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Abstract

Sub-Saharan Africa (SSA) has the world's highest fertility rates and is experiencing rapid urbanization (Njoh, 2003). Typically, rural areas have higher fertility rates than urban centers, suggesting that rural-to-urban migration could accelerate fertility transitions in the region (Brockerhoff and Yang, 1994). This study explores the complex relationship between migration and fertility in SSA, focusing on Nigeria and Zambia, chosen for their differing fertility and urbanization profiles. The study investigates fertility patterns among internal migrant women and how these differ from non-migrants. It examines whether migrants adopt new fertility behaviors or retain those from their childhood environments and assesses the role of education in moderating the impact of migration on fertility. The methodology includes a baseline fertility analysis of total and age-specific fertility rates, a survival analysis using Kaplan-Meier techniques to study the transition time from the first to the second birth, and a time-discrete model to evaluate the likelihood of subsequent births by birth parity, accounting for socio-economic factors. An extended time-discrete model further explores the interplay between migration, fertility, and education.

The results reveal that internal migrants display distinct fertility behaviors compared to non-migrants. The baseline fertility analysis shows strong adaptation patterns in both countries, particularly among rural-to-urban migrants. Nigerian migrants experience shorter intervals between the first and second births compared to natives, while Zambian rural-to-urban migrants appear to adapt gradually, suggesting that the socialization hypothesis holds true, at least for the transition to the second birth. Rural-to-urban migrants in Nigeria do not show significant adaptation to fertility behaviors when socio-demographic factors are controlled, whereas Zambian migrants display gradual adaptation, especially with higher birth parity. Urban-to-rural migrants in Nigeria show mixed patterns depending on their returnee status, while in Zambia, these migrants tend to socialize rather than adapt. Education significantly moderates fertility behavior in Zambia for urban-to-rural migrants, but this effect is not observed in Nigeria. These results are attributed to Nigeria's narrower urban-rural fertility gap and more rapid urbanization compared to Zambia. The findings suggest that SSA policymakers should focus on integrating migrants into urban areas and investing in women's secondary education, particularly in rural regions, to lower fertility rates and support fertility transitions.

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List of Abbreviations

ASFR	Age-specific fertility rate
DHS	Demographic and Health Surveys
KPM	Kaplan-Meier
SSA	Sub-Saharan Africa
TFR	Total fertility rate

1. Introduction

Sub-Saharan Africa (SSA) is in the midst of a demographic shift of unparalleled scale. It is projected that by 2050, half of the world's population growth will take place in SSA, where the population is expanding at a rate three times higher than the global average (Ahn, 2023). By the end of the century, the region is expected to account for one-third of the global population (Ahn, 2023), underscoring the region's critical role in shaping future global demographic trends. This swift population growth poses major challenges for some of the world's poorest countries, as it has the potential to exacerbate existing socio-economic problems and vulnerabilities and put additional strain on already limited resources and infrastructure (Ahn, 2023). A key factor contributing to the population expansion is the persistently high fertility rates across the region (Tesfa et al., 2023). However, it is essential to note the substantial disparities in fertility behavior based on the area of residence, with rural areas consistently exhibiting higher fertility rates than urban areas across all subregions (ICF, 2012). Migration patterns further complicate these disparities, as individuals moving between rural and urban areas and those who remain non-migrants exhibit differential fertility behaviors (Menashe-Oren & Sánchez-Páez, 2023). Understanding these patterns is crucial for developing targeted policies and interventions that address the unique demographic dynamics of SSA and mitigate the potential socio-economic impacts of its rapid population growth (Brockerhoff and Yang, 1994).

SSA is the least urbanized region globally, with urbanization being a relatively recent development. Nevertheless, the region has the fastest urbanization rate in the world, and urbanization is rapidly accelerating to catch up with global trends (Njoh, 2003). As the region continues to urbanize, this development is likely to influence fertility rates significantly (Brockerhoff and Yang, 1994). Urban areas often experience lower fertility rates because the high cost of living makes it more difficult to afford raising large families, and children are economically less valuable in city settings. Additionally, there is a growing preference for smaller families, and better access to modern contraception allows residents to manage their reproductive choices more effectively (White et al., 2008). Consequently, migration to urban areas may accelerate the decline in fertility rates (Brockerhoff and Yang, 1994). Yet the rapid urbanization in SSA cities has increased the demand for basic amenities, while the provision of accommodation, education, and health care has not kept up (Hove et al., 2013). These developments could potentially reverse the fertility rate gap between urban and rural areas, as the traditional advantages of urban living may diminish.

The literature identifies four main mechanisms to explain the relationship between migration and fertility. The socialization hypothesis posits that migrants keep their reproductive behaviors from their birthplace. The selection hypothesis proposes that migrants have distinct characteristics that lead to differing fertility patterns when compared to both their home and host populations. According to the adaptation hypothesis, migrants gradually conform to the fertility norms of their new location over time. Lastly, the disruption hypothesis posits that fertility is delayed as a result of factors such as spousal separation or physical stress encountered during migration (Menashe-Oren & Sánchez-Páez, 2023).

Despite the explanations provided by these four mechanisms, there remains a notable research gap in understanding the detailed interplay between migration and fertility with respect to SSA. This gap is mainly due to the absence of longitudinal data and comprehensive information on both migration and birth history, which are needed to assess the interplay between migration and fertility. Without such data, it is challenging to capture the long-term effects of migration on fertility and to understand how changes in migration patterns and urbanization impact reproductive behaviors (Brockerhoff and Yang, 1994). The introduction of the DHS Program, which also provides data on migration and retrospective birth histories, has made research on fertility and migration more practical (Brockerhoff and Yang, 1994). Besides, most research on this topic in developing countries has predominantly concentrated on rural-to-urban migrants, overlooking other significant migration streams (Gyimah, 2006).

Hence, the paper utilizes DHS data to investigate the relationship between both rural-to-urban and urban-to-rural migration and fertility. The central research question is: What are the fertility patterns among internal migrant women in SSA, and how do these patterns compare to those of non-migrant women? This analysis is further complemented by evaluating the role of education in moderating the impact of migration on fertility behavior. Nigeria and Zambia are chosen as case studies to offer a comparative perspective. Examining both countries provides a nuanced view of demographic and urbanization trends in SSA due to their distinct stages of urban development and fertility patterns. Nigeria, as Africa's most populous country, plays a central role in regional dynamics within West Africa. Its higher levels of urbanization and relatively elevated overall fertility rates contrast with Zambia, located in Southern Africa, where urbanization is more recent and overall fertility rates are lower (see Figures 1 & 2). Additionally, Zambia exhibits a more pronounced difference between rural and urban fertility rates compared to Nigeria (Nigeria Population Commission, 2019; Zambia Statistics Agency, Ministry of Health Zambia, & ICF, 2019).

The analysis is split up into two parts. First, a baseline fertility analysis using the total fertility rate (TFR) and age-specific fertility rate (ASFR) is conducted to explore overall fertility behavior. The baseline analysis is then followed by a survival analysis, which is further divided into two segments. The first segment involves a Kaplan-Meier (KPM) survival estimation, which examines the timing between births and compares survival functions across different groups, providing insights into differences in birth intervals among various migrant groups. In this study, the time between births serves as a fertility indicator. This is complemented by a discrete-time hazard model, which incorporates various socio-economic variables to assess how migration, as a time-dependent factor, influences fertility transitions. This part is further extended by including a model that examines the interaction between migration status and education, exploring how this interaction affects the transition from the first to the second birth.

The thesis is structured as follows: The theoretical framework section starts with a literature review that explores current research on the relationship between migration and fertility, focusing on the four key hypotheses: socialization, adaptation, selection, and disruption. These hypotheses provide various lenses through which the effects of migration on fertility can be understood. The section then offers a comprehensive overview of both Nigeria and Zambia, analyzing current and historical trends in fertility and internal migration for each country. Additionally, the theoretical framework includes a brief discussion evaluating the role of education in moderating the impact of migration on fertility behavior, which adds depth to the analysis. Based on insights from the literature and country-specific data, the methodology section formulates research questions and hypotheses, outlining the type of research conducted and introducing the research methods used. The subsequent parts detail the data description and the process of data management and preparation before diving into the analysis. The results are then explored, and the hypotheses are tested in the discussion section. Finally, the conclusion addresses the overarching research question, acknowledges limitations, and proposes directions for future research.

2. Theoretical Framework

2.1. Literature Review: The Interplay Between Migration and Fertility

Within the literature, researchers have proposed four primary hypotheses to clarify the variations in fertility rates observed among female nonmigrants and different migrant groups (Menashe-Oren & Sánchez-Páez, 2023). These hypotheses provide frameworks for understanding how migration influences fertility behaviors, yet they are not mutually exclusive; instead, they often interact or complement each other (Lindstrom & Saucedo, 2002).

