Démographie et sociétés

Centre de recherche en démographie
Institut d'analyse du changement dans l'histoire
et les sociétés contemporaines
Université catholique de Louvain

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Document de travail 22

mars 2021
www.uclouvain.be/demo

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Abstract

Across the world, populations have transitioned to inhabiting urban spaces, and in low- and middle-income countries the proportion of people living in cities is expected to continue to increase. Anticipation of this fundamental process calls for better understanding of the demographic factors that drive the urban transition. By indirectly estimating the joint contribution of migration and reclassification to urban transition in 129 countries using Urban and Rural Population by Age and Sex data available from the United Nations over 1985 to 2015, we find that differences in natural increase between the rural and urban sectors explains most of the urbanisation over the thirty-year period examined. The role of migration-reclassification declines and is negligible by 2015. Despite data limitations, we confirm that it is misleading to view migration as fuelling urbanisation in low- and middle-income countries.

Introduction

It is of little surprise that urbanisation has played a central role in classic social research. Exposed to increasingly urban environments, Marx referred to the specialisation of the labour force, Durkheim to organic solidarity, Tonnies to Gesellschaft, and Simmel to social psychology within the city. Weber suggested that cities are related to economic structure, and indeed it is unreasonable today to consider urbanisation as disconnected from economic development (Montgomery 2008; Dyson 2001). Urbanisation, the increase in the proportion of the population concentrated in urban settlements, is intrinsically related to development. Also known as the urban transition, urbanisation involves a shift from small mostly agricultural settlements dispersed over large areas to larger more industrial settlements with highly concentrated populations (Montgomery et al. 2003). Although urbanisation is fundamentally spatial redistribution of populations, it invariably involves changes in lifestyle, occupations, environment and economic structure. Social scientists, including demographers, have thus studied these changes societies have experienced as they urbanised.

The benefits of urbanisation are vast. They include, and are not limited to, increased social interactions, comprising of weak ties (Granovetter 1973), wider spread of ideas through efficient communication, easier access to higher education and health services, and greater division of labour. At the same time, disadvantages of urbanisation are common. Urbanisation is associated, among other issues, with social isolation and alienation, greater exposure to environmental pollution and with wider socio-economic inequalities. What is more, just as urbanisation impacts development, development impacts urbanisation too. Better infrastructure and economic opportunities in cities attracts migrants from the rural sector. Faster diffusion of modern methods of family planning or higher financial costs of childbearing in the urban sector can slow down urban natural growth. Considering their interconnectedness, it is unrealistic to maintain a one-directional causal relationship.

The synergy between urbanisation and development has led to apparent conflicting evidence of this relationship. Based on the historical experiences of Europe in particular, urbanisation has been described as following a logistic curve in relation to industrialisation – slowly urbanising in pre-industrial times, rapidly urbanising hand in hand with industrialisation, and then levelling off (Davis 1965; Kelley and Williamson 1984). Yet it is unclear if this is a universal phenomenon. While urbanisation in Asia has been linked to industrialisation and economic growth since the 1950s (Bloom, Canning, and Fink 2008; Fox 2012; Henderson, Roberts, and Storeygard 2013; Hoselitz 1957; Hugo 2003; Jones 2002), in sub-Saharan Africa it is often considered to be decoupled from economic development (Cohen 2004; Fay and Opal

2000). Though this relationship in Africa is subject to ongoing debate (Kessides 2007). Urbanisation, particularly migration, closely follows economic growth in some African countries (Potts 2016). It is likely this relationship also differs across countries (Gollin, Jedwab, and Vollrath 2016). Moreover, by expanding the development perspective beyond economic, to include technological sophistication, educational achievements, health and general standards of living, urbanisation in sub-Saharan Africa can be considered as related to development, and not so different to global or historical evidence (Njoh 2003; Henderson, Roberts, and Storeygard 2013). In light of this conflicting evidence, understanding the drivers of urbanisation, particularly in contemporary urban transitions, may be beneficial to our understanding of this relationship to development. For example, development may be slower where migration plays a minor role in urbanisation.

Considering urbanisation at its core is a demographic phenomenon, we aim to identify the disparate contribution of demographic forces to urbanisation by specifically examining the trends in the role of internal migration across low- and middle-income countries.[1] We focus on urbanisation, rather than urban growth, since urbanisation is dependent on both rural and urban growth.[2] Urbanisation is defined as the proportion of the total population living in the urban sector. Urbanisation is driven by faster urban growth than rural growth, as well as internal and international migration, and reclassification (shifting boundaries or changes in the definitions of settlements) (Dyson 2011; Zelinsky 1971; de Vries 1990). The endogeneity of these demographic processes – declining mortality and fertility along with migration – means that they cannot be studied separately (Dyson 2011; Bocquier and Costa 2015; Farrell 2017).

Internal migration (from rural to urban areas) is commonly considered the main contributor to urbanisation. Migration certainly played a large role in historic urban transitions in 19th century Europe (Bocquier and Brée 2018; Bocquier and Costa 2015) and in some more recent urban transitions (Lerch 2014). At the beginning of the urban transition, in parallel with the demographic transition, deaths outnumber births in the urban sector, considered an "urban penalty" (Gould 1998; Reher 2001; Woods 2003). Therefore, urban growth is initially solely driven by internal migration (Keyfitz 1980; Jiang and O'Neill 2018). Only when death rates begin to decline in the urban sector does natural growth begin to promote urbanisation (de Vries 1990; Fox 2012; Dyson 2011). When mortality declines in the rural sector too, high natural growth rates in the rural sector create larger pools of prospective migrants, and greater

[1] Throughout the text, when we refer to internal migration we refer to migration between the rural and urban sectors.
[2] Essentially, it is possible to have urban growth without urbanisation when the rural population grows at equal or greater rates (Davis 1965).

competition over resources, potentially leading to higher migration rates to the urban sector (Keyfitz 1980; Zelinsky 1971). When this rural to urban migration materialises, it may also boost natural increase in the urban sector since the majority of these migrants are of reproductive ages (Rogers, Raymer, and Willekens 2002; Montgomery et al. 2003; Menashe-Oren and Stecklov 2018a).

Although historically internal migration contributed considerably to urbanisation, in contemporary developing countries between the 1960s to 1990s, only around 40% of urban growth is attributable to migration (together with reclassification) across regions (Preston 1979; United Nations 2001; Stecklov 2008; Chen, Valente, and Zlotnik 1998; Jedwab, Christiaensen, and Gindelsky 2015; Farrell 2017). However, research also suggests considerable variation between regions in their urbanisation process (United Nations 2018; Cohen 2004). Sub-Saharan Africa is the least urban region of the world, with less than half of its population living in urban areas (United Nations 2018). It has seen a slowdown in urbanisation since the 1980s as the urban economy became less attractive, and internal migration staggered (Potts 2009; Brockerhoff 1999; Bocquier 2004; Cohen 2004; de Brauw, Mueller, and Lee 2014; Potts 2016; Crankshaw and Borel-Saladin 2018; Beauchemin and Bocquier 2004). Admittedly, migration from the urban to the rural sector, often termed return migration, has become more common (Amis 1989; Beauchemin and Bocquier 2004; Beauchemin 2011; Potts 1995; Hirvonen and Lilleør 2015; Clark et al. 2007; Beauchemin 2000; Cattaneo and Robinson 2020).

Asia too is characterised by low proportions urban, around 50% on average, despite the proliferation of urban agglomerations in the region (United Nations 2018; Cohen 2004; Angel et al. 2011). Around half of the world's urban population lives in the region (Cohen 2006). China and India together account for 30% of the urban population worldwide due to their sheer numbers – the megacities of Delhi and Shanghai alone have populations of 29 and 26 million respectively (United Nations 2018). In contrast to Asian countries where urban agglomerations continue to expand and to be most attractive due to economic success, in Latin America growth of particularly large cities has slowed down. Instead, new investments in secondary cities have attracted migrants, leading to faster urban growth (Cohen 2004). Overall, countries in Latin America have low rates of urbanisation because the region is already characterised by especially high levels of urbanisation, averaging 81% urban in 2018 (United Nations 2018).

