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Migration Dynamics in Nairobi Slums

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Abstract:

Nairobi has grown at a fairly constant annual rate of 4.8% in the last 30 years. About 8 out of 10 of its inhabitants are migrants, and most of them came between 17 and 23 years old. This is indicative of a circular migration system, whereby the migrants consider the city as a transitory place of residence. The APHRC Nairobi Urban Health and Demographic Surveillance System (NUHDSS) offers a unique opportunity to measure in a precise way the in- and out-migration flows, as well as the determinants of these flows, during the 2003-2007 period. The results confirm the high intensity of migration flows: about a quarter of the total population of the two studied slums is renewed every year, and about one third in the 15-30 age bracket. This confirm the existence of a circular migration system whereby the majority of the slum dwellers are short-term migrants spending on average less than 3 years in the same slum. Although males are predominant in the slum population, the migration rates by age and by year do not differ much by gender. Also, the determinants of migration are very similar for males and females. Barring some data collection effects, regression results show that migration is higher among the most deprived slum dwellers, but that the least educated tend to stay longer in the slums. This suggests that a policy aiming at providing basic services (electricity, water and sanitation) in the slums would have a direct effect on decreasing the circulation of migrants. In addition to the obvious direct advantage at reducing health hazards, the indirect effect on the retention of migrants would then make health policies targeted at the poorest and the least educated easier to implement in the slums and would have multiplicative effect on the overall health indicators. Results also call for further analysis of the health determinants and consequences of migration.

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1. Introduction

Urban growth in sub-Saharan Africa is fuelled largely by sustained rural-urban migration of adult men and women mostly seeking to find jobs and other livelihood opportunities in urban areas. For example, half of the migrants to Nairobi came between 17 and 23 years old or so, and that did not change much over the past 40 years (Agwanda et al. 2008). Most of the migrants come as young adults, usually after secondary school. A majority of migrants comes to Nairobi to look for employment, while a minority comes for vocational or higher education.

The fall in employment opportunities did not result in a slow-down in the capital city's growth as a whole. Over the 1970s to the 1990s, Nairobi grew at a relatively constant rate, varying only from 4.7% to 4.9% a year. However the growth rate of the population in active age started to decline in the 1990s. Whereas it was above Nairobi population growth rate (5.1% a year in the 1970s and 5.2% in the 1980s) it went below in the 1990s (4.7%). The growth rate of the population in active age remained high for women and even slightly increased from the 1970s (5.7%) to the 1990s (6.0%), but for men, it went down from 4.8% in the 1970s and the 1980s to 3.9% in the 1990s. As the major labour market in Kenya, Nairobi is still attractive to many migrants—especially because other urban centres do not offer much of an alternative—but much less than in the past. This could be an indication that unemployment and lack of opportunity in the formal sector served as a deterrent to male migrants, especially in the 1990s when the economic crisis seems to have struck hard on the workers. It appears that female migration is less sensitive to the labour market situation as the female labour participation rate (51%) is much lower than for males (84%).

However, many migrants who continue to flock into the city live in over-crowed informal settlements, because of the stagnating economies and poor governance. It is estimated that between one and two million people live in cramped conditions in Nairobi slums, which are characterized by extreme poverty, poor sanitation, inadequate social services, insecurity, social fragmentation, and poor livelihood opportunities (APHRC, 2002).

The main objective of this paper is to examine the main determinants of migration movements in and out of two Nairobi slums – Korogocho and Viwandani. We use longitudinal data collected between 2003 and 2007 under the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) to monitor and evaluate health and demographic trends. First, the paradox of people continuing to flock into the poor slum communities justifies the need to examine and better understand the migration dynamics in these communities in Nairobi city. Second, understanding the migration dynamics in the DSS context is of great importance and the NUHDSS offers the opportunity to that respect. Indeed, not only migration is essential to monitor the population size and composition in the Demographic Surveillance Area (DSA) but also it greatly affects other behaviours, including fertility and mortality. Also, reliable estimation of the size of the resident population of the DSS site at any time during the follow-up period requires to accurately capture, monitor, and analyze these three events.

Given the possible sensitivity to field-work procedures (survey rounds are organized every 4 months to collect information on the same households, with possible changes in the field-work procedures between rounds), the paper aims also to evaluate importance

of calendar effects, in particular those related to field-work procedures and quality of the data collection. Lastly, this analysis is also an attempt to validate the Event History Analysis (EHA) technique to monitor migration and other events in a DSS context. This is the major difference between this study and similar ones conducted in the past on migration dynamics in DSS context since this is the first time that both in and out migration analysis is done using EHA technique. Previous studies used actuarial method to do it, and none used EHA technique for in-migration analysis. The same technique can be used for any other event recorded through the DSS.

2. Migration in the urban African context: research questions

Chen, Valente et al. (1998) showed that the contribution of natural growth to urban growth is more substantial in Africa than in other parts of the world: in this continent natural growth represents 75% of urban growth while this share was only 50% in Asia (without China) in the 1980s. Knowing that sub-Saharan Africa experienced a decline of urban growth in the 1990s and 2000s (Potts 1995; Bocquier & Traoré, 2000; Bocquier 2003), although this growth is still higher than the world average (Bocquier 2005), we can reasonably assume that migration contribute even less to the current Africa urban growth (Potts 2006). This is a normal phenomenon when considering the historical urban transition process: migration contributes mainly at the inception of the transition, while natural growth boosted by a young age structure as in most cities, and reclassification (when a locality crosses the urban population threshold and is no longer classified as rural), dominate at later stages of the transition. While the demographic transition is under way, we can also expect a fertility decline in urban areas, and, considering that mortality is on the rise due to HIV/AIDS, a further decline in African urban growth.

The mobility transition theory (Zelinsky 1971) predicts that as the urban transition progresses, urban-rural migration should give way to circulation. Where this has been studied in Africa, circular migration systems have indeed been confirmed in many cities: Harare, Zimbabwe (Potts 2000), Abidjan, Côte d'Ivoire (Beauchemin 2002), and Nairobi, Kenya (Agwanda et al. 2009). At the other end of the migration system, circulation has also been confirmed in rural areas (Clark et al. 2007; INDEPTH 2009). In short, the decline in urban growth does not seem to translate in a decline in migration intensity. Circular migration means on the contrary an intensification of the rural-urban migration.

Yet, circular migration has not been paid sufficient attention so far. DSS offer a rare opportunity to analyse migration flows both ways. In the case of Nairobi slums, does the circular migration hypothesis hold? If yes, what is the pattern of the circular migration system? The descriptive analysis of section 4 will help to measure the importance of in- and out-migration flows by sex and age, as well as the resulting population growth in the two slums covered by the DSS.

Migration theories have addressed the determinants of migration, with emphasis on migration decisions at the micro-level and employment being central since it is believed that migrants primarily moved from their rural places in search of job in urban areas. The well known theory of Todaro (Todaro 1969, Harris and Todaro 1970) is the first to hypothesize that potential migrants decide to move to urban settings if the financial costs of their migration is less than the positive difference between their expected earnings in their places of origin and different places of destination. This theory has been challenged, pointing out the fact that wage differentials cannot fully explain the movements towards cities but that a number of other noneconomic factors such as individual and household

characteristics as well as circumstances at the origin and destination are key determinants of the rural-urban migration (Bilsborrow, 1998).

The life-cycle approach posits that an individual's life is made up of transitions or life events whose interactions shape the decision to migrate over the lifetime (Kulu and Milewski, 2006; Lututala, 1995). Indeed, changes in educational, family and professional lives are considered to be major reasons why individuals need to move from their place of origin to a new area. For example, Lututala (1993) found that schooling is the main motive of the first migration in DRC (former Zaire) since access to education requires to move to the school area which is sometimes far from the place of residence. Also, subsequent graduation from school leads number of people to move to other areas where job opportunities corresponding to their skills are available. Evidence of links between changes in family life and migration was found in Ghana where being married or having more than two living children deters migration from rural to urban areas (Reed, Andrzejewski and White, 2005). Brockerhoff and Eu (1993) stressed the influence of family events on rural-urban migration in most countries in sub-Saharan Africa where, married women, those with at least two recent births were less likely to move to an urban area.

In rural areas in Africa, poor living conditions in conjunction with critical environmental hazards like drought, floods and famine pushed many people to move in search of better livelihood opportunities in urban areas (Oucho, 1998; Adepoju, 1993). Accordingly, rural households maximize their chances for survival by sending some of their members to urban places to look for other sources of income that their home places are unable to provide (Anderson, 2001). In addition, not only urban areas provide job opportunities but they also offer better health care and educational facilities that attract the poor rural inhabitants. In other words, migration is a way to diversify economic risks but also health, educative and other social risks at the household or family level. This risk diversification factor is probably explaining the circular pattern of migration in some areas.

