Food and Agriculture Organization of the United Nations

# Economic development and the evolution of internal migration

## Moving in steps, returnees, and gender differences

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## Abstract

This paper uses Demographic and Health surveys to estimate internal migration between and within rural and urban areas for 31 countries at different stages of development. The methodological approach is to estimate migration transition matrices indicating the shares of the population (by gender) that move or stay in rural and urban areas over three periods (childhood and two forward periods). Results indicate that rural-to-rural migration is the dominant form of migration in many countries in sub-Saharan Africa and South Asia that are still relatively less developed. For countries that have already undertaken the path of structural transformation, rural-to-urban migration is greater than intra-rural migration. Sizeable urban to rural migration flows are found in many countries, with rural returnees often contributing substantially to these urban-to-rural flows, which has implications for development options in both rural and urban areas. Return migration to rural areas is particularly large in countries in relatively early phases of development, and higher for males than for females. For the sample of countries in sub-Saharan Africa, on average 51 percent of males and 32 percent of females migrating from urban-to-rural areas are return migrants who lived in rural areas as children. The analysis also confirms anecdotal evidence that migrants move in several steps: in the overall sample of countries, at least 43 percent of males and 36 percent of females who move once will move a second time (or more). Internal migration patterns vary considerably according to gender in some regions of the world; however, in countries that are further along the path of structural transformation, and particularly urbanization, the magnitude of migration flows appears to be similar across genders.

**Keywords:** migration, rural, urban, return migration

**JEL codes**: C51; O15; R23.

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# 1 Introduction

In the last century we have witnessed one of the most sweeping transformations in human society: the transition from predominantly rural to increasingly urban societies in which internal migration has played a major role (Skeldon, 2006). Today, more than 1.3 billion people living in developing countries have moved internally between rural and urban areas (FAO, 2018). This has far-reaching implications for structural transformation and for people's livelihoods in developing countries.

Despite the importance of internal migration there are considerable gaps in our understanding of the dynamics of the process. One reason for these gaps is that analysis of rural migration is hampered by the relative scarcity of data. Integrated data collection that record migration decisions following a population over long periods of time are rare. A fundamental problem in analysing internal migration is the absence of international statistical standards for measuring it, which is an essential pre-requisite for conducting cross-national comparisons. Due to this problem, there is considerable heterogeneity in the types of data collected across countries and the methods of collection across the Globe (Bell and Charles-Edwards, 2013). This is particularly true when estimating rural-urban, rural-rural, urban-rural, and urban-urban migration, which, in addition to being sensitive to distance and time, is also sensitive to how "rural" and "urban" are defined. Country definitions of urban and rural vary widely. The great disparity in country definitions, and the fact that definitions change, hinder comparison of urban and rural population sizes (FAO, 2017) and consequently of the various migration typologies adopted across countries.

Given many countries' high level of urbanization, internal migration is often characterized as a one-way street that starts in rural areas and ends in the city. However, while the net effect of migration is definitely contributing to urbanization, migratory flows are more complex. For example, there is substantial rural-rural migration in many developing countries, and also urban-to-rural flows are not negligible. Furthermore, with the exception of a few localized studies (Hirvonen and Lilleor, 2015; Junge *et al*., 2015; Piotrowski and Tong, 2015; Wang and Fan, 2006; Zhao, 2002), there is very little knowledge on individuals' migration history, whether it is a stepwise process, or the extent to which return migration plays a role.

Due to the data paucity, some studies, with a broader geographic scope, have attempted to estimate rural-urban migration indirectly from population and demographic data. For example, De Brauw, Mueller and Lee (2014) conclude that rural-urban migration in sub-Saharan Africa was very low between 1990 and 2000, and point to the presence also of urban-rural migration. But such indirect estimation of migration can only consider net flows, and cannot take into account a lot of counter-flows that cancel each other when the focus is only on net migration. The use of net migration flows has been criticized in the literature because it does not capture actual migration decisions, but rather the result of those decisions, since the "net migrant' does not exist in reality (Rogers, 1990).

This paper addresses some of the above issues by shedding new light on internal migration processes. This is done by estimating – for 31 countries – the share of the population that has (i) undertaken moves within rural and urban areas, and between rural and urban areas (in both directions); (ii) gone through multiple moves between rural and urban areas; and (iii) decided to return to their areas of origin, be it rural or urban. This is done using data from Demographic and Health Surveys (DHS) for these countries covering migration decisions spanning several decades. The results are discussed in the context of the existing literature on internal migration.

## 2 Estimating gross migration histories: a new approach

The approach adopted in this paper is driven by the need to better understand internal migration flows. These flows are a reflection of the type of structural transformation taking place in a country. So a better understanding of migratory movements can have implications for a country's development strategy. For example, identifying the magnitude of internal return migration flows can be a first step in shedding light on the potential rural development impacts of returnees. Similarly, examining the extent to which individuals migrate multiple times, and the spatial evolution of such stepwise migration can provide important information for policymakers. These are aspects of migration histories of individuals that can be aggregated into shares of a population that follow a similar migration path. Ideally, with enough data one could map migratory movements in a typology that is exhaustive and internally consistent.

Following Young (2013), data from the Demographic and Health Surveys (DHS) of the US Agency for International Development (USAID) are used to show patterns of various internal migration between and across rural and urban areas. The DHS data are composed of in-depth household surveys focused on fertility and health in developing countries, and they also include substantial data on migration. The surveys originally covered only women, but they evolved to include men as well. The data contain answers to questions that indicate: (1) what type of region survey respondents lived in prior to the age twelve and at the time of the survey (capital, city, town, or countryside); and (2) whether they still live in the same locale as at the age of 12 or whether they moved and, if so, from where (again from capital, city, town, or from countryside).[1] Following Young (2013), we reclassify regions into rural or urban, considering capital, city and town as urban, while countryside is rural. This approach allows us to assess four types of internal migration: rural-rural, rural-urban, urban-rural and urban-urban.

Estimation of all the movements between rural and urban areas requires information from both questions. However, as many surveys include only one of the two questions, here we use only surveys that include both. If there was more othan one survey for a given country, the most recent was chosen. This amounts to 52 surveys covering 31 developing countries across the globe with a total of 187,942 and 29,854 observations for women and men respectively. We have female data for all 31 countries but lack adequate male data for 10: Egypt, Jordan, Morocco, Namibia, Niger, Paraguay, Senegal, South Africa, Uzbekistan and Vietnam. The year the survey was administered varies by country, ranging from 1990 for Paraguay, to 2006 for Mali and Niger. The descriptive statistics are in the Annex (Table 5 and 6).

Table 1 summarises data from the first question and compares residence at the age of twelve with current residence. Results reported in the first row are: 77 percent of women and 78 percent of men who had lived in rural areas prior to the age of 12 years are found to be living in rural areas at the time of the survey. The third row shows that the same share of women and slightly lower shares of men (77 and 74 percent respectively) who had lived in urban centres prior to the age of 12 years are living in urban centres. On the other hand, the second and fourth rows include shares of people who changed their residence from rural to urban and from urban to rural. For example, 23 and 26 percent of women and men, respectively, who lived in urban areas prior to the age of 12 years had migrated to rural areas,

[1] Following Young, we focus on individuals aged 25-49. While Young focused on this age range to be able to include surveys that only cover women that were ever married, here it also serves the purpose of allowing a window of time for multiple migration steps to take place.

while 22 percent and 23 percent of men and women, respectively, lived in rural areas prior to the age of 12 years, but migrated to urban areas. The table provides no information on whether the respondents undertook migration within rural or urban areas between the age of 12 and when the survey was administered. For instance, a respondent could have migrated between rural areas and these movements would not be captured by Table 1.

The result is that rural-rural and urban-urban migration is "hidden". In addition, as these shares account for a considerable time span (from the age prior to 12 until the time of survey, where the average age of the surveyed is about 35 years), they do not capture the possibility of multiple moves as many people could have gone through intermediate migration steps before they reached their "current" area of residence. For example, a migrant could have moved from rural to urban and back to rural and still fall in the first row of Table 1.

**Table 1. Inferring people's change of residence type (rural vs urban) based on where they lived at the survey time and where they lived prior to the age of 12 years (shares at the origin)**

| Type of residence at age 12 | Residence at time of survey | Men | Women |
|---|---|---|---|
| **Rural childhood** | currently rural | 78% | 77% |
| | currently urban | 22% | 23% |
| **Urban childhood** | currently urban | 74% | 77% |
| | currently rural | 26% | 23% |

Source: FAO elaboration from DHS data based on Young (2013).

The second migration-related question in the DHS considers whether the respondents have ever moved and, for those who have, the direction of their most recent move (rural-urban, rural-rural etc.). Table 2 presents the shares of these different categories based on their area of residence (rural or urban) before the latest move, if any. Of the total number of people who were recently in rural areas, 15 percent of men and 17 percent of women moved to urban areas, while 24 percent of men and 33 percent of women moved to other rural areas. The shares of rural residents who never moved constituted 61 percent for men and 50 percent for women. The table also highlights the importance of urban-rural movements. Of the population living in urban areas, 28 percent of men and 37 percent of women moved to rural areas. However, this portrays only part of respondents' migration history as it only includes the most recent move at the time of the survey.

**Table 2. Type of movement based on residence before last move (if any)**

| Residence before last move (if any) | Most recent move | Men | Women |
|---|---|---|---|
| **Rural** | Never moved | 61% | 50% |
| | Rural-urban | 15% | 17% |
| | Rural-rural | 24% | 33% |
| | *Total* | *100%* | *100%* |
| **Urban** | Never moved | 36% | 43% |
| | Urban-urban | 36% | 20% |
| | Urban-rural | 28% | 37% |
| | *Total* | *100%* | *100%* |

Source: FAO elaboration from DHS data based on Young (2013).

By comparing Table 1 and Table 2 we can see that the share of rural population who remained respectively rural as a result of the most recent move, or of never moving, (Table 2) are different from the share of rural population who were in rural areas both at the age of 12 and at the time of the survey (Table 1). The same is true for urban areas. If individuals moved only once in their lifetime, then the numbers would have to match. For instance, in Table 2, among rural men the combined share of those who moved to another rural area in their latest move (24 percent) and those who never moved (61 percent) amounts to 85 percent, which is larger than the share, found in Table 1, of men residing in rural areas both at the age of 12 and at the time of the survey 78 percent). This difference points to the existence of multiple moves for some segments of the rural and urban populations.

Combining the information in Tables 1 and 2 we can make a first attempt to estimate migration histories in a very simplified framework where we distinguish between individuals who never moved, those who moved once, and those who moved twice or more, with migration occurring either within rural or urban areas (rural-rural, urban-urban) or across them (rural-urban, urban-rural). The first step is to assume there are two phases of potential movements. So, for example, someone who lived in a rural area prior to 12 years of age in the first phase could either stay in this area, migrate to another rural area, or migrate to an urban area. In the second phase, again, she/he could continue to stay in her/his area of residence, migrate again to another rural area, or migrate to an urban area. The same paths can be illustrated for someone who lived in an urban area prior to 12 years old. These different migration paths sum to 18 possible patterns of moves/stays (2 times 3 times 3)[2]. In our estimation procedure, we account for the "hidden" flows with the shares of people who move or stay.

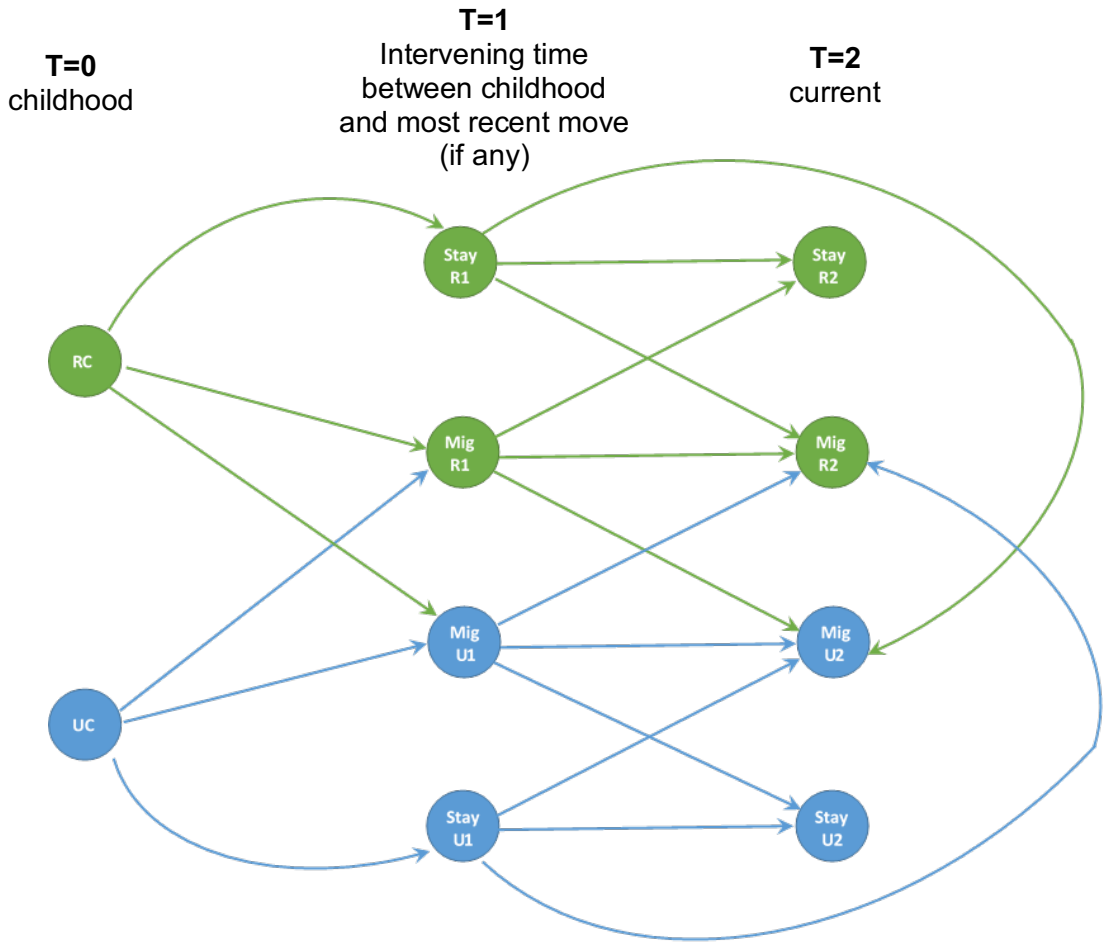
In our approach, internal migration is viewed as a directed graph (see Figure 1) in the spirit of a Markov process, with a matrix of transition probabilities which measure how individuals move across rural and urban areas over time. Here the transition probabilities are used to capture the share of population that has undergone a specific migratory movement.[3] Direct estimation of transition matrices is difficult, since time-series panel data following specific migrants are

[2] Under these assumptions, all moves prior to the last one are considered as one (from place of residence at 12 and place of residence before the latest move).

[3] We do not want to imply that the migration process is a static process defined by transition probabilities, rather the transition probabilities capture a snapshot of flows over a period of time. These transition probabilities should not be interpreted as predictors of future migratory movements.

typically unavailable. Demographic and health surveys have information on migration, but the information contained is not sufficient to determine the migration coefficients analytically, let alone provide enough degrees of freedom for standard econometric estimation. To address the issue of estimating the different flows in the directed graph, we turn to maximum entropy econometrics, which offers a feasible way to estimate transition matrices using the two migration-related questions from the DHS surveys.[4]

**Figure 1. A stylized representation of possible moves from childhood to the time of survey**




Source: Authors' own elaboration.

