60 too, women also tend to migrate more than men from the rural to the urban sector, contributing to the feminisation of mature adults in urban populations (combined with women surviving till older ages than men across the rural and urban sectors).

Internal migration in Africa is also unique in having relatively balanced in- and out-migration flows, so that net migration is negligible, and does not contribute to the urban transition from around 30% urban. That said, it is worth noting that we underestimate migration by only considering cross-regional migration. Migration within regions, often of shorter distances, is common (Hoffmann et al. 2023) and could also contribute to urbanisation, as people shift from periphery to urban centres within the same region. In contrast to Africa, in Latin America particularly high urban in-migration levels at lower proportions urban has driven the continent to be much more urbanised to date than Asia and Africa. Our analysis of rural/urban populations at stable state (assuming constant fertility, mortality and migration rates) identifies migration as a significant contributing factor during the 1970s through to the 2000s in Latin America. Despite this, the "projected' proportion urban based on the demographic rates of the period 1970-1999 in Latin America are very low (around half of the estimated proportions urban in 1990 (UN 2018)), not as a result of migration, but of the large gap between rural and urban fertility driving fast rural growth (see Figure A3).

In stark contrast, proportions urban in Africa at stable state are practically the same whether we account for migration or not. In Africa, where in- and out-migration flows are more balanced, and net migration close to zero, fertility plays an important role. Over the decades examined, not only has fertility remained relatively high, as the fertility transition in Africa has stalled (Bongaarts 2016; Shapiro and Gebreselassie 2008), but the gap between the rural and urban sectors remains wide. In fact, while declining fertility rates (even if they were to remain as they were between 1985-2014) clearly age the urban populations in Asia and Latin America, in Africa, only during the period of 2000-2014 does the stable state of the urban population indicate lower proportions of youth.

Overall, we find that the age and sex structure of rural and urban populations are barely affected by migration at the continental level. However, internal migration does influence rural/urban growth rates. Notably, we find that intrinsic growth rates in Asia and Latin America are higher in the urban sector when we account for migration than they would be if there was zero migration. This is captured by the higher proportions urban anticipated in stable populations with migration than without. All the same, our analysis points to particularly low proportions urban whether internal migration contributes or not to urbanisation. Excluding Latin America in the 2000-2014 period, were the historical values of the fertility, mortality and migration rates to remain constant, they could have slowed down the urban transition, and even reversed urbanisation in Asia.

Implications of our findings for development

Our results point to a remarkably insignificant role of internal migration in driving age and sex structures of rural/urban populations. This is likely because the in- and out-migration flows balance each other out. At the same time, we noted that the internal migration flows are concentrated in young adult ages, as expected (Rogers et al. 1978), and that men tend to migrate more than women in these ages. Perhaps more surprising are the female dominated migration flows of children and adolescents noted in Africa. Whether in or out of the urban sector, girls appear to migrate more than boys, and further research is needed to understand the reasons for this. It is possible that in the past some of this migration was for marriage, but considering that the median age at first marriage has increased for women (with improvements in female education) (Amoo 2017; Garenne 2004; Hertrich 2017), and that the young female dominant sex ratios persist, other reasons are more likely. The higher proportion of girls migrating is probably related to employment, like domestic labour. With girls often leaving school at younger ages (Psaki et al. 2018), they may migrate for work. In fact, female labour migration also allows them to postpone marriage (Hertrich and Lesclingand 2012). Female mobility, at young ages and independently, should be acknowledged as an instrument for women to secure capital and improve their social standing (Lesclingand et al. 2017). Policies supporting young female migrants would be beneficial for women's autonomy.

Although we have found that the role of internal migration in shaping rural and urban population structure is negligible, we did find that internal migration has the potential to speed up the urban transition in Asia and Latin America. Since the proportions urban in Asian countries are still low (averaging around 50% (UN 2018)), migration can be expected to contribute to urbanisation in Asia. Certainly, over-confidence in the strength of migration flows is not encouraged: as was seen in China, this lead to “ghost cities” (Sorace and Hurst 2016). However, in Latin America, proportions urban are already very high (averaging over 80% (UN 2018)) and the likelihood of further urbanisation low. In contrast, internal migration has no leverage in driving urbanisation in Africa. Indeed, over all the periods we examine (from 1970 to 2014), the role of migration is inconsequential, and we therefore cannot expect there to be a change in this in the future. While this negligible role of rural-urban migration in Africa has been known for some time (see Chen et al. 1998 and Preston 1979 for instance), scholars continue to maintain that migration contributes to urbanisation in Africa, and that rapid urbanisation is expected in the future, accompanied with poverty and poor infrastructure (see for example Collier 2017 and Parienté 2017). Urbanisation is actually considered with concern by some governments, fearing the consequences of large young populations, as in the Arab Spring (Hvistendahl 2011), despite evidence that neither urban growth nor migrants contribute to social unrest and conflict (Buhaug and Urdal 2013; Menashe-Oren 2020; Urdal and Hoelscher 2009).