In light of these regional differences, and of the relationship between urbanisation and development, we examine urbanisation across 129 low- and middle-income countries. We use indirect estimates of net internal migration (between rural and urban areas) to ascertain the role of internal migration in urbanisation over three decades (1985-2015). As with previous research, these estimates are based on

cohort survival ratios between national censuses, with the residual providing an estimate of net internal migration (Menashe-Oren and Stecklov 2018a; Hamilton and Henderson 1944; Preston 1979; United Nations 2001). We examine the contribution of migration to urbanisation across six regions of the world, and how this shifts over time and as countries become proportionately more urban. We expect that the contribution of natural increase to urbanisation increases while that of internal migration declines over the urban transition.

Data and Methodology

We use data from the United Nations on urban and rural populations by age and sex (URPAS) in 129 countries for every five years between 1980 and 2015 (United Nations 2014b). The URPAS data builds on national population censuses and population registers. Estimates of the population by rural/urban sector and by age and sex were computed in two methods according to availability of observed data (United Nations 2014a). For 38 countries with at least one year of observed data, estimates are procured based on the reported national source, while also guaranteeing that the populations by sector are consistent with the World Urbanisation Prospects' aggregates, and that the populations by sex and age are consistent with the World Population Prospects. Age and sex-specific urban proportions for every five years were obtained by linear interpolation. For countries with no observed empirical data, proportions urban by age and sex were imputed based on sub-regional estimates from countries with data available (United Nations 2014a). To ensure consistency of results and provide a comprehensive perspective, we present part of our analysis according to data quality, that is, whether the estimates are based on observed data or were imputed. Countries are classified into six groups based on standard geographical regions (see Appendix Table A1).

The URPAS data is used to estimate net migration, following Menashe-Oren and Stecklov (2018a). These estimates follow the residual or census survival ratio method (CSRM), developed by Hamilton and Henderson (1944), and are used by the United Nations in examining urban growth (United Nations 2014b, 2001). This approach builds on the population counts by age and sex in the rural and urban sectors, and broadly estimates the survivorship in each sector, based on national level survival. The method assumes that rural survival is 25% lower than urban across all age groups, despite some evidence of higher urban mortality among adults (Menashe-Oren and Stecklov 2018b; Günther and Harttgen 2012). However, adjusting this assumption ultimately has negligible effects on the migration rates (Menashe-Oren and Stecklov 2018a). This is likely because mortality among young adults, often the bulk of migrants, is not very high (Naghavi et al. 2015). We maintain the 25% assumption across countries for consistency, and to

allow for comparison to previous research. The difference between the estimated population based on national-level survivorship, and the measured population, is considered the net migration between the rural and urban sectors, as expressed in Eq. 1 where *MR* stands for migration-reclassification, *P* for population, *U* for urban, *S* for survival, *t* for time, *a* for age cohort and *n* for time interval (also see Appendix Figure A1). The residual essentially captures both net internal migrants as well as reclassification, *MR*, and though we refer mostly to migration, it necessarily includes both. It also includes any time and age specific errors, *e*, from any miscounts of the population, or inaccurate survival functions.

Eq. 1 $$MR_a + e_{(a+n,t+n)} = P_{u(a+n,t+n)} - \hat{P}_{u(a+n,t+n)}$$

where: $$\hat{P}_{u(a+n,t+n)} = S_{u(a,a+1)} * P_{u(a,t)}$$

Eq. 1 is valid when $a \geq 1$, that is, it does not account for estimation of migration of under-five year olds. Indirect estimation of "yet-to-be born at time *t*" migrants builds on the number of estimated female migrants, and the proportionate distribution of fertility by age in low- and middle-income countries.[3] We employ rural fertility rates since rural to urban migration is the predominant flow, and it may take time before women adapt to lower urban fertility at destination (Gyimah 2006; Lee and Pol 1993). The assumptions made in estimating under-five year old migration, including rural fertility, may cause some bias, essentially reducing the role of natural increase in our analysis.

The estimated net number of internal migrants by sex and five-year age group were combined to estimate total net migration rates (for both sexes and all ages). Urban in-migration rates are the number of net migrants as a proportion of the urban population. The natural estimates are used to find the contribution of migration-reclassification and natural growth to urbanisation across low- and middle-income countries. The difference in natural growth and in migration growth between the urban and rural sectors allows us to examine the contemporary urbanisation process. We capture urbanisation as the difference in urban and rural growth, expressed as *dG* (Eq. 2a). The urban-rural growth difference in the components, migration-reclassification (*dMRG*) and natural increase (*dNG*), are expressed in equations 2b and 2c.

Eq.2a $$dG_{t+n} = \frac{100*\left(\frac{U_{t+n}-U_t}{n}\right)}{(U_{t+n}+U_t)/2} - \frac{100*\left(\frac{R_{t+n}-R_t}{n}\right)}{(R_{t+n}+R_t)/2}$$

[3] See Stecklov (2008) for extensive explanation on the estimation of child migrants and the underlying fertility assumptions.

Eq.2b $$dNG_{t+n} = \frac{100*\left(\frac{NR_t}{n}\right)}{(U_{t+n}+U_t)/2} - \frac{100*\left(\frac{NU_t}{n}\right)}{\frac{R_{t+n}+R_t}{2}} = dG_{t+n} - dMRG_{t+n}$$

Eq. 2c $$dMRG_{t+n} = \frac{100*\left(\frac{MR_t}{n}\right)}{(U_{t+n}+U_t)/2} - \frac{100*\left(\frac{MR_t}{n}\right)}{\frac{R_{t+n}+R_t}{2}} = dG_{t+n} - dNG_{t+n}$$

where *MR* represents migration-reclassification, *NR* and *NU* represents the number of natural movements (births minus deaths) in rural and urban areas; *U* indicates the urban population, *R* the rural population and *t* represents time and *n* the time interval (in our analysis *n*=5). The net number of migrations (in-migrations minus out-migrations) and reclassified populations (reclassified from rural to urban minus reclassified from urban to rural) is obtained by subtracting natural to total differences in urban and rural growth.

We model the relative contributions of migration-reclassification growth and natural growth using seemingly unrelated regressions (SUR), a subclass of generalized structural equations (Eq. 3 and 4). SUR models consist of multiple regression equations each with their own dependent variables and explanatory variables, but the error terms across the equations are assumed to be correlated (Zellner 1962). We employ SUR to account for contemporaneous correlation between natural growth and migration-reclassification. This modelling approach allows us to capture the dependency between natural growth and migration-reclassification growth in their contribution to urbanisation.

Eq.3 $$Y_{NG} = \alpha_1 + \boldsymbol{\alpha_2 X} + \varepsilon_n$$

Eq.4 $$Y_{MRG} = \beta_1 + \boldsymbol{\beta_2 X} + \varepsilon_m$$

In equations 3 and 4, natural growth and migration-reclassification growth are indicated respectively by Y_{NG} and Y_{MRG}, the intercepts by α_1 and β_1, the coefficients by the vectors $\boldsymbol{\alpha_2}$ and $\boldsymbol{\beta_2}$, the covariates by $\boldsymbol{X}$, and the error terms by ε_n and ε_m. The vector of covariates $\boldsymbol{X}$ in the models are year, country and proportion urban, as well as a squared term of proportion urban since we do not expect a linear but a curvilinear (concave) relationship (Bocquier 2005; Bocquier and Mukandila 2011). The intercepts and coefficients are assumed to be uncorrelated between equations 2 and 3 (i.e. the correlation σ between the natural and migration-reclassification equations is zero):

$$\sigma_{\alpha_1,\beta_1} = 0$$

$$\sigma_{\alpha_2,\beta_2} = 0$$

However, since outcomes Y_{NG} and Y_{MRG} are produced for the same statistical units (each a combination of country-period) in the two equations, the model asserts that the error terms of natural growth and migration-reclassification are allowed to be correlated:

$$\sigma_{\varepsilon_{NG},\varepsilon_{MRG}} \neq 0$$

We use the total population size as weights. Using the weights essentially allows us to examine the urbanisation process at a broader aggregate level, rather than at country level. That said, in our descriptive analysis we refrain from using weights since internal migration by definition is at country level. We present the results of the SUR models in a series of figures based on the predicted values estimated from the models, including 95% confidence intervals. The coefficients of our main set of models, on which Figures 3 and 6 are based, are available in Appendix Table A2.