Considering the circular migration system at hand, one key question is why should migrants stay short period of time in the slums when they could actually make the slum their own by staying longer? Are the living conditions and in particular the access to amenities, or lack thereof, a key determinant of the duration in the slums? Or is the circulation mainly dependent from the life cycle, i.e. the age of the migrant? DSS data are particularly adapted to answer these questions as long as the determinants of both in- and out-migrations are well collected.

3. Method

Korogocho and Viwandani are two informal settlements in Nairobi city, located about 5-10 km from the city centre and 3 km from each other. These two areas cover nearly 23 000 households. As later results will show, the total population in the two slums grow from about 53 000 in mid-2003 to about 57 500 in mid-2007. Korogocho has a more settled population since many of the residents have resided here for many years. On the other hand, Viwandani which lies close to Nairobi's industrial area attracts a youthful and highly mobile population seeking job opportunities in the nearby industries. This population is mainly made up of males and is also better educated compared to that in Korogocho.

3.1. Data collection

This paper draws on longitudinal data routinely collected under the NUHDSS that APHRC implemented since August 2002 Korogocho and Viwandani. As of December 2008, eighteen (18) rounds of data collection were completed. The initial census was carried out in 2000 to enumerate the initial residents to be followed-up over time in the DSA. Subsequently, fieldworkers are being sent, every round of survey, to visit households to collect information on key demographic events (births, deaths, migrations and internal changes of residence, etc.) that induce any changes in the initial size of the resident population in each area and in the whole DSA. In addition, information on health status (morbidity in the last two weeks, pregnancy related morbidity, verbal autopsy, vaccination, health seeking behaviour, etc), socio-economic status (marriage, education, household possessions and amenities, livelihood sources, and birth history information), and housing characteristics are collected. These information are also collected from new individuals that are registered every round. These new individuals enter DSA through in-migration or birth while those who exit DSA do so through death or out-migration.

The procedures related to the NUHDSS organization can impact the quality of data collected, with mediating or moderating influences on the analysis derived from. This includes decisions on data collection periodicity, coverage of the DSA, management of the internal moves, time threshold for external migration, change in questionnaire design, etc.

Indeed, from August 2002 to December 2007, the NUHDSS used the threshold period of 90 days of continuous residence to determine migration status. In- and out-migration occur across the DSA boundary. Movement within the DSA is considered as change of residence. That is, one had to live in the DSA for at least 90 days to be in-migrated and away from the DSA for at least 90 days for him/her to be out-migrated. The threshold period was changed from 90 days to 120 days from January 2007 in order to make fieldwork easier by having the same period for the visitation cycle and the threshold period. The visitation cycle was changed from 90 days to 120 days in May 2003.

Any movements between the two areas are considered as internal migrations or changes of residence. Internal out-migration and in-migration are called 'exit' and 'entry', respectively. In principle, a resident who 'exited' from a location in one the DSA area is supposed to 'enter' in another location in the other DSA area. But this is not always the case since some 'exit' individuals are not found by interviewers. These cases are called 'hanging cases' and induce biases in the calculation of demographic and health indicators in the DSA if they are not solved. Several measures have been implemented to tackle this issue, including a tracking system whereby a group of tracking and migrant officers (different from the usual fieldworkers) has been created in 2007 (Round 17) to trace and resolve the 'hanging cases'. As a result, 85% of the hanging cases accumulated between Round 0 and Round 15 were resolved, with most of them (77%) being finally found out as out-migrations (cf. APHRC Internal Report on Hanging cases, 2008). The DSS database was then updated accordingly. The tracking system is still ongoing to solve the remaining cases and those accumulated during the subsequent rounds. In this paper, we therefore analyze data covering the period between January 1, 2003 and December 31, 2007 since the data collected in 2008 are yet to be completely cleaned and updated with the resolved hanging cases.

It is likely that the changes in the periodicity and issues related to the internal and external movements in the DSA impact the quality of the data. Also, accuracy and reliability of the data collected may depend on fieldworkers who may have different comprehension of the questionnaire. Although several control procedures, either at fieldwork or computing level have been put in place to ensure good data quality, changes in data collection procedures and coding system may have an effect on the data quality and data analysis. The latter may be difficult if the follow-up data are not comparable over time. It is therefore important to control for data collection effect using for example survey round or fieldworker as covariates in the analysis of NUHDSS data.

In addition, the quality of out-migration data can also be hampered by the fact that the related information is collected from a proxy respondent, given that the respondent himself has left the DSA at the time of interview.

3.2. Measures

Out-migration and in-migration are both dependent variables examined in this analysis. A resident in the DSA is considered as out-migrant when he moved out of the DSA for at least 3 months (4 months from January 2007). Also, an individual is considered as in-migrant when he moved into the DSA to live there for at least 4 months (4 months from January 2007). However, for both out-migration and in-migration, we considered a 6-months periodicity to comply with the definition usually used in migration analysis. Each variable takes the value 1 when a person out-migrates or in-migrates and 0 otherwise.

The independent variables used in our models include trimester, rank of trimester, slum area, gender, educational attainment, marital status, period of notice of demolition (time-varying calendar variable), a set of household characteristics (toilet, tap water, KPLC power, ownership of the structure), fieldworker and ethnic group. To control for seasonal effects, trimester is used as a continuous variable while rank of trimester which indicates the rank of each trimester in each year is divided into four groups: trimester 1, trimester 2, trimester 3 and trimester 4. Educational attainment is divided into three groups: no education, primary education and secondary education or higher. Marital status is used as a dichotomous variable: married/lived together vs. not married. Ethnicity comprises seven groups – Kikuyu, Luyha, Luo, Kamba, Meru/Embu, Kisii, Somali – and a residual group of other ethnic groups. In each slum area, the period of notice of demolition characterizes the date when the Kenya Power Lighting Company (KPLC) told the residents that all structures constructed under high voltage electricity lines will be demolished. This period goes from January 4th, 2004 to March 2nd, 2004. Socio-economic status is measured through a set of four variables that characterize the household: whether the individual lives in a structure with access to toilets or not, whether the structure uses tap water or not, whether the shelter is connected to KPLC power or not, whether respondent is owner or not of the structure. Data collection procedures are controlled for using fieldworker group that classifies the fieldworkers into three categories: Group 1, group 2 and group 3. This classification is derived from the results of a prior Cox model (of out-migration and in-migration) with the sole fieldworker as covariate. Fieldworkers with chances less than 1 (negative) or null composed the group 1; those with non significant chances are in group 2 and those with chances greater than 1 or total (positive) are in group 3. Slum area comprised two categories: Korogocho and Viwandani. An interaction term between fieldworker group and slum area is included in the models.

3.3. Analytic approach

Migration study involves the analysis of both in- and out-migrations. The event of interest cannot be out-migration only, as in-migration forms part and parcel of the migration dynamic. In-migration rates are often computed using the aggregate-based method, i.e. in-migrations are counted for a specific time-interval (usually the year, or the month if one is interested in seasonal variations) and divided by the resident population at the beginning of the interval to produce migration probabilities or at mid-interval to produce migration rates. With out- and in-migration probabilities, techniques of the increment-decrement tables can apply (Kintner 2004).

At best, these are the techniques that were used in DSS. Most of the published analyses are descriptive in nature. This was typically the approach adopted so far to analyse APHRC DSS data (Zulu et al., 2006).

How does the life table method of analysing migration translate into EHA? The difficulty is not with out-migration, which can be analysed as any other demographic event, i.e. with decrement tables. The individual who experienced out-migration is removed from the population at risk, or at best (in the case of renewable event), remains in the population at risk until censoring by last observation or death. In-migration is more difficult to deal with because the in-migrants are incrementing the population at risk instead of decrementing it as for out-migration, death, marriage, etc. The population at risk is the population that receive the in-migrants (host population) and not the population from where the in-migrants originate (sending population). In other words, the in-migrant is added to the population at risk of receiving migrants.

Noticing that in-migration is just the opposite process of out-migration, our method consists in running the time of analysis in reverse in order to produce tables that will formally have the same structure and properties as decrement tables but which will be interpreted as increment tables. Beyond descriptive analysis, our method allows to conduct multivariate analysis on the determinants of in-migration in much the same way as out-migration is analysed.