The estimation methodology starts with the structure of the transition matrices implied by the graph in Figure 1. Separately for males and females, there are two possible initial states in time T0: Rural Childhood (RC) and Urban Childhood (UC). In T1, there are three possible "destinations" for movement from each of the two initial states: not moving ("stay R1" or "stay U1"), migrating to an urban area (Mig U1) or migrating to a rural area (Mig R1). Similarly in T2

[4] See Golan, Judge, and Miller (1996), Miller and Judge (2015), and Golan (2018) for a discussion of the information-theoretic approaches to estimation with incomplete, partial, data estimated with error. There are many applications to estimation problems in developing countries; e.g., Robinson, Cattaneo, and El-Said (2001).

there are also three possible destinations for movement from each of the four possible T1 nodes. So, for each Markov transition matrix, there are 18 (2x3x3) possible frequencies to be estimated.[5] Each path, defined by the two arcs going from T0 to T1 and then T2, represents a share of population with a similar migration history, for example all people who moved from a rural to an urban area and then moved back to a rural area. The share of population with a given migration history can be calculated once the frequency of each transition is estimated.

It should be noted that "time" in the framework proposed is an artificial construct – time T1 for one respondent may occur (in real time) after time T2 for another respondent. For this reason T1 can be interpreted as a point in time intervening between childhood and when the survey was administered, identified by the most recent move (the actual date will differ for each respondent). This calls for some caution when interpreting the results.

Next we describe briefly the procedure used to estimate the transition probabilities based on the available DHS data. We use the maximum entropy estimation approach, which starts from the premise that estimation requires "information" which must be processed. Zellner argues that an optimal information processing rule should use all the information available for estimation and not assume any information that is not available.[6] In estimating migration transition probabilities, we use four types of information: (1) a Bayesian prior for the transition probabilities; (2) DHS data that provide partial specification of the results of the migration process and some data on individual cells; (3) estimates of the degree of measurement error in the data; and (4) adding up constraints for the process – all migrants have to be accounted for, so the transition probabilities have to sum to one.

The estimation process is Bayesian in that we specify a prior set of probabilities and then use data to revise the prior to estimate posterior transition probabilities.[7] We started by assuming an "uninformative" prior for the various transition matrices and also experimented with using the solution probabilities for some of the countries as a more "informative" prior for estimation in similar countries. In our case, the results of the estimation process are robust to the specification of the prior, which indicates that the available data and the theoretical constraints on the process are very "informative" in the estimation process.

As previously mentioned, the DHS data contain two questions that provide information on migration. The first question indicates whether the surveyed people, at the time of the survey, were living in the same type of region (rural vs urban) where they had lived prior to the age of 12 years. The second question indicates whether the surveyed people recently moved to the area of residence at the time of the survey and, if yes, from what type of area (again rural vs urban).

[5] The structure of the transition probability matrices for the Markov representation of the process is shown in Table 7, which provides empirical results for the 18 possible transition frequencies. The empty cells are transition paths that cannot occur and are fixed at zero. The transitions are normalized in such a way that the coefficients reported can be interpreted as share of a national population following a specific transition path.

[6] See Zellner (1988). Mathematically, the Shannon entropy measure is the unique metric to use for an optimal information processing rule. The use of any other measure imposes information that is not justified.

[7] Formally, we minimize the Kullback-Liebler cross entropy "divergence" of the posterior from the prior. The problem is converted from maximizing entropy to minimizing cross entropy. In the case of a uniform, uninformative, prior, the two approaches are identical. The estimation problem is implemented and solved using GAMS (General Algebraic Modeling System). See Bussieck and Meeraus, 2004.

Estimation of the all the movements between rural and urban areas requires information from both questions. Using the most recent DHS survey for each country, we have adequate data to estimate 52 transition matrices for 31 countries. The descriptive statistics are in the Annex (Table 5 and 6).

Estimation steps:

1) We calculate the share of the sample that is rural or urban in childhood and that is currently rural or urban (4 categories to account for all combinations) and we impose it as a constraint on the individual flows in the transition matrices.
2) We calculate the share of the sample that is rural or urban before the previous move and that is currently rural or urban (4 categories to account for all combinations) and we impose it as a constraint on the individual flows.
3) We calculate the share of "returnees" (rural-urban-rural or urban-rural-urban) relative to rural-urban moves and urban-rural moves respectively. For example, for rural returnees, this is done by identifying respondents who were in a rural area before the age of 12, but experienced a recent urban-to-rural migration. This is then divided by the number obtained by summing the respondents who are identified as returnees and respondents who were rural in childhood and are currently in an urban area.
4) We impose that from any given node in T0 and T1 the entire population must be accounted for in terms of either staying put or migrating to a rural or urban area (coefficients branching out from a node need to sum to one).
5) In addition, we assume that the flows are measured with error, which we formally account for following an approach developed by Golan, Judge and Miller (1996) to introduce "noise" into the estimation problem.

In sum, the cross-entropy estimation method makes efficient use of prior information about the structure of the transition matrices and how they may vary by region. The approach is very flexible, allowing the use of information in a variety of forms such as inequality constraints, errors in measurement and prior estimates.

# 3 Estimation results: Diversity across countries, but patterns emerge

In this section we present the results of the estimation described in the previous section. Since the transition probability matrices are not easy to compare across countries (each is made up of 18 transition probabilities), here we present some result that can be inferred once the transition probability matrices are known. The full set of matrices is presented in the annex (Table 7) for information. The results are reported in three subsections. In the first we look at the the relative prevalence of different types of move, among those who are moving, independently of individual migration histories.[8] In the second subsection, we start thinking about migration histories, discussing the share of individual's who decide to move at least once. In the third subsection, we delve a bit deeper into migration histories by looking at the share of national population who moves more than once and among these the role of "returnees" in shaping migration flows. Finally, in subsection 3.4 we explain some of the caveats of the analysis and report on the robustness of the estimated results.

## 3.1 Relative prevalence of different types of moves within and across rural and urban areas

We start by looking at the share of migratory movements between rural and urban areas, and within the two categories. In Figure 2 we present the shares of moves between and within rural and urban areas. People may move more than once, so the sum of the moves is greater than the number of people who have moved. We consider gross migration flows, and each move is considered a separate event. What emerges very strongly is that rural-to-rural migration is the dominant form of migration in a number of countries in sub-Saharan Africa and South Asia that are relatively less developed (see Figure 2a). In several of these cases, rural-to-rural moves represent more than 50 percent of all moves. Exceptions include Cameroon, Zambia and South Africa, but these were countries that already had a level of urbanization of 40 percent or more in 1990, which would be the relevant time frame given the timing of the surveys in the late 1990s. This is quite a different situation compared to other countries in sub-Saharan Africa where the urbanization rate at the time was often below 20 percent, as was the case also for Bangladesh, Nepal and Vietnam. In fact, for countries that have already undertaken a path of structural transformation, with an already sizeable urban population, rural-to-urban and urban-to-urban migration flows are larger than intra-rural migration.[9]

One surprising element are the sizeable urban–to-rural migration flows in many countries. In sub-Saharan Africa, their share ranges from 6 percent of female movements in Burkina Faso Ethiopia to approximately 25 percent of male movements in Cameroon and Nigeria. The share is high also for some countries at a more advanced stage of development. For example, in Peru 16 percent of male movements and 19 percent of female movements are urban-to-rural migration. This provides a strong indication that although often only net rural-urban migration estimates are available, these can substantially underestimate rural-urban migration while completely ignoring urban-rural migration flows. One can easily calculate, based on Figure 2a and 2b, the net migration movements from rural to urban, and observe that in all cases in sub-Saharan Africa (except females in Mozambique) the net migration rural-to-urban migration

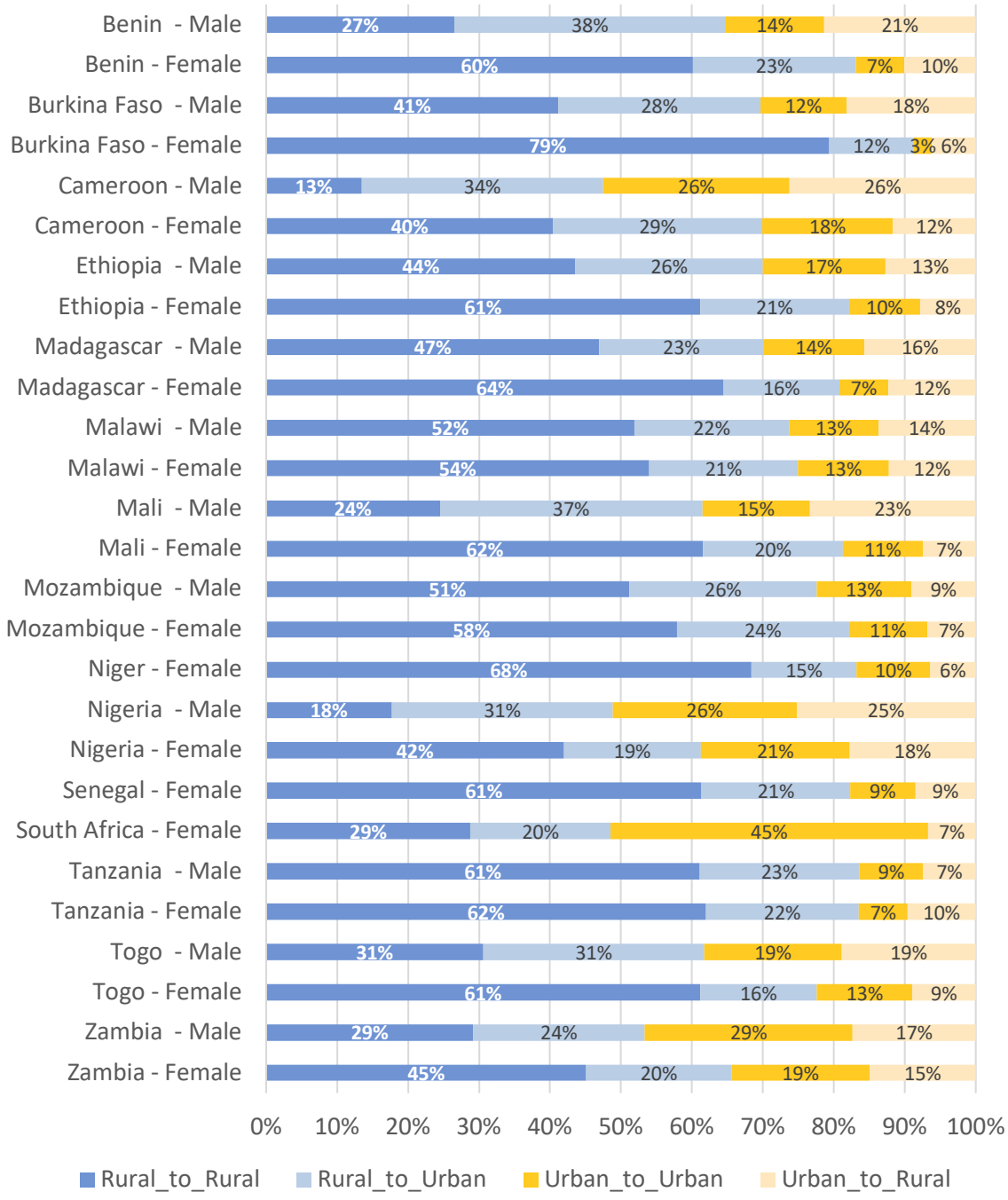
[8] Thus, if a given individual moves twice, both "migration events" are considered as separate entities.

[9] The charts are a simplified representation of a subset of flows represented in Figure 1. Please refer to Table A1 in the Annex to see the share of population that follows a specific path in Figure 1.

rate is at least one third lower than the gross rate.[10] In some countries it goes as far as being 70 percent lower (Madagascar, Nigeria and Zambia). This could explain the findings of De Brauw *et al.* (2014, who, using net migration estimates, report that rural-to-urban migration rates are very low. As we will see later in the paper, migration to rural areas from urban areas may be associated with a number of different drivers, which may have different implications for development options in rural areas.

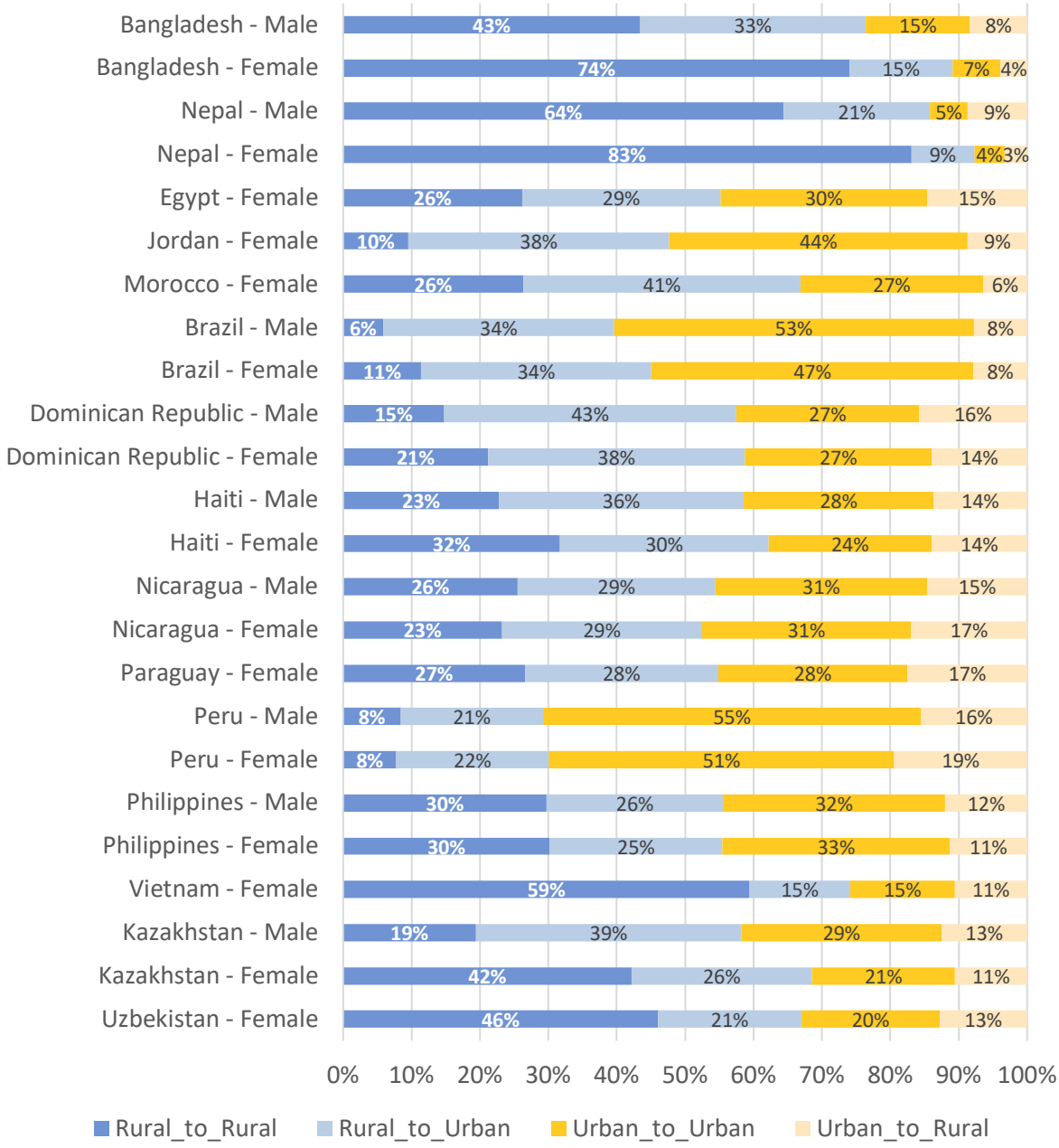
**Figure 2. Share of moves between and within rural and urban areas**

**a) Sub-Saharan countries**




[10] The same is true for a majority of countries sampled in other regions.