Limitations in data and methods that could potentially bias results

In analysing the role of internal migration in urbanisation, we acknowledge the limitations associated with both the migration-reclassification estimation method as well as urbanisation. Considering urbanisation, using a consistent definition of what is urban across countries and over time would be preferable. This is not the case, with heterogeneity in definitions, ranging from those based on population density, to those considering economic activity, or based on purely administrative decisions. While there have been numerous attempts in standardising the definition of urban across countries and reconceptualising settlement types (Hugo, Champion, and Lattes 2003), no new definition has been adopted globally. Satellite imagery is a promising tool but is not useful for our purposes since it does not cover earlier periods. Thus, when we consider proportions urban, we recognize that for each country this may mean something different. Although standardisation of what is considered urban across countries could be advantageous, we postulate that country-specific definitions capture the essence of what is considered urban more suitably for each country. Defining a settlement of 5,000 people as urban in Namibia (with a population of 2.4 million in 2015) would not be the same as a settlement of 5,000 people in Bangladesh (with a population of 156.3 million in 2015). All the same, since we include country dummies in our models, which control for contextual factors that may be related to the urbanisation process, we partially account for the differences in the definition of urban across countries.

Considering internal migration estimates, direct estimation of internal migration from each country would be ideal. Such data is scarce, especially for comparable time periods and across countries. Moreover, direct estimates of migration are mostly obtained from censuses or surveys which also entail their own

biases. Indirect estimation using the URPAS is useful for our purposes since it captures the balance of migration-reclassification flows between the rural and urban sectors. However, the URPAS data is restricted since it uses linear interpolation and extrapolation between periods. Where empirical data is missing, population estimates are imputed based on sub-regional proportions urban by age and sex. To account for imputation-related bias, we compare trends in countries with observed and with imputed data. Additionally, important limitations should be acknowledged in using the residual method of estimating migration-reclassification with these data.

This indirect method, the CSRM, has two important caveats, namely, neglecting the role of international migration, and including reclassification as part of the estimated net internal migration (Menashe-Oren and Stecklov 2018a; Preston 1979). Firstly, reclassification is lumped together with migration estimates, as the residual of natural growth. However, reclassification has been suggested to play an important and increasing role in urban growth (Jiang and O'Neill 2018; United Nations 2001; Beauchemin and Bocquier 2004; Jones and Balk 2020). Few studies have examined the disparate role of reclassification, but they indicate that reclassification has contributed to 26.4% of urban growth in Africa, 28% in Southeast Asia, 22% in China in the 1990s, and 9.6% in India (Beauchemin and Bocquier 2004; United Nations 2001; Chan and Hu 2003; Jiang and O'Neill 2018). Reclassification is determined by two factors, namely, 1) a change in the definition of what is considered urban, or 2) the shift of a settlement from one category (rural) to another (urban) when its boundaries expand, it is annexed to an adjacent settlement, or once it passes specific criteria such as a population density threshold (Farrell 2017). This second factor is basically determined by internal migration and natural growth too. Rural settlements are "re"-defined as urban when they grow beyond a certain threshold. Keeping this in mind, where reclassification is high, the indirect migration estimates would be lower, and the relative contribution of migration to the urban transition also lower.

Secondly, international migration may play a role in the urbanisation process. Internal migration can lead to international migration, often known as step-wise migration, and vice versa (Skeldon 2006; King and Skeldon 2010). International migration could contribute to urbanization if emigrants leave the rural sector more than the urban, and immigrants move to the urban sector more than to the rural. Migration surveys in seven West African countries around 1990 showed that the rural areas were losing more to foreign countries than to urban areas (Bocquier and Traore 1998).[4] However international migrants to and from

[4] With the notable exception of Côte d'Ivoire, where net migration rate was positive to the benefit of rural areas (+2%), shared equally between from urban areas and foreign countries.

developed countries generally migrate to or from urban areas (Bocquier 2004). Regardless of rural/urban origin and destination, in some countries, international migration may be as common as internal migration, in particular where borders are relaxed, and even arbitrarily defined (dividing socio-ethnic groups). For example, a migrant belonging to the Hausa ethnic group in Niger may equally consider moving to a city within Niger or across the border to a town in northern Nigeria where Hausa are also in majority. International migration could thus be regarded as an extension of internal migration (Adepoju 1998). Yet, without enough evidence across countries of rural/urban origin and destination of international migrants, it is not possible to fully understand the role of international flows in the urban transition. That said, based on evidence from low- and middle-income countries which suggests that as cities grow, net international migration substitutes losses from net internal migration in large cities, we expect that at higher levels of urbanisation, international migration plays a larger role (Lerch 2020). Broadly, were it possible to include international migration, we would expect that the role of migration-reclassification may be lower.

Considering the assumption of fertility (for estimating under-five migration), the inclusion of reclassification in the net migration estimates, and that international migration is not accounted for, our estimates of internal migration represent a maximum contribution to urbanisation. Correspondingly, the natural increase differentials are conservative and represent a minimum contribution to urbanisation.

Results and Discussion

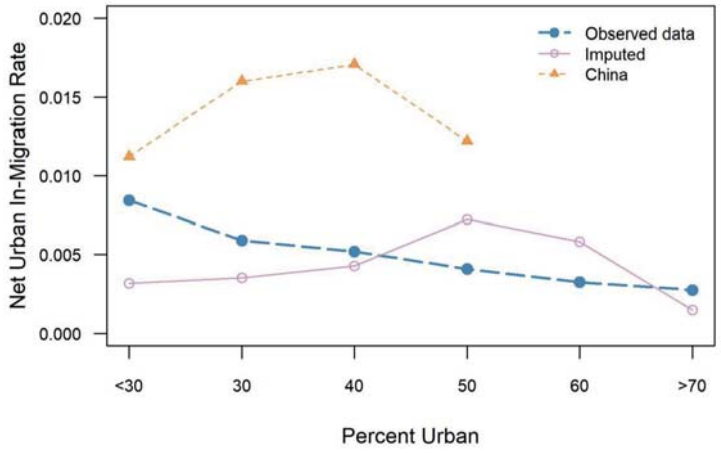
Net urban in-migration rates declined as countries urbanised, in relatively socio-economically and politically stable countries

Between 1985 and 2015, net migration rates declined as countries become more urban (Figure 1). For countries where only observed data were available, there is a decline in net urban in-migration rates the higher the proportion urban. In contrast, where migration estimates are based on imputed data, net urban in-migration rates seem to increase when countries are 50-60% urban, and then decline again when countries are over 70% urban.[55] In China too, net migration rates increased and then declined over the three decades, though at lower proportions urban. Although the data is imputed for China, the high internal migration rates likely reflect the shift in China's migration process, from restrained migration due to the Hukou system of household registration, to a market-orientated economy, pulling migrants to cities (Liang and Song 2016). With a change in the Hukou policy to freer movement, rural people were permitted

[5] Figure 1 is not presented at the regional level since some regions have few countries with imputed data, rendering such a perspective invaluable.

to reside in cities while maintaining their attachment to their rural Hukou. The decline in migration rates at 50% urban may be reflecting increases in temporary migrations, or "floating populations" (Liang and Song 2016). Similarly, the migration trends based on countries with imputed data may be related to the characteristics of these countries for which the data is missing, that is, representative of countries experiencing political upheaval and conflict (e.g. Democratic republic of Congo, Sudan, Algeria), economic turmoil (e.g. Argentina, Zimbabwe) or with small populations (e.g. Martinique, Djibouti, Samoa, Western Sahara). In these countries internal migration peaks when the population shifts to predominantly urban.