In out-migration analysis the starting time of analysis is often birth, any specific age (e.g. age 15 or 18, when the migrant is likely to migrate of his/her own will), or a specific calendar date when one is to produce period-specific migration rates. When it comes to in-migration analysis, specific calendar dates or age can also be used, but reversing time will prevent us from using date of death (the mirror equivalent of date of birth) as a starting time of analysis. This is because death occurs at very different ages and therefore would introduce an unnecessary heterogeneity in the analysis time. In addition, death is in most cases not independent from migration behaviour. For these reasons, in order to produce age-specific in-migration rates, the analyst has to choose the age for starting the time in reverse, depending on the size of the sample and the scope of the analysis.

In this paper, we chose age 70 as our starting (reverse) time for in-migration analysis, as the population becomes small after this age, with likely consequence on the quality and precision of the estimates. To note, death and last observation time (last census round in DSS) are censoring events for out-migration analysis, whereas birth and first observation time (first census round in DSS) are censoring events for in-migration analysis using reverse time.

One way to validate the reverse-time technique is to verify that the population at risk of in-migration is, at each time-interval, exactly the same as for the out-migration tables produced with the normal-time technique. Beside this internal validation, one can check the quality of the migration data by looking at the trends in the population at risk, from which total growth rates can be computed and confronted to the net migration rates and natural growth rates.

4. Descriptive results

4.1. Age and sex pattern

Figure 1 presents rates of in- and out-migration to and from the DSA during the period between January 1, 2003 and December 31, 2007-2007. The migration intensity is particularly high in the DSA, with about a quarter of the residents moving in (26.7%) and out (27.1%) of the slums every year. In total, the annual out-migration rate was 22% for Korogocho and 31% for Viwandani. The corresponding annual in-migration rates are 21% and 32%. In general, curves show similar shapes, with rates decreasing between age 0-4 and age 10-14, followed by an increase until age 20-24 then a decrease till age 65-69. The general pattern observed is then the one of higher probability of movements (in- and out-) between 0-4 and 20-24 years old and lower probability between 10-14 and 25-69 years old. For both in-migration and out-migration, the highest pick is observed at age 20-24, where people are most likely to move in and out the DSA.

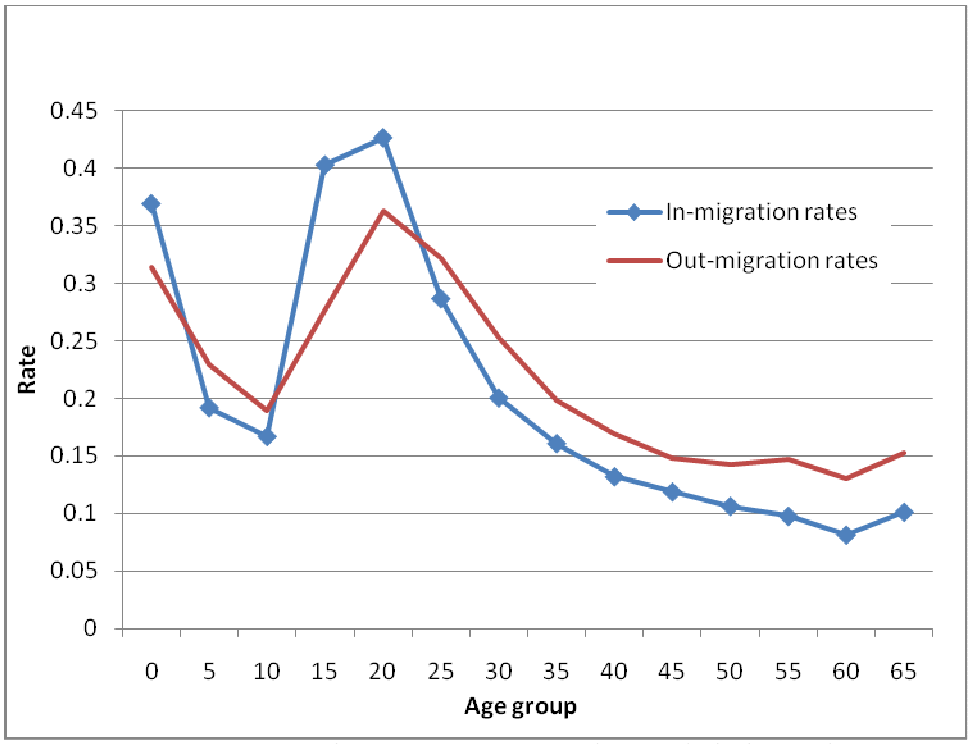

Figure 1: In- and out-migration rates by age (whole DSA)

Data also show that individuals aged less than 5 are less likely to in-migrate (37%) than to out-migrate (31%). The opposite holds between 5 and 14 years old where people are slightly more likely to move out of the DSA than to move into. Indeed, the in-migration rates were 19% and 17% for the 5-9 and 10-14 year old respectively whereas the out-migration rates were 23% and 19% for the same age groups. The major differences

between the two rates occur between 15 and 25 years old. At these ages, the in-migration rates are much higher than the out-migration rates. Forty percent of individuals aged 15-19 and 42% of those aged 20-24 moved into the slum areas, compared to 28% and 36% of their counterparts from the same respective groups who moved out of the communities. From age 25 to age 70, it appears that people are more likely to out-migrate than to in-migrate into the DSA. For example, at age 30-34, a quarter of residents are considered as out-migrants while only a fifty of their counterparts are in-migrants. Similarly, 15% and 10% of residents aged 65-69 are out-migrants and in-migrants, respectively.

The general pattern observed for the whole DSA applies when turning to consider each slum area separately, tough some slight differences are noticed. First, the high mobility of the population in Viwandani is corroborated by data showed by Figure 2. Indeed, at every age group, in- and out-migration rates are much higher in Viwandani than in Korogocho. For example, at age 10-14, 14% and 17% of residents in Korogocho are in-migrants and out-migrants respectively, compared to 21% in-migrants and 22% out-migrants in Viwandani, at the same age. The highest pick previously observed for the whole DSA seems to have been mainly brought about by the movements in Viwandani. Indeed, the probabilities of in-migration are as much higher as 58% and 51% at age 15-19 and 20-24, respectively, while in Korogocho, the in-migration rates only reach 29% at 15-19 and 30% at 20-24. Also, whereas 34% and 40% in Viwandani are out-migrants at age 15-19 and 20-24 respectively, it is the case of only 23% and 30% of their counterparts at the same age in Korogocho. It is noteworthy that the higher in-migration rate in Viwandani could be just due to a different application of data collection procedure (by fieldworkers) in this particular part of the DSA, rather than a consequence of its attractiveness. To ascertain this, we will include an interaction term between fieldworker and slum area in the regression models.

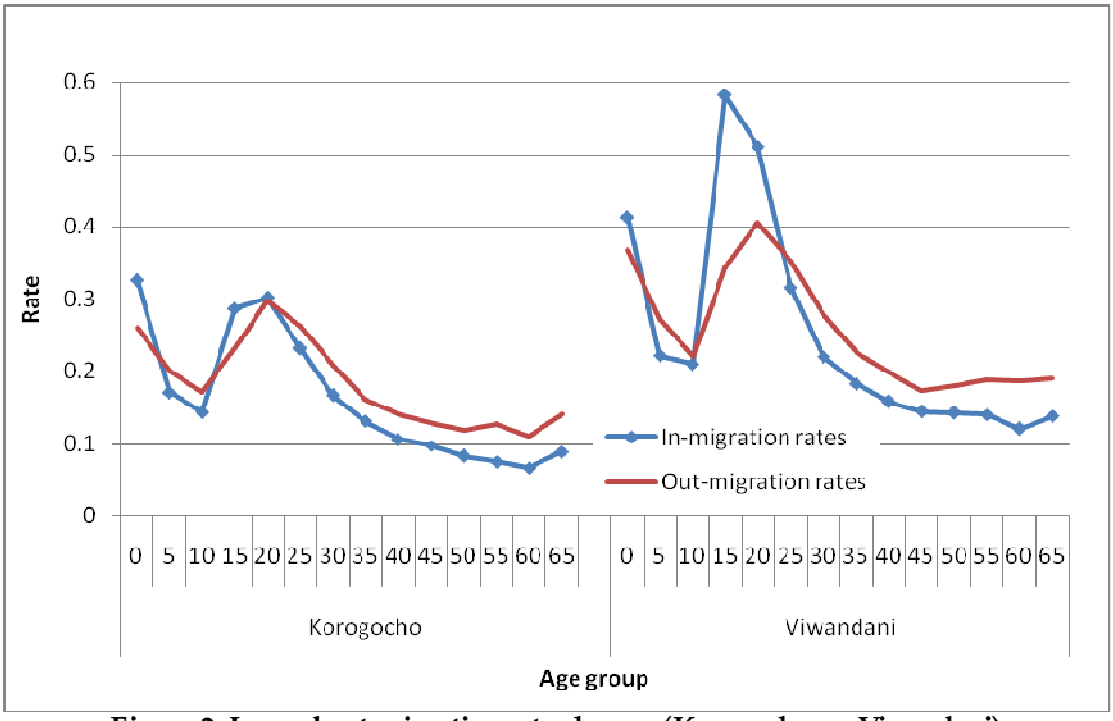

Figure 2: In- and out-migration rates by age (Korogocho vs. Viwandani)