The relationship between urbanisation and economic development in Africa is considerably debated (Kessides 2007), where on the one hand the relationship is considered decoupled (Fay and Opal 2000; Gollin et al. 2016), and on the other hand critically integrated (Dyson 2001). If we advocate for the later, urbanisation can be used as a proxy for economic growth. Thus, a delay in the urban transition in Africa could suggest stagnation of the economy, maintaining global inequalities and an economic hierarchy of countries. Although a reduction of economic growth may be considered disadvantageous, a slowdown in urbanisation and in economic growth could provide the opportunity to rethink the sustainability of urbanisation. As we find in Africa, people chose to live in the rural sector – migration from the urban to rural sector is as high as in the reverse direction. This suggests opportunities in the rural sector exist too, and that other aspects rather than economic perspectives are valued too, including individual well-being, resilience to climate change and social ties. Moreover, even without urbanisation, economic growth from changing age structure, a demographic dividend, is feasible in rural Africa. Assuming fertility continues to decline and educational opportunities improve in the rural sector, the possibility of leveraging economic growth in the rural sector will increase. Internal migration will not threaten such growth since rural-to-urban and urban-to-rural flows balance out, and do not affect age structures.

Our analysis of stable populations indicates a strong potential for de-urbanisation. Simply put, urbanisation is not inevitable. This is not because of changes in internal migration patterns such as increased migration to the rural sector, but because of the differential pace of fertility decline across the rural and urban sectors. Continued investment and creation of opportunities in the rural sector is therefore necessary: not to keep the rural population from migrating, but because the rural population will continue to constitute an important sector, and because people are choosing to migrate to the rural sector. Even if net migration is minimal, we noted high turnover of populations. Considering the possibility of migration is also imperative.

For example, in providing health services that require regular follow-up or adherence to treatment, the possibility of migration should be aforethought. This has been noted in relation to antiretroviral treatment of HIV/AIDS (Bernardo et al. 2021; Murnane et al. 2022). Overall, the potential of mobility should be acknowledged, at the same time that the potential for de-urbanisation recognised.

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Appendix

Data to inform the Leslie matrices

Initial Populations

Population size for rural and urban sectors by age and sex are taken from United Nations (UN) Urban and Rural Populations by Age and Sex (URPAS) data (United Nations 2014a). The UN generated these estimates based on censuses and population registers, imputed them where missing based on linear interpolation, and ensured they are consistent with the UN WUP (United Nations 2014b). As noted above with the census samples, here too the definition of urban is country-specific. Since the URPAS data is in five-year intervals, we use the population size closest date to mid-period available for each region (for which the data is provided at aggregated continental level). For 1970-1984 we use the 1980 population (the earliest period available in URPAS), for 1985-1999 we use 1990 and for 2000-2014 we use 2005 data.

Migration

We rely on the continent-specific modelled net migration rates using direct measures of in- and out-migration from IPUMS census samples by age and sex, as described above. The models are weighted by national population size. Following the model, margins where covariates are held at the mean, for each specified period (1970-1984, 1985-1999 and 2000-2009), age (17 five-year age groups) and sex, provide net internal migration rates using the *dydx()* option in Stata which provides the difference between the in- and out-flows for the rural and urban sectors. For simplicity, migration for the last age group (80+) is assumed to be zero. Note that under-five year old migration estimates are biased and cannot be corrected for in the Asian and Latin American models since we do not have one-year estimates from these censuses. Rather than rely on the under-estimated rates, for the matrices we chose to indirectly estimate the migration rates for under-five year olds ($M_{0\text{-}4}$) as follows for all continents and periods (here shown for urban sector):

Eq. 1 $$M_{0-4} = SRB_T * \frac{\sum_{x=15-49} B * P_{T,f}}{2 * P_{U,f,0-4} * 5}$$

Where *B* is the proportion of births by age group (distributed according to age-specific fertility rates), *SRB* is the sex ratio at birth, and *P* represents the population size. Although these under-five migration estimates are quite rough, since they assume the children migrate with their mother, we prefer this approach using a standardised method across the continents. The marginal annualised net migration rates (see Figure A1) are multiplied by five to inform the diagonal of our matrices.

We assume that migrants do not contribute to births, and do not die during the five-year period of migration. More precisely, since migrants are assumed to move at mid-period, for 2.5 years “net migrants” do not die and do not have children. By only considering that this is the case for net migrants only (the diagonal of the matrices are of net migration), we do not expect this assumption to be significant. Once incorporated in the population (after 2.5 years), migrants are assumed to adapt instantly to the population at destination, exposed to the same fertility and mortality rates. Of course, it is possible for migrants to have lower or higher fertility and survival for an extended period after migration, but results on this are mixed (see for example on mortality Ginsburg (2016) and on fertility Chattopadhyay et al. (2006)), and incorporating this in the cohort component analysis would require more complex analysis.