Figure 1: Mean net urban in-migration over the urban transition (portrayed as percent urban), according to data quality (not weighted by national population size)

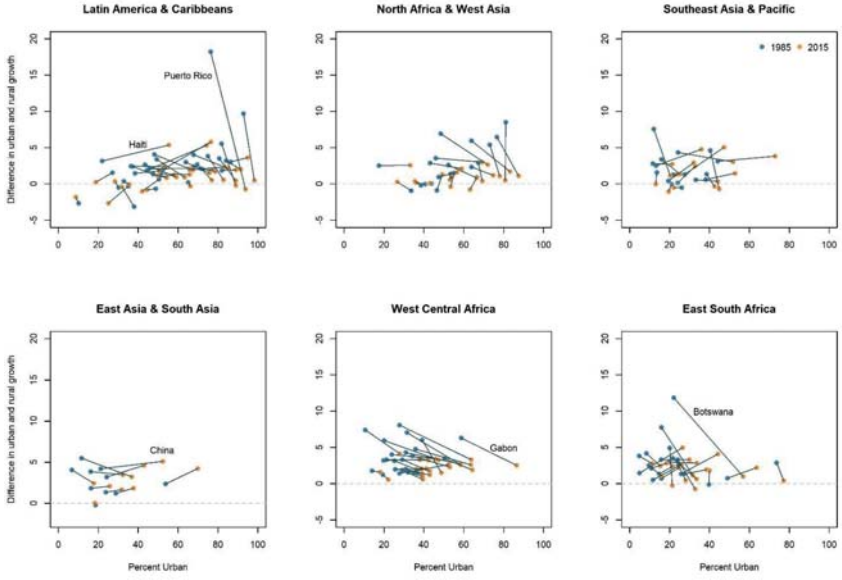


The urbanisation process differs across countries in addition to regional trends

The declining net urban in-migration rates, the higher the proportion urban, as depicted in Figure 1, suggest a slowdown in urbanisation, if natural increase remained constant. In Figure 2 we examine urbanisation, as portrayed by dG, the difference in urban and rural growth (Eq. 2a), in 1985 and 2015 for each country. In North Africa and West Asia urbanisation is clearly lower in 2015 than in 1985 (nearly all yellow dots are below blue dots). In countries in this region where the proportion urban is relatively high, above 70% in 1985, the dG drops substantially over the 30-year period without much change in the proportion of the population living in the urban sector. Similar changes in urbanisation, at high proportions urban, are observed in some countries in Latin American and Caribbean too. In this region

there are also many countries where differences in 1985 compared to 2015 were negligible, although the countries shifted to higher proportions urban (reflected in the relatively flat lines in Figure 2). Countries in West and Central Africa are noticeably homogenous, having lower dG in 2015 than in 1985, yet accompanied by increases in proportions urban over this period. Despite a slowdown, the dG is still positive. The regions of East and South Africa, and Southeast Asia and Pacific have less definite trends across countries. Notably, some countries in East and South Africa saw increases in urbanisation at very low proportions urban, of below 20% in 1985 (evident by positive slopes in Figure 2). In East and South Asia, changes in urbanisation were small between 1985 and 2015. Most evident in Figure 2 is that each country follows its own trajectory in the urban transition although there is some homogeneity within certain regions. Moreover, countries have generally become increasingly urban over the thirty-year period, unsurprisingly (United Nations 2018), with the yellow dots in Figure 2 further right on the x-axis than the blue dots for the majority of countries.

Figure 2: The difference between urban and rural growth over the urban transition (portrayed as percent urban), by country and region for 1985 and 2015



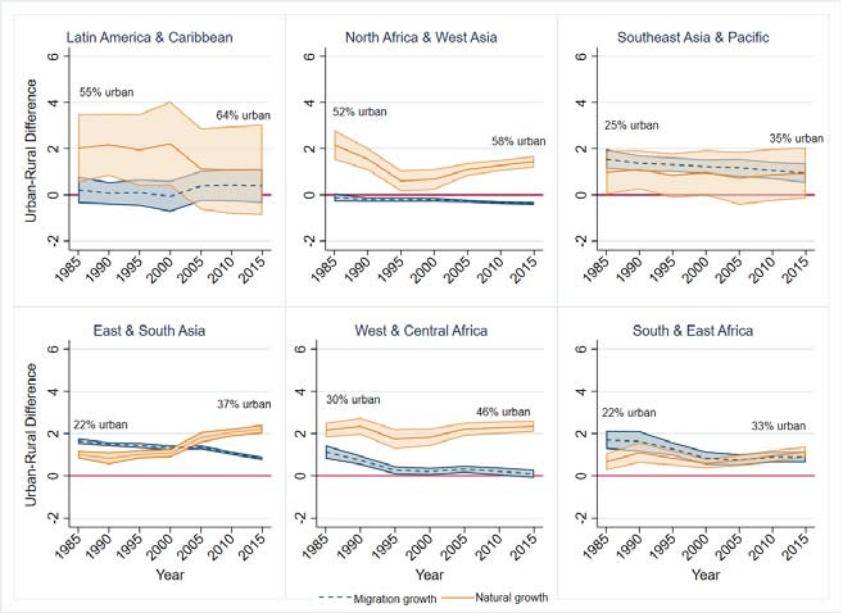
Note: Each country is represented by two dots from different years, and a line connecting them.

Natural growth is the main contributor to contemporary urbanization, particularly since 2005

While the descriptive Figure 2 contributes to our understanding of the urban transition at the country level, we now focus on a modelling approach, based on the SUR regressions in Eq. 3 and Eq. 4. allowing us to examine trends on average, controlling for country-specific differences in proportion urban. This approach allows for predicting the values of natural growth and internal migration with 95% confidence intervals, based on marginal effects (presented in Figures 3-6). Examining the contribution of internal migration and natural growth to urbanisation (Eq. 2b & 2c), we note how each region follows different trajectories between 1985 and 2015 (Figure 3). In West and Central Africa, the contribution of natural growth (dNG) is higher than migration-reclassification (dMRG) throughout the period, with an increasing gap in later years, as migration-reclassification growth becomes negligible. This is also the case in North Africa and West Asia, where proportions urban are higher. Moreover, in this region, the contribution of migration-reclassification growth is even negative – meaning that there is higher urban-rural than rural-urban migration (reclassification from urban to rural is seldom observed). In South and East Africa, migration-reclassification growth played an important role in the urbanization process until around 2000, when it started to contribute at par with natural growth to urbanization. Similarly, in East and South Asia migration-reclassification growth played a greater role in urbanization in earlier years. The increased role of natural growth in the region could in part be attributed to lower fertility in rural China and a shrinking gap between rural and urban fertility (Murthi 2002). Additionally, India, with a large population, partly drives this trend of migration-reclassification slowing down (Bhagat and Mohanty 2009). In Asia as a whole, migration-reclassification growth is positive throughout the period, and plays a key role in the urban transition (Charles-Edwards et al. 2019).

These regions, East and South Asia and South and East Africa, have similar proportions urban over the 1985-2015 period. Although Southeast Asia and the Pacific also have comparable urbanization levels, natural growth is found to contribute to urbanisation less than migration-reclassification growth (though the confidence interval of natural growth is wide and overlap that of migration-reclassification). Throughout the thirty-year period natural growth is the main contributor to urbanization in Latin America and the Caribbean, and the role of migration-reclassification is negligible. Overall, Figure 3 demonstrates how each region follows its own urbanization trajectory and that contemporary urban transitions are dissimilar to historical transitions (Farrell 2017).