**b) Other countries**




Source: Authors' elaboration based on estimation results.

The extent of gender differences in migration patterns varies considerably across countries. We observe that in our sample, South Asian countries (Bangladesh and Nepal), select West African Countries (Benin, Burkina Faso, Cameroon, Mali, Nigeria and Togo), as well Ethiopia, Madagascar and Zambia exhibit noticeably different patterns of migration based on gender. In these countries rural-to-rural migration is more prevalent among the female migrants than among the males. Conversely for male migrants urban-to-urban and urban-to-rural movements have a higher prevalence than for female migrants. For other countries in our sample for sub-Saharan Africa (Malawi, Mozambique and Tanzania) the prevalence of different migration flows are quite similar for both genders.

It is worth noting that in countries that are further along the path of structural transformation, and particularly with high rates of urbanization, migration patterns tend to be similar across genders. This is the case for the Latin American countries (Nicaragua, Peru and Brazil) and the Philippines, where migration to urban areas (urban-urban and rural-urban) is the dominant form for both genders. However, there are exceptions, such as the case of Kazakhstan, which despite having a comparable level of urbanization still has clear gender distinctions in migration patterns and more than 50 percent of the female movements going into rural areas (rural-rural and urban-rural).

## 3.2 To move or not to move? Taking that first step

In the previous section we have looked at the number of moves as a way to gauge the relative importance of different internal migration flows between and within rural and urban areas. However, putting things in context requires having a sense of the share of people who migrate and who do not from rural and urban areas. Even more importantly, migration histories are about the paths followed by individuals, not about single migration occurrences taken in isolation from an individual's previous migration decisions. Looking at migration paths enables us to examine the relevance of step-migration and whether return migration is an important phenomenon or not.

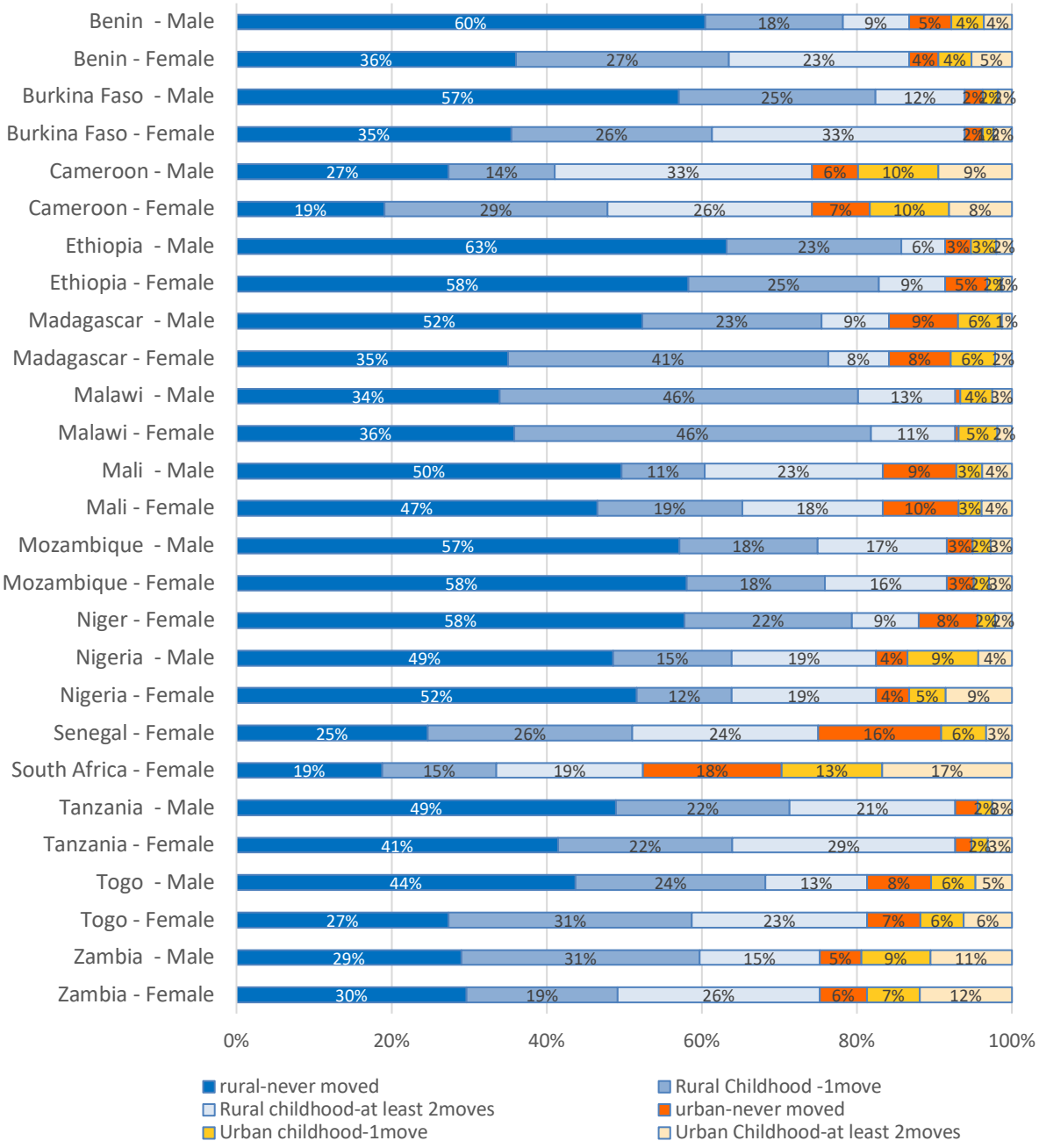
In Figure 3 we present shares of national population (by gender) based on whether they moved or not and, if yes, whether they moved once, or more than once. We distinguish between people who were in rural (blue) or urban (orange) areas as children.[11] The orange and yellow shares in the chart add up to the share of respondents who resided in urban areas at the age of twelve, while the sum of the blue ones corresponds to the share of those who resided in rural areas in childhood. The first aspect to emerge is that a sizeable share of the population migrates, ranging from 29 percent (of females) in Egypt to more than 85 percent (of females) in Bangladesh and Nepal. There is a considerable range of variation; however, it appears that, in most cases, among those who lived in rural areas at childhood a larger proportion of women migrated internally compared to men. Although there are some exceptions (Mali, Mozambique, Nigeria, Peru and Zambia), this seems to be a consistent pattern across levels of development and regions, even though the extent of female migration is likely affected by cultural norms. Such cultural norms may explain situations where female mobility is much higher than for males (Bangladesh, Benin, Burkina Faso, Kazakhstan, Madagascar, Nepal and Togo).

In South Asia, the cases of Bangladesh and Nepal are striking in terms of difference across gender: while more than 85 percent of women migrate at least once, that is the case for only one third of the men. In these two countries women in rural areas are likely to move as a result of marriage, which would also explain why the share of women who then move a second time is proportionately smaller when compared to that of men. Since there is a high proportion of men who do not migrate (74 percent in Bangladesh and 65 percent in Nepal), for women who move to marry their migration history is more likely composed of only one move compared to women who move independently.

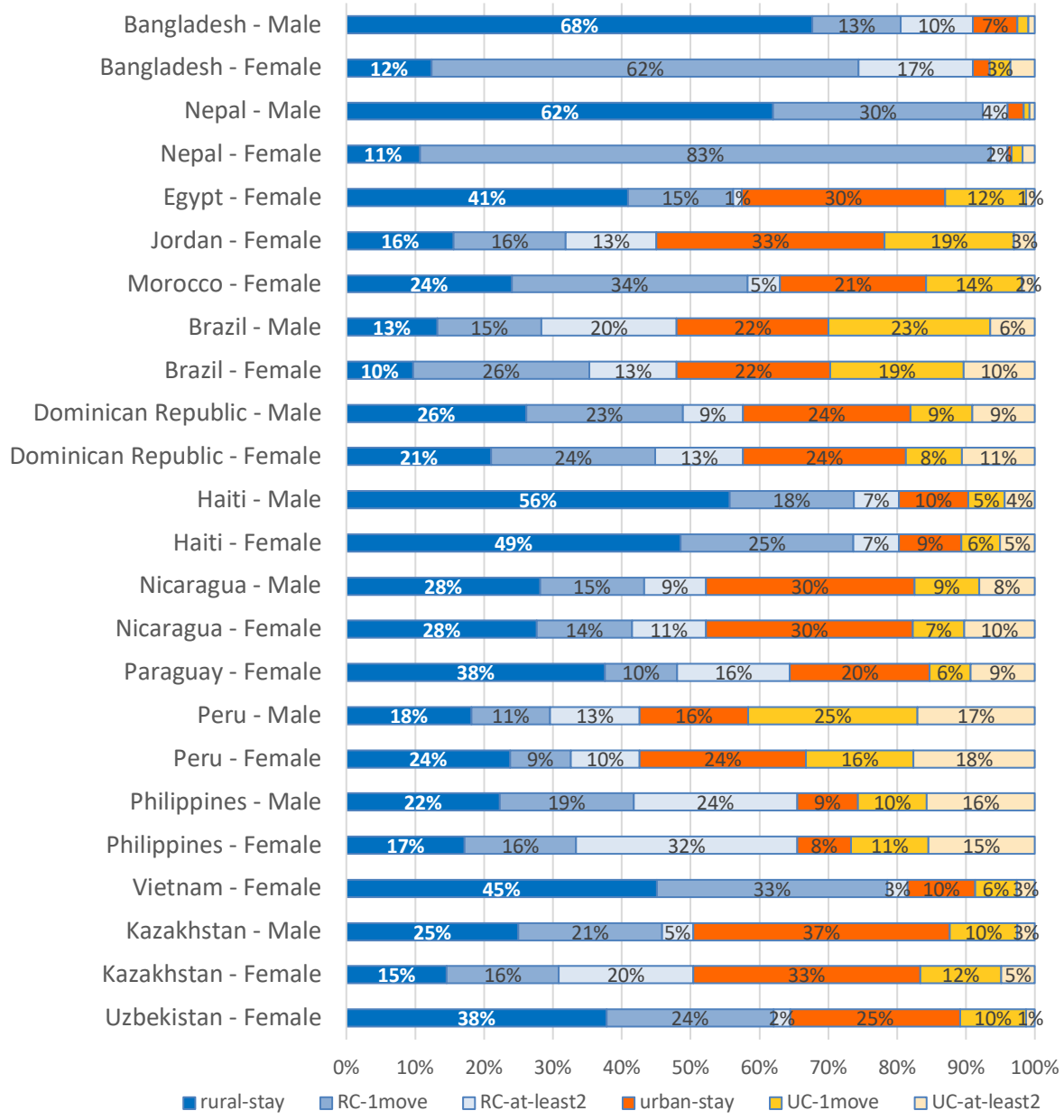
[11] The figure does not consider the destination of migrants, only their residence at 12, whether they moved and, if so, whether they moved more than once.

**Figure 3. Share of national population (by gender) that stays put, moves once, or moves more than once – broken down by childhood residence in rural (blue) or urban (orange) areas**

**a) Sub-Saharan countries**



### b) Other countries




Source: Authors' elaboration based on estimation results.

For countries that are more advanced in terms of structural transformation the share of people who do not move at all from their childhood place of residence is influenced by the degree of mobility of those born in urban areas. For this category of countries, when the proportion of "stayers" is higher than 50 percent it is attributable to an urban population, that is less inclined to move, as is the case for Nicaragua and Kazakhstan. In general, in countries further along their development path gender differences in migration are smaller. This is in part due to the fact that their urbanization rates are higher, and that migration patterns appear to be quite similar across gender for individuals who were in urban areas as children.

## 3.3 Once on the move, always on the move? Stepwise migration and the role of return migration

Concerning those who move, one often finds anecdotal evidence in the literature that people tend to migrate multiple times. However, evidence of the magnitude of this phenomenon is usually confined to localized studies because of the need to follow individuals over long periods. One excellent example reporting on multiple moves in Tanzania is Ingelaere *et al.* (2018). To our knowledge, no comprehensive analysis with a broad geographic scope has been done on this topic. With the estimation of internal migration flows reported in this paper it is possible to assess the extent and relevance of migration in multiple steps. For rural areas, an important question is how many of the urban-to rural-migrants are return migrants rather than people who grew up in an urban setting migrating to rural areas. The distinction matters since these two groups of people will have different motivations and sets of skills that they bring to rural areas.

The results presented in figure 3 indicate that here too there is considerable heterogeneity across countries when it comes to the share of the population that reports moving more than once since their childhood, ranging from less than one tenth to more than one third of the population, depending on the country. However, the absolute proportion of the population that migrates more than once will be contingent on how many people migrate in the first place. Therefore, a more meaningful representation of the step migration process is to express it relative to those who migrated at least once.

To see the extent to which people who move once will move again, Table 3 presents the percentage of people who move more than once relative to all those who move (not distinguishing by rural or urban childhood – see Table 6 in the Annex 1 for breakdown into specific paths).To give a general sense of the magnitude of the phenomenon, in the overall sample of countries used, 43 percent of males and 36 percent of females who move at least once will move a second time (or more). Before we move to analysing the results on stepwise migration in more detail, it should be noted that the share of people who move twice or more is likely a lower bound. The reason is that whether the respondent was 25 or 49 at the time of survey will make a big difference in terms of how much we are capturing the lifetime migration history of that individual – the younger respondent has a migration history that is potentially still in the making. One could resolve this problem by estimating the flows limiting the sample to individuals who are older than 35 (instead of 25); however, this would reduce the sample size considerably.

In sub-Saharan Africa 10 out of 15 countries have about half the female migrants (or more) migrating more than once, and one third of male migrants (or more) doing the same, indicating that step-migration is a consolidated practice in this region. For those countries where there is a big gender difference it could be linked to cultural norms. For example, in countries where there is a very high proportion of men who do not migrate compared to women (Bangladesh and Nepal), for women who move to marry, their migration history is likely to be composed of only one move. This explanation, however, does not seem to fit for Benin, Burkina Faso and Togo, which show few men moving and despite this it is women who undertake multiple moves in proportionately greater numbers (Table 3). Possible explanations of this difference are that in these three countries there is a larger proportion of women migrating independently, or that if they do move for marriage that the family ties are not a major impediment to women migrating a second time.