Mortality

Survival ratios (S_x) are needed for each age group and sex to capture mortality. We use the survival ratios from life tables available from the UN World Population Prospects (WPP) 2022 for each continent for the mid-periods of our 15-year periods: 1977, 1992, and 2007 (Gaigbe-Togbe et al. 2022). Since we require separate matrices by rural/urban sector, we adjust the S_x using a factor based on rural and urban survival rates taken from Menashe-Oren & Masquelier (2021). The ${}_{15}q_0$ and ${}_{45}q_{15}$ are averaged across the Demographic and Health Surveys (DHS) by continent (see Table A2). The rural/urban gap is slightly larger in the later period for countries in Africa, however we chose to use a stable factor over time since the DHS are not representative of all countries for all periods (notably Northern African countries are lacking), and we do not have enough surveys to conclude on trends in Asia and Latin America. Though for these two continents it appears there is a constant gap in rural/urban adult mortality over time, and in Latin America the gap for children becomes smaller in the later period, in general, there is a larger gap between the sectors amongst children than amongst adults. The adjustment factor (*Adj*) is estimated for two age groups (0-14 and 15-59) as:

Eq. 2
$$Adj = \frac{(q_{x,R} - q_{x,U})}{\frac{q_{x,R} + q_{x,U}}{2}}$$

Since the national level S_x will reflect more of the urban sector as the proportion urban increases, in adjusting the S_x we also need to account for the population in each sector. We use the UN URPAS data for population counts by continent (and by age, sex and sector). Sex- and age-specific mortality rates for the urban sector are estimated as:

Eq. 3
$$S_{x,U} = \frac{(S_{x,T} * P_{x,T}) + (Adj * P_{x-5,T}) - (Adj * P_{x,U})}{((1 + Adj) * P_{x,T}) - (Adj * P_{x,U})}$$

Figure A2 provides the final survival ratios by rural/urban sector used to inform the Leslie matrices.

Fertility

To capture entry into the populations through birth we rely on age-specific fertility rates (ASFR) for every five-year age group between ages 15-49, from the World Population Prospects (WPP) 2022 for each continent, using the mid-period value of ASFR for each 15-year period. As with mortality, we adjust the national ASFR to get them for each rural/urban sector. For this we rely on the average rural/urban total fertility rates (TFR) obtained from all DHS available in each continent (regardless of period), downloaded from STATcompiler.com (see Table A2).[9] In building the matrices, the ASFR are used to estimate the number of children aged 0-4 by sex, and therefore sex ratios at birth (SRB) and survival rates S_0 are required. We proxy SRB using sex ratios for 0-1 year olds from the WPP 2022, and convert these to the proportion of births that are male.[10] Sex ratios of 0-4 year olds do not differ by rural/urban sector (Menashe-Oren and Stecklov 2023), so we do not adjust these. Age, and sex-specific fertility rates for the urban sector are estimated as:

Eq. 4

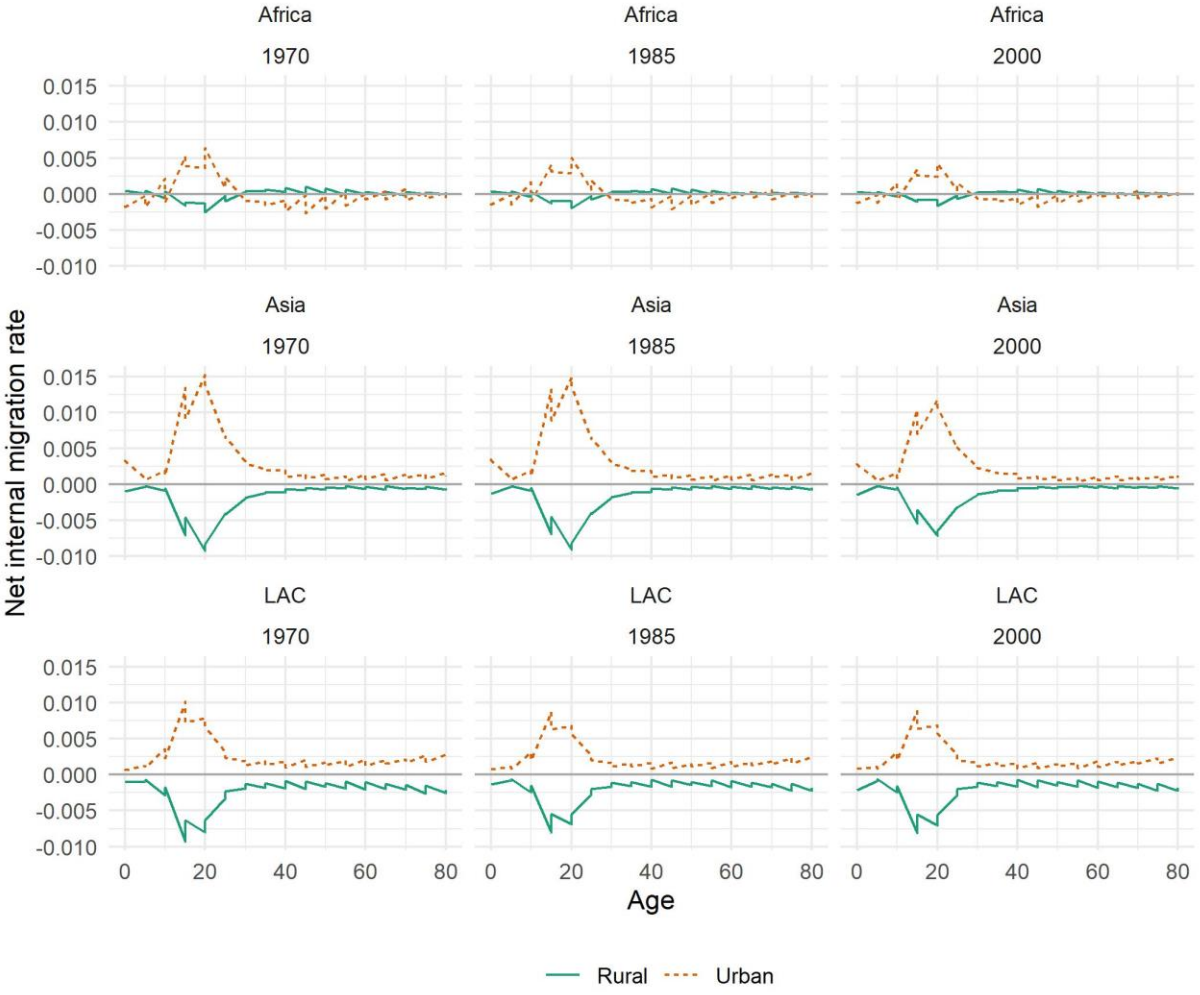
$$ASFR_U = \frac{(ASFR_T * P_{T,f}) * (Adj * P_{T,f}) - (Adj * P_{U,f})}{((1+Adj) * P_{T,f}) - (Adj * P_{U,f})} * \frac{SRB_T}{1+ SRB_T}$$

With the sector adjustment factor (*Adj*) is as in Eq. 2 but based on TFR rather than q_x. The age-specific fertility rates for the rural/urban sectors are presented in Figure A3.

[9] We checked to see if the rural/urban gap in TFR shifted over time based on the DHS surveys (at least from 1985 to 2014), and didn't observe a large enough change over time to justify different adjustment for rural/urban TFR over time.