2.1.1. The Socialization Hypothesis

The socialization hypothesis suggests that migrants' fertility behaviors reflect the norms and values learned during their childhood. Initially, migrants maintain fertility patterns from their place of origin, and only in the next generation do they begin to adopt the fertility norms of their new environment. This process of adjustment is gradual and spans multiple generations (Lindstrom & Saucedo, 2002).

Goldberg's seminal studies (1959, 1960), as discussed by Kulu (2005), introduced the socialization hypothesis in migration and fertility research. He aimed to explore whether fertility differences between blue-collar and white-collar families were linked to the rural background of migrants. His findings showed that urban migrants from rural areas had higher fertility rates compared to native urban residents, supporting the hypothesis. In Rosenwaike's (1973) study on inter-generational differences among Italian-born women in America, the first generation of foreign-born women showed significantly higher fertility rates than American citizens, reflecting their rural background. By the 1960 census, however, the daughters born in America had reduced their childbearing to levels even lower than those of other native urban Americans. By examining the fertility behavior of different groups of first-generation migrants and native-born women in the US, Kahn (1994) observed that during the 1980s, there was no evidence of major shifts in reproductive patterns within most immigrant groups. Further analysis revealed that immigrants' higher fertility could be entirely attributed to their demographic, socioeconomic, and ethnic characteristics that favor larger families. After adjusting for these characteristics, immigrants exhibited even lower fertility rates than similar native-born women. Additional backing for this hypothesis comes from Hervitz's (1985) analysis of inter-regional migrants and resident fertility in Brazil. His results showed that the socialization hypothesis is applicable to migrants from the least developed areas of Brazil, including border regions and traditional rural areas.

2.1.2. The Adaptation Hypothesis

While early studies supported the socialization hypothesis in migration and fertility, the adaptation hypothesis gained wider and lasting acceptance in subsequent research (Kulu, 2005). Environmental disparities between origin and destination contribute to fertility declines among migrants, who often adopt the lower fertility norms of their new location, even after accounting for individual factors (Jensen & Ahlburg, 2004). In rural-to-urban migration, factors like women's labor market motivations, the opportunity costs of having children, and improved access to healthcare and education lead to lower fertility rates. Consequently, the fertility gap between migrants and those who remain in rural areas grows over time (Lee & Pol, 1993).

In recent years, numerous authors have examined and provided evidence supporting the adaptation hypothesis concerning fertility. Lee and Pol (1993) studied rural-urban migration's impact on fertility in Korea, Mexico, and Cameroon. They found significant fertility reductions in Korea and Mexico due to migration, which aligned with urban fertility norms and led to national birth rate declines. In contrast, migration had little effect on fertility in Cameroon, where improved birth conditions from urban living were counterbalanced by cultural and economic shifts that reduced the demand for children. Brockerhoff and Yang (1994) conducted a similar study across six SSA countries, where, in contrast, they found evidence supporting the hypothesis in SSA. Their analysis, using DHS data, showed that migrants had lower fertility rates compared to rural non-migrants over time. This decline was linked to improved living standards in urban areas and possibly temporary separations from spouses. This finding is further supported by Gyimah’s (2006) study conducted in Ghana, which also found evidence in favor of the adaptation hypothesis. Interestingly, in the long run, migrants in Ghana adjust to fertility norms prevalent in their destination area, regardless of whether they come from urban or rural backgrounds.

2.1.3. The Selection Hypothesis

Not all views link migration directly to fertility changes. The selectivity hypothesis suggests that migrants' fertility patterns are more a result of pre-existing characteristics rather than migration itself influencing fertility outcomes (Lindstrom & Saucedo, 2007). Selectivity can be based on observable traits like education and occupation from the area of origin or unobservable traits such as ambitions for relocation or receptiveness to innovation (Lindstrom & Saucedo, 2002).

Support for the selectivity hypothesis is provided by Chattopadhyay et al. (2006) with data from Ghana. Their study of migrant fertility, analyzing duration of stay, pre-migration fertility, and comparison with non-migrant fertility at the origin for four different migrant groups, found significant differences. Migrant fertility diverged notably from that of non-migrants at the origin but closely followed the fertility trends of the destination area prior to migration. Similarly, White et al. (1995) found that in Peru, migration from rural to urban areas is more common among unmarried women or those with fewer children, leading to lower lifetime fertility rates and preferences in urban centers. Thus, migration based on education also increases urban-rural fertility disparities, as more educated women are more likely to move to urban centers.

2.1.4. The Disruption Hypothesis

The disruption hypothesis examines how a partner’s separation from migration affects birth timing and frequency. Although separation may initially postpone births and interrupt reproduction patterns, its effect on total fertility is influenced by the expected number of births without migration and the length and frequency of the migration (Lindstrom and Saucedo, 2007).

Migration in Thailand disrupts fertility due to the stress of moving and initial spousal separation. However, long-term settlement in urban areas eventually compensates for this, leading to similar fertility levels between long-term migrants and non-migrants, as shown in Goldstein and Tirasawat’s (1977) study. Massey and Mullan (1984) found that male seasonal migration to the US significantly reduces fertility among rural Mexican women, especially affecting those whose husbands are frequently absent. Longer separations further decrease fertility rates. Migration also increases the family's socioeconomic status and cultural exposure, leading to greater female labor force participation and a further decline in fertility. In contrast, Lindstrom and Saucedo (2002) found that while spousal separation may cause temporary reductions in fertility, it does not significantly impact overall fertility rates. Couples generally adjust to make up for lost reproductive time, leading to only short-term effects. The disruption hypothesis is further challenged by Singley and Landale (1998), who found that migration to the U.S. affects Puerto Rican women differently based on their relationship status. Single women migrating are more likely to form a union and conceive than those remaining in Puerto Rico. This suggests migration plays a key role in family formation rather than merely disrupting fertility patterns.

2.1.5. Further Research

Given the inherent complexity of the interplay between migration and fertility, simplifying it through hypotheses can sometimes be misleading. Factors such as the reasons for migration—like the more significant disruptions faced by refugees compared to economic migrants—along with several migration moves, circular migration, and the composition of migration partners, increase the complexity (Menashe-Oren & Sánchez-Páez, 2023). Further, family migrants typically have their first child sooner and tend to have more children overall compared to independent and first-time migrants (Ortensi, 2015). While much of the existing research emphasizes how migration influences fertility, it is equally important to consider that fertility can also impact migration decisions (Menashe-Oren & Sánchez-Páez, 2023). For example, individuals with multiple children and/or recent births are more likely to not migrate (Brockerhoff & Eu, 1993). Conversely, Kulu (2008) found that many couples choose to relocate when they have multiple children, primarily to adjust their housing size to better fit their (expected) family needs. In rural agriculture settings, families send children to urban areas to invest remittances and surplus in agriculture, leading to more children being seen as valuable assets and sources of capital (Basu, 1999).

In summary, several hypotheses have been put forth to explain and understand the fertility behaviors of migrants with literature presenting both supporting and challenging evidence. These theories, based on different frameworks, emphasize various factors such as childhood environments, economic conditions, cultural adaptations, and structural influences in the new setting (Kulu, 2005). Together, these perspectives contribute to a nuanced understanding of how migration shapes fertility patterns and vice versa among diverse migrant populations.

2.2. Fertility and Internal Migration Patterns in Nigeria and Zambia: A Comprehensive Overview

This chapter provides an overview of fertility trends and the broader demographic context in both countries, illustrating how population growth and varying fertility rates shape their demographic landscapes. Furthermore, it explores the historical background of internal migration in Nigeria and Zambia, detailing how economic, social, and historical factors have influenced migration patterns and urbanization. Finally, the chapter examines the implications of rapid urbanization on the demographic landscape and socio-economic development of these countries.

2.2.1. Fertility Trends and Demographic Context

In 1950, Nigeria's population stood at approximately 38 million people. Over the subsequent six decades, Nigeria's population has experienced significant growth, reaching an estimated 231 million by 2025 (Wittgenstein Centre for Demography and Global Human Capital, 2018). Nigeria's annual population growth rate between 1950 and 2020 ranged from 1.7% to 3% per year (Wittgenstein Centre for Demography and Global Human Capital, 2018). Looking ahead, projections indicate that Nigeria's population will continue to rise, potentially reaching an estimated 382 million by 2050, solidifying its place among the most populous countries globally (Wittgenstein Centre for Demography and Global Human Capital, 2018). In comparison, Zambia had a population of around 2 million people in 1950. By 2020, Zambia's population had grown to approximately 19 million (Wittgenstein Centre for Demography and Global Human Capital, 2018). Over the period from 1960 to 2020, Zambia's annual population growth rate fluctuated between 2.7% and 3.5% per annum (Wittgenstein Centre for Demography and Global Human Capital, 2018). Projections suggest that Zambia's population could reach 37 million by 2050 (Wittgenstein Centre for Demography and Global Human Capital, 2018).