**Table 3. Ratio of individuals moving more than once relative to all individuals who moved**

| Countries (sub-Saharan Africa) | Male | Female | Countries (other regions) | Male | Female |
|---|---|---|---|---|---|
| **Benin** | 36% | 47% | **Bangladesh** | 44% | 24% |
| **Burkina Faso** | 33% | 56% | **Nepal** | 12% | 5% |
| **Cameroon** | 64% | 47% | **Egypt** | | 8% |
| **Ethiopia** | 23% | 27% | **Jordan** | | 32% |
| **Madagascar** | 26% | 18% | **Morocco** | | 12% |
| **Malawi** | 23% | 20% | **Brazil** | 40% | 34% |
| **Mali** | 66% | 50% | **Dominican Republic** | 36% | 42% |
| **Mozambique** | 49% | 49% | **Haiti** | 32% | 28% |
| **Niger** | | 31% | **Nicaragua** | 41% | 50% |
| **Nigeria** | 48% | 62% | **Paraguay** | | 61% |
| **Senegal** | | 46% | **Peru** | 45% | 53% |
| **South Africa** | | 56% | **Philippines** | 57% | 63% |
| **Tanzania** | 50% | 57% | **Vietnam** | | 12% |
| **Togo** | 37% | 44% | **Kazakhstan** | 19% | 47% |
| **Zambia** | 40% | 59% | **Uzbekistan** | | 10% |

Source: Authors' elaboration based on estimation results.

Above we have presented the prevalence of stepwise migration, independently of whether individuals were in rural or urban areas during childhood. However, there are situations in which this distinction matters. For example, earlier in the paper we highlighted how rural-to-urban gross migration differs substantially from net migration estimates because the countervailing urban-to-rural flows can be significant. However, little is known about urban-to-rural migrants, and whether they were raised as children in urban areas or moved there at a later stage. What kind of individuals are moving to rural from urban areas will have implications in terms of development options for rural areas.

Indeed, migration to rural areas from urban areas may be associated with a number of different drivers. It could be that rural and urban labour markets require different skills and that people are migrating as a function of their skill set. With rural wages typically lower than urban wages, this would be interpreted as lower skilled urban workers migrating to rural areas (Young, 2013). However, people could also be returning to rural areas after having previously moved from a rural to an urban area. This return migration may be linked to family ties, the desire to invest in their area of origin, or simply not having succeeded in their move to an urban setting. The implications for the receiving rural areas will be quite different depending on what is driving the decision to return.

**Table 4. Rural returnees – as percentage of those who "moved out" of rural areas, and as percentage of those moving from urban to rural areas**

| Countries (sub-Saharan Africa) | As share of rural-to-urban migrants | | As share of urban-to-rural migrants | | Countries (other regions) | As share of rural-to-urban migrants | | As share of urban-to-rural migrants | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | | Male | Female | Male | Female |
| **Benin** | 32% | 19% | 56% | 41% | **Bangladesh** | 11% | 6% | 40% | 18% |
| **Burkina Faso** | 51% | 32% | 82% | 60% | **Nepal** | 27% | 16% | 68% | 45% |
| **Cameroon** | 46% | 18% | 61% | 43% | **Egypt** | | 0% | | 1% |
| **Ethiopia** | 31% | 14% | 64% | 34% | **Jordan** | | 11% | | 45% |
| **Madagascar** | 7% | 5% | 9% | 5% | **Morocco** | | 6% | | 39% |
| **Malawi** | 38% | 31% | 60% | 52% | **Brazil** | 10% | 9% | 29% | 22% |
| **Mali** | 47% | 7% | 77% | 16% | **Dominican Rep.** | 10% | 9% | 23% | 20% |
| **Mozambique** | 14% | 10% | 37% | 33% | **Haiti** | 15% | 18% | 36% | 37% |
| **Niger** | | 3% | | 6% | **Nicaragua** | 10% | 9% | 17% | 12% |
| **Nigeria** | 39% | 30% | 47% | 31% | **Paraguay** | | 21% | | 31% |
| **Senegal** | | 23% | | 56% | **Peru** | 21% | 17% | 21% | 14% |
| **South Africa** | | 4% | | 4% | **Philippines** | 12% | 13% | 17% | 19% |
| **Tanzania** | 15% | 29% | 43% | 63% | **Vietnam** | | 11% | | 13% |
| **Togo** | 37% | 14% | 60% | 23% | **Kazakhstan** | 6% | 9% | 17% | 18% |
| **Zambia** | 28% | 25% | 35% | 32% | **Uzbekistan** | | 2% | | 3% |

Source: Authors' elaboration based on estimation results.

A first step to better understand the types of migrants moving from urban to rural areas is to see, among the people who are moving more than once, what proportion are returning to their rural area of origin. We cannot answer this question in detail without knowing the geographic information of all movements. However, we can establish whether someone who moved from rural to urban after childhood decided to go back to a rural area even though it may not be the one of original provenance. As it turns out, this "return" migration can be quite substantial, especially in countries in relatively early phases of development (see Table 4).

In Table 4 the percentage of returnees is reported as a share of those who have moved out of rural areas and as a share of those moving from urban to rural areas. The first expresses how many rural-urban migrants return to rural areas, while the second captures the importance of rural returnees in the broader context of urban-to-rural migration.

### 3.3.1 Rural returnees as a share of those who moved out of rural areas

In the overall sample of countries, the population-weighted average of rural returnees (as a share of those who moved out of rural areas) is 27 percent for males and 26 percent for females. However, this average conceals that – at the country level where both males and female data are available – return migration to rural areas is higher for males than for females (Haiti, Kazakhstan, Philippines and Tanzania being the sole exceptions in gender terms). To give sense of the potential magnitude of return migration to rural areas, in Burkina Faso 51 percent of males who moved from rural to urban then have a subsequent move back to

rural areas, compared to 31 percent for women. This corresponds, respectively, to 8.5 and 4.3 percent of the male and female population, which has the potential to have an impact on rural development, depending on what drives the return migration.

The case of Burkina Faso is at the higher end in terms of incidence of return migration; however, for a number of countries return migration to rural areas by males is still in the range of 25–45 percent of those who migrated from rural to urban at an earlier stage (Benin, Cameroon, Ethiopia, Malawi, Mali, Nepal, Nigeria, Togo and Zambia). Multiple explanations may be valid for these high return rates to rural areas of males in these countries. This may be capturing circular migration where the household stays in the rural area and the males in the household are the ones moving back and forth between the rural area of origin and the urban areas. Alternatively, it could be that, having found limited opportunities in the urban areas, these people are returning to rural areas. Or yet another explanation could be that people are returning to apply skills acquired in the urban areas to set up economic activities in rural areas.

It should be noted that as countries become more developed, return migration to rural areas decreases (as a share of those who migrated rural-urban) to about 10 percent or less of those who moved (Brazil, Kazakhstan, Nicaragua, Philippines, Vietnam), an exception being Peru (21 percent for males and 17 percent for females). Furthermore, with development the gender difference between the share of returnees disappears as conveyed by similar proportions of migrants returning to rural areas among both males and females.

### 3.3.2 Rural returnees as a share of those moving from urban to rural areas

Understanding the prevalence of rural returnees -- expressed as a percentage of the urban-to-rural flow of migrants -- can contribute to the debate on why urban-to-rural migration occurs. If it is low, then urban-to-rural migration could be interpreted as lower skilled urban workers migrating to rural areas, as suggested by Young (2013). If prevalence of rural returnees is high then, people may be returning for different reasons: e.g. family ties, the desire to invest in their area of origin, or because of the presence of a social safety net that they may lack in urban areas.

Rural returnees are important for the distinction between gross and net rural-urban migration rates. If the share of returnees relative to the share of urban-to-rural migrants is high, then the distinction between gross and net migration is less relevant from a practical standpoint. The reason is that the cancelling out of the migration flows occurs at the level of the individual making the migration decision. In the case of high return migration, the strength of criticism that the “net migrant” does not exist is in part reduced.

The result that emerges from the estimated migration histories is that return migration plays an important role in the dynamics of urban-to-rural migration. For the sample of countries in sub-Saharan Africa, using a population-weighted average, 51 percent of males and 32 percent of females migrating from urban to rural areas are return migrants who lived in rural areas as children. On a country-by-country basis the share of returnees is above 30 percent for both males and females in sub-Saharan African countries, with only a few exceptions. Similar high return migration shares are found among urban-to-rural migrants for the two countries in South Asia – Bangladesh and Nepal – with the exception of females in Bangladesh. The exception is likely due to a high mobility among females who were in urban areas of Bangladesh as children, diluting the effect of returnees as a share of urban-to-rural migration. The same

applies also to Nepal, but the urban base is much smaller, so that returnees play a more important role in urban-to-rural migration.

As in the preceding sections, as countries become more developed, return migration to rural areas decreases as a share of those migrating from urban to rural areas and is found to be consistently below 40 percent. However, it remains significant, with most countries in other parts of Asia and in Latin America, ranging between 15 percent and 35 percent. Furthermore, with development the gender difference in the share of returnees is much smaller.

Finally, it must be remembered that the data reported only includes people up to 49 years of age at the time of the survey; therefore, we can exclude that the numbers reported are linked to people moving back to rural areas after retirement. In fact, it raises the question of the extent to which urban-rural migration of the overall population may be underestimated due to the absence of retirees from the sample.

## 3.4 Caveats apply, but estimation results are robust

This paper is meant as a first step towards achieving a broader understanding of internal migration patterns. In fact, much remains to be done, and the results presented here come with a number of caveats. First and foremost, the results are based on country surveys that were taken at different times between 1990 and 2006, which should be kept in mind when comparing results across countries. Furthermore, as this paper notes, internal migration patterns tend to evolve as a country develops and urbanizes. This implies that the estimated flows should be considered as a snapshot at a particular moment in time – they are not a structural parameter of a country.

Although the paper aims at improving the understanding of migration histories – individuals undertaking similar migration paths between rural and urban areas – these are approximated in a very stylized manner. The available data allows us to estimate migration between three points in time: childhood, the time of the most recent move, and the time of survey. This means that we capture at most 2 migration events, while an individual may have experienced more moves. For this reason, our estimates can only distinguish between migration histories characterized by one move, or “two or more” moves.

Finally, the estimates are based on the movement of migrants over a period of time that can span from the 1960s to the time of the survey, depending on the age of the respondent at the time of the survey. As already mentioned, whether the respondent was 25 or 49 at the time of the survey will make a big difference in terms of how much we are capturing the lifetime migration history of that individual – the younger respondent has a migration history that is potentially still in the making. For this reason, the share of people who move twice or more is likely underestimated. Resolving this problem by limiting the sample to individuals who are older than 35 (instead of 25) would reduce the sample size considerably.

One further limitation of the data is also that the surveys only cover people resident in the survey country at the time of a survey. They therefore do not include people who have moved to another country. The implication is of course that the surveys provide no information on international migration. However, in addition it also means that people who have migrated internationally after one or more moves within the country of origin – international stepwise migration – and the internal movements of these people are simply not recorded. This

reinforces the notion that our estimate of individuals who move more than once should be interpreted as a lower bound.

Overall, we have found the estimation procedure to be robust, and well suited to recovering structural migration parameters using limited data. The results presented here are assuming a normal prior with the standard error of measurement of 0.075 for data used in the estimation. This implies a domain for the error that runs from minus 22.5 percent to plus 22.5 percent of the value in the data. A number of estimations were run varying the standard errors up to 2 times the assumed values (0.15), and the results were robust. The greatest sensitivity was for the share of moves that are rural-to-rural (Figure 2) for female migration (most affected are Burkina Faso, Mali, Nigeria, Senegal, Tanzania, and Zambia, showing a variation between 10 percent and 16 percent relative to the value reported), while very little sensitivity was reported for male migration (variation less than 3 percent, with the exception Mali and the Philippines that had a variation of about 10 percent ).

Results for stepwise migration (Figure 3) were relatively robust, while those concerning returnees (Table 4) were very robust. In the case of stepwise migration, the same set of countries as for rural-to-rural migration, plus Togo, show sensitivity above 10 percent, with the largest single variation for stepwise migration by females in Burkina Faso decreasing by 27 percent, with the higher standard error assumption. Outside of Sub-Saharan Africa almost every other estimate in Figure 3 changes by less than 4 percent relative to the estimate presented. Finally, the estimates of the share of rural returnees, both as a share of rural-to-urban and of urban-to-rural migrants, are extremely stable, with most estimates changing by less than 1 percent. The maximum sensitivity being a 10 percent change relative to the estimate for Jordan female return migration as a share of urban-to-rural migrants.

To conclude this section on sensitivity, it should be noted that the higher end of standard errors simulated in the sensitivity analysis are likely well beyond the actual standard errors for measurement in the surveys. The reason is that the flows being estimated, which we are assuming being measured with error, are not the individual responses, but rather an average of all responses. The reason is that the variables express the share of population that moved along a specific path. Unless there is a bias in the error of individual responses, then the measurement error for the migration flows will be low. The limited sensitivity of the results to even extreme assumptions about the error structure is very encouraging.

# 4 Conclusions

This paper uses DHS data (Demographic and Health Surveys) to analyse internal migration flows between rural and urban areas in developing countries. We use a methodology that supports estimation also of rural-rural and urban-urban migration, which are usually hidden in net migration data. The estimation methodology starts from the specification of migration as a dynamic process, with the population moving from one residence status to another over time, including the possibility of remaining in the same status. The framework provided deconstructs migratory movements over time relying on cross-sectional data based on questions related to respondents' migration experience. The approach enables us to interpret data for each individual as migration between three points in time: childhood, the time of the most recent move, and the time of survey.

Information contained in DHS surveys enables the estimation of stylized migration histories for migration flows in 31 countries. We estimate the probabilities of migration by period using an information-theoretic estimation procedure. The approach efficiently incorporates information about allowable migration paths, prior information on the probabilities, DHS data assumed to be measured with error, and various adding-up constraints. It provides the opportunity to examine the extent to which people move more than once (step migration) and what proportion of these multiple-movers can be characterized as return migrants to the type of area where they spent their childhood.

A general conclusion is that the magnitudes of internal migration paths vary as a function of the level of development. Rural-rural migration dominates in the earlier phases of development, and while it remains important in later stages, the migration profile becomes more diversified with people moving more between urban areas and from rural to urban areas. Urban to rural migration is also evident, although to a lesser degree. In countries in the early phases of development, a considerable share of migration from urban to rural areas is made up of people returning to rural areas, accounting for upwards of 50 percent of the urban-to-rural migration flows. As countries develop the importance of returnees in urban-to-rural migration diminishes.

In terms of stepwise migration, we find that in the overall sample of countries used 43 percent of males and 36 percent of females who move at least once will move a second time (or more). In sub-Saharan Africa and in the two countries in South Asia present in our sample the proportion of migrants who move more than once is typically higher among females than females. For those countries where there is a big gender difference, this could be linked to cultural norms, such as females in rural areas moving for marriage and not moving after that being one possible example.

Although we cannot say with certainty what is behind these differences along the development path of countries, it is plausible that different processes are at play, depending on the phase of development and how the structure of labour and credit markets evolves in the course of structural transformation. One possible interpretation of the results is that in earlier phases of development rural-urban mobility is motivated along the lines described by the New Economics of Labour Migration (NELM), with circular migration being part of a household strategy over time. As labour and credit markets improve, migration may be increasingly driven by a process of matching skills to demand, in line with Young (2013). Similarly, gender differences in migration flows appear to narrow as the development process advances. This may be an indication that in earlier phases of development, migration by males or females is strongly conditioned by cultural norms, while at later stages – as the demographic transition and urbanization take hold – economic opportunity may become the main driver.