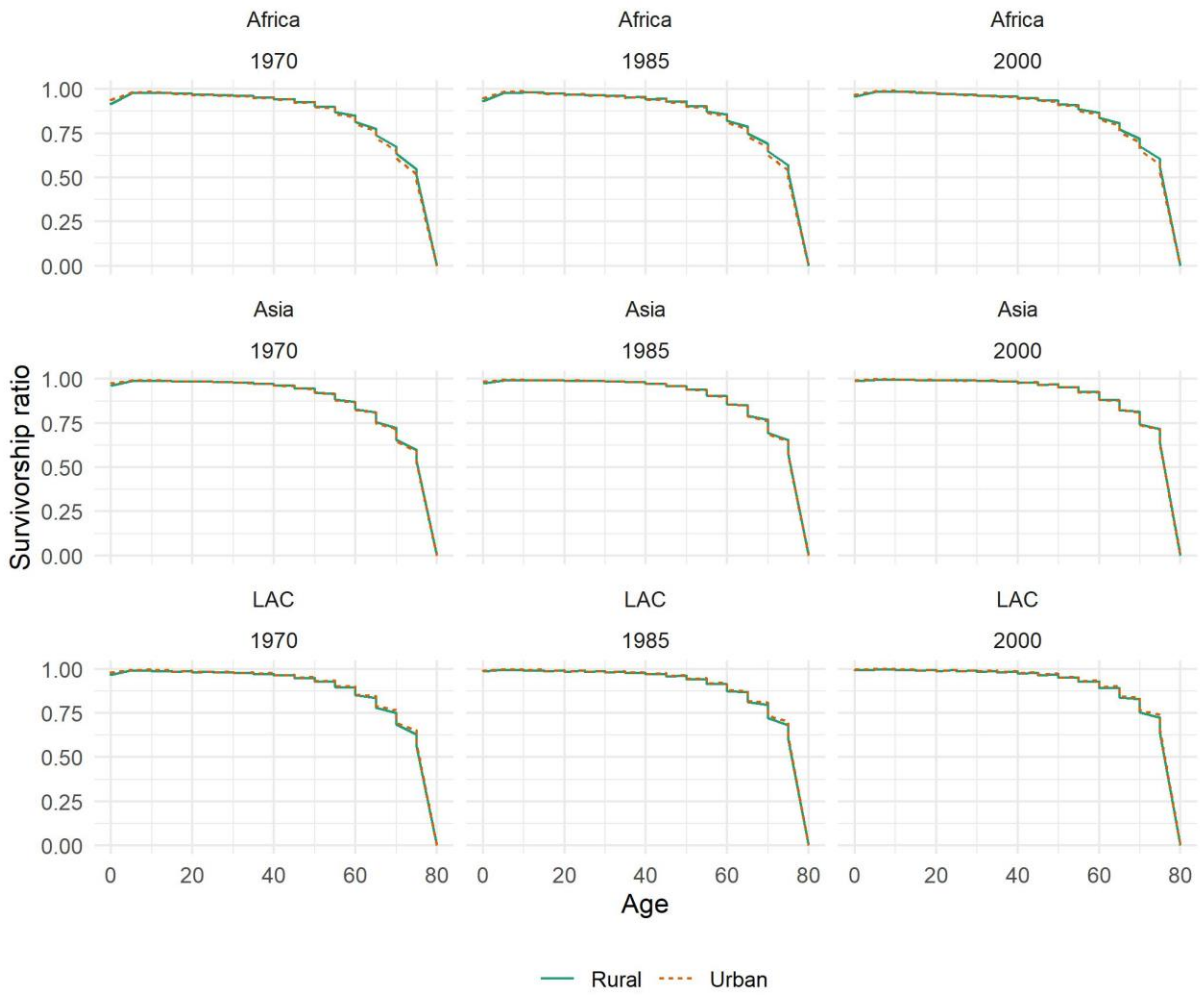
[10] We chose to use sex ratios of 0-1 year olds as a proxy for SRB to be consistent with the boundaries of the continents. We compared these sex ratios to SRBs from Bayesian projections (Chao et al. 2021), and found reasonably similar sex ratios.

<u>Figure A1</u> Rural and urban net migration rates used to inform the Leslie matrix



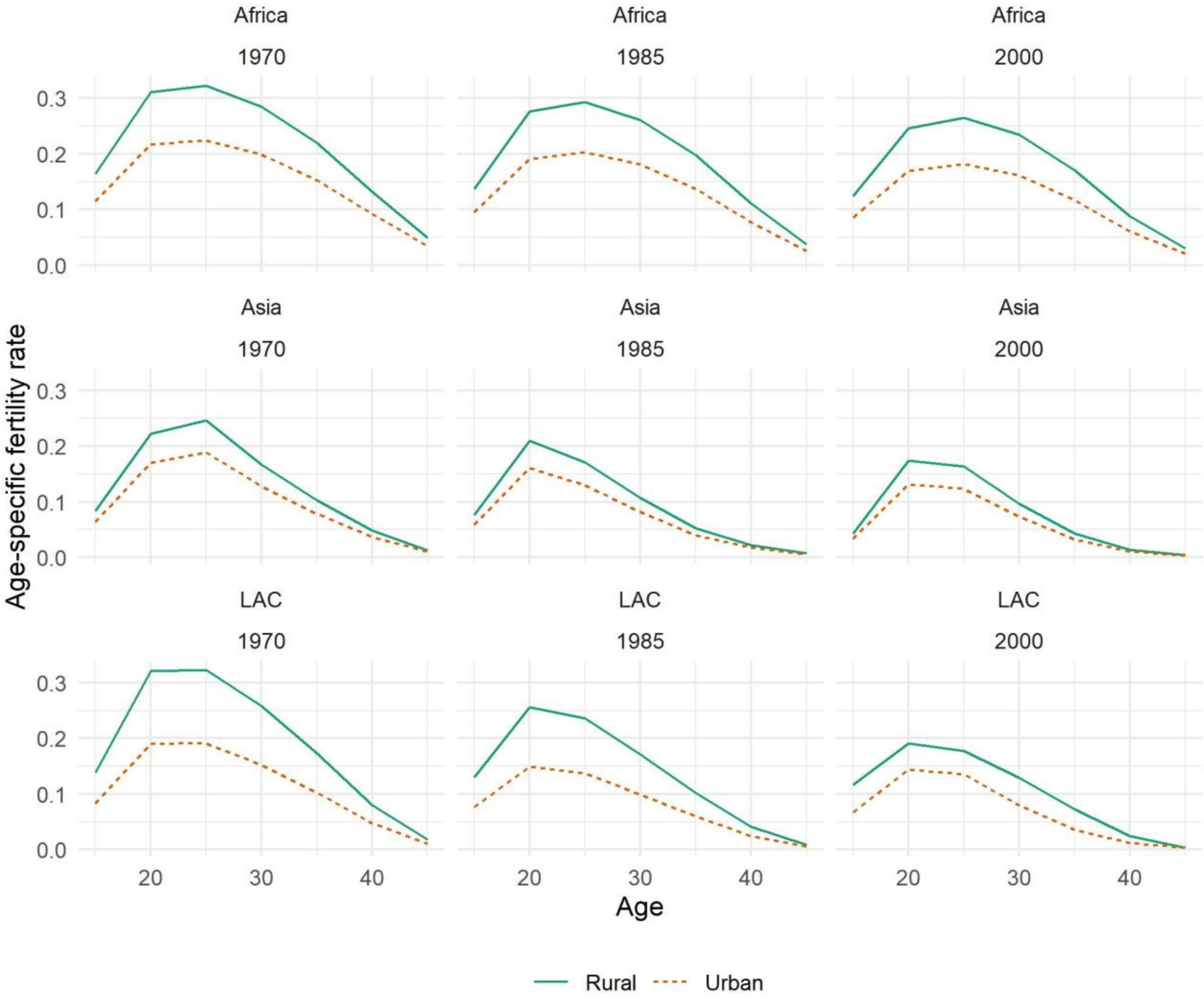
Source: IPUMS census samples, smoothed to account for measurement biases