Figure 3: Predicted contribution of migration-reclassification growth (dMRG) and natural growth (dNG) to urbanisation over time (for all countries), with 95% confidence intervals



The largely higher contribution of natural growth to urbanisation is confirmed when examining trends based only on countries with observed data (Appendix Figure A2). When we examine the contribution of migration-reclassification and natural growth in countries where data is imputed, we focus particularly on China and West and Central Africa where there are many countries with missing data which are also relatively populous (Appendix Table A1). Between 1985 and 2015 in China migration-reclassification growth dominated, contributing to urbanisation more than in other regions (Appendix Figure A3), and reflecting the pull of the economic zones set up by the government (Liang and Song 2016). Before 2005 the contribution of natural growth in China was low, likely a manifest higher fertility rates in the rural sector where the one-child policy is more flexible (Baochang et al. 2007). Between 2005 and 2015, however, the contribution of migration-reclassification declined, and that of natural growth increased, to similarly positive levels. It is essential to note here that our migration estimates include reclassification, and that in China, the definition of urban has changed numerous times (Chan and Hu 2003; Yu 2002; Ma

and Cuit 1987). In 1984, China revised its definitions of cities and towns with criteria of minimal population size and share of non-agricultural population being relaxed. These new definitions, based on political considerations, "ruralized" cities (Goldstein 1990). Thus, over a five-year period (1982 to 1987), China supposedly shifted from 20.6% urban to 46.6% urban, though the "urban" sector now included numerous towns of rural and agricultural character. Based on the URPAS data however, China was 21% urban in 1985 and 25% in 1990.

The role of migration-reclassification declines at higher proportions urban

In addition to computing the components of urbanisation over time, we do the same over the percentage urban to better relate the components to the stage of urban transition. Figure 4 depicts the components of urbanisation for each region. The *x*-axis covers proportions urban for which the majority of the countries with observed data lie (between one standard deviation below and above the mean proportion urban for the region). In the four regions where the proportions urban are below 50% over the thirty-year period, there is a notable crossover from higher migration-reclassification growth to higher natural growth. This crossover seems to occur at approximately 30% urban, across these regions. In contrast, in Latin America and the Caribbean the crossover is at a higher proportion urban, about 50%, while in North Africa and West Asia there is no such crossover during the examined period. If we were to extend the model to predict at what level of urbanisation natural growth began to contribute more than migration-reclassification growth, we would discern a crossover at around 20% urban in North Africa and West Asia. The trends in Latin America, and North Africa and West Asia, suggest that at advanced stages of the urban transition natural growth is the main driver of urbanisation, while the contribution of migration-reclassification growth is even negative. There is also some indication that towards the end of the transition the contribution of natural growth declines.

Already from early stages of the urban transition, urbanisation is therefore not driven by migration-reclassification but by the positive urban-rural difference in natural growth. In sub-Saharan Africa, urbanisation is likely currently driven by high urban crude birth rates – a consequence of the stalled fertility transition in urban areas (Schoumaker 2019; Shapiro and Gebreselassie 2008). Fertility decline has suspended in the urban sector, and capital or large cities in particular, in part due to higher ideal family size and an unmet need for contraception (Bongaarts and Casterline 2013; Sánchez-Páez and Schoumaker 2020), in part due to disruptions in female education (Kebede, Goujon, and Lutz 2019; Ezeh, Mberu, and Emina 2009), and in part due to continued reliance on intergenerational wealth flows where alternatives to family redistributive systems are lacking (Caldwell 2005; Cunningham et al. 2013; Y.-J. Lee, Parish, and

Willis 1994). Because fertility first declines in the urban sector (Bongaarts and Watkins 1996; Dyson 2011; de Vries 1990; Bongaarts 2016; Lerch 2018), a stall in urban fertility decline necessarily lessens the gap between rural and urban fertility rates – and therefore between rural and urban natural growth. Additionally, in some sub-Saharan Africa countries there is evidence of a widening gap in rural and urban under-five mortality, and stalls in rural mortality decline, which adds to the increasing contribution of natural component to urbanisation (Günther and Harttgen 2012; Akoto and Tambashe 2002).

Figure 4: Predicted contributions of natural growth (dNG) and migration-reclassification growth (dMRG), over the urban transition (percent urban) excluding countries with imputed estimates, with 95% confidence intervals

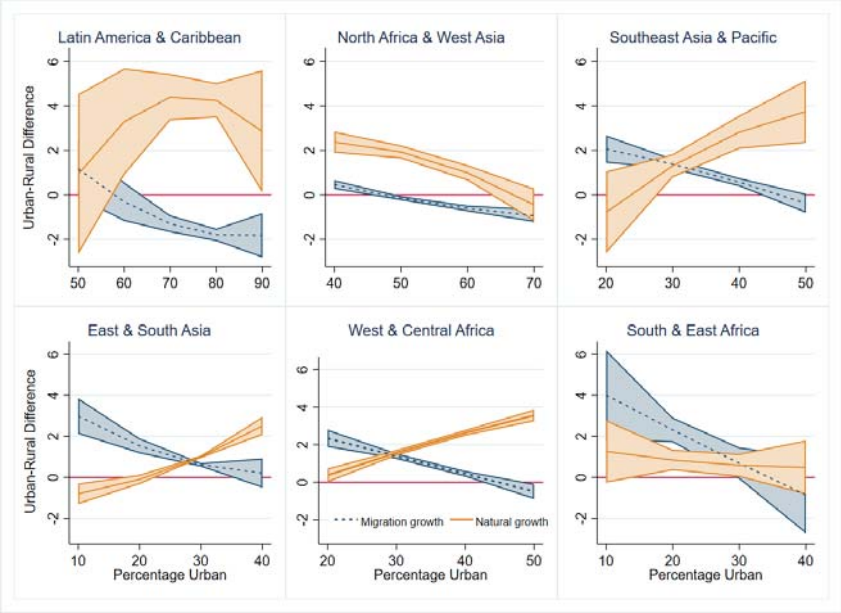
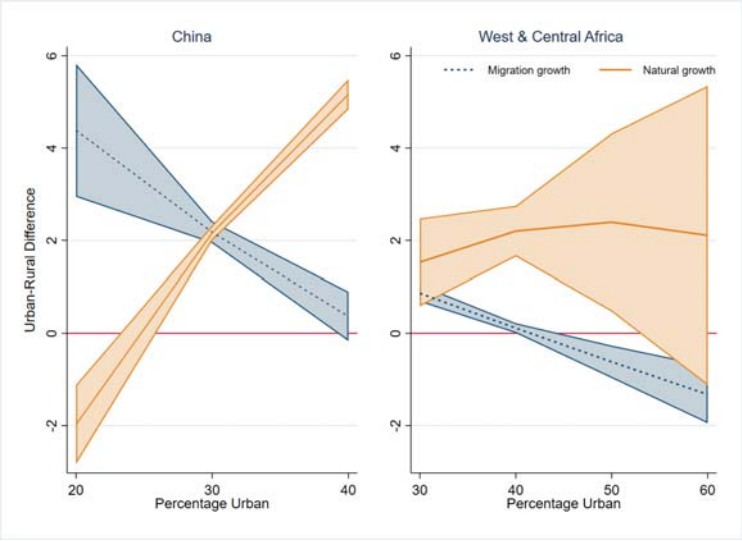


Figure 4 does not include countries for which data is imputed. We therefore examine these countries which may follow different trajectories in the role of migration in the urban transition. In Figure 5, we particularly focus on China, with an especially large population, and the region of West and Central Africa where there is a large number of relatively populous countries with imputed data, such as Angola, Cameroon and the Democratic Republic of Congo. This region also includes numerous countries that are riddled with conflict, and internal migration may be more erratic or not directed to the urban sector as a result. The role of natural growth in the region is positive, though with especially large confidence intervals, reflecting at the same time the uncertainty of the estimates and the country heterogeneity in the sub-region. Additionally, Figure 5 suggests that before reaching 30% urban, there was a crossover to higher natural growth on average in the region. Likewise, in China there is a crossover to lower migration growth at around 30% urban, making natural growth the driving force of urbanisation in the country. This is fuelled by lower rural growth than urban growth due to population momentum, despite the lower fertility rates (Farrell and Westlund 2018; Davis 1965). The combination of powerful policies in China of one-child and of the Hukou system, likely slowed down the urban transition in the country at a time when rapid economic development was associated with accelerating urban growth. Administrative re-definition of what is considered urban, that is reclassification, sped the process up.