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# Annexes

## Annex 1. Share of population by migration paths between rural and urban areas

**Table 5. Descriptive statistics for surveys of female individuals**

| Country | Childhood residence | Year of survey | Observations | Average age of respondent | Years of education | Percentage of people in childhood category who never moved |
|---|---|---|---|---|---|---|
| **Bangladesh** | Urban | 2004 | 969 | 34.73 | 5.41 | 27% |
| | Rural | 2004 | 6143 | 35.46 | 2.50 | 14% |
| **Benin** | Urban | 1996 | 932 | 34.25 | 2.14 | 26% |
| | Rural | 1996 | 1600 | 35.30 | 0.54 | 41% |
| **Brazil** | Urban | 1996 | 5319 | 35.17 | 7.14 | 42% |
| | Rural | 1996 | 2651 | 36.61 | 3.97 | 19% |
| **Burkina Faso** | Urban | 2003 | 1505 | 34.23 | 2.92 | 35% |
| | Rural | 2003 | 5726 | 35.58 | 0.33 | 37% |
| **Cameroon** | Urban | 2004 | 1949 | 33.88 | 7.27 | 28% |
| | Rural | 2004 | 3407 | 34.99 | 3.96 | 26% |
| **Dominican Republic** | Urban | 2002 | 6492 | 35.04 | 8.96 | 52% |
| | Rural | 2002 | 6430 | 36.17 | 6.42 | 34% |
| **Egypt** | Urban | 2003 | 2791 | 36.54 | 8.58 | 64% |
| | Rural | 2003 | 4119 | 35.87 | 3.53 | 72% |
| **Ethiopia** | Urban | 2000 | 1397 | 32.69 | 6.95 | 41% |
| | Rural | 2000 | 7252 | 35.08 | 0.56 | 58% |
| **Haiti** | Urban | 2000 | 1909 | 34.54 | 5.41 | 44% |
| | Rural | 2000 | 3729 | 36.26 | 1.90 | 58% |
| **Jordan** | Urban | 1997 | 2171 | 34.22 | 9.63 | 52% |
| | Rural | 1997 | 1120 | 35.29 | 6.27 | 36% |
| **Kazakhstan** | Urban | 1999 | 1416 | 36.69 | 12.50 | 66% |
| | Rural | 1999 | 1857 | 36.37 | 11.62 | 28% |
| **Madagascar** | Urban | 2004 | 2380 | 35.17 | 8.14 | 51% |
| | Rural | 2004 | 2572 | 35.24 | 3.90 | 33% |
| **Malawi** | Urban | 2004 | 986 | 33.33 | 6.16 | 6% |
| | Rural | 2004 | 5134 | 34.34 | 3.17 | 49% |
| **Mali** | Urban | 2006 | 1933 | 33.95 | 2.90 | 48% |
| | Rural | 2006 | 6531 | 34.72 | 0.44 | 54% |
| **Morocco** | Urban | 2004 | 3890 | 35.71 | 6.15 | 56% |
| | Rural | 2004 | 6191 | 36.07 | 0.70 | 39% |
| **Mozambique** | Urban | 2003 | 2077 | 33.83 | 4.42 | 38% |
| | Rural | 2003 | 4930 | 35.30 | 1.44 | 58% |
| **Namibia** | Urban | 1992 | 567 | 34.55 | 8.05 | 51% |
| | Rural | 1992 | 2210 | 35.04 | 4.62 | 59% |
| **Nepal** | Urban | 2001 | 331 | 34.70 | 5.22 | 16% |

| Country | Childhood residence | Year of survey | Observations | Average age of respondent | Years of education | Percentage of people in childhood category who never moved |
|---|---|---|---|---|---|---|
| | Rural | 2001 | 4956 | 35.34 | 0.97 | 11% |
| **Nicaragua** | Urban | 2001 | 3929 | 35.31 | 7.34 | 56% |
| | Rural | 2001 | 3350 | 35.40 | 3.19 | 47% |
| **Niger** | Urban | 2006 | 1181 | 33.97 | 3.38 | 59% |
| | Rural | 2006 | 4183 | 34.27 | 0.50 | 61% |
| **Nigeria** | Urban | 1999 | 1898 | 33.52 | 6.30 | 23% |
| | Rural | 1999 | 2114 | 34.04 | 3.36 | 55% |
| **Paraguay** | Urban | 1990 | 1791 | 34.77 | 7.68 | 48% |
| | Rural | 1990 | 1633 | 35.38 | 4.43 | 52% |
| **Peru** | Urban | 2000 | 11319 | 35.37 | 9.46 | 39% |
| | Rural | 2000 | 5148 | 35.95 | 4.83 | 47% |
| **Philippines** | Urban | 2003 | 2976 | 35.80 | 10.54 | 22% |
| | Rural | 2003 | 5606 | 36.00 | 8.23 | 25% |
| **Senegal** | Urban | 1993 | 1033 | 33.58 | 3.83 | 61% |
| | Rural | 1993 | 2213 | 34.86 | 0.32 | 33% |
| **South Africa** | Urban | 1998 | 3062 | 35.38 | 9.57 | 36% |
| | Rural | 1998 | 3780 | 35.62 | 6.75 | 35% |
| **Tanzania** | Urban | 1999 | 534 | 33.26 | 6.39 | 27% |
| | Rural | 1999 | 1562 | 34.61 | 4.12 | 43% |
| **Togo** | Urban | 1998 | 1036 | 33.42 | 3.78 | 35% |
| | Rural | 1998 | 2346 | 34.26 | 1.48 | 33% |
| **Uzbekistan** | Urban | 1996 | 1312 | 35.46 | 11.38 | 68% |
| | Rural | 1996 | 1315 | 34.75 | 10.31 | 57% |
| **Vietnam** | Urban | 2002 | 997 | 37.22 | 9.07 | 53% |
| | Rural | 2002 | 4036 | 36.55 | 6.96 | 54% |
| **Zambia** | Urban | 1996 | 1564 | 33.44 | 7.04 | 24% |
| | Rural | 1996 | 2452 | 35.23 | 4.05 | 39% |

Source: Authors' elaboration based on Demographic and Health Surveys used for estimation.

## Table 6. Descriptive statistics for surveys of male individuals

| Country | Childhood residence | Year of survey | Observations | Average age of respondent | Years of education | Percentage of people in childhood category who never moved |
|---|---|---|---|---|---|---|
| **Bangladesh** | Urban | 2004 | 308 | 34.47 | 6.45 | 59% |
| | Rural | 2004 | 1561 | 36.17 | 4.22 | 63% |
| **Benin** | Urban | 1996 | 293 | 34.55 | 5.23 | 37% |
| | Rural | 1996 | 426 | 35.73 | 1.87 | 66% |
| **Brazil** | Urban | 1996 | 971 | 35.02 | 7.06 | 42% |
| | Rural | 1996 | 535 | 36.88 | 3.79 | 27% |
| **Burkina Faso** | Urban | 2003 | 397 | 33.86 | 5.81 | 37% |
| | Rural | 2003 | 1308 | 35.88 | 1.22 | 57% |
| **Cameroon** | Urban | 1998 | 379 | 33.56 | 8.91 | 23% |
| | Rural | 1998 | 705 | 35.52 | 6.11 | 30% |
| **Dominican Republic** | Urban | 2002 | 576 | 34.73 | 8.54 | 52% |
| | Rural | 2002 | 672 | 35.97 | 5.95 | 44% |
| **Ethiopia** | Urban | 2000 | 189 | 33.78 | 9.43 | 38% |
| | Rural | 2000 | 1043 | 35.34 | 2.15 | 64% |
| **Haiti** | Urban | 2000 | 384 | 34.24 | 7.55 | 48% |
| | Rural | 2000 | 962 | 36.56 | 3.29 | 68% |
| **Kazakhstan** | Urban | 1999 | 360 | 36.09 | 12.17 | 72% |
| | Rural | 1999 | 499 | 36.09 | 11.45 | 47% |
| **Madagascar** | Urban | 2003 | 629 | 35.61 | 9.07 | 52% |
| | Rural | 2003 | 723 | 35.87 | 4.46 | 50% |
| **Malawi** | Urban | 2004 | 264 | 32.96 | 8.41 | 9% |
| | Rural | 2004 | 1471 | 34.06 | 5.41 | 37% |
| **Mali** | Urban | 2006 | 545 | 35.22 | 4.66 | 50% |
| | Rural | 2006 | 1619 | 36.33 | 1.32 | 58% |
| **Mozambique** | Urban | 2003 | 411 | 34.63 | 6.77 | 37% |
| | Rural | 2003 | 914 | 35.65 | 3.47 | 56% |
| **Nepal** | Urban | 2001 | 82 | 37.10 | 7.76 | 56% |
| | Rural | 2001 | 1240 | 35.92 | 4.16 | 61% |
| **Nicaragua** | Urban | 1998 | 712 | 34.89 | 7.32 | 57% |
| | Rural | 1998 | 674 | 35.53 | 3.10 | 55% |
| **Nigeria** | Urban | 1999 | 523 | 34.52 | 9.17 | 22% |
| | Rural | 1999 | 586 | 34.88 | 6.33 | 54% |
| **Peru** | Urban | 1996 | 867 | 35.02 | 10.35 | 27% |
| | Rural | 1996 | 395 | 35.90 | 6.89 | 37% |
| **Philippines** | Urban | 2003 | 903 | 35.77 | 9.90 | 22% |
| | Rural | 2003 | 1795 | 35.88 | 7.66 | 33% |
| **Tanzania** | Urban | 1999 | 384 | 33.90 | 7.68 | 36% |
| | Rural | 1999 | 1307 | 35.28 | 5.70 | 48% |
| **Togo** | Urban | 1998 | 400 | 33.85 | 7.35 | 42% |
| | Rural | 1998 | 1004 | 35.04 | 4.09 | 52% |
| **Zambia** | Urban | 1996 | 334 | 33.92 | 9.22 | 21% |
| | Rural | 1996 | 504 | 34.71 | 6.63 | 38% |

Source: Authors' elaboration based on Demographic and Health Surveys used for estimation.

**Table 7. Share of national population (by gender) following a given transition path going from T0 to T2 (for each set of male and female population results the numbers need to sum to one to get the whole male and female population respectively)**

| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | T0 | T1 | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Bangladesh | Male | RC | Stay_R1 | 0.677 | | 0.104 | 0.022 |
| Bangladesh | Male | RC | Migr_R1 | | | 0.010 | 0.036 |
| Bangladesh | Male | RC | Migr_U1 | | 0.003 | 0.014 | 0.044 |
| Bangladesh | Male | UC | Stay_U1 | | 0.065 | 0.012 | 0.004 |
| Bangladesh | Male | UC | Migr_R1 | | | 0.001 | 0.004 |
| Bangladesh | Male | UC | Migr_U1 | | 0.000 | 0.001 | 0.004 |
| Bangladesh | Female | RC | Stay_R1 | 0.124 | | 0.567 | 0.052 |
| Bangladesh | Female | RC | Migr_R1 | 0.000 | | 0.068 | 0.070 |
| Bangladesh | Female | RC | Migr_U1 | | 0.001 | 0.009 | 0.019 |
| Bangladesh | Female | UC | Stay_U1 | | 0.025 | 0.011 | 0.017 |
| Bangladesh | Female | UC | Migr_R1 | 0.000 | | 0.007 | 0.007 |
| Bangladesh | Female | UC | Migr_U1 | | 0.001 | 0.007 | 0.015 |
| Benin | Male | RC | Stay_R1 | 0.604 | | 0.089 | 0.088 |
| Benin | Male | RC | Migr_R1 | 0.000 | | 0.001 | 0.000 |
| Benin | Male | RC | Migr_U1 | | | 0.055 | 0.030 |
| Benin | Male | UC | Stay_U1 | | 0.054 | | 0.035 |
| Benin | Male | UC | Migr_R1 | 0.008 | | 0.032 | 0.004 |
| Benin | Male | UC | Migr_U1 | | | 0.000 | 0.000 |
| Benin | Female | RC | Stay_R1 | 0.360 | | 0.143 | 0.132 |
| Benin | Female | RC | Migr_R1 | | | 0.165 | 0.013 |
| Benin | Female | RC | Migr_U1 | | 0.000 | 0.037 | 0.018 |
| Benin | Female | UC | Stay_U1 | | 0.038 | 0.000 | 0.042 |
| Benin | Female | UC | Migr_R1 | | | 0.048 | 0.004 |
| Benin | Female | UC | Migr_U1 | | 0.000 | 0.000 | 0.000 |
| Brazil | Male | RC | Stay_R1 | 0.132 | | 0.049 | 0.103 |
| Brazil | Male | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Brazil | Male | RC | Migr_U1 | | | 0.031 | 0.166 |
| Brazil | Male | UC | Stay_U1 | | 0.221 | 0.007 | 0.215 |
| Brazil | Male | UC | Migr_R1 | 0.013 | | 0.005 | 0.008 |
| Brazil | Male | UC | Migr_U1 | | | 0.008 | 0.044 |
| Brazil | Female | RC | Stay_R1 | 0.097 | | 0.082 | 0.174 |
| Brazil | Female | RC | Migr_R1 | 0.001 | | 0.003 | 0.002 |
| Brazil | Female | RC | Migr_U1 | | 0.000 | 0.026 | 0.095 |
| Brazil | Female | UC | Stay_U1 | | 0.223 | 0.002 | 0.187 |
| Brazil | Female | UC | Migr_R1 | 0.003 | | 0.013 | 0.009 |
| Brazil | Female | UC | Migr_U1 | | 0.000 | 0.018 | 0.064 |
| Burkina Faso | Male | RC | Stay_R1 | 0.571 | | 0.218 | 0.035 |
| Burkina Faso | Male | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Burkina Faso | Male | RC | Migr_U1 | | | 0.077 | 0.038 |
| Burkina Faso | Male | UC | Stay_U1 | | 0.024 | 0.004 | 0.013 |
| Burkina Faso | Male | UC | Migr_R1 | 0.002 | | 0.004 | 0.003 |
| Burkina Faso | Male | UC | Migr_U1 | | | 0.007 | 0.004 |
| Burkina Faso | Female | RC | Stay_R1 | 0.355 | | 0.217 | 0.041 |
| Burkina Faso | Female | RC | Migr_R1 | 0.000 | | 0.254 | 0.025 |
| Burkina Faso | Female | RC | Migr_U1 | | | 0.036 | 0.011 |
| Burkina Faso | Female | UC | Stay_U1 | | 0.023 | 0.000 | 0.014 |
| Burkina Faso | Female | UC | Migr_R1 | 0.000 | | 0.022 | 0.002 |
| Burkina Faso | Female | UC | Migr_U1 | | | 0.000 | 0.000 |

| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | **T0** | **T1** | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Cameroon | Male | RC | Stay_R1 | 0.273 | | 0.096 | 0.027 |
| Cameroon | Male | RC | Migr_R1 | 0.000 | | 0.008 | 0.033 |
| Cameroon | Male | RC | Migr_U1 | | 0.014 | 0.168 | 0.123 |
| Cameroon | Male | UC | Stay_U1 | | 0.060 | 0.060 | 0.039 |
| Cameroon | Male | UC | Migr_R1 | 0.000 | | 0.002 | 0.008 |
| Cameroon | Male | UC | Migr_U1 | | 0.004 | 0.049 | 0.036 |
| Cameroon | Female | RC | Stay_R1 | 0.191 | | 0.122 | 0.165 |
| Cameroon | Female | RC | Migr_R1 | 0.000 | | 0.121 | 0.032 |
| Cameroon | Female | RC | Migr_U1 | | 0.000 | 0.054 | 0.057 |
| Cameroon | Female | UC | Stay_U1 | | 0.074 | 0.006 | 0.096 |
| Cameroon | Female | UC | Migr_R1 | 0.000 | | 0.040 | 0.011 |
| Cameroon | Female | UC | Migr_U1 | | 0.000 | 0.015 | 0.016 |
| Dominican Republic | Male | RC | Stay_R1 | 0.261 | | 0.020 | 0.206 |
| Dominican Republic | Male | RC | Migr_R1 | 0.000 | | 0.015 | 0.002 |
| Dominican Republic | Male | RC | Migr_U1 | | 0.002 | 0.027 | 0.043 |
| Dominican Republic | Male | UC | Stay_U1 | | 0.243 | 0.011 | 0.078 |
| Dominican Republic | Male | UC | Migr_R1 | 0.000 | | 0.048 | 0.008 |
| Dominican Republic | Male | UC | Migr_U1 | | 0.001 | 0.014 | 0.022 |
| Dominican Republic | Female | RC | Stay_R1 | 0.211 | | 0.044 | 0.195 |
| Dominican Republic | Female | RC | Migr_R1 | 0.000 | | 0.037 | 0.009 |
| Dominican Republic | Female | RC | Migr_U1 | | 0.000 | 0.026 | 0.056 |
| Dominican Republic | Female | UC | Stay_U1 | | 0.236 | 0.015 | 0.067 |
| Dominican Republic | Female | UC | Migr_R1 | 0.000 | | 0.041 | 0.010 |
| Dominican Republic | Female | UC | Migr_U1 | | 0.000 | 0.018 | 0.038 |
| Egypt | Female | RC | Stay_R1 | 0.409 | | 0.074 | 0.072 |
| Egypt | Female | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Egypt | Female | RC | Migr_U1 | | 0.007 | 0.000 | 0.012 |
| Egypt | Female | UC | Stay_U1 | | 0.295 | 0.031 | 0.083 |
| Egypt | Female | UC | Migr_R1 | 0.004 | | 0.010 | 0.002 |
| Egypt | Female | UC | Migr_U1 | | 0.000 | 0.000 | 0.001 |
| Ethiopia | Male | RC | Stay_R1 | 0.632 | | 0.178 | 0.043 |
| Ethiopia | Male | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Ethiopia | Male | RC | Migr_U1 | | 0.005 | 0.032 | 0.024 |
| Ethiopia | Male | UC | Stay_U1 | | 0.033 | 0.005 | 0.025 |
| Ethiopia | Male | UC | Migr_R1 | 0.001 | | 0.002 | 0.004 |
| Ethiopia | Male | UC | Migr_U1 | | 0.001 | 0.008 | 0.006 |
| Ethiopia | Female | RC | Stay_R1 | 0.583 | | 0.202 | 0.014 |
| Ethiopia | Female | RC | Migr_R1 | 0.017 | | 0.020 | 0.018 |
| Ethiopia | Female | RC | Migr_U1 | | 0.013 | 0.013 | 0.035 |
| Ethiopia | Female | UC | Stay_U1 | | 0.054 | 0.009 | 0.005 |
| Ethiopia | Female | UC | Migr_R1 | 0.004 | | 0.005 | 0.004 |
| Ethiopia | Female | UC | Migr_U1 | | 0.001 | 0.001 | 0.002 |

| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | **T0** | **T1** | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Haiti | Male | RC | Stay_R1 | 0.557 | | 0.086 | 0.095 |
| Haiti | Male | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Haiti | Male | RC | Migr_U1 | | 0.000 | 0.025 | 0.040 |
| Haiti | Male | UC | Stay_U1 | | 0.101 | 0.005 | 0.044 |
| Haiti | Male | UC | Migr_R1 | 0.004 | | 0.017 | 0.001 |
| Haiti | Male | UC | Migr_U1 | | 0.000 | 0.010 | 0.016 |
| Haiti | Female | RC | Stay_R1 | 0.486 | | 0.154 | 0.096 |
| Haiti | Female | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Haiti | Female | RC | Migr_U1 | | 0.000 | 0.029 | 0.037 |
| Haiti | Female | UC | Stay_U1 | | 0.091 | 0.008 | 0.043 |
| Haiti | Female | UC | Migr_R1 | 0.005 | | 0.017 | 0.002 |
| Haiti | Female | UC | Migr_U1 | | 0.000 | 0.014 | 0.017 |
| Jordan | Female | RC | Stay_R1 | 0.156 | | 0.039 | 0.115 |
| Jordan | Female | RC | Migr_R1 | 0.000 | | 0.001 | 0.000 |
| Jordan | Female | RC | Migr_U1 | | 0.008 | 0.027 | 0.104 |
| Jordan | Female | UC | Stay_U1 | | 0.332 | 0.000 | 0.184 |
| Jordan | Female | UC | Migr_R1 | 0.004 | | 0.024 | 0.003 |
| Jordan | Female | UC | Migr_U1 | | 0.000 | 0.001 | 0.003 |
| Kazakhstan | Male | RC | Stay_R1 | 0.250 | | 0.082 | 0.122 |
| Kazakhstan | Male | RC | Migr_R1 | 0.000 | | 0.001 | 0.001 |
| Kazakhstan | Male | RC | Migr_U1 | | 0.004 | 0.011 | 0.033 |
| Kazakhstan | Male | UC | Stay_U1 | | 0.373 | 0.032 | 0.062 |
| Kazakhstan | Male | UC | Migr_R1 | 0.002 | | 0.003 | 0.003 |
| Kazakhstan | Male | UC | Migr_U1 | | 0.002 | 0.005 | 0.014 |
| Kazakhstan | Female | RC | Stay_R1 | 0.146 | | 0.105 | 0.050 |
| Kazakhstan | Female | RC | Migr_R1 | 0.000 | | 0.063 | 0.083 |
| Kazakhstan | Female | RC | Migr_U1 | | 0.007 | 0.016 | 0.032 |
| Kazakhstan | Female | UC | Stay_U1 | | 0.330 | 0.033 | 0.081 |
| Kazakhstan | Female | UC | Migr_R1 | 0.000 | | 0.010 | 0.013 |
| Kazakhstan | Female | UC | Migr_U1 | | 0.004 | 0.009 | 0.017 |
| Madagascar | Male | RC | Stay_R1 | 0.523 | | 0.218 | 0.008 |
| Madagascar | Male | RC | Migr_R1 | | | 0.000 | 0.011 |
| Madagascar | Male | RC | Migr_U1 | | 0.005 | 0.007 | 0.069 |
| Madagascar | Male | UC | Stay_U1 | | 0.089 | 0.057 | |
| Madagascar | Male | UC | Migr_R1 | | | 0.000 | 0.013 |
| Madagascar | Male | UC | Migr_U1 | | | Eps | Eps |
| Madagascar | Female | RC | Stay_R1 | 0.350 | | 0.393 | 0.012 |
| Madagascar | Female | RC | Migr_R1 | 0.000 | | 0.006 | 0.023 |
| Madagascar | Female | RC | Migr_U1 | | 0.008 | 0.004 | 0.045 |
| Madagascar | Female | UC | Stay_U1 | | 0.080 | 0.056 | 0.001 |
| Madagascar | Female | UC | Migr_R1 | 0.000 | | 0.004 | 0.017 |
| Madagascar | Female | UC | Migr_U1 | | 0.000 | 0.000 | 0.000 |
| Malawi | Male | RC | Stay_R1 | 0.340 | | 0.414 | 0.048 |
| Malawi | Male | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Malawi | Male | RC | Migr_U1 | | | 0.065 | 0.060 |
| Malawi | Male | UC | Stay_U1 | | 0.006 | 0.026 | 0.012 |
| Malawi | Male | UC | Migr_R1 | 0.003 | | 0.003 | 0.003 |
| Malawi | Male | UC | Migr_U1 | | | 0.010 | 0.009 |
| Malawi | Female | RC | Stay_R1 | 0.358 | | 0.409 | 0.051 |
| Malawi | Female | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Malawi | Female | RC | Migr_U1 | | | 0.049 | 0.058 |
| Malawi | Female | UC | Stay_U1 | | 0.004 | 0.031 | 0.016 |
| Malawi | Female | UC | Migr_R1 | 0.002 | | 0.002 | 0.002 |
| Malawi | Female | UC | Migr_U1 | | | 0.007 | 0.008 |

| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | **T0** | **T1** | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Mali | Male | RC | Stay_R1 | 0.497 | | 0.064 | 0.043 |
| Mali | Male | RC | Migr_R1 | 0.000 | | 0.029 | 0.038 |
| Mali | Male | RC | Migr_U1 | | | 0.114 | 0.049 |
| Mali | Male | UC | Stay_U1 | | 0.095 | 0.014 | 0.020 |
| Mali | Male | UC | Migr_R1 | 0.000 | | 0.005 | 0.007 |
| Mali | Male | UC | Migr_U1 | | | 0.018 | 0.008 |
| Mali | Female | RC | Stay_R1 | 0.465 | | 0.123 | 0.064 |
| Mali | Female | RC | Migr_R1 | | | 0.120 | 0.025 |
| Mali | Female | RC | Migr_U1 | | 0.000 | 0.009 | 0.027 |
| Mali | Female | UC | Stay_U1 | | 0.097 | 0.015 | 0.015 |
| Mali | Female | UC | Migr_R1 | | | 0.017 | 0.004 |
| Mali | Female | UC | Migr_U1 | | 0.000 | 0.005 | 0.014 |
| Morocco | Female | RC | Stay_R1 | 0.240 | | 0.141 | 0.192 |
| Morocco | Female | RC | Migr_R1 | 0.002 | | 0.003 | 0.001 |
| Morocco | Female | RC | Migr_U1 | | 0.007 | 0.016 | 0.027 |
| Morocco | Female | UC | Stay_U1 | | 0.213 | 0.000 | 0.132 |
| Morocco | Female | UC | Migr_R1 | 0.007 | | 0.012 | 0.005 |
| Morocco | Female | UC | Migr_U1 | | 0.000 | 0.001 | 0.001 |
| Mozambique | Male | RC | Stay_R1 | 0.572 | | 0.143 | 0.034 |
| Mozambique | Male | RC | Migr_R1 | | | 0.051 | 0.049 |
| Mozambique | Male | RC | Migr_U1 | | | 0.021 | 0.045 |
| Mozambique | Male | UC | Stay_U1 | | 0.033 | 0.015 | 0.009 |
| Mozambique | Male | UC | Migr_R1 | | | 0.006 | 0.006 |
| Mozambique | Male | UC | Migr_U1 | | | 0.005 | 0.010 |
| Mozambique | Female | RC | Stay_R1 | 0.581 | | 0.102 | 0.077 |
| Mozambique | Female | RC | Migr_R1 | | | 0.098 | 0.023 |
| Mozambique | Female | RC | Migr_U1 | | 0.000 | 0.014 | 0.023 |
| Mozambique | Female | UC | Stay_U1 | | 0.035 | 0.005 | 0.015 |
| Mozambique | Female | UC | Migr_R1 | | | 0.011 | 0.003 |
| Mozambique | Female | UC | Migr_U1 | | 0.000 | 0.006 | 0.010 |
| Namibia | Female | RC | Stay_R1 | 0.508 | | 0.067 | 0.103 |
| Namibia | Female | RC | Migr_R1 | | | 0.069 | 0.027 |
| Namibia | Female | RC | Migr_U1 | | 0.000 | 0.008 | 0.031 |
| Namibia | Female | UC | Stay_U1 | | 0.111 | 0.005 | 0.025 |
| Namibia | Female | UC | Migr_R1 | | | 0.018 | 0.007 |
| Namibia | Female | UC | Migr_U1 | | 0.000 | 0.004 | 0.017 |
| Nepal | Male | RC | Stay_R1 | 0.620 | | 0.256 | 0.049 |
| Nepal | Male | RC | Migr_R1 | | | Eps | Eps |
| Nepal | Male | RC | Migr_U1 | | 0.000 | 0.023 | 0.013 |
| Nepal | Male | UC | Stay_U1 | | 0.024 | 0.006 | 0.002 |
| Nepal | Male | UC | Migr_R1 | 0.000 | | 0.001 | 0.001 |
| Nepal | Male | UC | Migr_U1 | | 0.000 | 0.003 | 0.002 |
| Nepal | Female | RC | Stay_R1 | 0.107 | | 0.770 | 0.059 |
| Nepal | Female | RC | Migr_R1 | | | Eps | Eps |
| Nepal | Female | RC | Migr_U1 | | 0.000 | 0.013 | 0.011 |
| Nepal | Female | UC | Stay_U1 | | 0.006 | 0.005 | 0.010 |
| Nepal | Female | UC | Migr_R1 | 0.001 | | 0.002 | 0.002 |
| Nepal | Female | UC | Migr_U1 | | 0.000 | 0.008 | 0.006 |
| Nicaragua | Male | RC | Stay_R1 | 0.281 | | 0.042 | 0.107 |
| Nicaragua | Male | RC | Migr_R1 | 0.000 | | 0.031 | 0.001 |
| Nicaragua | Male | RC | Migr_U1 | | 0.002 | 0.017 | 0.040 |
| Nicaragua | Male | UC | Stay_U1 | | 0.303 | 0.013 | 0.080 |
| Nicaragua | Male | UC | Migr_R1 | 0.000 | | 0.044 | 0.002 |
| Nicaragua | Male | UC | Migr_U1 | | 0.001 | 0.010 | 0.025 |

| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | **T0** | **T1** | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Nicaragua | Female | RC | Stay_R1 | 0.277 | | 0.034 | 0.103 |
| Nicaragua | Female | RC | Migr_R1 | 0.000 | | 0.030 | 0.003 |
| Nicaragua | Female | RC | Migr_U1 | | 0.000 | 0.017 | 0.058 |
| Nicaragua | Female | UC | Stay_U1 | | 0.301 | 0.026 | 0.048 |
| Nicaragua | Female | UC | Migr_R1 | 0.000 | | 0.049 | 0.004 |
| Nicaragua | Female | UC | Migr_U1 | | 0.000 | 0.011 | 0.038 |
| Niger | Female | RC | Stay_R1 | 0.578 | | 0.241 | 0.032 |
| Niger | Female | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Niger | Female | RC | Migr_U1 | | 0.001 | 0.002 | 0.025 |
| Niger | Female | UC | Stay_U1 | | 0.076 | 0.012 | 0.010 |
| Niger | Female | UC | Migr_R1 | 0.001 | | 0.007 | 0.007 |
| Niger | Female | UC | Migr_U1 | | 0.000 | 0.001 | 0.006 |
| Nigeria | Male | RC | Stay_R1 | 0.485 | | 0.119 | 0.033 |
| Nigeria | Male | RC | Migr_R1 | 0.001 | | 0.001 | 0.001 |
| Nigeria | Male | RC | Migr_U1 | | | 0.084 | 0.100 |
| Nigeria | Male | UC | Stay_U1 | | 0.041 | 0.071 | 0.019 |
| Nigeria | Male | UC | Migr_R1 | 0.001 | | 0.002 | 0.001 |
| Nigeria | Male | UC | Migr_U1 | | | 0.018 | 0.022 |
| Nigeria | Female | RC | Stay_R1 | 0.504 | | 0.146 | 0.005 |
| Nigeria | Female | RC | Migr_R1 | 0.016 | | 0.019 | 0.011 |
| Nigeria | Female | RC | Migr_U1 | | | 0.042 | 0.082 |
| Nigeria | Female | UC | Stay_U1 | | 0.041 | 0.062 | 0.025 |
| Nigeria | Female | UC | Migr_R1 | 0.003 | | 0.003 | 0.002 |
| Nigeria | Female | UC | Migr_U1 | | | 0.013 | 0.026 |
| Paraguay | Female | RC | Stay_R1 | 0.376 | | 0.044 | 0.060 |
| Paraguay | Female | RC | Migr_R1 | 0.000 | | 0.038 | 0.004 |
| Paraguay | Female | RC | Migr_U1 | | | 0.040 | 0.082 |
| Paraguay | Female | UC | Stay_U1 | | 0.203 | 0.007 | 0.052 |
| Paraguay | Female | UC | Migr_R1 | 0.000 | | 0.056 | 0.005 |
| Paraguay | Female | UC | Migr_U1 | | | 0.011 | 0.022 |
| Peru | Male | RC | Stay_R1 | 0.181 | | 0.045 | 0.069 |
| Peru | Male | RC | Migr_R1 | 0.001 | | 0.004 | 0.001 |
| Peru | Male | RC | Migr_U1 | | | 0.041 | 0.084 |
| Peru | Male | UC | Stay_U1 | | 0.158 | 0.023 | 0.214 |
| Peru | Male | UC | Migr_R1 | 0.009 | | 0.026 | 0.005 |
| Peru | Male | UC | Migr_U1 | | | 0.045 | 0.094 |
| Peru | Female | RC | Stay_R1 | 0.238 | | 0.013 | 0.076 |
| Peru | Female | RC | Migr_R1 | 0.000 | | 0.001 | 0.000 |
| Peru | Female | RC | Migr_U1 | | | 0.029 | 0.069 |
| Peru | Female | UC | Stay_U1 | | 0.242 | 0.032 | 0.117 |
| Peru | Female | UC | Migr_R1 | 0.007 | | 0.046 | 0.004 |
| Peru | Female | UC | Migr_U1 | | | 0.037 | 0.089 |
| Philippines | Male | RC | Stay_R1 | 0.222 | | 0.079 | 0.116 |
| Philippines | Male | RC | Migr_R1 | | | 0.087 | 0.030 |
| Philippines | Male | RC | Migr_U1 | | | 0.031 | 0.089 |
| Philippines | Male | UC | Stay_U1 | | 0.088 | 0.020 | 0.080 |
| Philippines | Male | UC | Migr_R1 | | | 0.039 | 0.013 |
| Philippines | Male | UC | Migr_U1 | | | 0.027 | 0.078 |
| Philippines | Female | RC | Stay_R1 | 0.172 | | 0.085 | 0.077 |
| Philippines | Female | RC | Migr_R1 | 0.000 | | 0.101 | 0.058 |
| Philippines | Female | RC | Migr_U1 | | | 0.037 | 0.124 |
| Philippines | Female | UC | Stay_U1 | | 0.079 | 0.037 | 0.075 |
| Philippines | Female | UC | Migr_R1 | 0.000 | | 0.024 | 0.014 |
| Philippines | Female | UC | Migr_U1 | | | 0.027 | 0.090 |

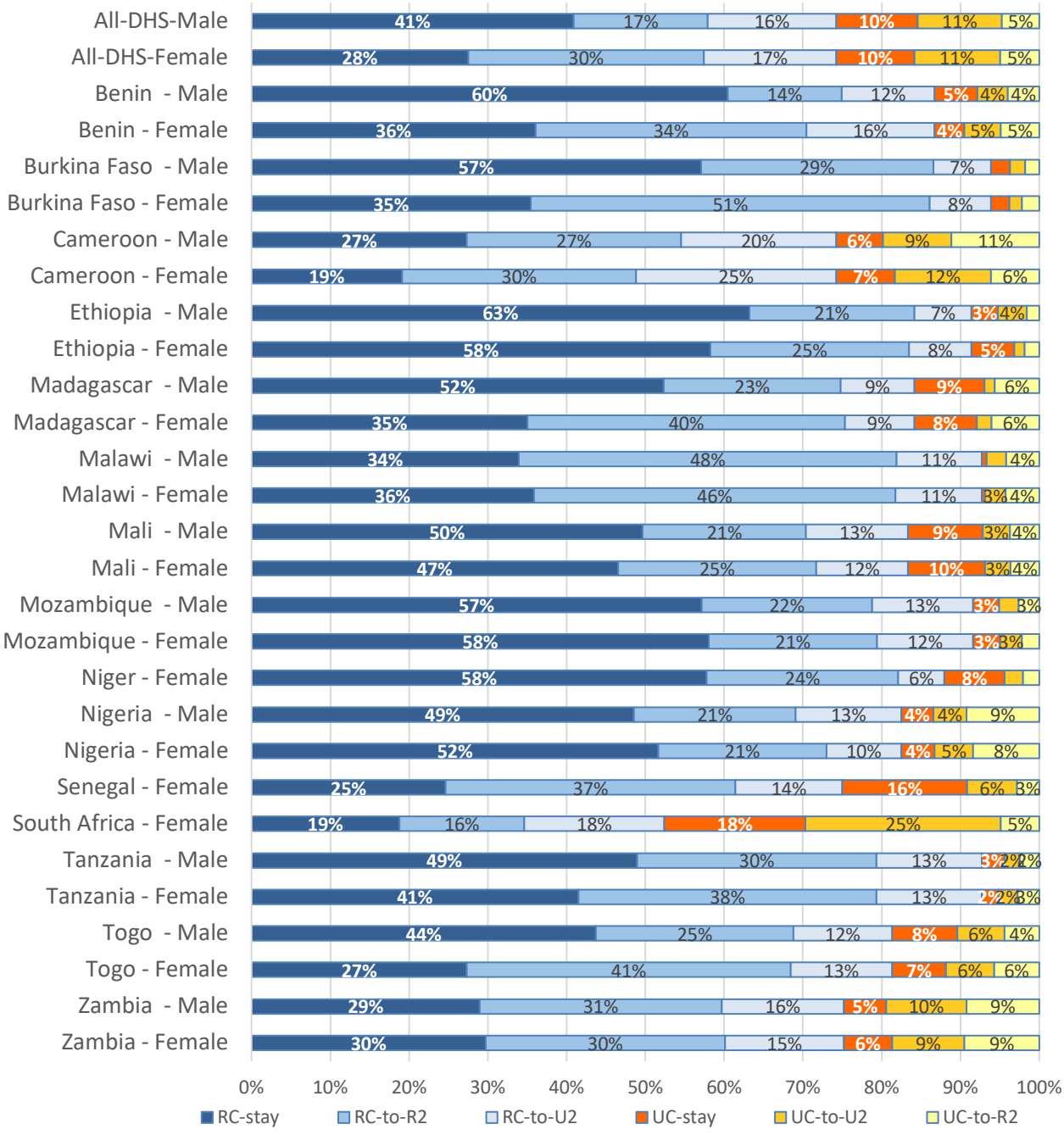
| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | **T0** | **T1** | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Senegal | Female | RC | Stay_R1 | 0.247 | | 0.178 | 0.081 |
| Senegal | Female | RC | Migr_R1 | 0.004 | | 0.146 | 0.037 |
| Senegal | Female | RC | Migr_U1 | | 0.002 | 0.040 | 0.017 |
| Senegal | Female | UC | Stay_U1 | | 0.158 | 0.002 | 0.056 |
| Senegal | Female | UC | Migr_R1 | 0.001 | | 0.022 | 0.006 |
| Senegal | Female | UC | Migr_U1 | | 0.000 | 0.004 | 0.002 |
| South Africa | Female | RC | Stay_R1 | 0.188 | | 0.076 | 0.071 |
| South Africa | Female | RC | Migr_R1 | 0.001 | | 0.074 | 0.041 |
| South Africa | Female | RC | Migr_U1 | | 0.000 | 0.007 | 0.067 |
| South Africa | Female | UC | Stay_U1 | | 0.179 | 0.016 | 0.113 |
| South Africa | Female | UC | Migr_R1 | 0.000 | | 0.019 | 0.010 |
| South Africa | Female | UC | Migr_U1 | | 0.000 | 0.014 | 0.125 |
| Tanzania | Male | RC | Stay_R1 | 0.490 | | 0.182 | 0.042 |
| Tanzania | Male | RC | Migr_R1 | | | 0.097 | 0.055 |
| Tanzania | Male | RC | Migr_U1 | | | 0.024 | 0.037 |
| Tanzania | Male | UC | Stay_U1 | | 0.029 | 0.012 | 0.007 |
| Tanzania | Male | UC | Migr_R1 | | | 0.008 | 0.004 |
| Tanzania | Male | UC | Migr_U1 | | | 0.005 | 0.008 |
| Tanzania | Female | RC | Stay_R1 | 0.415 | | 0.154 | 0.071 |
| Tanzania | Female | RC | Migr_R1 | | | 0.171 | 0.023 |
| Tanzania | Female | RC | Migr_U1 | | | 0.053 | 0.040 |
| Tanzania | Female | UC | Stay_U1 | | 0.021 | 0.000 | 0.020 |
| Tanzania | Female | UC | Migr_R1 | | | 0.027 | 0.004 |
| Tanzania | Female | UC | Migr_U1 | | | 0.000 | 0.000 |
| Togo | Male | RC | Stay_R1 | 0.437 | | 0.176 | 0.068 |
| Togo | Male | RC | Migr_R1 | 0.000 | | 0.001 | 0.000 |
| Togo | Male | RC | Migr_U1 | | 0.000 | 0.073 | 0.056 |
| Togo | Male | UC | Stay_U1 | | 0.083 | 0.005 | 0.045 |
| Togo | Male | UC | Migr_R1 | 0.006 | | 0.022 | 0.007 |
| Togo | Male | UC | Migr_U1 | | 0.000 | 0.010 | 0.008 |
| Togo | Female | RC | Stay_R1 | 0.274 | | 0.279 | 0.034 |
| Togo | Female | RC | Migr_R1 | 0.000 | | 0.111 | 0.067 |
| Togo | Female | RC | Migr_U1 | | 0.001 | 0.021 | 0.027 |
| Togo | Female | UC | Stay_U1 | | 0.069 | 0.027 | 0.028 |
| Togo | Female | UC | Migr_R1 | 0.000 | | 0.010 | 0.006 |
| Togo | Female | UC | Migr_U1 | | 0.001 | 0.020 | 0.026 |
| Uzbekistan | Female | RC | Stay_R1 | 0.378 | | 0.182 | 0.055 |
| Uzbekistan | Female | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Uzbekistan | Female | RC | Migr_U1 | | 0.005 | 0.002 | 0.022 |
| Uzbekistan | Female | UC | Stay_U1 | | 0.247 | 0.037 | 0.054 |
| Uzbekistan | Female | UC | Migr_R1 | 0.005 | | 0.007 | 0.002 |
| Uzbekistan | Female | UC | Migr_U1 | | 0.001 | 0.000 | 0.003 |
| Vietnam | Female | RC | Stay_R1 | 0.451 | | 0.293 | 0.037 |
| Vietnam | Female | RC | Migr_R1 | 0.000 | | 0.000 | 0.000 |
| Vietnam | Female | RC | Migr_U1 | | 0.005 | 0.008 | 0.021 |
| Vietnam | Female | UC | Stay_U1 | | 0.098 | 0.026 | 0.027 |
| Vietnam | Female | UC | Migr_R1 | 0.005 | | 0.007 | 0.004 |
| Vietnam | Female | UC | Migr_U1 | | 0.003 | 0.004 | 0.011 |
| Zambia | Male | RC | Stay_R1 | 0.290 | | 0.236 | 0.068 |
| Zambia | Male | RC | Migr_R1 | 0.004 | | 0.006 | 0.003 |
| Zambia | Male | RC | Migr_U1 | | 0.000 | 0.061 | 0.085 |
| Zambia | Male | UC | Stay_U1 | | 0.054 | 0.036 | 0.046 |
| Zambia | Male | UC | Migr_R1 | 0.008 | | 0.013 | 0.005 |
| Zambia | Male | UC | Migr_U1 | | 0.000 | 0.036 | 0.051 |

| | | | | Action between t1 and time survey was administered (T2) | | | |
|---|---|---|---|---|---|---|---|
| | | **T0** | **T1** | Stay_R2 | Stay_U2 | Migr_R2 | Migr_U2 |
| Zambia | Female | RC | Stay_R1 | 0.297 | | 0.120 | 0.075 |
| Zambia | Female | RC | Migr_R1 | 0.000 | | 0.135 | 0.025 |
| Zambia | Female | RC | Migr_U1 | | 0.000 | 0.049 | 0.051 |
| Zambia | Female | UC | Stay_U1 | | 0.061 | 0.017 | 0.051 |
| Zambia | Female | UC | Migr_R1 | 0.000 | | 0.046 | 0.008 |
| Zambia | Female | UC | Migr_U1 | | 0.000 | 0.031 | 0.033 |

Source: Authors' elaboration based on estimation results.