<u>Figure A2</u> Rural and urban survival ratios used to inform the Leslie matrix



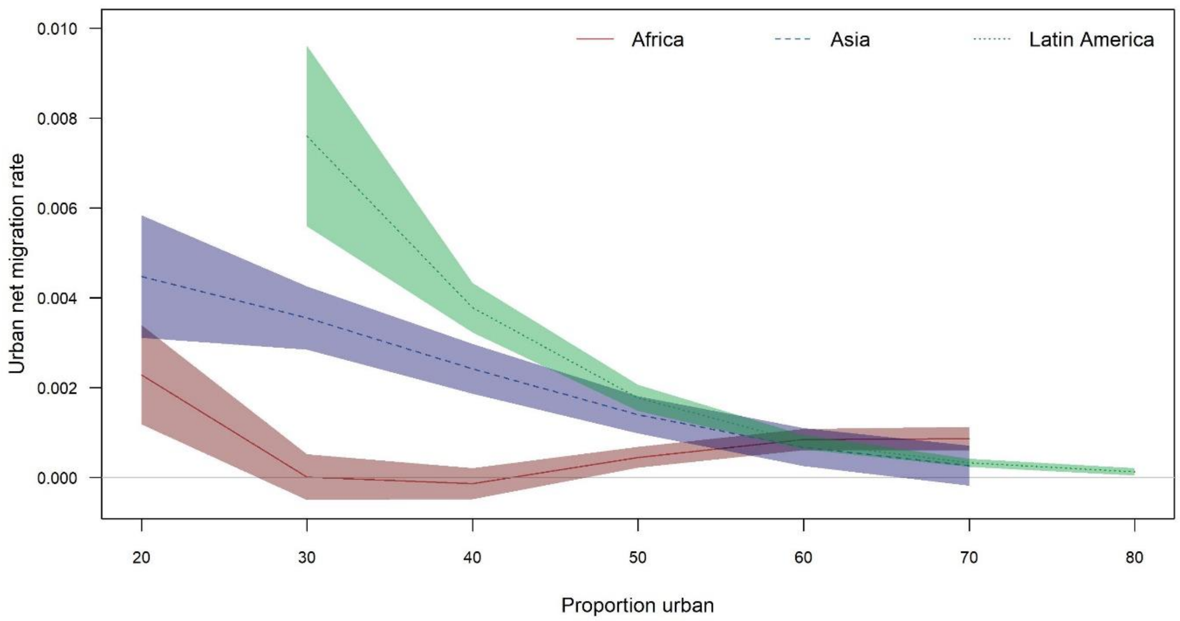
Source: WPP, rural urban adjustment factors based on DHS

<u>Figure A3</u> Rural and urban age-specific fertility rates used to inform the Leslie matrix