Examining Nigeria's TFR over time reveals significant fluctuations. In 1960, Nigeria's TFR stood at 6.4. Over the next decade, from 1960 to 1970, there was minimal change, with the TFR remaining relatively stable around this value. Subsequently, starting in 1971, the TFR began to rise, peaking in 1978 at 6.9. Thereafter, the TFR gradually decreased, albeit with fluctuations, indicating a slow decline trend. A notable plateau occurred from 2000 to 2009, where the TFR hovered around 6.1. However, starting from 2010, there was a notable acceleration in the decline of the TFR, surpassing the rate of decline observed in the 1980s and 1990s leading to a TFR of 5.3 in 2020. Turning to Zambia, in 1960, Zambia's TFR was recorded at 7.1. Until 1975, the TFR slightly but steadily increased, reaching its peak at 7.4. From 1975 onwards, the TFR steadily decreased until 2002. From 2002 to 2007, Zambia experienced a plateau, with the TFR remaining around 5.7. Subsequently, from 2005 onwards, the TFR continued to decrease, reaching a value of 4.4 by 2020 (Figure 1).

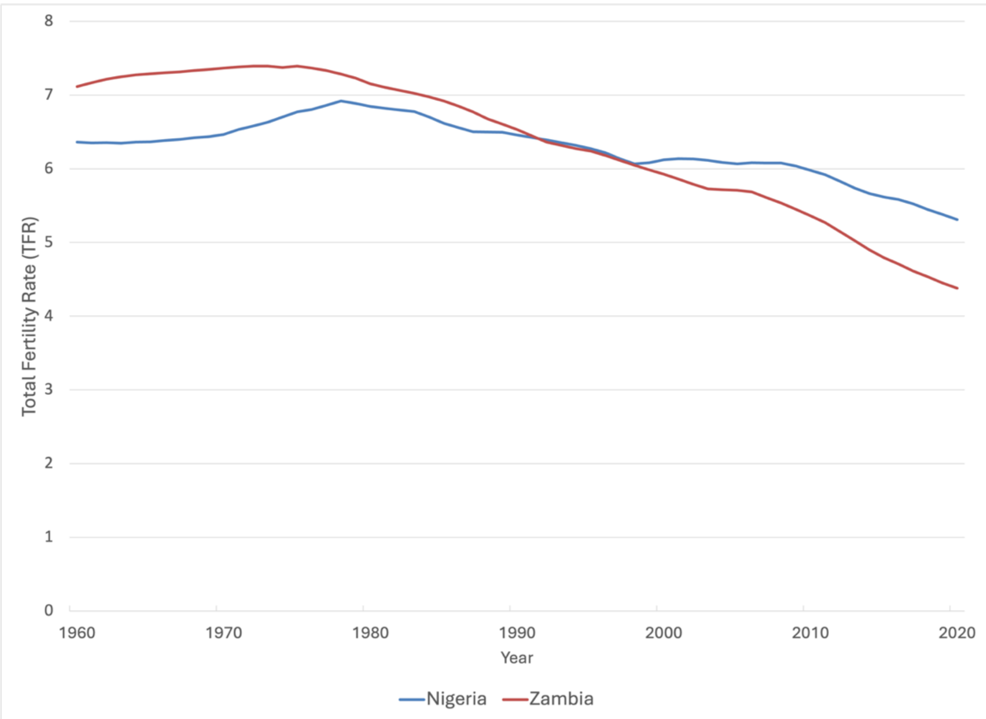

Figure 1: TFR by Country (1960 – 2020) (Source: World Bank, 2024a)

When looking at Nigeria’s TFR by background characteristics, the DHS data reveals consistent disparities between different socio-economic groups. In the 1990 DHS, rural women had an average of 6.3 children compared to 5.0 children for urban women. While fertility rates among rural women have shown slight declines over time, dropping to 5.9 in the latest DHS, urban women have exhibited a more pronounced downward trend, reaching 4.5 children in the most recent survey. Additionally, there is a noticeable decrease in the number of children per woman as wealth quintiles increase, ranging from 6.7 among the lowest quintile to 3.8 among the highest. Similarly, higher levels of education are associated with fewer children per woman: women with no education have an average of 6.7 children compared to 3.4 children for those with more than a secondary education (Nigeria Population Commission, 2019).

For Zambia, the DHS data also illustrate significant disparities in fertility rates over time and across different socio-economic groups. The TFR declines have been higher in urban areas, dropping from 5.8 children per woman in 1992 to 3.4 in 2018. In contrast, rural areas have seen a more modest reduction, with the TFR decreasing from 7.1 to 5.8 children per woman during the same period. These figures highlight a sharper fertility decline in urban settings compared to rural ones. Wealth disparities are equally striking, with women in the lowest wealth quintile averaging 6.7 children, almost four more than those in the highest wealth quintile, who average just 3.0 children. Education also plays a crucial role in fertility rates in Zambia. Women with no education have an average of 6.4 children, whereas those with higher education levels have significantly fewer, averaging 2.4 children per woman (Zambia Statistics Agency, Ministry of Health Zambia, & ICF, 2019).

2.2.2. Historical Background of Internal Migration

Although there is no universally agreed-upon definition of internal migration, the generally accepted understanding is the movement of individuals within a country's borders, leading to a new temporary or permanent home. This encompasses those forced to leave their regular homes, such as internally displaced persons, as well as those who voluntarily relocate, such as in rural-to-urban migration. It includes both nationals and non-nationals who move away from their usual place of residence (International Organization for Migration, 2015).

For centuries, migration has been intrinsic to the socioeconomic structure of Nigeria. During the colonial era, migration primarily occurred as a shift from rural to urban areas. After the British unified Nigeria in 1914, cities like Lagos and Abeokuta saw substantial growth due to increased migration (Vargas-Lundius, 2018). Even though internal migration was pivotal during this time, it garnered negative perceptions. It became associated with urban unemployment, social challenges, and environmental degradation. Migrants were often seen as disorganized, unemployed, and economically marginalized (Oyeniyi, 2013). In post-colonial

Nigeria, the fluctuations in the economy have primarily influenced migration patterns. During the 1970s, Nigeria underwent a dramatic oil boom that accelerated urban growth due to rural-to-urban migration, particularly in big cities like Lagos (Oyeniyi, 2013). During this period, investments were heavily concentrated in urban sectors like industry, commerce, and education, while rural areas remained underdeveloped. This created a dualistic economy with thriving urban industries and struggling rural agriculture. The government's focus on urban centers as economic hubs intensified regional inequalities and fueled migration, as migrants were drawn to areas with better economic opportunities, shaping migration patterns across the country (Adepoju, 1977). The economic downturn of the 1980s significantly reduced the incomes of the urban residents. Even though urbanization continued, the recession prompted new migration patterns, including a shift from urban to rural areas (Potts, 1995). Similar to other countries in SSA, migration in Nigeria nowadays exhibits significant variety and consistency. Although rural-to-urban migration remains predominant, other patterns of migration are also prevalent. These migrations are influenced by a variety of factors, many of which are not strictly economic (Oyeniyi, 2013). Some examples include marriage, conflicts, environmental conditions, and social factors (Poufon et al., 2021).

In the late 1800s, Northern Rhodesia (now Zambia) primarily supplied labor for gold mines in Southern Rhodesia and South Africa. However, after copper reserves were discovered in 1928, migration patterns changed, leading to increased internal migration towards the Copperbelt province, attracting rural migrants from across Zambia. Before Zambia's independence in 1964, the Copperbelt's mining workforce mainly consisted of single male migrants who left their families behind. Post-independence, relaxed restrictions enabled family reunifications and urban growth in mining towns. By 1980, Zambia had become one of SSA's most urbanized nations, with 40% of its population in urban areas. However, falling copper prices from 1973 led to economic challenges, reduced mining, and urban decline. From the 1980s to 1990s, urban-to-rural migration emerged, with more people migrating to rural areas than urban centers. The Zambian government supported this shift with a "back to land" initiative, leveraging the country's ample land. This led to increased rates of rural households originating from urban areas. Despite the mid-2000s mining boom and agricultural growth, improving economic conditions in Zambia have reversed the trend, leading to renewed urban expansion (Girard & Chapoto, 2017). Based on the 2010 population census, internal migration trends in Zambia show a clear preference for rural-to-urban movements at 30.0%, with urban-to-rural migrations making up 14.2% of the total migration flow (International Organization for Migration, 2022).

2.2.3. Migration, Urbanization, and its Implications

Over the years, Nigeria has experienced a significant and gradual migration to urban places, leading to a substantial increase in population across major urban centers (Aliyu & Amadu, 2017). In 1960, only 15% of Nigeria's population resided in urban areas. This figure steadily rose to 18% by 1970, 35% by 2000, and reached 54% by 2022 (see Figure 2). The urbanization of Nigeria's cities is driven by multiple factors. While urban areas exhibit lower fertility rates compared to rural regions, migration from rural to urban areas and transforming rural villages into small urban townships are the primary reasons for urbanization. Further on, the disparity between natural population growth and urban growth rates exceeds 5%, highlighting the substantial impact of rural-to-urban migration on urbanization trends (Aliyu & Amadu, 2017). Nonetheless, the influence of natural population growth should not be overlooked (Oyeniyi, 2013).