Figure 3 shows gender differences in out- and in-migration rates for the whole DSA. In general, similar patterns are observed for males and females. There is not much

difference between males and females regarding both in-migration and out-migration. In total, the in-migration rate in the whole DSA was 29% for female and 26% for males. In the same way, 28% females and 26% males were out-migrants during the period 2003-2007. When looking at in-migration, data show that at every age group, females and males have same probability of in-migration, except at age group 15-19 where it appears that females are more likely to move into the DSA than males (45% vs. 35%). Turning to out-migration, females show higher rates of moving out than males at age groups 15-19 (31% vs. 23%) and 20-24 (38% vs. 34%). From age 60, males are clearly more likely to out-migrate than their female counterparts (16% vs. 9% at 60-64 and 18% vs. 11% at 65-69). A similar pattern is observed for both in-migration and out-migration when considering Korogocho and Viwandani separately.

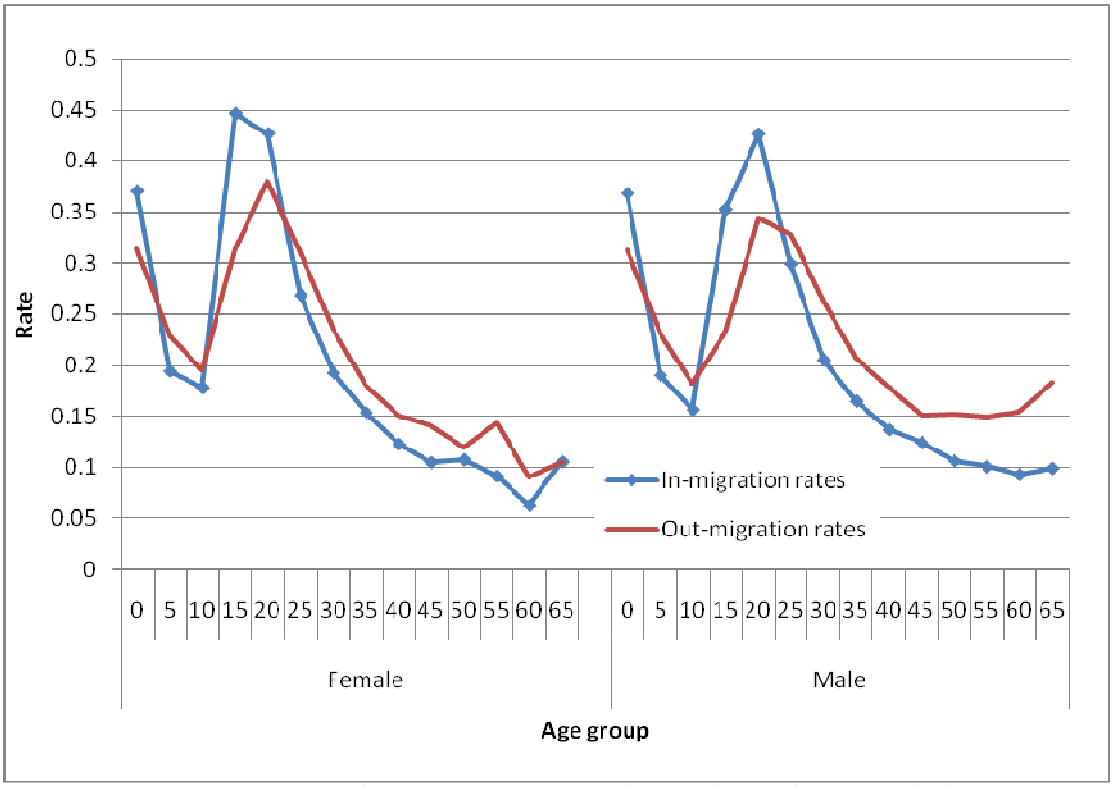

Figure 3: In- and out-migration rates by age (Females vs. Males)

4.2. Evidence of calendar effects

To capture possible calendar effects (either seasonal or not), we compute annual in- and out-migration rates during the period 2003-2007 that covers 60 months in total. First, monthly rates are calculated during the 60-month period. The ensuing annual rates are computed by multiplying the monthly rates by 12, assuming that an observed monthly rate will be the same during the whole year. The results are shown in Figures 4 to 8. For each figure, each number on the horizontal axis represents the number of months since January 1st, 2003 to December 31st, 2007 (0 represents January 1st, 2003 while the value 60 corresponds to December 31st, 2007).

Figure 4 presents the annual rates for the whole DSA. The general pattern observed is the one of higher probability of in-migration at the end of every year (around December), from mid-2003 to mid-2007, reflecting a seasonal effect. The out-migration pattern observed is the one of higher probability of moving out around the end of the preceding and the beginning of the following year, from mid-2003 to mid-2007. In particular, the

highest pick observed at the beginning of the year 2004 (12 on Figure 4) is due to the KPLC demolition of structures that led many slum residents to leave the areas. The trends observed during the period before July 2007 and the one after July 2007 are likely to reflect data collection procedures (for period before July 2003 where the DSS is still stabilizing its data collection procedures) and hanging cases (for the period after July 2007).

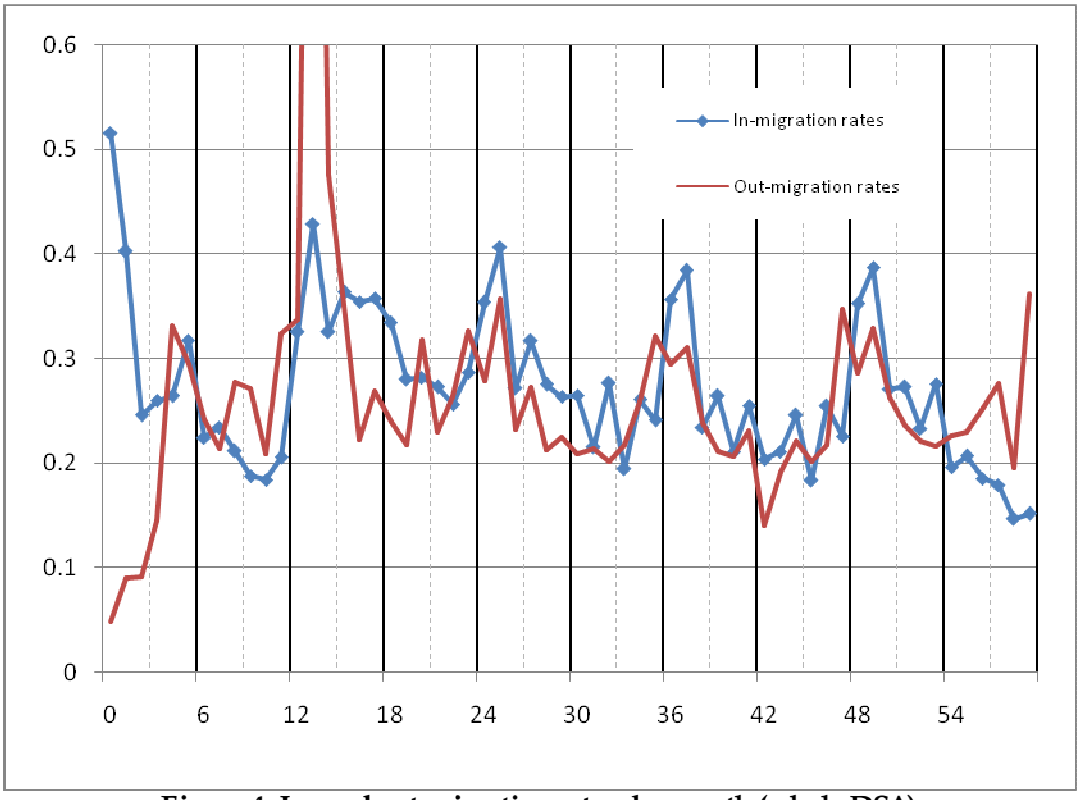

Figure 4: In- and out-migration rates, by month (whole DSA)

The Figures 5 and 6 show the same results for each slum area. The pattern of higher in- and out-migration rates holds for each slum community. The effect of KPLC demolition clearly appears in Viwandani but not in Korogocho.