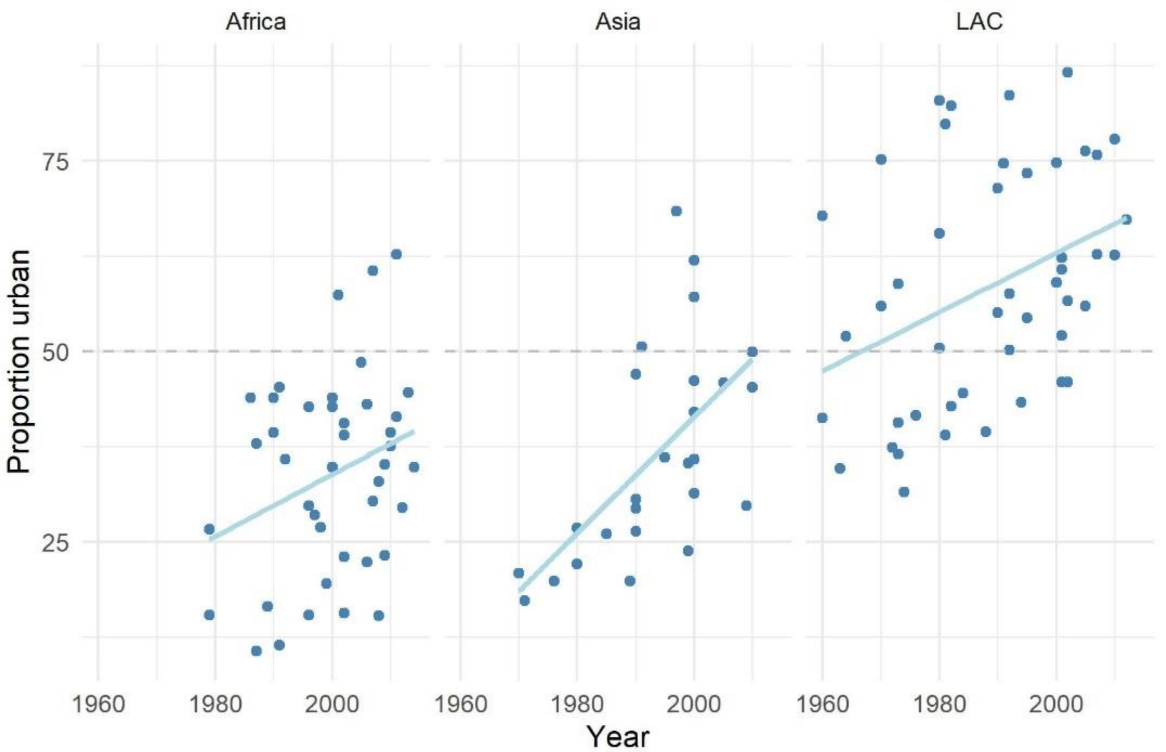
Source: WPP, rural urban adjustment factors based on DHS

<u>Figure A4</u> Shifting net migration rates over the urban transition, with 95% confidence intervals, modelled IPUMS census samples



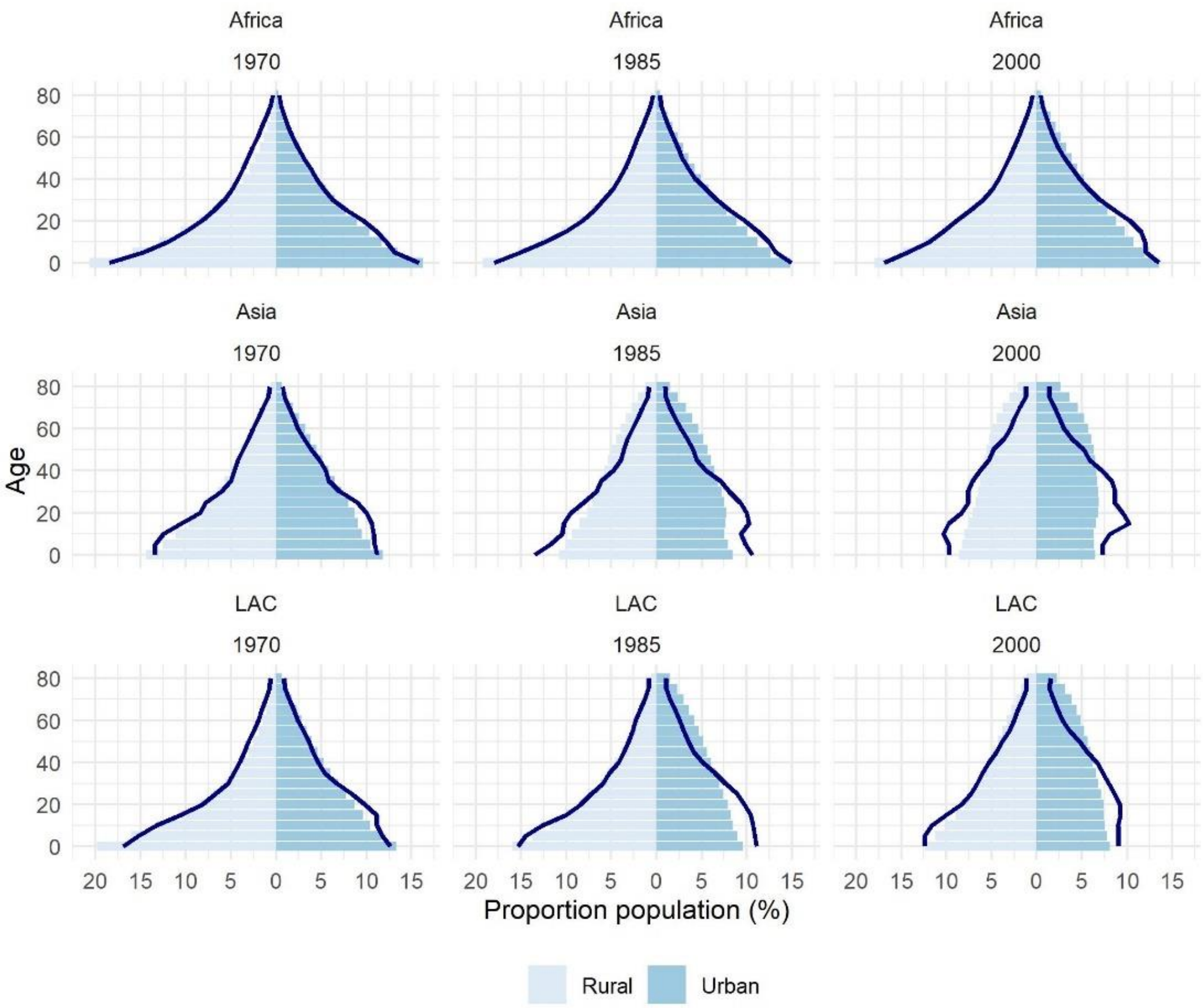
Notes: The trends for Asia and Africa end at 70% urban since we do not have any countries in the census data who have reached this stage of urbanisation, and similarly the trend for Latin America is only plotted from 30% urban since there are no countries in our data with less than this proportion urban.