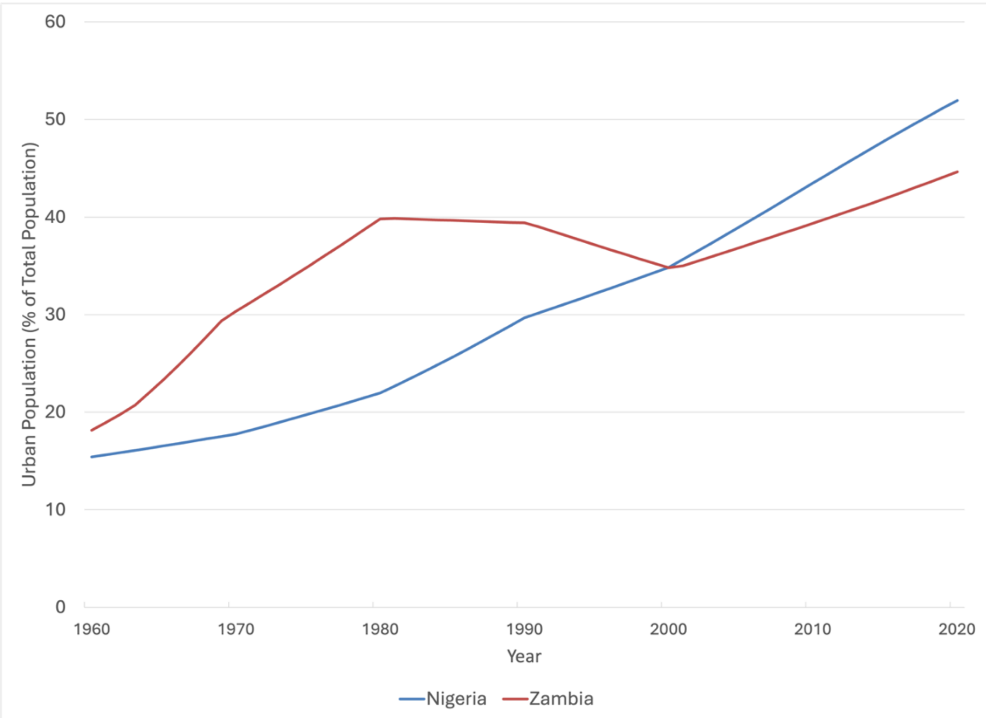

Figure 2: Urbanization Rate by Country (1960 – 2020) (Source: World Bank, 2024b)

In contrast, Zambia has experienced fluctuating trends in urbanization. In 1960, the urbanization rate was approximately 18%, increasing sharply. However, the decline in global copper prices starting in 1973 prompted a significant shift toward rural areas over the next decade, resulting in a decrease in urbanization (Girard & Chapoto, 2017). Urbanization rates remained stagnant from 1980 to 1990 before declining further, reaching around 35% by 2000.

From this point onward, urbanization gradually increased again, reaching a peak of 44.5% by 2020 (see Figure 2).

Rapid and consistent urbanization has significant effects on both urban and rural areas. As discussed by Idowu (2013), there are two main perspectives on urbanization in SSA. The first views it as crucial for economic and societal growth (e.g., Arthur, 1991), while the second emphasizes issues like environmental degradation, slum formation, and crime (e.g Olutunde, & Olotuah, 2006). Further, the literature highlights that poverty was largely seen as a rural problem in developing countries over the past decade (e.g., Knowles, 2000). However, recent years have witnessed a significant shift, with urban areas now experiencing increasingly severe levels of poverty (Garland et al., 2007).

The impact of rural-to-urban migration on rural areas in Nigeria is profound, driven by rapid population growth and land strain that contribute to increasing rural poverty (Adamu, 2009). This out-migration, especially among young people, exacerbates economic challenges and hinders sustainable development in rural areas, which depend heavily on a young workforce for agriculture (Idowu, 2013). Regarding the impact on urban places, Aliyu and Amadu (2017) highlight that Nigeria's growing cities heavily struggle with insufficient infrastructure, lack of housing, and traffic jams. This leads to an increase in urban areas and the informal settlement growth while the absence of essential services deepens social and economic disparities, causing major health issues.

For Zambia, urbanization and its implications can be understood through two distinct phases of post-independence economic development (Rogerson, 1990). After independence, Zambia experienced rapid growth in administrative, service, and manufacturing jobs, which accelerated urbanization as people moved to cities for new opportunities. Although the urban population initially grew faster than job creation, many migrants still found employment (Rakodi, 1987).

The decline in global copper prices in the first half of the 1970s marked the onset of the second phase of Zambia's post-independence economic development (Rogerson, 1990). Zambia faced typical developing country challenges: stagnant formal wage jobs, declining rural productivity, and rising urban unemployment, which increased poverty in both areas (Hansen, 1980). Nowadays, the rapid urbanization in Zambia has led to a rise in underserved informal settlements. This growth has caused severe environmental degradation and increased disaster risks, especially from flooding (World Bank, 2022). Still, Zambian cities play a crucial role in reducing poverty. Additionally, metropolitan areas supply secondary schooling, healthcare, and government services (World Bank, 2022).

2.3. The Moderating Effect of Education on the Relationship Between Migration and Fertility Behavior

Education level may influence how migration impacts fertility behavior, reflecting the selectivity hypothesis, which posits that individuals with different characteristics exhibit varying migration and fertility patterns (Lindstrom & Saucedo, 2002). In urban areas, where the costs of living—such as food, housing, and services—are higher compared to rural settings (Becker, 1991), higher-educated migrants might be more attuned to these elevated expenses. Educated individuals are generally more aware of and have better access to family planning resources, and they also use contraception more frequently (Martin, 1995). As a result, higher educated rural-to-urban migrants may be more inclined to limit their family size to manage the financial demands of city living compared to their less-educated counterparts.

Moreover, urban environments often lead to increased expenditures on children due to societal expectations that prioritize investing in the quality of life for each child over having a larger number of children (Becker, 1991). Higher-educated migrants may be more likely to adhere to these expectations, focusing on enhancing the quality of life for fewer children rather than increasing their family size. Additionally, urban settings offer abundant work and recreational opportunities, which can raise the opportunity costs of raising children (Kulu, 2013). Higher education is frequently associated with greater awareness of and appreciation for these opportunities (Lakomý, 2017). Therefore, higher-educated migrants might limit their family size more than less-educated migrants to preserve their professional and personal goals.

In contrast, rural areas often have stronger religious and societal norms that discourage family planning (Tesfa et al., 2023). Less-educated urban-to-rural migrants in these settings may be more likely to adhere to these norms, resulting in higher fertility rates compared to their more educated peers, who are generally more inclined to utilize family planning methods.

3. Data and Methodology

3.1. Research Questions and Hypothesis

This paper aims to answer the overarching research question: What are the fertility patterns among internal migrant women in SSA, and how do these patterns compare to those of non-migrant women? To address this question comprehensively, the analysis is divided into three subsections, each addressing specific sub-research questions and exploring different dimensions of fertility behavior to provide a detailed and nuanced understanding of the topic. All three subsections assess whether migrants align more with the adaptation hypothesis or the socialization hypothesis.

The first subsection involves a baseline fertility analysis, examining both the indicators ASFR and the TFR. This analysis aims to answer the question: How does the overall fertility behavior differ among various migrant groups? The hypothesis for this section is that internal migrant women exhibit different fertility behaviors compared to non-migrants.

Next, a KPM survival analysis is conducted, consisting of two parts. First, the intervals between different birth orders are examined for the entire population, up to the transition from the seventh to the eighth birth. The second part focuses specifically on the transition from the first to the second birth among different internal migrant groups, aiming to determine if there are significant differences in birth intervals among these groups. It is expected that the birth interval lengths vary significantly across different internal migrant groups in comparison to non-migrants.

Finally, a discrete-time hazard model is employed, which will be divided into two parts. The first part of this analysis involves identifying how the likelihood of having a subsequent birth over time differs among different migrant groups, accounting for various socio-demographic factors. Although the primary focus is on the transition from the first to the second birth, transitions from the second to the third and from the third to the fourth births are also considered. The second part then focuses solely on examining the interaction between education and migration regarding the likelihood of transitioning to a second birth over time. The hypothesis for this analysis is twofold. First, it posits that the likelihood of having a subsequent birth varies among different migrant groups when various socio-demographic factors are accounted for. Second, it is expected that there is a significant interaction between education and migration status that influences the transition to a second birth.

3.2. Type of Research

For the purpose of this study, quantitative research, defined by Creswell (1994) as the investigation of phenomena through numerical data and statistical methods, will be used to objectively measure and analyze data. Quantitative methods enable the collection of data from large populations, which is essential for studying phenomena like migration and fertility that can vary widely across different groups and regions. This approach will help identify patterns and relationships between migration and fertility, providing a thorough and statistically valid understanding. The relationship will be investigated using multiple DHS surveys for Nigeria and Zambia.