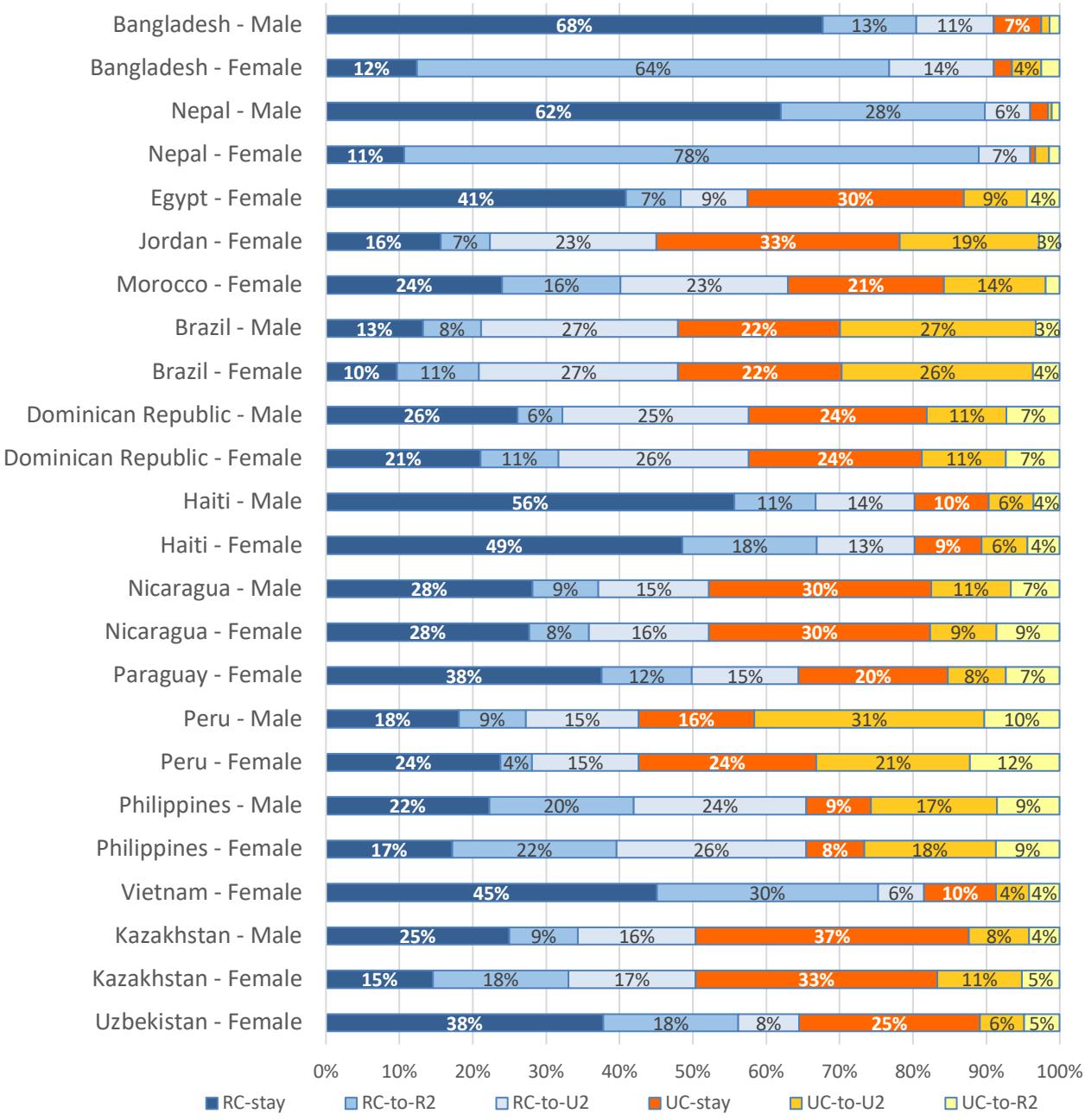
## Annex 2. Migration outcome between childhood and time of survey (ignoring multiple moves that happened in-between childhood and survey)

**Figure 4. Share of population that migrated or remained based on childhood residence and current location at time of survey (for whole DHS sample and for countries in sub-Saharan Africa)**




Source: Authors' estimates.

**Figure 5. Share of population that migrated or remained based on childhood residence and current location at time of survey (other regions)**




Source: Authors' estimates.

## Annex 3. Migration estimation model

This appendix sets out the migration model equations that are solved to provide estimates of the migration probabilities in the Markov migration transition matrices. The estimation methodology starts with the structure of the transition matrices described in the paper. Separately for males and females, there are two possible initial states in time T0: Rural Childhood (RC) and Urban Childhood (UC). In T1, there are three possible "destinations" for movement from the two initial states, and in T2 there are also three possible destinations for movement from the six possible T1 states. For each Markov transition matrix, there are 18 possible frequencies to be estimated – the rest are not possible and are fixed at zero.

In estimating migration transition probabilities, we use four types of information: (1) a Bayesian prior for the transition probabilities; (2) DHS data that provide partial specification of the results of the migration process, and some data on individual cells; (3) estimates of the degree of measurement error in the data; and (4) adding up constraints for the process – all migrants have to be accounted for, so the transition probabilities have to sum to one. Below, we describe the migration model estimation equations, following notation conventions that are based on the GAMS programming language, which was used for estimation (Bussieck and Meeraus, 2004). We start with definitions of the sets of all nodes and possible transitions. We then present the transition model equations and all constraints on probability values, and then discussion the treatment of measurement error. In GAMS, the summation operator for an expression over an index is written as SUM (index, expression).

### Sets of possible transitions

Set "node" includes all possible nodes in the Markov representation. Subsets of "node" are shown with parentheses (node).

### Set definitions

Node: Set of all possible nodes

| | |
|---|---|
| RC | Rural childhood (t0) |
| UC | Urban childhood (t0) |
| Stay_R1 | Stay in same rural area at t1 as in t0 (t1) |
| Stay_U1 | Stay in same urban area at t1 as in t0 (t1) |
| Migr_R1 | Moving to rural area after childhood (t1) |
| Migr_U1 | Moving to urban area after childhood (t1) |
| Stay_R2 | Stay in same rural area at t2 as in t0 & t1 (t2) |
| Stay_U2 | Stay in same urban area at t2 as in t0 & t1 (t2) |
| Mig_R1_SR2 | Stay in same rural area at t2 as in t1 after migrating from t0 to t1(t2) |
| Mig_U1_SU2 | Stay in same urban area at t2 as in t1 after migrating from t0 to t1(t2) |
| Migr_R2 | Currently in rural areas after migrating btw t1 and t2 (t2) |
| Migr_U2 | Currently in urban areas after migrating btw t1 and t2 (t2) |

Node_t0(node): nodes at t=0 in Markov representation

RC Rural childhood (t0)

UC Urban childhood (t0)

Node_t1(node): nodes at t=1 in Markov representation

Stay_R1 Stay in same rural area at t1 as in t0 (t1)

Stay_U1 Stay in same urban area at t1 as in t0 (t1)

Migr_R1 Moving to rural area after childhood (t1)

Migr_U1 Moving to urban area after childhood (t1)

Node_t2(node): nodes at t=2 in Markov representation

Stay_R2 Stay in same rural area at t2 as in t0 & t1 (t2)

Stay_U2 Stay in same urban area at t2 as in t0 & t1 (t2)

Mig_R1_SR2 Stay in same rural area at t2 as in t1 after migrating from t0 to t1 (t2)

Mig_U1_SU2 Stay in same urban area at t2 as in t1 after migrating from t0 to t1(t2)

Migr_R2 Currently in rural areas after migrating btw t1 and t2 (t2)

Migr_U2 Currently in urban areas after migrating btw t1 and t2 (t2)

RurUrb: rural urban aggregation of nodes at t1 and t2

R1 All rural population share at t1

U1 All urban population share at t1

R2 All rural population share at t2

U2 All urban population share at t2

RurUrb_t1(RurUrb): rural urban aggregation of nodes at t1

R1 All rural population share at t1

U1 All urban population share at t1

RurUrb_t2(RurUrb): rural urban aggregation of nodes at t2

R2 All rural population share at t2

U2 All urban population share at t2

Mapping of possible links between nodes over time.

Node before the period is linked to nodes in parentheses after the period.

MAP_ALL(node1, node2): links between nodes compatible with viable transitions

RC .(Stay_R1, Migr_R1, Migr_U1)

UC .(Stay_U1, Migr_R1, Migr_U1)

Stay_R1 .(Stay_R2, Migr_R2, Migr_U2)

Stay_U1 .(Stay_U2, Migr_R2, Migr_U2)

Migr_R1 .(Migr_R2, Migr_U2, Mig_R1_SR2)

Migr_U1 .(Migr_R2, Migr_U2, Mig_U1_SU2)

MAP_MIG(node1, node2): links for which we have data (excludes staying put)

RC .(Migr_R1, Migr_U1)

UC .(Migr_R1, Migr_U1)

Stay_R1 .(Migr_R2, Migr_U2)

Stay_U1 .(Migr_R2, Migr_U2)

Migr_R1 .(Migr_R2, Migr_U2)

Migr_U1 .(Migr_R2, Migr_U2)

MAP_RURURB(RurUrb, node1): rural urban breakdown at t1 and t2

R1 .(Stay_R1, Migr_R1)

R2 .(Stay_R2, Migr_R2, Mig_R1_SR2)

U1 .(Stay_U1, Migr_U1)

U2 .(Stay_U2, Migr_U2, Mig_U1_SU2)

MAP_STAY(node1, node2): links where people are staying put

RC .Stay_R1

UC .Stay_U1

Migr_R1 .Mig_R1_SR2

Migr_U1 .Mig_U1_SU2

Stay_R1 .Stay_R2

Stay_U1 .Stay_U2

MAP_RET(node_t0,node_t1,node_t2): return paths for rural-urban-rural and urban-rural-urban

RC .Migr_U1 .Migr_R2

UC .Migr_R1 .Migr_U2

MAP_LIFE_SHIFT(node_t0,node_t2): rural in childhood, currently urban (and vice versa)

RC .(Mig_U1_SU2, Migr_U2)

UC .(Mig_R1_SR2, Migr_R2)

MAP_RECENT_MIG(node1, node2): links with recent migration

Migr_R1 .(Migr_R2, Migr_U2)

Migr_U1 .(Migr_R2, Migr_U2)

## Variable and equation names

**Variable names**

| | |
|---|---|
| lifetime_migV(node0,RurUrb) | lifetime migration in DHS from node1 to node2 in DHS data (Question 1) |
| recent_migV(RurUrb,node2) | recent migration in DHS data (Qeestion 2) |
| lifetime_stayV(node0,node2) | lifetime stayers in DHS data (Question 2) |
| ret_migV(node0) | returnees in DHS data |
| P(node1,node2) | probability of migrating between two nodes |

**Names of migration equations**

| | |
|---|---|
| FINAL_DEST_EQ(node,RurUrb) | lifetime migration from childhood to current urban or rural node |
| RECENT_MIG_EQ(RurUrb,node) | migrations after childhood from an urban or rural node |
| STAY_EQ(node,node) | shares of people not moving over their lifetime |
| RETURN_EQ(node_t0) | share of returnees to rural and to urban areas |

**Names of adding up constraint equations**

| | |
|---|---|
| ADDING_UP_EQ(node) | shares of population (transition probabilities) migrating or staying must sum up to 1 |
| STOCKS_EQ1(node) | population stock balance on inflow nodes at time t1 |
| STOCKS_EQ2(node) | population stock balance on inflow nodes at time t2 |

Data for Model Initialization

| | |
|---|---|
| POPSHR_t0(node_t0) | share of population that is rural or urban at t0 |

## Estimation equations

**Migration equations**

FINAL_DEST_EQ(node_t0,RurUrb) {For allowable RurUrb_t2 transitions}

**lifetime_migV**(node_t0,RurUrb)

=

SUM[(node_t1,node_t2) {Summing over allowable MAP_RURURB and MAP_ALL mappings}, **P**(node_t0,node_t1)***P**(node_t1,node_t2)]

RECENT_MIG_EQ(RurUrb,node_t2) {For allowable RurUrb_t1 transitions}

**recent_migV**(RurUrb,node_t2)

=

SUM(node_t1 {Summing over allowable MAP_RURURB and MAP_MIG mappings},

**P**(node_t1,node_t2))

STAY_EQ(node_t0,node_t2) {For allowable MAP_STAY mappings}

**lifetime_stayV**(node_t0,node_t2)

=

SUM(node_t1 {Summing over allowable MAP_STAY mappings},

**P**(node_t0,node_t1)*P(node_t1,node_t2))

RETURN_EQ(node_t0) {For allowable MAP_RET and MAP_LIFE_SHIFT mappings with data}

**ret_migV**(node_t0)*

[SUM((node_t1,node_t2){Summing over allowable MAP_RET mappings},

**POPSHR_t0**(node_t0)*P(node_t0,node_t1)***P**(node_t1,node_t2))

+ SUM((node_t1,node_t2){Summing over allowable MAP_LIFE_SHIFT mappings},

**POPSHR_t0**(node_t0)*P(node_t0,node_t1)***P**(node_t1,node_t2))]

=

SUM[(node_t1,node_t2){Summing over allowable MAP_RET mappings),

**POPSHR_t0**(node_t0)***P**(node_t0,node_t1)***P**(node_t1,node_t2)]

**Adding up Constraint Equations**

ADDING_UP_EQ(node) {for node_t0(node) or node_t1(node)}

SUM(node2 {over Map_all(node,node2)}, **P**(node,node2)) = 1

STOCKS_EQ1(node_t1)

**STOCK**(node_t1) =

SUM(node_t0 {over Map_all(node_t0,node_t1)},

**POPSHR_t0**(node_t0)*__P__(node_t0,node_t1))

STOCKS_EQ2(node_t2)

**STOCK**(node_t2) =

SUM(node_t1 {over Map_all(node_t1,node_t2)},

**STOCK**(node_t1)*__P__(node_t1,node_t2))

### Specification of measurement error

There are four variables for which we have data that are assumed to be measured with error: lifetime_migV, recent_migV, lifetime_stayV, and ret_migV. For each of these variables, we add an additional equation to the model specifying that the variable is subject to multiplicative error, and we specify a prior on the standard error of measurement for that variable.[12] The equations follow a standard form. Assume we have data for a variable, X, which is denoted by X0. We add an equation to the model:

X = X0·EXP(errX)

where EXP is the exponentiation operator and errX is the error variable. A value of errX = 0 implies no measurement error since EXP(0) = 1.

The variable errX is given by another equation specifying it as a weighted sum of an error support set, V(k) which has k elements.

errX = SUM[k, W(k)·V(k)]

where the W(k) variables are probability weights to be estimated and the values of V(k) define the domain over which the error is defined. The V(k) values are typically assumed to be equally spaced and span three standard deviations of measurement error. The probability weights, W(k), must sum to one. In effect, the measurement error is specified as following a discrete probability distribution whose estimated values determine the error.

We estimate the W(k) values using an information theoretic Bayesian approach where we specify a prior on the distribution that includes the number of discrete probabilities to be estimated (k) and a prior on the discrete W probabilities, which we specify as WBAR(k). The estimation procedure searches for a set of solution values of W(k) that minimizes the Kullback-Leibler cross-entropy divergence (KL) between the prior WBAR(k) and the estimated W(k).

KL = SUM(k, W(k)·LOG[W(k)/WBAR(k)]

[12] See Golan, Judge and Miller (1996) for a detailed discussion of the approach used here. The approach is used widely in estimating Social Accounting Matrices and national accounts data using scattered information measured with error. A GAMS program for such estimation, which demonstrates the methodology, is available from the GAMS program library that comes with the GAMS package. The file is “Cross Entropy SAM Estimation,” CESAM2, Sequence number 393, in the library.

The choice of k determines how general is the discrete distribution that is being estimated. The larger is k the more general or flexible is the distribution that is being estimated. For example, if k = 5, then the estimated distribution can have degrees of freedom for estimating up to four parameters (e.g., mean, variance, skewness, kurtosis). We typically specify the prior as either "informative" with specified moments or "uninformative" with a uniform distribution. For an uninformative uniform prior, we specify that WBAR(k) = 1/k. In our case, we use k = 5 and specify a normal prior with mean zero, variance ($Sigma^2$), skewness zero, and kurtosis ($3 \cdot Sigma^4$). The values for the error support set, V, are:

V = [-3·Sigma, -1.5·Sigma, 0, +1.5·Sigma, +3·Sigma]

The prior on the probability weights, WBAR, which are consistent with the normal distribution, can be derived by using the values of the mean, variance, skewness, and kurtosis for the discrete prior distribution. They are:

WBAR = [1/162, 16/81, 48/81, 16/81, 1/162]

We specify that the prior for the standard error of measurement is 0.05 for data for the four variables, which implies a domain for the error that runs from minus 15 percent to plus 15 percent.

Note that in Bayesian estimation, the priors provide the starting point for the estimation process. The results (the "posterior" distributions) will be determined by the estimation procedure. The data "pull" the estimated posterior distributions away from the prior.

### Objective function

In estimating the model, we minimize the sum of the Kullback-Leibler cross-entropy divergences for all the estimated probabilities. These include all the Markov migration transition probabilities and the probability weights for all variables measured with error. The estimation procedure is run separately for male and female migrants in each country.

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