<u>Figure A5</u> IPUMS census samples distribution over time and proportion urban



Notes: Linear fitted line with 95% confidence intervals. LAC is short for Latin America and the Caribbean.

Figure A6 Female age structures comparing estimated mid-period population (based on URPAS data) and "projected" age structure at stable state, including internal migration



Notes: The lines represent the mid-period initial population (based on URPAS data), and the bars the population at stable state. LAC is short for Latin America and the Caribbean.

Table A1 Complete list of IPUMS census samples used

Africa		Asia		Latin America & Caribbean	
Country	**Year(s) of census**	**Country**	**Year(s) of census**	**Country**	**Year(s) of census**
Benin	1979, 1992, 2002,2013	China	1990, 2000	Argentina	1980
Botswana	1991	Indonesia	1971, 1976, 1980, 1985, 1990, 1995, 2000, 2005, 2010	Bolivia	1976, 1992, 2001, 2012
Burkina Faso	1996, 2006	Iraq	1997	Brazil	1970, 1980, 1991
Cameroon	1987, 2005	Kyrgyzstan	1999	Chile	1960, 1970, 1982, 1992, 2002
Egypt	1986, 1996, 2006	Malaysia	1991, 2000	Colombia	1964, 1973
Ghana	2000	Mongolia	2000	Costa Rica	1963, 1973, 1984, 2000
Guinea	1996, 2014	Philippines	1990, 2000, 2010	Ecuador	1990, 2001, 2010
Kenya	1979, 1989, 1999, 2009	Thailand	1970, 1980, 1990, 2000	El Salvador	2007
Malawi	1987, 2008	Vietnam	1989, 1999, 2009	Guatemala	1973, 1981, 1994, 2002
Mali	1998, 2009			Honduras	1974, 1988, 2001
Mauritius	1990, 2000, 2011			Jamaica	2001
Mozambique	1997, 2007			Mexico	1990, 1995, 2000, 2005, 2010
Senegal	2002			Nicaragua	1995, 2005
South Africa	2001, 2007, 2011			Panama	1960, 1980
Sudan	2008			Paraguay	1972, 1982, 1992, 2002
Togo	2010			Peru	2007
Uganda	1991, 2002			Venezuela	1981
Tanzania	2002, 2012				
Zambia	1990, 2000, 2010				

Table A2 Rural and urban mean fertility rates and mortality rates used to adjust national estimates (across all periods)

		TFR	$_{15}q_0$	$_{45}q_{15}$
Africa	Rural	5.82	157.13	309.56
	Urban	3.92	116.69	329.96
Asia	Rural	3.65	86.79	176.68
	Urban	2.74	55.05	179.63
LAC	Rural	4.47	101.47	181.40
	Urban	2.78	65.00	169.93

Source: DHS surveys