The DHS data is cross-sectional, referring to data collected at a specific point in time from a representative sample of the population (Setia, 2016). This type of data allows for the analysis of the current state of fertility behaviors and migration patterns without tracking changes over time. However, standard DHS surveys are conducted approximately every five years, enabling comparisons across different time points to study trends and shifts in population characteristics and behaviors (ICF, n.d.b). The DHS data was accessed through the DHS website, which required registration and approval for data use.

3.3. Research Methods

3.3.1. Baseline Fertility Analysis

The baseline fertility analysis consists of two demographic indicators: the ASFR and the TFR. The first indicator that is looked at is the ASFR. The ASFR illustrates the fertility patterns across different age groups (Nigeria Population Commission, 2019). Because reproductive capability fluctuates with age, fertility rates are often analyzed with a focus on age. Additionally, social, behavioral, and motivational factors that influence fertility also differ across various age groups (Preston et al., 2001). The following formula for the calculation of the ASFR is used (Preston et al., 2001):

$$ {}_nF_x\,[0,T] \;=\; \frac{{}_nB_x\,[0,T]}{{}_nW_x\,[0,T]} $$

Here, ${}_nF_x$ is the ASFR for age interval x to $x + n$ for the period from 0 to T. In the numerator, ${}_nB_x$ is the number of births in the period from 0 to T to women aged x to $x + n$, which is divided by ${}_nW_x$, the person-years lived by women aged x to x + n for the period from 0 to T. Person-years lived quantify the total time individuals contribute to a rate denominator over a specified period. This measure accounts for the varying lengths of observation or risk time for individuals. Each person's contribution is based on their presence during the study: a full year contributes one person-year, while partial years are proportional (e.g., six months equals 0.5 person-years) (Preston et al., 2001).

The second indicator that is looked at is the TFR. The TFR for a given year represents the average number of children a woman would have if she lived through her entire childbearing years, giving birth according to the current ASFR (OECD, 2024). It is calculated as follows (Preston et al., 2001):

$$ TFR[0,T] = n * \sum_{x=a}^{ß-n} {}_nF_x\,[0,T] $$

In this context, TFR$[0,T]$ represents the TFR for the period from 0 to T. Because a woman spends n years in each n-year-wide age interval, the multiplier n is included. The summation $\sum_{x=a}^{ß-n}$ denotes the aggregation over the age range from $x = a$ to $x = ß - n$, where a and $ß$ are the minimum and maximum ages at childbearing, respectively, and n represents the length of the age interval. ${}_nF_x\,[0,T]$ refers to the ASFR for the age interval from x to $x + n$ within the time period $[0,T]$.

3.3.2. Survival Analysis

Survival analysis is a set of statistical methods used to analyze and interpret data where the objective result is the time to event. It assesses the likelihood of the event occurring over time and determines factors that affect the timing of the event (Kleinbaum & Klein, 1996). One key problem survival analysis has to deal with is censoring. Censoring occurs when there is incomplete information about an individual's survival time, preventing the precise determination of when the event will occur (Kleinbaum & Klein, 1996). It is important to distinguish between left and right censoring (Jenkins, 2005).

Right censoring occurs when a subject's total survival time cannot be precisely assessed due to various reasons, such as dropping out, being lost to follow-up, or the study ending before the event of interest occurs. Censoring can happen both during the study and at its conclusion. For example, if a respondent reaches the study's end not experiencing the event, their total survival time remains unknown, making it inaccurate to assume a fixed survival duration based on incomplete data (Rich et al., 2010). Conversely, left censoring refers to a situation where the onset of an event or the beginning of a time period is not observed, making it unclear when the event actually started. Consequently, the exact duration of the event or time period, from its start to a certain point of observation, remains unknown (Jenkins, 2005). However, in most cases, one has to deal with right censoring (Kleinbaum & Klein, 1996).

For a survival analysis, two important concepts have to be introduced: The survivor function and the hazard function. The survivor function, denoted $S(t)$, indicates the probability that an individual will survive, meaning that the event does not happen, past a certain time t. It is essential for summarizing survival data by providing survival probabilities over varying time values (Kleinbaum & Klein, 1996). It is calculated the following way (Kleinbaum & Klein, 1996):

$$S(t) = P(T > t)$$

Here, $P(T > t)$ represents the probability that the random variable T (which is the time until an event occurs) is greater than a specified time t. When drawing the resulting graph, a step function is obtained. Further, because the study period is most of the time limited, not all participants may experience the event being studied. As a result, the survivor function might not reach zero by the study's end (Kleinbaum & Klein, 1996).

The second concept necessary for the survival analysis is the hazard function, denoted by $h(t)$. It represents the instantaneous rate at which events occur, given that no event has occurred up to a specific time (Kleinbaum & Klein, 1996). The formula for the calculation is as follows (Kleinbaum & Klein, 1996):

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T < t + \Delta t \mid T \geq t)}{\Delta t}$$

In this context, T represents the random variable that denotes the time until the event occurs. At a specific time t, the hazard function measures the probability that the event will occur in the small interval $[t, t + \Delta t)$, given that the event has not occurred before time t, where Δt is a small interval of time. This probability is denoted as $P(t \leq T < t + \Delta t \mid T \geq t)$. The notation lim refers to the limit as the time interval becomes extremely small, and the hazard rate reflects the likelihood of an event happening within that very small interval of time (Steele, 2005).

3.3.2.1. Kaplan-Meier Estimator

In order to compute the survival probabilities, the KPM estimation method is used, denoted as $\hat{S}(t)$. In this method, the continuous time axis, which represents the duration until an event occurs, is segmented into multiple discrete intervals. Unlike methods that use fixed-length intervals, the KPM method defines these intervals based on the actual occurrence of events (Tolley et al., 2016). To conduct a KPM survival analysis, three key pieces of information are required: First, the date of the initial observation; second, the final date of observation; and third, the status at that final date, which indicates whether an event occurred or if the observation was censored (Stalpers & Kaplan, 2018). The following formula for the calculation of the KPM is used (Jenkins, 2005):

$$\hat{S}(t) = \prod_{i: t_i \leq t} \left(1 - \frac{d_i}{n_i}\right)$$

Within this equation, t_i denotes the time at which the i-th event happens, d_i indicates the number of events occurring at time t_i, and n_i represents the number of individuals at risk immediately before t_i. The overall survival probability is obtained by multiplying these probabilities at each time point.

It is possible to compare survival curves between two or more groups to determine if there are significant differences in their survival experiences by using the log-rank test. This test assesses whether the survival curves differ significantly by evaluating the null hypothesis, which posits no difference in survival among the groups (Goel et al., 2010). The log-rank test is most effective for detecting differences between groups when one group consistently shows a higher risk of an event than another. It may have difficulty identifying differences if the survival curves cross, a situation that can arise in certain comparisons. Therefore, further plotting survival curves is crucial when analyzing survival data (Bland & Altman, 2004). The formula for the log-rank test is given by (Kleinbaum & Klein, 1996):

$$x_i^2 = \frac{\sum_i (O_i - E_i)^2}{\sum_i Var(O_i - E_i)}$$

Here, the numerator is the sum of squared differences between the observed number of events O_i and the expected number of events E_i. The squared differences $(O_i - E_i)^2$ reflect how much the observed counts deviate from the expected counts, and summing these squared differences provides a measure of overall deviation. The denominator consists of the sum of variances of these differences, $\sum_i Var\,(O_i - E_i)$, which accounts for the variability in the observed data. By aggregating these variances, the denominator adjusts for the expected variability.

3.3.2.2. Discrete-Time Hazard Model

When incorporating time-varying covariates into survival analysis, discrete-time methods may be more suitable than continuous-time approaches (Steele, 2005). Additionally, when dealing with categorical explanatory variables, discrete-time hazard models can be estimated using logistic regression models, which offers straightforward interpretability (Allison, 1982).

For conducting a discrete-time analysis with cross-sectional data, the data must first be reorganized into a person-period format. This process involves converting the data into a series of binary responses, where each time period is denoted by 1 if the event occurred or 0 if it did not. This format uses binary indicators to represent each discrete-time interval—such as months or years—showing whether the event took place during that specific period (Steele, 2005). The discrete-time hazard then is calculated as follows (Steele, 2005):

$$h_{ti} = Pr(y_{ti} = 1 \mid y_{si} = 0,\ s < t)$$

In this context, the term $Pr(yti = 1 \mid ysi = 0, s < t)$ represents the probability that an event occurs during interval t for n independent individuals (i = 1, 2, 3, …, n), under the condition that these individuals have not experienced the event in any prior intervals s before t.