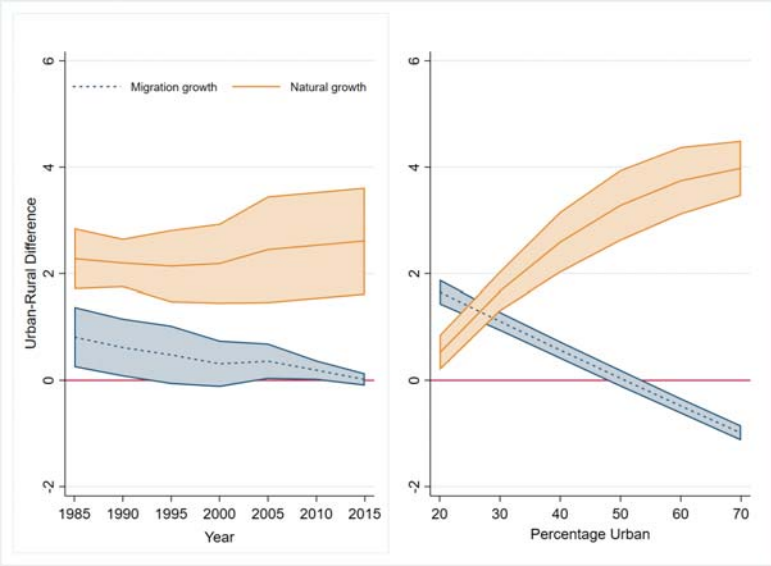
Figure 5: Predicted contributions of natural growth (dNG) and migration-reclassification growth (dMRG) over the urban transition (percent urban), for China and countries in West-Central Africa where estimates were imputed, with 95% confidence intervals



On average, migration-reclassification plays a smaller role in urbanisation than natural growth

Evidently there are differences in the role migration plays in the urban transition between regions and countries, and according to the quality of the available data. By way of summarising our results, we model the dNG and dMRG (as in Eq. 3 and Eq. 4) for all regions combined. Across all 129 low and middle-income countries dG (the sum of dNG and dMRG) is positive; urban growth exceeds rural growth for the 30-year period examined (Figure 6). The contribution of migration-reclassification already below 1% in 1985, declines over time reaching zero in 2015, while that of natural growth is above 2% and slightly increases after 2000. When we examine the trends over the urban transition, the contribution of natural growth increases dramatically, from less than 1% when the percentage urban is below 25%, to 4% when the percentage urban is above 70%, in sharp contrast to the steep decline in the contribution of migration-reclassification, as proportion urban increases, becoming even negative when the percentage urban reaches 50%.

Figure 6: Predicted contributions of natural growth (dNG) and migration-reclassification growth (dMRG) to the urban transition (depicted by percent urban) and over time, including all countries, with 95% confidence intervals



Conclusion

As the world population increases, urbanisation in low- and middle-income countries is propelled forward by natural growth, and, to a lesser extent by internal migration and reclassification. Indeed, from early stages of the urban transition, when proportion urban exceeds 30%, natural increase becomes the driving force of urbanisation. Reduced mortality differentials by rural/urban sector most likely explains this substantial role of natural increase from early stages of urbanisation. Despite overall declines in under-five mortality, rural mortality remains consistently higher than urban mortality (Garcia 2020; Günther and Harttgen 2012; Bocquier, Madise, and Zulu 2011). Since urban mortality decline initiates the demographic transition (Dyson 2011), we also see the effect of higher urban natural growth early on in the urban transition.

Our analysis broadly shows a consistent picture of a greater role of natural increase in urbanisation, but, there is also considerable variation across regions. The contribution of migration-reclassification growth

to urbanisation in Latin America and the Caribbean, and North Africa and West Asia, is negligible, while in Asia, especially China and India, it is substantial. In sub-Saharan Africa the slowdown of urbanisation is mostly due to declining contributions of migration-reclassification. The contribution of natural growth is higher than that of migration-reclassification growth over the thirty-year period in countries with imputed data too, which are often characterised by conflict and economic instability, emphasising the consistency of our results despite data uncertainty and economic and political heterogeneity.

Of course, there is also variation in migration-reclassification within regions. For example within Asia, where internal migration occurs largely towards the densely populated capital city in Mongolia, while in Indonesia migration is towards less densely settled areas (Charles-Edwards et al. 2019). Or within Latin America, where migration intensity is high and migrants tend to be older in Chile which was 89% urban in 2015, while in Ecuador which was 64% urban in 2015, migration intensity is low and migrants younger (Bernard et al. 2017). Indeed, each country has its own history, geography, culture, economic situation and political structure, and - most relevant here – its own definition of what is considered urban. Although the diverse urban definitions between countries impedes our ability to fully appreciate cross-national analysis, we posit that each country-specific definition of urban reflects the nature of settlement types in each country. The definition of urban is meaningful when it is country-specific, and relating to the context of each country (Potts 2017).

We reiterate that, despite heterogeneity in urban definitions, natural growth is the main contributor to urbanisation in contemporary transitions in low- and middle-income countries (Preston 1979; United Nations 2001; Stecklov 2008; Chen, Valente, and Zlotnik 1998; Jedwab, Christiaensen, and Gindelsky 2015; Farrell 2017). Importantly, we demonstrate how the contribution of migration to urbanisation shifts over the course of the urban transition. The role of migration declines as the proportion of the population in the urban sector increases, and from an early stage, when countries are around 30% urban, the role of natural increase becomes larger than that of migration. This relationship provides a context for understanding current and future urbanisation trends, notwithstanding regional diversity.

Future research should focus on collecting direct measures of migration. Ideally, censuses or surveys with specific questions on migration would contribute to a better understanding both of migration trends in low- and middle-income countries and to the contribution of migration to urbanisation. We acknowledge that the indirect method used here to estimate migration has its limitations, and further research is needed using direct methods of migration estimation, to account for both the role of reclassification and international migration.

Our results imply that, assuming urbanisation is invariably linked to development, governments aiming at promoting development should focus on the dominant role of natural growth, and therefore on spatially differentiated demographic transitions, in contemporary urbanisation of low- and middle-income countries. While it is tempting to focus on internal migration when it comes to urban development, slowing down population growth, either in urban or in rural areas, will be the key to the future urban transition trajectory. Although policies that aim to slow down internal migration are misguided considering the minor role of migration in urban transition, the side effects of these policies may be beneficial. Increased access to education in the rural sector may lower rural fertility (Behrman 2015; Kebede, Goujon, and Lutz 2019), more effectively than rural-to-urban migration. By also satisfying unmet need for family planning in the rural sector, governments may promote lower natural growth in the rural sector and thus faster urbanisation. This is assuming governments are interested in urbanisation and the benefits that come with it. However, it is also likely that dampening urbanisation is desired, due to its perceived negative associations including overcrowding and slum expansion. In this case, population policies aimed at slowing down urban natural growth would also be strong contenders, as exemplified by the one-child policy in China that was aimed more towards urban than rural areas.

Instead of focusing on either the urban or the rural population policies, it is also possible to consider that urbanisation, as part of the development process in general, is driven by a force stronger than population policies can handle. The fact that urbanisation now has little to do with migration indicates how little leverage policy-makers have on urban transition. Demographic transition is a long-term, slow-moving process, unlike internal migration that can more easily, and rapidly, swing one way or the other depending on economic circumstances. Natural-growth-driven urban transition is actually slipping out of the hands of policy-makers.