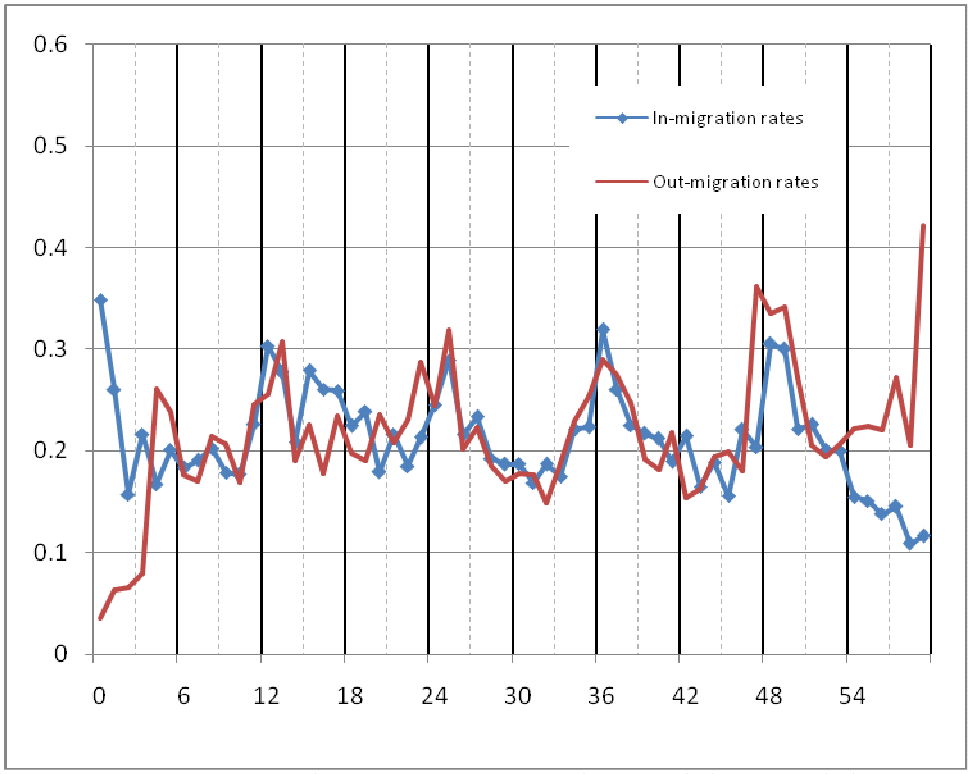

Figure 5: In- and out-migration rates, by month (Korogocho)

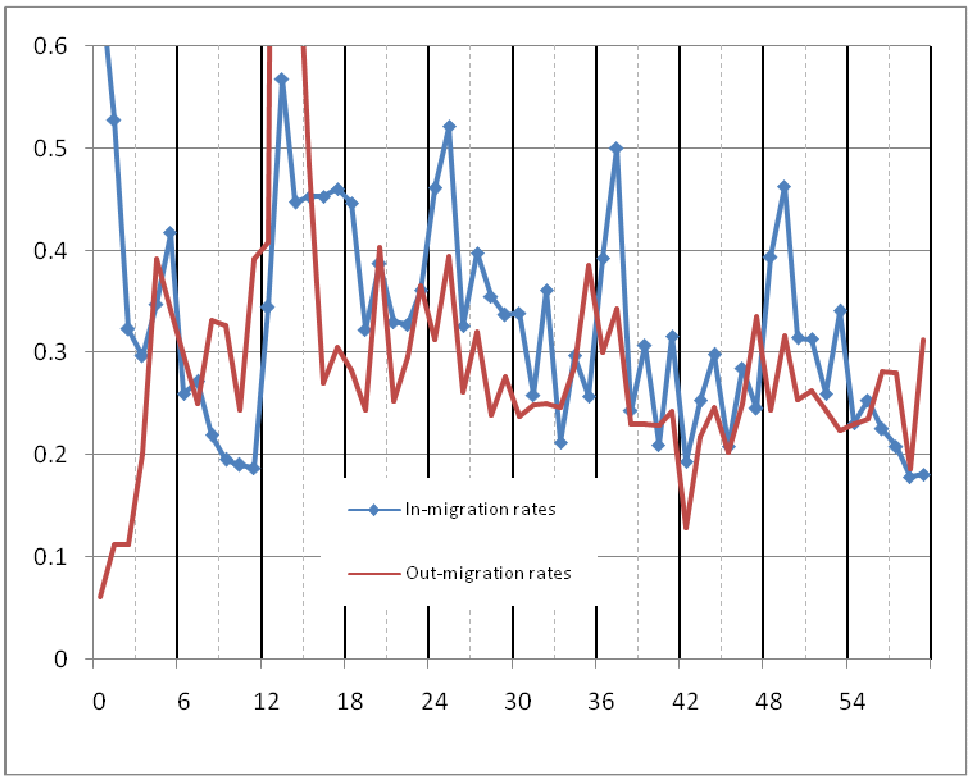

Figure 6: In- and out-migration rates, by month (Viwandani)

Figure 7 presents the net migration rates over the 2003-2007 period. Negative net migration rates reflect higher movements out of the slum communities, thus meaning that the DSA is losing its population, as was the case at the time of KPLC demolition in Viwandani. Positive net migration rates mean higher movements into the DSA, which is then gaining additional population. On average, after the KPLC demolition, Viwandani is

gaining more population than Korogocho. This can be seen in the population trends depicted in Figure 8. Despite the KPLC demolition, Viwandani grew faster than Korogocho from mid-2004 to mid-2007 (from mark 18 to mark 54 on Figure 8).