After restructuring the data from a case-duration format into a person-period format, the logistic regression model is applied to analyze how the happening of the event is determined by both time and explanatory variables. Since the outcome variable is binary (whether the event occurs or not), the most appropriate model to use is the logit regression model (Allison, 1982). It is computed as follows (Steele, 2005):

$$logit(h_{ti}) = log(\frac{h_{ti}}{1-h_{ti}}) = a(t) + ß * x_{ti}$$

Within this equation, $logit(h_{ti})$ represents the logit function applied to the hazard rate h_{ti}, which converts the probability of an event occurring during interval t for n independent individuals (i = 1, 2, 3, …, n) into a log-odds scale. The term $a(t)$ denotes the baseline component of the model, capturing the intercept that can vary with time t, referred to as the baseline logit-hazard. In addition, $ß * x_{ti}$ represents the effect of the fixed or time-varying covariates on the log-odds of the hazard rate, with $ß$ being a vector of coefficients that quantify the impact of these variables.

3.4. Data Description

The primary data source for this study is the DHS Program, a project supported by the U.S. Agency for International Development and the countries that participate. The program provides data on a range of demographic and health indicators such as fertility, family planning, or HIV/AIDS in developing countries, enhancing global knowledge on these topics (ICF, n.d.a). A single executing agency is typically responsible for carrying out a survey. This can be a governmental, non-governmental, or private organization. Common choices include National Statistical Offices, due to their experience and access to sampling frames, or Ministries of Health (ICF, n.d.h).

Four standard questionnaires are employed for the surveys: the Household Questionnaire for obtaining household and resident information; the Individual Woman's and Man's Questionnaires for detailed interviews with eligible individuals; and the Biomarker Questionnaire for collecting health data. The DHS Model Questionnaires are conducted for the age groups 15-49, 15-54, or 15-59. To meet specific needs, the questionnaires include alternative modules and country-specific questions. The questionnaires have evolved significantly from the initial DHS phases to the current DHS8 (ICF, n.d.e).

The sample is designed to be representative at multiple levels: nationally, by residence type and regionally. This means the data reflects the country's diversity. The sampling method usually follows a two-step cluster design. In the first step, Enumeration Areas are randomly selected from Census files. In the second step, a subset of households is selected from a list of households. This approach helps achieve a comprehensive and representative dataset by capturing variations at both broad and localized levels (ICF, n.d.d). Similarly, in order to guarantee data consistency across countries, the DHS program has created standardised documentation to accompany its model questionnaires and survey procedures. This includes a variety of fieldwork and sampling manuals (ICF, n.d.c).

With regard to this study, the individual datasets for women aged 15-49 are used, as this group is at risk of childbirth. The geographical scope of this research includes urban and rural areas within Nigeria and Zambia. The selected datasets from Nigeria include the surveys conducted by the National Population Commission in 2003, 2008, and 2018. Specifically, the DHS4 in 2003 included 7,620 observations, DHS5 in 2008 had 33,385 observations, and DHS7 in 2018 comprised 41,821 observations. Unfortunately, DHS3 and DHS6 were not utilized due to the absence of crucial variables regarding migration, and DHS8 is still in progress and therefore not included in the study.

Similarly, for Zambia, the selected datasets span multiple DHS rounds conducted by various agencies. The DHS3 in 1996, conducted by the Central Statistical Office, had 8,021 observations. The DHS4 in 2001, by the Central Board of Health/Central Statistical Office, included 7,658 observations. The DHS5 in 2007, managed by the Central Statistical Office/Ministry of Health, comprised 7,146 observations. The DHS6 in 2013-2014, also conducted by the Central Statistical Office/Ministry of Health, had 16,411 observations, while the DHS7 in 2018-2019 included 13,683 observations. As with Nigeria, the DHS8 in Zambia is ongoing and thus not part of the current study.

3.5. Data Management

The DHS datasets are available in several formats, including Stata, Flat ASCII data, SAS, SPSS, and hierarchical ASCII data, with the Stata format being utilized for this analysis. In a DHS dataset folder, several key files serve distinct purposes. The .MAP file contains mapping information that details the variables, including their names, labels, and formats, assisting in understanding the data structure. The .DOC file provides comprehensive documentation, often including a codebook or user guide with explanations of the variables, data collection methods, and additional notes about the dataset. The .DTA file, which is Stata's primary data file format, holds the survey data for statistical analysis. The .FRQ file provides frequency distributions, summarizing the occurrence of different values or categories for each variable, aiding in initial data exploration. Finally, the .FRW file contains formatted weights necessary for adjusting the data to account for the survey design and ensure representative results (ICF, n.d.f).

After downloading the necessary datasets from the DHS website, they are securely stored and organized by folders by country and survey year. One of the key advantages of DHS datasets is their standardization; once an analysis is conducted for a specific year and country, the same codes can be applied to similar analyses across different countries and variables. However, it is important to note that not all datasets contain the same variables, so caution is required. For the statistical analysis, the R programming language is utilized. Before analyzing and processing the data, it is essential to load the necessary packages into R. Once the packages are loaded, it is important to prepare the raw data for analysis. Throughout the analysis, DHS datasets are adjusted using weighting to account for survey design and ensure the sample accurately represents the broader population.

The preparation of the data differs for each of the three subcategories but remains consistent across both countries. To begin, the .DOC file provides detailed information on any inconsistencies within the data file. Each inconsistency noted in the document is thoroughly checked and reviewed to ensure the accuracy of the data. This process involves crossreferencing the documented inconsistencies with the original data entries, verifying the correctness of the data points, and making necessary corrections to resolve any discrepancies.

After addressing data inconsistencies, the next critical aspect is preparing the raw data and categorizing migration status. While the categorization of migration status slightly differs across the subcategories, the same three key variables are essential for categorizing migration status. First, *v102* denotes the type of current residence, coded as 1 for urban and 2 for rural. Second, *v104* indicates the duration of residence at the current location. Values range from 0 to 90 for years lived there, 95 for individuals who have always lived in the place, and special codes 96 for visitors, 97 for inconsistent data, 98 for unknown information, and 99 for missing data; codes 96-99 are excluded from the dataset. Finally, *v105* captures the type of previous residence, where codes 0-2 correspond to urban areas (capital/large city, city, town) and code 3 represents rural areas, while code 4 indicates a previous residence abroad and code 9 signifies missing data; observations with codes 4 or 9 are excluded. This approach ensures a consistent and clear categorization of migration status across the dataset. For the purpose of this paper, only migrations between urban and rural areas are considered. Individuals who have moved between urban locations or rural locations are categorized as natives.

3.5.1. Baseline Fertility Analysis

For the baseline fertility analysis, only the aforementioned variables are needed to categorize migration status. The categorization based on current and previous residence is as follows: Individuals are classified as urban natives if their current residence is urban (*v102* = 1), and they have always lived there (*v104* = 95). Similarly, individuals are classified as rural natives if their current residence is rural (*v102* = 3) and they have always lived there (*v104* = 95). Additionally, a person is also considered a rural native if both their current (*v102 = 2*) and previous residences (*v105 = 3*) are rural. Conversely, if both the current and previous residences are urban, the person is classified as an urban native. Specifically, if a person's current residence is urban (*v102* = 1) and their previous residence was rural (*v105* = 3), they are categorized as a rural-to-urban migrant. Conversely, if their current residence is rural (*v102* = 2) and their previous residence was urban (*v105* = 0-2), they are categorized as an urban-to-rural migrant.

The baseline fertility analysis requires the use of different DHS datasets. For Zambia, it is feasible to create 5-year intervals of these indicators using the closest DHS datasets. However, for Nigeria, this approach is not possible since, as mentioned before, the DHS3 and DHS6 datasets lack information on migration. Therefore, for the 5-year interval from 1991-1995, the DHS4 dataset from 2003 is used, and for the 2006-2010 period, the DHS7 dataset from 2018 is utilized.

To calculate the ASFR, the following variables are required: the date of birth of the child (*b3*), the date of birth of the respondent (*v011*), the date of the interview (*v008*), and the survey weights (*v005*). These calculations are performed using the DHS.rates package. The TFR is then derived from the ASFR results.

3.5.2. Survival Analysis

3.5.2.1. Kaplan-Meier Estimator

The KPM analysis is based on the data from the DHS7 for both countries. The preparation begins by setting the observation period to five years and excluding multiple births, such as twins and triplets. Addressing censoring is also essential, as it is a fundamental component of survival analysis. R packages and functions handle censoring automatically in KPM estimations, ensuring accurate management of both events and censored observations and minimizing the need for additional data manipulation. However, creating the time-to-birth indicator is still necessary. This indicator is generated by calculating the difference between the birth dates of each pair of consecutive children (*b3*). Additionally, an event indicator variable is used to determine whether a subsequent birth has occurred. This involves using the interview date variable (*v008*). If a subsequent birth occurs within the 60-month period, the indicator is set to 1; if no birth occurs within this timeframe, or if the case is censored, the indicator is set to 0. The remaining steps and calculations are then performed using the survival package.