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Acknowledgements

We would like to thank Mathias Lerch for his valuable comments on an earlier draft of this paper. This work was supported by the Fédération Wallonie-Bruxelles through its ARC (Actions de recherche concertées) program under Grant GLOBMIG; Agreement 18/23-091, Project "New Approaches to Understanding and Modelling Global Migration Trends". Menashe-Oren holds a post-doctoral research fellowship funded by the F.R.S.-FNRS Fonds de la Recherche Scientifique.

Appendix

Table A1: Low and middle income countries by region of the world, and indication of which countries had no observed data (i.e. estimates are imputed)

Latin America & Caribbean	North Africa & West Asia	East & South Asia	Southeast Asia & Pacific	South & East Africa	West & Central Africa
Antigua and Barbuda *(i)*	Algeria *(i)*	Afghanistan	Brunei Daruldclam	Botswana	Angola *(i)*
Argentina *(i)*	Armenia	Bangladesh	Cambodia	Burundi	Benin
Aruba *(i)*	Azerbaijan	Bhutan	Federated States of Micronesia *(i)*	Comoros	Burkina Faso
Bahamas *(i)*	Egypt	China *(i)*	Fiji	Djibouti *(i)*	Cabo Verde
Barbados *(i)*	Georgia	India	Indonesia	Eritrea *(i)*	Cameroon *(i)*
Belize	Iran	Maldives	Kiribati	Ethiopia	Central African Republic
Bolivia	Iraq	Mongolia	Lao People's Democratic Republic	Kenya	Chad *(i)*
Bolivia	Jordan	Nepal	Laos	Lesotho	Congo *(i)*
Brazil	Kazakhstan	Pakistan	Malaysia	Madagascar	Côte d'Ivoire
Chile	Kyrgyzstan	Sri Lanka	Myanmar	Malawi	Democratic Republic of the Congo *(i)*
Colombia	Lebanon		Papua New Guinea	Mozambique	Equatorial Guinea *(i)*
Costa Rica	Libya		Philippines	Namibia	Gabon *(i)*
Cuba	Morocco		Polynesia	Rwanda	Gambia *(i)*
Dominican Republic	Palestine		Samoa *(i)*	Somalia	Ghana
Ecuador	Syrian Arab Republic		Solomon Islands *(i)*	South Africa	Guinea *(i)*
El Salvador	Tajikistan		Thailand	Sudan *(i)*	Guinea-Bissau *(i)*
French Guiana *(i)*	Tunisia		Timor-Leste *(i)*	Swaziland	Liberia *(i)*
Grenada *(i)*	Turkey		Tonga	Uganda	Mali
Guadeloupe *(i)*	Turkmenistan		Vanuatu	United Republic of Tanzania	Mauritania *(i)*
Guatemala	Uzbekistan		Viet Nam	Zambia	Niger
Guatemala	Western Sahara *(i)*			Zimbabwe *(i)*	Nigeria
Guyana *(i)*	Yemen				Sao Tome and Principe
Haiti *(i)*					Senegal
Honduras					Sierra Leone *(i)*
Jamaica					Togo *(i)*
Martinique *(i)*					
Mexico					
Nicaragua					
Panama					
Paraguay					
Peru					
Puerto Rico					

Saint Lucia
Saint Vincent and the Grenadine *(i)*
Suriname
Trinidad and Tobago *(i)*
Uruguay
Venezuela (Bolivarian Republic of)

Note: (i) indicates imputed data, for countries where rural/urban populations by age and sex have no observed data

Table A2: Seeming unrelated regression (SUR) results examining the role of migration and reclassification and natural growth in urbanisation, including countries with imputed URPAS data

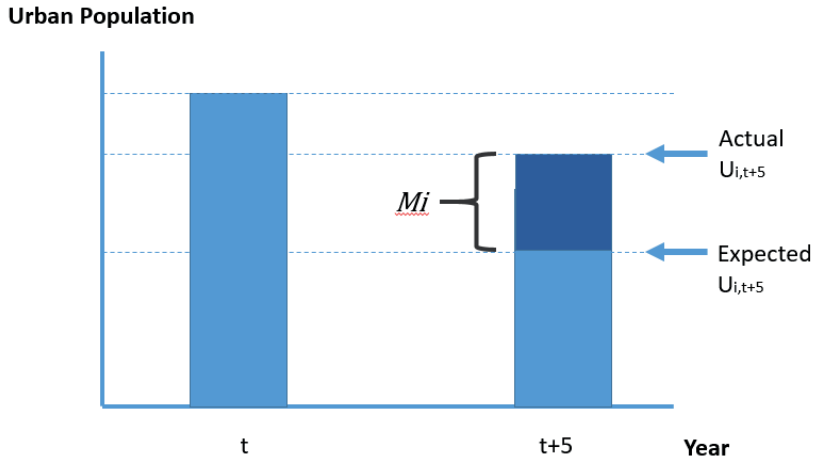
	Latin America & Caribbean	East & South Asia	North Africa & West Asia	Southeast Asia & Pacific	South & East Africa	West & Central Africa	All Countries
				Migration and reclassification (dMRG)			
Reference period: 1980-84							
1985-89	0.0256	0.033	0.0121	-0.0649	0.27	-0.0417	-0.0696
	[-0.211,0.262]	[-0.0521,0.118]	[-0.201,0.226]	[-0.588,0.458]	[-0.430,0.971]	[-0.432,0.349]	[-0.873,0.734]
1990-94	0.217	0.129	0.0644	0.0147	0.224	-0.243	-0.102
	[-0.0997,0.534]	[-0.00233,0.260]	[-0.143,0.272]	[-0.528,0.558]	[-0.480,0.927]	[-0.617,0.132]	[-0.903,0.700]
1995-99	0.192	0.197**	0.0723	0.0706	0.0108	-0.112	-0.184
	[-0.333,0.718]	[0.0684,0.326]	[-0.133,0.277]	[-0.509,0.651]	[-0.751,0.773]	[-0.492,0.267]	[-0.898,0.531]
2000-04	0.740**	0.514***	0.0488	0.172	0.138	0.208	-0.0508
	[0.229,1.251]	[0.388,0.640]	[-0.153,0.250]	[-0.502,0.847]	[-0.695,0.970]	[-0.192,0.607]	[-0.700,0.598]
2005-09	0.826**	0.600***	0.0326	0.201	0.484	0.325	-0.135
	[0.205,1.447]	[0.466,0.735]	[-0.176,0.241]	[-0.517,0.919]	[-0.510,1.478]	[-0.127,0.777]	[-0.718,0.448]
2010-14	0.841*	0.732***	0.0382	0.249	0.733	0.434	-0.215
	[0.130,1.551]	[0.601,0.864]	[-0.174,0.251]	[-0.575,1.072]	[-0.484,1.949]	[-0.0814,0.949]	[-0.776,0.347]
Proportion urban	-0.288***	-0.0711***	-0.146***	-0.0328	-0.157	-0.113**	-0.0573***
	[-0.375,-0.201]	[-0.113,-0.0288]	[-0.199,-0.0926]	[-0.106,0.0405]	[-0.338,0.0238]	[-0.191,-0.0351]	[-0.0783,-0.0364]
Proportion urban squared	0.00161***	-0.000565*	0.000851***	-0.00069	0.000291	0.000277	0.0000483
	[0.0008,0.0024]	[0.0011,-0.00004]	[0.0004,0.0013]	[0.0014,0.00005]	[-0.0010,0.0016]	[0.0007,0.0013]	[0.000156,0.000252]
Constant	6.467***	2.314***	4.962***	2.400**	7.683**	4.874***	2.902***