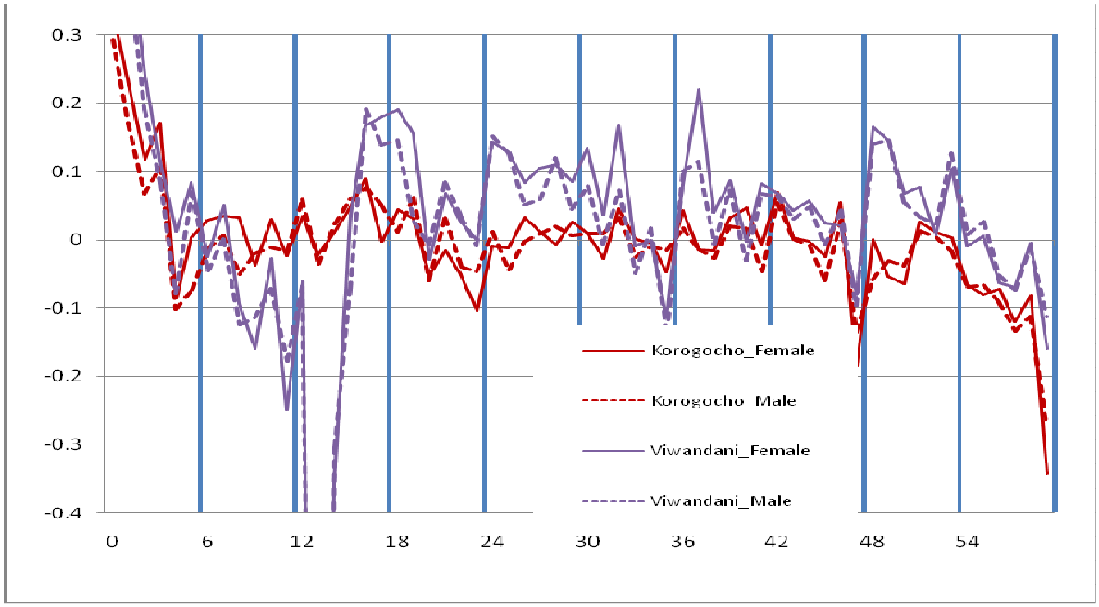

Figure 7: Net migration rates by sex in each slum, 2003-2007

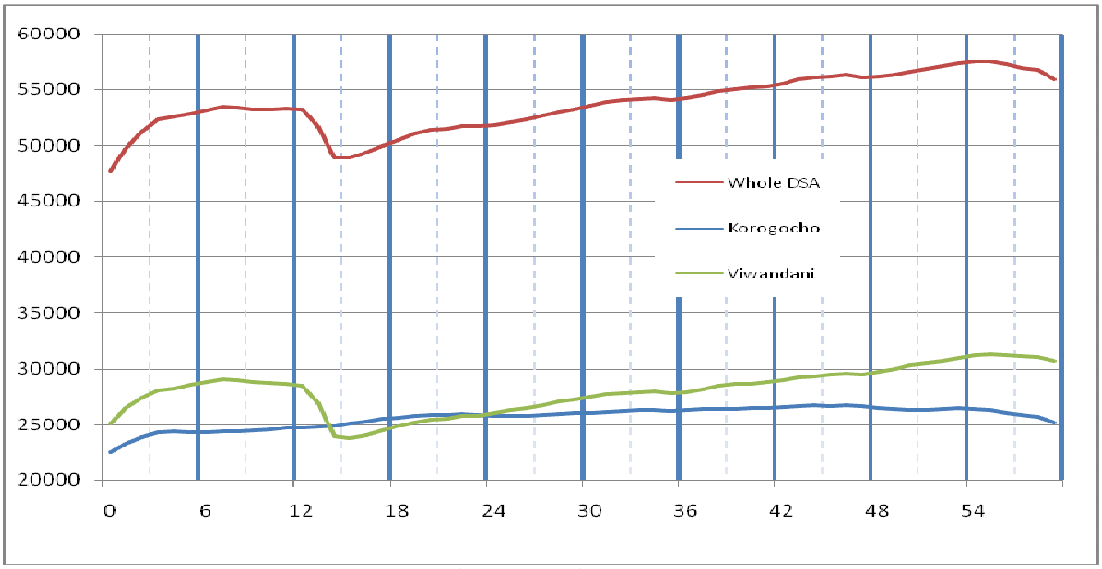

Figure 8: Slum population, 2003-2007

5. Regression analysis

For regression analysis, Cox proportional hazards model was used since it does not need to specify the form of the distribution of baseline hazard rate (Cox, 1984; Blossfeld and al., 1989; Courgeau and Lelièvre, 1989; Allison, 1991; Trussel et al., 1992; Bocquier, 1996). For each individual, the earliest observation time is July 1, 2003 and the latest is June 31, 2007. This covers a total of 77303 individuals aged at least 12 years old (as of July 1, 2003) in the DSA, of which 43167 are out-migrants and 41916 are in-migrants. Individuals are observed until the end of the observation time (the latest is June 31, 2007). Gaps are considered in the analysis since individuals can move in and out continuously. Three models were run; for male and female separately and for both sexes

(which is referred to as general model in the section). We interpret the findings from the general model and only comment on the gender-specific models if the results of the latter are different from those of the general model. When the hazard ratio is greater than one, it means a higher risk of occurrence of the event in the corresponding covariate (compared to the reference covariate). Conversely, the risk of occurrence of the event is lower when the coefficient is lesser than one.

5.1. Factors related to movements in and out of the slum areas

Findings from Cox models are shown in Table 1, Table 2 and Table 3. Results from separate models for males and females are presented in Tables 1 and 2, for out- and in-migration respectively. Table 3 displays results from general model for both sexes (in-migration vs. out-migration). In the general model, the trimester effect indicates a downward trend in both out-migration and in-migration (Table 3). Individuals are less likely to out-migrate or in-migrate during the 2nd, 3rd and 4th trimesters than during the first trimester. This seasonal pattern is continuous for in-migration, with the chances of in-migrating decreasing from the first trimester to the last, whereas it is not continuous for out-migration since the chances to out-migrate in trimester 4 are higher than those in trimesters 2 and 3.

The KPLC notice of demolition has a more significant positive effect on out-migration than on in-migration. It is expected that the chance of leaving the DSA increases during the period when the notice of demolition was given to the inhabitants. The fact that people are also more likely to in-migrate during the same period is likely to be a data collection issue rather than indicative of an increased attractiveness of the slum areas. Indeed, it is possible that the residential status of some people who changed residence within the same slum during this period was misreported by the fieldworkers. Those respondents who were already residents of the same slum were registered as out-migrants from an area and in-migrants in another place, thereby increasing the movements in and out of the DSA.

Differences based on ethnicity are observed for both movements, with Kikuyu being less likely to in-migrate or out-migrate than other ethnic groups (except Somali ethnic group). It should be reminded that Nairobi is situated in a predominantly Kikuyu region: the distance to the 'home' area is therefore reduced for this ethnic group and day-time moves might actually replace longer-term migration. Except for the Somali ethnic group, all the other ethnic groups have higher chances to move in or out of the DSA than the Kikuyu ethnic group. Education is significantly associated with out-migration and in-migration, with non educated residents being less likely to leave or move into the DSA areas than those with primary or secondary education. This implies that not only non educated people are more likely to move into the slums but also to stay longer in the slum areas once they are living in. In addition, current school attendance deters both in- and out-migration since those who are currently attending school have less chance to move in or out of the slum areas. Marriage or living together is significantly associated with movements in the DSA, with married people having less chance to in-migrate into or out-migrate from the slum communities.

With regard to household characteristics, results show that individuals living in a structure with sanitation (toilets) are less likely to out-migrate. Also, access to toilets seems to be attractive since individuals living in structures with such amenity have higher chances of in-migration. Living in a structure connected to KPLC power reduces the

likelihood of moving out and surprisingly deters also in-migration. This unexpected latter effect is probably an indication of the cost of KPLC power. These results indicate that the presence of basic needs like proper water or electricity may limit the movement out of the slum areas, thereby retaining the residents. While for out-migration, we did not find any significant differences based on having tap water in the structure, results indicate a positive but negligible (significant at 10%) effect of tap water on in-migration.

Being owner of his/her structure has a significant effect on out-migration, with residents being less likely to move out from the slums when they own their structures. To note, being tenant is the common norm in the slum communities (7 out of 8 slum dwellers are tenants). Also, individuals are less likely to in-migrate as owner of their structure since those with such attribute have less chance to in-migrate.

When looking at the interaction effect between fieldworker group and slum area, it appears that once controlled for fieldworker bias, individuals from Viwandani are more likely to out-migrate than their counterparts from Korogocho. But the differences based on slum area are negligible for in-migration. In fact, Viwandani seems to be less attractive than Korogocho but the effect is only significant for one group of fieldworker (Group 1). This is not consistent with the higher in-migration rates observed earlier (in the descriptive section) for Viwandani. This higher attractiveness for Viwandani could be explained by the fact that only those who are most likely to move into Viwandani do so. In fact, people moving into Viwandani are, on average, more educated; less likely to attend school and more likely to come from ethnic groups like Kamba, Kisii and Meru/Embu. The higher in-migration into Viwandani is mostly due to the characteristics of migrants, rather than to the net attractiveness of this slum area.

Gender has a significant effect on in- and out-migration, with males being less likely to move in and out of the DSA than females. However, for both out- and in-migration, the effects observed for both sexes in the general model hold for the gender-specific models, with minor differences regarding ethnicity and educational attainment (Table 1 and Table 2). For out-migration, if results for males show the same effect for ethnicity as in the general model, it is not the case for females where Somali ethnic group are less likely to out-migrate than other ethnic groups (Table 1). For in-migration, it seems that females belonging to Somali ethnic group are less likely to in-migrate than Kikuyu females. For males, Somali ethnic group has higher chance of in-migration (as the other ethnic groups) whereas no significant difference was found between Meru/Embu and Kikuyu (Table 2). With regard to education, if results for males show the same effect as in the general model, it is not the case for females where there is no significant difference between individuals with secondary education and those with primary education. Apart from these minor gender differences in ethnic and education, it should be noted that the effect of other covariates remains remarkably similar across gender. Although the population is predominantly male in the slums, the determinants of migration vary only marginally by gender. This is a noticeable result that goes counter to the conventional wisdom that conceive migration mechanism as being different for males and females.