In the first part of the KPM analysis, which examines the general transition across different birth parities up to the eighth child, distinguishing between migration statuses is not necessary. However, in the second part of the KPM analysis, which focuses specifically on the transition from the first to the second child based on migration status, it becomes essential to categorize migration status again. First, the number of years the respondent has lived in the area (*v104*) is converted from years to months. This standardization to months allows for a direct comparison with the ages of the children, which are recorded in months, and facilitates the accurate determination of migration status. In line with the approach used in the baseline fertility analysis, individuals who have always lived in the same place (indicated by *v104* = 95) are classified as either rural or urban natives based on their current place of residence (*v102*). If both the current (*v102* = 2) and previous (*v105* = 3) places of residence are rural, the individual is categorized as a rural native. Conversely, if both are urban (*v102* = 1 and *v105* = 0-2), they are categorized as an urban native**.** For cases where the initial categorization does not resolve the migration status, further refinement is conducted. This refinement considers the relationship between the years lived in the current residence (*v104*) and the age of the most recent child, as well as the place of previous residence (*v105*). Specifically, if the years lived in the current residence (*v104*) is equal to or less than the age of the most recent child, and the place of previous residence is rural (*v105* = 3), the individual is classified as a rural native. If *v105* indicates an urban residence (*v105* = 0-2), the individual is classified as an urban native. On the other hand, if *v104* exceeds the age of the most recent child, and the current residence is rural (*v102* = 2) while the previous residence was urban (*v105* = 0-2), the individual is categorized as an urban-to-rural migrant. Conversely, if the current residence is urban (*v102* = 1) and the previous residence was rural (*v105* = 3), the individual is classified as a rural-to-urban migrant.

3.5.2.2. Discrete-Time Hazard Model

As with the KPM survival analysis, the DHS7 data is used for both countries in the discrete-time hazard model. The data preparation involves several steps. Initially, only women who have at least one child are included, with those without children omitted from the dataset. Furthermore, any observations where the first birth was a twin, triplet, etc., are excluded. Unlike in the KPM estimator, where censoring is automatically handled by specific packages and formulas, here it must be explicitly defined and incorporated into the analysis. The censoring indicator measures the duration in months between the first and second births (*b3*). When the date of the second birth is missing, the indicator calculates the interval from the first birth to the interview date (*v008*). This variable represents the elapsed time between these two events. The censoring indicator serves to differentiate between observations where the event of interest (a second birth) has occurred versus those where it has not by the study's end, thus marking whether the observation is censored or completed. The observation period is standardized to 60 months.

The next stage involves transforming the data from a case-duration format—where each individual is tracked over single time periods—into a person-period format. This format organizes the data to capture multiple observation periods for each individual, expressed in years. Additionally, to categorize migration status as a time-dependent covariate, two new variables are introduced. The first variable, *year*, represents the actual year of each observation, determined through transformations that align with birth timings and other relevant factors. The second variable, *migration year*, indicates the year in which migration occurred, calculated by subtracting the number of years spent in the current place of residence (*v104*) from the interview year (*v007*).

Consistent with the methodology applied in the baseline fertility analysis and KPM survival analysis, individuals who have consistently resided in the same location throughout the observation period (*v104* = 95) are categorized based on their current place of residence (*v102*). If both the current residence (*v102* = 2) and the previous residence (*v105 = 3*) are rural, the individual is classified as a rural native. Similarly, if both are urban (*v102* = 1 and *v105* = 0-2), the individual is designated as an urban native. For individuals who migrated, the following steps are applied: Individuals whose current residence is rural (*v102* = 2) and previous residence is urban (*v105* = 0-2) are designated as urban-to-rural migrants, while those with the opposite pattern are classified as rural-to-urban migrants. Additionally, to refine this categorization, an extra condition is applied: If the variable *year* (actual year of each observation) is less than the variable *migration year* (the year when migration occurred), the migration status is reassigned based on the current place of residence. For example, if an individual's current residence is urban (*v102* = 1) and their prior residence was rural (*v105* = 3), but the year of observation is before the recorded migration year, they are categorized as a rural native rather than a rural-to-urban migrant. This classification ensures that the migration status accurately represents the individual's residential history relative to the timing of their migration and the actual period represented within each observation.

The final stage in preparing for the discrete-time-hazard analysis involves configuring the covariates to be included in the regression model. A crucial covariate is the age group (*v013*) in 5-year intervals, which is treated as a time-varying covariate. This means the age group is updated dynamically to reflect the individual's changing age throughout the observation period. Additional variables included into the analysis are education (*v106*), religion (*v130*) and wealth (*v190*).

While it is straightforward to assume that the first two covariates, education and religion, are time-invariant and do not change over time, wealth is also treated as a time-invariant covariate. This approach interprets wealth as expected wealth, recognizing that actual wealth can fluctuate. Since wealth is anticipated to influence the outcome of interest, a fixed wealth status, based on the values recorded at the time of the interview, is used in the analysis.

In the DHS dataset, educational level is initially recorded with the following values: 0 for no education, 1 for primary education, 2 for secondary education, and 3 for higher education. However, due to the low prevalence of individuals with higher education (generally around or less than 10% for both countries), a revised categorization is applied. In this adjusted scheme, educational levels are recoded as follows: 0 remains for no education, 1 for primary education, and both 2 and 3 are combined into a single category for secondary or higher education. This reclassification better aligns with the distribution of educational attainment observed in the dataset. The second covariate used, religion, is originally coded as follows: 1 for catholic, 2 for other christian, 3 for islam, 4 for traditionalist, and 96 for other. Traditionalist and other categories are excluded due to their minor prevalence (below 1%). Thus, the remaining categories are consolidated into christian (combining catholic and other christian) and islam.

The final variable included in the regression analysis is wealth. Initially, wealth is categorized as follows: 1 for poorest, 2 for poorer, 3 for middle, 4 for richer, and 5 for richest. For simplicity in interpretation, the categories are summarized as follows: categories 1 and 2 are combined into poor, category 3 remains middle, and categories 4 and 5 are merged into rich.

In the section focusing solely on the interplay between education and migration, the educational variable will be simplified compared to the first part of the analysis. Specifically, education will be categorized into two broad groups: no education and some education. In this simplified scheme, a value of 0 represents no education, while all other educational levels (1 for primary, 2 for secondary, and 3 for higher) will be combined into a single category, some education.

3.6. Ethical Considerations

The DHS Program ensures respondent privacy and confidentiality through stringent procedures. Participants receive a consent form before interviews, outlining the study's objective, steps, risks, benefits, and their option to discontinue at any time. During data collection, privacy is maintained by conducting interviews discreetly, especially on sensitive topics such as sexual activity or domestic violence. Eligible respondents within households are interviewed separately to uphold confidentiality and avoid influence from other household members. The collected data is anonymized using unique identifiers for each individual, household, and enumeration area to prevent identification. Geographic coordinates of households are randomly relocated to further protect respondent identities, with displacements of a maximum of two kilometers in urban areas and up to five kilometers in rural areas. In some cases, rural clusters are displaced up to ten kilometers to ensure that individuals and households cannot be precisely located, thereby enhancing the confidentiality and security of the data (ICF, n.d.g).

4. Results

4.1. Baseline Fertility Analysis

The baseline fertility analysis is detailed in the Appendix. Appendix B contains both the graphs and tables with the exact values for the ASFRs, while Appendix C provides the tables with the precise values for the TFR graphs.

4.1.1. Age-Specific Fertility Rate

The analysis begins with the examination of the ASFRs, starting with Nigeria. The ASFRs for the 1991 to 1995 interval are shown in Figure 13 (see Appendix B). Among the youngest age groups (15-19, 20-24, and 25-29) and the two oldest (40-44 and 45-49), rural natives consistently exhibited the highest ASFRs. In contrast, urban-to-rural migrants dominated the 30-34 and 35-39 age groups with ASFRs of 315.42 and 248.60 per 1,000 women, respectively, though they had the lowest ASFRs in the two oldest groups. Urban natives maintained the lowest ASFRs across all groups except for the two oldest. All groups peaked in the 25-29 age range, with urban-to-rural migrants achieving an ASFR of around 315 in both the 25-29 and

30-34 age brackets. For the 15-19 and 20-24 age groups, urban-to-rural and rural-to-urban migrants displayed similar ASFRs to both rural and urban natives, with urban-to-rural migrants slightly leaning towards urban natives. This trend shifted, as urban-to-rural migrants surpassed rural natives in ASFRs for the 30-34 and 35-39 age groups, while rural-to-urban migrants followed a similar trajectory before both groups converged towards the urban native pattern in the oldest age groups.