	[4.304,8.631]	[1.628,2.999]	[3.411,6.512]	[0.848,3.952]	[2.423,12.94]	[3.378,6.371]	[2.089,3.714]
			Natural growth (dNG)				
Reference period: 1980-84							
1985-89	-0.000371	-0.537***	-0.479	-0.182	0.432	-0.206	-0.253
	[-0.633,0.632]	[-0.832,-0.242]	[-1.336,0.378]	[-1.648,1.284]	[-0.274,1.139]	[-0.516,0.105]	[-0.975,0.469]
1990-94	-0.388	-0.660***	-1.329***	-0.708	0.177	-1.082***	-0.453
	[-1.280,0.503]	[-0.911,-0.409]	[-2.111,-0.548]	[-2.389,0.974]	[-0.396,0.750]	[-1.552,-0.612]	[-1.344,0.439]
1995-99	-0.248	-0.947***	-1.213**	-0.831	-0.0854	-1.154***	-0.521
	[-1.684,1.187]	[-1.268,-0.627]	[-1.977,-0.449]	[-2.706,1.043]	[-0.689,0.518]	[-1.796,-0.512]	[-1.465,0.424]
2000-04	-1.415*	-0.677***	-0.780*	-1.321	0.064	-0.948**	-0.369
	[-2.829,-0.0000581]	[-1.076,-0.279]	[-1.478,-0.0823]	[-3.477,0.835]	[-0.613,0.741]	[-1.620,-0.275]	[-1.510,0.772]
2005-09	-1.453	-0.981***	-0.552	-1.417	0.266	-1.033*	-0.386
	[-3.156,0.250]	[-1.395,-0.568]	[-1.253,0.148]	[-3.734,0.901]	[-0.526,1.057]	[-1.855,-0.211]	[-1.495,0.724]
2010-14	-1.409	-1.320***	-0.303	-1.519	0.445	-1.150*	-0.423
	[-3.353,0.535]	[-1.770,-0.871]	[-1.027,0.421]	[-3.933,0.894]	[-0.502,1.391]	[-2.138,-0.163]	[-1.502,0.655]
Proportion urban	0.669***	0.234***	0.247***	0.354*	-0.0341	0.242***	0.172***
	[0.460,0.877]	[0.147,0.322]	[0.103,0.391]	[0.0845,0.624]	[-0.170,0.102]	[0.163,0.321]	[0.0923,0.252]
Proportion urban squared	-0.00465***	-0.000945	-0.00273***	-0.00290*	0.000653	-0.00193***	-0.00114**
	[-0.0067,-0.0026]	[-0.0020,0.0001]	[-0.0040,-0.0014]	[0.0056,-0.00021]	[-0.0006,0.00195]	[0.0027,-0.00113]	[0.00192,-0.000366]
Constant	-17.06***	-2.786***	-0.382	-4.067**	3.206	-2.387**	-2.102*
	[-22.11,-12.01]	[-3.999,-1.573]	[-5.082,4.318]	[-6.918,-1.216]	[-1.257,7.669]	[-4.140,-0.634]	[-3.710,-0.494]
Number of country-years	235	66	144	91	146	164	846
var(e.dMRG)	0.3386	0.0158	0.0488	0.1684	0.4221	0.0652	0.3941093

	[0.1745,0.6572]	[0.0081,0.0306]	[0.0313,0.07604]	[0.0982,0.2886]	[0.2623,0.6794]	[0.0316,0.1343]	[0.3182,0.4882]
var(e.dNG)	1.8617	0.0262	0.5296	0.9352	0.3760	0.2425	2.04259
	[1.0056,3.4467]	[0.0174,0.0394]	[0.3802,0.7376]	[0.5825,1.5015]	[0.2612,0.5411]	[0.0984,0.5976]	[1.6023,2.6039]
cov(e.dMRG,e.dNG)	-0.7342	0.0031	-0.1069	0.2640	0.2758	0.0316	0.1800625
	[-1.2243,-0.2441]	[-0.0022,0.0085]	[0.1616,0.0522]	[0.1586,0.3693]	[0.1547,0.3970]	[0.0073,0.0559]	[0.0349,0.3252]

*Note: 95% confidence intervals in brackets; * p<0.05, ** p<0.01, *** p<0.001; e= error; country coefficients are not shown; Fig.3 and Fig. 6 are based on these models*

Figure A1: Census survival ratio method for estimating net migration over five-year interval



Note: a=age, t=time, n=time interval, M=migrants, P= population, U=urban

Figure A2: Predicted contribution of migration growth and natural growth (urban-rural differences- dMRG and dNG respectively) to urbanisation over time (only countries with observed data), with 95% confidence intervals

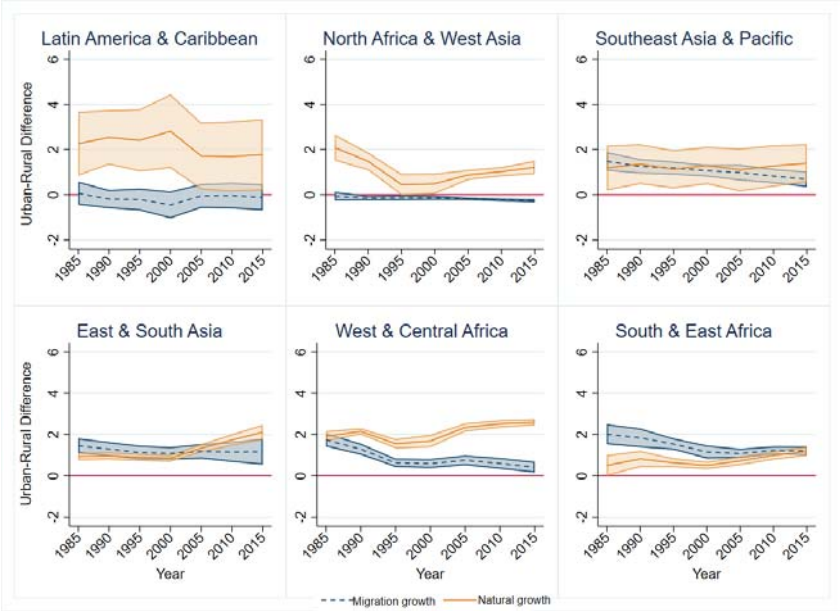
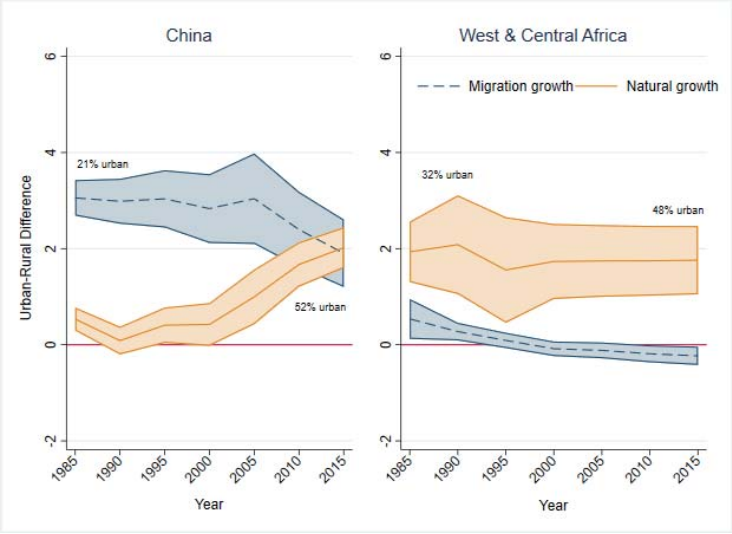


Figure A3: Predicted contribution of migration growth and natural growth (urban-rural differences- dMRG and dNG respectively) to urbanisation over time (only countries without observed data), with 95% confidence intervals



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Ester Rizzi

Référence de ce document
Menashe-Oren A., Bocquier P. (2021), *The role of internal migration in urbanisation in contemporary low- and middle-income countries, Document de Travail 22*, Centre de recherche en démographie, Louvain-la-Neuve, 40 p.

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mars 2021
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