Table 1. Out-migration model for individuals aged at least 12 years old (Female vs. Male, 2003-2007)

Variables	Female		Male	
	% person-years at risk	Hazard ratios (95% CI)	% person-years at risk	Hazard ratios (95% CI)
Trimester	8.67	0.985*** (0.981 - 0.988)	8.57	0.985*** (0.981 - 0.988)
Rank of trimester				
Trimester 1 [ref.]	24.66%	-	24.65%	-
Trimester 2	24.94%	0.807*** (0.768 - 0.848)	24.76%	0.803*** (0.767 - 0.841)
Trimester 3	25.12%	0.695*** (0.659 - 0.733)	25.27%	0.740*** (0.705 - 0.776)
Trimester 4	25.28%	0.887*** (0.844 - 0.932)	25.32%	0.849*** (0.811 - 0.889)
Notice of demolition				
No [ref.]	96.17%	-	96.06%	-
Yes	3.83%	2.330*** (2.181 - 2.491)	3.94%	2.785*** (2.632 - 2.946)
Ethnicity		-		-
Kikuyu [ref]	35.09%	-	29.77%	-
Luhya	13.43%	1.161*** (1.102 - 1.224)	13.31%	1.152*** (1.099 - 1.207)
Luo	15.88%	1.185*** (1.125 - 1.249)	14.52%	1.174*** (1.120 - 1.232)
Kamba	21.90%	1.107*** (1.058 - 1.158)	28.11%	1.065*** (1.025 - 1.107)
Meru/Embu	1.78%	1.165*** (1.039 - 1.306)	1.87%	1.176*** (1.061 - 1.302)
Kisii	3.49%	1.116** (1.023 - 1.216)	4.90%	1.188*** (1.112 - 1.271)
Somali	6.67%	0.863*** (0.779 - 0.956)	4.95%	1.025 (0.938 - 1.119)
Other	1.77%	1.308*** (1.165 - 1.469)	2.56%	1.437*** (1.320 - 1.564)
Education				
No education [ref]	6.67%	0.875*** (0.801 - 0.955)	3.11%	0.987 (0.900 - 1.082)
Primary	66.66%	-	58.82%	-
Secondary	24.53%	0.978 (0.944 - 1.013)	35.97%	0.982 (0.954 - 1.010)
Unknown	2.15%	1.309*** (1.197 - 1.431)	2.09%	1.354*** (1.258 - 1.457)
Currently in school	13.58%	0.672*** (0.626 - 0.722)	10.41%	0.747*** (0.692 - 0.806)
Ever married/ living together	47.28%	0.884*** (0.856 - 0.914)	49.49%	0.848*** (0.821 - 0.875)
Household characteristics				
HHD owns or shares toilet	94.76%	0.875*** (0.817 - 0.937)	93.88%	0.804*** (0.763 - 0.847)
Tap water in HHD	89.28%	1.014 (0.959 - 1.072)	89.92%	1.013 (0.965 - 1.064)
KPLC power in HHD	22.92%	0.677*** (0.646 - 0.709)	18.57%	0.666*** (0.637 - 0.696)
House owner	14.94%	0.677*** (0.633 - 0.724)	10.50%	0.619*** (0.580 - 0.662)
Fieldworker*Slum area				
Group 1 * Korogocho [ref.]	47.55%	-	39.92%	-
Group 2 * Korogocho	2.20%	1.119** (1.011 - 1.239)	1.65%	1.218*** (1.103 - 1.346)
Group 3*Korogocho	0.96%	1.495*** (1.312 - 1.704)	0.62%	1.559*** (1.357 - 1.790)
Group 1 * Viwandani	6.11%	1.107*** (1.027 - 1.192)	6.98%	1.132*** (1.064 - 1.204)
Group 2 * Viwandani	26.00%	1.256*** (1.200 - 1.314)	30.53%	1.357*** (1.304 - 1.411)
Group 3*Viwandani	17.18%	1.460*** (1.392 - 1.531)	20.30%	1.541*** (1.479 - 1.607)
Wald Chi-square	**-**	**3261.436*** **	**-**	**5287.475*** **
Subjects (Failures)	**-**	**32649 (18530)**	**-**	**44654 (24637)**
Time at risk	**63957.003**	**-**	**91389.018**	**-**

Robust 95% confidence intervals in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2. In-migration model for individuals aged at least 12 years old (Female vs. Male, 2003-2007)

Variables	Female		Male	
	% person-years at risk	Hazard ratios (95% CI)	% person-years at risk	Hazard ratios (95% CI)
Trimester	8.67	0.967*** (0.963 - 0.970)	8.57	0.965*** (0.961 - 0.968)
Rank of trimester				
Trimester 1 [ref]	24.66%	-	24.65%	-
Trimester 2	24.94%	0.877*** (0.839 - 0.918)	24.76%	0.892*** (0.856 - 0.930)
Trimester 3	25.12%	0.775*** (0.739 - 0.813)	25.27%	0.739*** (0.707 - 0.772)
Trimester 4	25.28%	0.727*** (0.693 - 0.762)	25.32%	0.713*** (0.682 - 0.745)
Notice of demolition				
No [ref]	96.17%	-	96.06%	-
Yes	3.83%	1.099** (1.014 - 1.190)	3.94%	1.069* (0.995 - 1.149)
Ethnicity				
Kikuyu [ref]	35.09%	-	29.77%	-
Luhya	13.43%	1.160*** (1.101 - 1.221)	13.31%	1.217*** (1.159 - 1.278)
Luo	15.88%	1.045* (0.992 - 1.101)	14.52%	1.130*** (1.076 - 1.186)
Kamba	21.90%	1.103*** (1.056 - 1.152)	28.11%	1.054*** (1.013 - 1.096)
Meru/Embu	1.78%	1.235*** (1.104 - 1.380)	1.87%	1.087 (0.980 - 1.207)
Kisii	3.49%	1.170*** (1.088 - 1.259)	4.90%	1.277*** (1.198 - 1.361)
Somali	6.67%	0.870*** (0.787 - 0.962)	4.95%	1.096* (0.995 - 1.207)
Other	1.77%	1.365*** (1.223 - 1.524)	2.56%	1.417*** (1.298 - 1.546)
Education				
No education	6.67%	0.498*** (0.441 - 0.563)	3.11%	0.590*** (0.516 - 0.675)
Primary [ref]	66.66%	-	58.82%	-
Secondary	24.53%	1.016 (0.982 - 1.051)	35.97%	1.035** (1.006 - 1.066)
Unknown	2.15%	1.643*** (1.507 - 1.790)	2.09%	1.426*** (1.310 - 1.551)
Currently in school	13.58%	0.327*** (0.304 - 0.353)	10.41%	0.426*** (0.394 - 0.461)
Ever married/ living together	47.28%	0.823*** (0.798 - 0.849)	49.49%	0.843*** (0.815 - 0.872)
Household characteristics				
HHD owns or shares toilet	94.76%	1.412*** (1.300 - 1.533)	93.88%	1.669*** (1.548 - 1.799)
Tap water in HHD	89.28%	1.062** (1.008 - 1.119)	89.92%	1.015 (0.968 - 1.064)
KPLC power in HHD	22.92%	0.896*** (0.861 - 0.933)	18.57%	0.924*** (0.888 - 0.961)
House owner	14.94%	0.552*** (0.514 - 0.592)	10.50%	0.527*** (0.490 - 0.566)
Fieldworker group * slum area				
Group 1 * Korogocho [ref.]	42.77%	-	35.88%	-
Group 2 * Korogocho	4.31%	1.718*** (1.582 - 1.865)	3.40%	2.002*** (1.851 - 2.165)
Group 3*Korogocho	3.63%	2.744*** (2.577 - 2.922)	2.91%	3.302*** (3.108 - 3.508)
Group 1 * Viwandani	23.93%	0.749*** (0.705 - 0.795)	29.31%	0.855*** (0.811 - 0.902)
Group 2 * Viwandani	7.29%	1.700*** (1.593 - 1.815)	8.46%	1.996*** (1.884 - 2.114)
Group 3*Viwandani	18.07%	2.758*** (2.633 - 2.890)	20.04%	3.219*** (3.077 - 3.367)
Wald Chi-square	**-**	**6555.603*** **	**-**	**7860.781*** **
Subjects (Failures)	**-**	**32649 (18653)**	**-**	**44654 (23263)**
Time at risk	**63957.003**	**-**	**91389.018**	**-**

Robust 95% confidence intervals in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3. In- and Out-migration model for individuals aged at least 12 years old (Both sexes, 2003-2007)

Variables	In-migration		Out-migration	
	% person-years at risk	Hazard ratios (95% CI)	% person-years at risk	Hazard ratios (95% CI)
Trimester	8.61	0.966*** (0.963 - 0.968)	8.61	0.985*** (0.982 - 0.988)
Rank of trimester				
Trimester 1 [ref.]	24.66%	-	24.66%	-
Trimester 2	24.83%	0.883*** (0.854 - 0.913)	24.83%	0.806*** (0.776 - 0.837)
Trimester 3	25.21%	0.755*** (0.728 - 0.782)	25.21%	0.719*** (0.691 - 0.748)
Trimester 4	25.30%	0.719*** (0.693 - 0.745)	25.30%	0.867*** (0.834 - 0.900)
Notice of demolition				
No [ref.]	96.11%	-	96.11%	-
Yes	3.89%	1.081** (1.018 - 1.147)	3.89%	2.589*** (2.465 - 2.719)
Gender		-		
Female [ref]	41.17%	-	41.17%	-
Male	58.83%	0.939*** (0.921 - 0.957)	58.83%	0.928*** (0.911 - 0.945)
Ethnicity				-
Kikuyu [ref]	31.96%	-	31.96%	-
Luhya	13.36%	1.192*** (1.146 - 1.241)	13.36%	1.157*** (1.112 - 1.205)
Luo	15.08%	1.090*** (1.047 - 1.135)	15.08%	1.182*** (1.135 - 1.230)
Kamba	25.55%	1.074*** (1.040 - 1.109)	25.55%	1.086*** (1.051 - 1.122)
Meru/Embu	1.84%	1.150*** (1.060 - 1.247)	1.84%	1.177*** (1.082 - 1.279)
Kisii	4.32%	1.240*** (1.175 - 1.308)	4.32%	1.163*** (1.096 - 1.235)
Somali	5.66%	0.987 (0.909 - 1.071)	5.66%	0.953 (0.881 - 1.030)
Other	2.23%	1.410*** (1.310 - 1.518)	2.23%	1.410*** (1.309 - 1.519)
Education				
No education [ref]	4.58%	0.531*** (0.481 - 0.585)	4.58%	0.895*** (0.837 - 0.957)
Primary	62.05%	-	62.05%	-
Secondary	31.26%	1.032*** (1.008 - 1.055)	31.26%	0.986 (0.963 - 1.009)
Unknown	2.11%	1.523*** (1.430 - 1.622)	2.11%	1.344*** (1.267 - 1.427)
Currently in school	11.71%	0.373*** (0.353 - 0.395)	11.71%	0.697*** (0.661 - 0.735)
Ever married/ living together	48.58%	0.836*** (0.816 - 0.857)	48.58%	0.890*** (0.868 - 0.912)
Household characteristics				
HHD owns or shares toilet	94.24%	1.555*** (1.462 - 1.655)	94.24%	0.829*** (0.791 - 0.870)
Tap water in HHD	89.66%	1.036* (0.996 - 1.078)	89.66%	1.014 (0.971 - 1.058)
KPLC power in HHD	20.36%	0.910*** (0.881 - 0.940)	20.36%	0.671*** (0.647 - 0.697)
House owner	12.33%	0.539*** (0.510 - 0.571)	12.33%	0.643***(0.610 - 0.679)
Fieldworker*Slum area				
Group 1 * Korogocho [ref.]	38.72%	-	43.06%	-
Group 2 * Korogocho	3.77%	1.856*** (1.738 - 1.982)	1.88%	1.170*** (1.079 - 1.268)
Group 3*Korogocho	3.21%	3.014*** (2.873 - 3.163)	0.76%	1.540*** (1.385 - 1.712)
Group 1 * Viwandani	27.10%	0.802*** (0.766 - 0.838)	6.62%	1.125*** (1.067 - 1.187)
Group 2 * Viwandani	7.98%	1.852*** (1.764 - 1.945)	28.66%	1.320*** (1.275 - 1.366)
Group 3*Viwandani	19.23%	2.992*** (2.884 - 3.104)	19.02%	1.510*** (1.457 - 1.566)
Wald Chi-square	**-**	**11639.294*** **	**-**	**6540.476*** **
Subjects (Failures)	**-**	**77303 (41916)**	**-**	**77303 (43167)**
Time at risk	**155346.022**		**155346.022**	**-**

Robust 95% confidence intervals in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusion

The objective of this paper was to investigate the main determinants of movements in and out of two Nairobi slums – Korogocho and Viwandani, using longitudinal data collected between 2003 and 2007 under the Nairobi Urban Health and Demographic Surveillance System (NUHDSS). Overall, findings presented in this paper confirm that migration intensity is particularly high at ages 20-24, where residents are more likely to move in and out of the two slums. This is consistent with the traditional evidence about the high mobility of the young people in sub-Saharan Africa (Oucho and Gould 1993). Between 15-24 years old, people are more likely to move into the slums than to move out. The opposite holds between 25-70 years old. When turning to gender differences, data show that in-migration rates are higher for females between 15-19 years old. Also, higher out-migration rates are observed for females between 15-24 years old but males are more likely to out-migrate at older ages (at least 60). This gender-specific pattern is also observed for both in-migration and out-migration when considering Korogocho and Viwandani separately.

Results also show evidence of migration calendar effects whereby movements in and out of the DSA are intense at some specific times during the 2003-2007 follow-up period. Higher probability of in-migration is observed at the end of every year (around December), from mid-2003 to mid-2007 while higher chance of out-migration is observed around the end of the preceding and the beginning of the following year, from mid-2003 to mid-2007. In particular, the effect of the KPLC demolition is clearly corroborated, with the highest out-migration rate being observed at the beginning of the year 2004 where residents were told to leave the areas. Expectedly, the KPLC demolition effect is higher in Viwandani than in Korogocho. Other trends observed during the period before July 2007 and the one after July 2007 are likely to be related to the DSS organization itself. The trend observed during the period before July 2007 could reflect a data collection effect since this corresponds to the period where fieldwork procedures were still being stabilized. Also, hanging cases which were not completely solved can explain the downward trends observed after July 2007.

Although there is a downward trend for in- and out-migration, the multivariate analysis indicates different seasonal patterns for both events. Also, it shows the complex combination of age, sex, ethnic origin, and economic status in explaining in and out-migration. All else being equal, females are more likely to move in and out of the DSA, suggesting a counterbalance in favour of women. This is also indicative of the increasing female migration in Africa. In South African rural setting, Collinson and colleagues reported significant and growing female migration rates (Collinson et al. 2006). In the case of Nairobi, women may come to town for short stays between planting seasons to look for additional revenues for the household.

Migration is also selective on education, with less educated people being less likely to in-migrate on the hand and being more likely to stay longer in the DSA on the other hand. Bocquier et al. (2004) found that the education level of migrants keeps rising, with three-third of the male migrants who arrived in the 1970s having attained at least secondary education, as opposed to three-quarter of the migrants of the 1990s.

Marriage decreases the likelihood of both in- and out-migration. In general, this may reflect the age differential mobility since unmarried individuals are likely to be young and

thus more mobile than their married counterparts. With regards to women, there is evidence of higher propensity to make a rural-urban migration among unmarried women in sub-Saharan Africa (Brockerhoff and Eu 1993). However, for single women, moving into cities is likely to be related to their marriage intentions.

Social amenities like sanitation attract people into the slum communities and make them also stay longer. Unexpectedly, electricity is deterrent to in-migration, probably indicating a cost issue. But inhabitants are less likely to move out when their shelter is connected to electricity. Although house owners stay longer in the DSA, it is rare for individuals to move into the DSA as house owner, given that people usually rent their structure in the slums. Results call for further analysis of the health determinants and consequences of migration.

From a methodological point of view, this analysis shows the applicability of the EHA to the study of migration in a DSS context. The same analytical procedure can be used for the analysis of other events, including mortality and fertility. Most importantly, this technique should be used to control for in- and out-migration in analysis of these other events since migration greatly affects these behaviours. This is the only way the DSS population can be accurately monitored over time. In addition, this analysis also shows that hazards related to the management of the DSS itself such as data collection procedures are likely to affect data quality, thereby inducing bias on indicators. Movements observed in the DSA are very sensitive to the data collection procedure and subsequently to the heterogeneity in its application, between sites and between fieldworkers. Variables related to data collection such as round of survey, fieldworker are thus very useful to control for bias. It is therefore important and necessary to control for their possible effects when analyzing DSS data.

Finally, the findings should be interpreted in light of some limitations. Indeed, most of explanatory variables used in the analysis are time-invariant, thus limiting the causal explanation. Yet, it is the aim of the DSS to provide with relevant time-varying variables. Some variables such as marriage and education could have more explanatory power if they vary over the follow-up period. Also, out-migration data may be subject to misreporting given that the related information is collected from a proxy respondent.

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