From 1996 to 2000, rural natives exhibited the highest ASFRs across all groups, except for the oldest age group (45-49) (see Figure 14, Appendix B). Urban natives, conversely, had the lowest ASFRs in the youngest age groups (15-19 and 20-24) as well as in the 35-39 and 40-44 age groups, while urban-to-rural migrants showed the lowest ASFRs in the remaining age groups. The ASFRs for rural natives showed only a slight increase from the 20-24 to the 25-29 age group, where it peaked. In contrast, both urban natives and rural-to-urban migrants experienced a clear peak in the 25-29 age group. Notably, urban-to-rural migrants reached their highest ASFR of 253.46 per 1,000 women in the 20-24 age group, followed by a sharp decline. The ASFR curves of rural-to-urban and urban-to-rural migrants initially lay between those of rural and urban natives in the younger age groups but diverged noticeably thereafter. Urban-to-rural migrants aligned more closely with the urban native curve, even recording lower ASFRs in the middle age groups, whereas rural-to-urban migrants did not show a clear tendency towards either rural or urban native patterns.

From 2001 to 2005, rural natives exhibited the highest ASFRs across all age groups except for the oldest group (45-49) (see Figure 15, Appendix B). Urban natives consistently had the lowest ASFRs in all age groups except for 35-39, where both urban natives and urban-to-rural migrants recorded the lowest rates. All groups experienced a peak in the 25-29 age range, with rural-to-urban migrants, for instance, reaching an ASFR of 271.12 per 1,000 women. In the 15-19, 20-24, and 25-29 age groups, ASFRs for rural-to-urban and urban-to-rural migrants fell between the curves of rural and urban natives. However, in the older age groups, these migrants' fertility patterns increasingly aligned with those of urban natives.

Between 2006 and 2010, rural natives consistently exhibited the ASFRs in the younger and middle age groups, except for the two oldest age groups (see Figure 16, Appendix B). Urban natives had the lowest ASFRs in these younger and middle age groups, with an ASFR of 82.02 per 1,000 women in the 15-19 age group. This pattern shifted in the 30-34 age group, where urban natives and rural-to-urban migrants had similar ASFRs, and in the 35-39 age group, where rural-to-urban migrants showed an even lower ASFR than urban natives. In the oldest age groups, urban natives again had the lowest ASFRs, though the differences among all groups were minimal. Rural natives peaked in ASFRs during the 20-24 and 25-29 age groups, while other groups reached their peak in the 25-29 range. Apart from the oldest age groups, where fertility patterns generally converged, rural-to-urban and urban-to-rural migrants aligned more closely with the fertility patterns of urban natives across the remaining age groups.

For the last interval going from 2011 to 2015 (see Figure 17, Appendix B), rural natives again exhibited the highest ASFRs across all age groups, beginning with an ASFR of 193.95 in the youngest age group. Urban natives consistently had the lowest ASFRs until the 30-34 age group, after which urban natives, rural-to-urban migrants, and urban-to-rural migrants all shared the lowest ASFR position. While urban natives, rural-to-urban migrants, and urban-to-rural migrants peaked in the 25-29 age group, rural natives showed no clear distinction between their peak ASFRs in the 20-24 and 25-29 age groups. In the 15-19, 20-24, and 25-29 age groups, rural-to-urban migrants' ASFRs were intermediate between those of rural and urban natives, but from the 30-34 age group onward, their ASFRs clearly converged toward those of urban natives. Urban-to-rural migrants aligned more with urban natives in the youngest age groups (15-19 and 20-24), were intermediate in the 25-29 and 30-34 age groups, and then again converged towards the urban native ASFR curve in the older age groups.

The ASFRs for Zambia are examined next. The first interval, from 1991 to 1995, showed notable variations among different demographic groups (see Figure 18, Appendix B). The highest ASFR across all groups consistently occurred in the age group 20-24, where rural native women, for instance, recorded a peak ASFR of 317.16 per 1,000 women. Rural native women generally had the highest ASFRs for all age groups except for ages 40-44, where urban-to-rural migrants showed slightly higher rates. Urban-to-rural migrant women exhibited the lowest ASFRs in the age groups 20-24 and 25-29, while urban natives had consistently lower rates across the other age groups. Urban-to-rural migrants' ASFRs were closer to those of urban natives than to rural natives, while rural-to-urban migrants mirrored the higher fertility rates of rural natives, except in the oldest age groups where this pattern reversed.

During the period 1996-2000, rural-to-urban migrant women had the highest ASFRs in the youngest age group (see Figure 19, Appendix B). In the age groups 25-29 and 45-49, urban-to-rural migrants showed the highest ASFRs, while rural natives had the highest rates in the remaining age groups. Across all age groups, urban natives consistently had the lowest ASFRs, except for the oldest age group. Urban-to-rural migrant women peaked in ASFR during the 25-29 age group, with 293.25 per 1,000 women, whereas other groups peaked in the 20-24 age group. There was no clear, persistent pattern indicating whether rural-to-urban migrants or urban-to-rural migrants had ASFRs closer to those of urban natives or rural natives across different age groups.

From 2001 to 2005, rural natives consistently had the highest ASFRs across all age groups, except in the oldest age group (40-44), where rural-to-urban migrants recorded an ASFR of 68.75 per 1,000 women (see Figure 20, Appendix B). Urban natives consistently showed the lowest ASFRs, except in the 40-44 age group, where rural-to-urban migrants had comparable rates and urban-to-rural migrants had even lower rates. For most groups, the highest ASFR was in the 20-24 age group, except for urban-to-rural migrants, whose ASFRs peaked in the 25-29 age group. However, there was only a minor difference between the ASFRs in the 20-24 and 25-29 age groups. Initially, rural-to-urban migrants aligned closely with the ASFRs of rural natives, while urban-to-rural migrants closely resembled urban natives in the younger age groups. This pattern shifted in older age groups, with both migrant groups adopting ASFR patterns closer to those of urban natives.

During the period 2006-2010 (see Figure 21, Appendix B), rural natives consistently displayed the highest ASFRs across all age groups compared to other groups. Conversely, urban natives consistently showed the lowest ASFRs across all age groups. Both rural natives and urban-to-rural migrants reached their highest ASFRs in the 20-24 age group, with rates of 346.02 and 291.39 per 1,000 women, respectively. Rural-to-urban migrants peaked in the 25-29 age group, while urban natives showed no significant difference in ASFR between the 20-24 and 25-29 age groups. In the younger age groups (15-19 and 20-24), rural-to-urban migrants more closely mirrored the ASFRs of urban natives, whereas urban-to-rural migrants more closely resembled the ASFRs of rural natives. This pattern became less distinct in subsequent age groups, with both migrant groups aligning more closely with urban natives in the oldest age groups.

For the final period, 2011-2015 (see Figure 22, Appendix B), rural natives consistently exhibited the highest ASFRs across all age groups, while urban natives had the lowest ASFRs across all age groups, except for the 30-34 age group, where both urban-to-rural migrants and urban natives had comparable rates. While the ASFRs for rural natives, urban natives, and urban-to-rural migrants peaked in the 20-24 age group, rural-to-urban migrants reached their peak in the 25-29 age group. There was a significant decrease in ASFRs for rural natives between these age groups, whereas the difference for the other groups was minor. In the youngest age groups (15-19 and 20-24), both rural-to-urban migrants and urban-to-rural migrants showed a slight tendency to align more closely with the ASFRs of urban natives. As they aged, urban-to-rural migrants increasingly adopted urban native fertility patterns, whereas rural-to-urban migrants initially mirrored urban natives but then reverted to patterns more similar to rural natives in the oldest age groups.

4.1.2. Total Fertility Rate

The subsequent analysis focuses on the detailed examination of the TFR results. Figure 3 illustrates the TFR for Nigeria across five-year intervals, segmented by group. From 1991 to 1995, the overall TFR was 6.62 children per woman, which then decreased by 0.56 children per woman during 1996-2000. The TFR subsequently increased, reaching 6.19 children per woman from 2001 to 2005, followed by a slight rise to 6.33 children per woman from 2006 to 2010. In the most recent period (2011-2015), the TFR remained stable at 6.16 children per woman. Rural natives exhibited a TFR of 7.43 children per woman from 1991 to 1995, which decreased to 6.90 in 1996-2000, then increased to 7.12 in 2001-2005, and further rose to 7.53 in 2006-2010, with a slight drop to 7.26 in 2011-2015. In contrast, urban natives started with a TFR of 5.48 children per woman, which declined over the subsequent periods to 4.94 and 4.83 in 1996-2000 and 2001-2005, respectively. There was a modest increase in the following years, with TFRs rising to 5.17 and 4.98 in the later periods. Rural-to-urban migrants had a TFR of 6.55 children per woman from 1991 to 1995, which decreased to 5.96 in 1996-2000. Their TFR showed fluctuating patterns: it further decreased to 5.84 in 2001-2005, then to 5.75 from 2006 to 2010, and finally increased to 5.92 in the most recent period. Urban-to-rural migrants experienced a significant decline in TFR from 6.88 children per woman in 1991-1995 to 4.88 in 1996-2000. Their TFR then increased to 5.98 in 2001-2005, followed by a rise to 6.05 in 2006-2010, and stabilized at 5.73 children per woman in the last analyzed period.

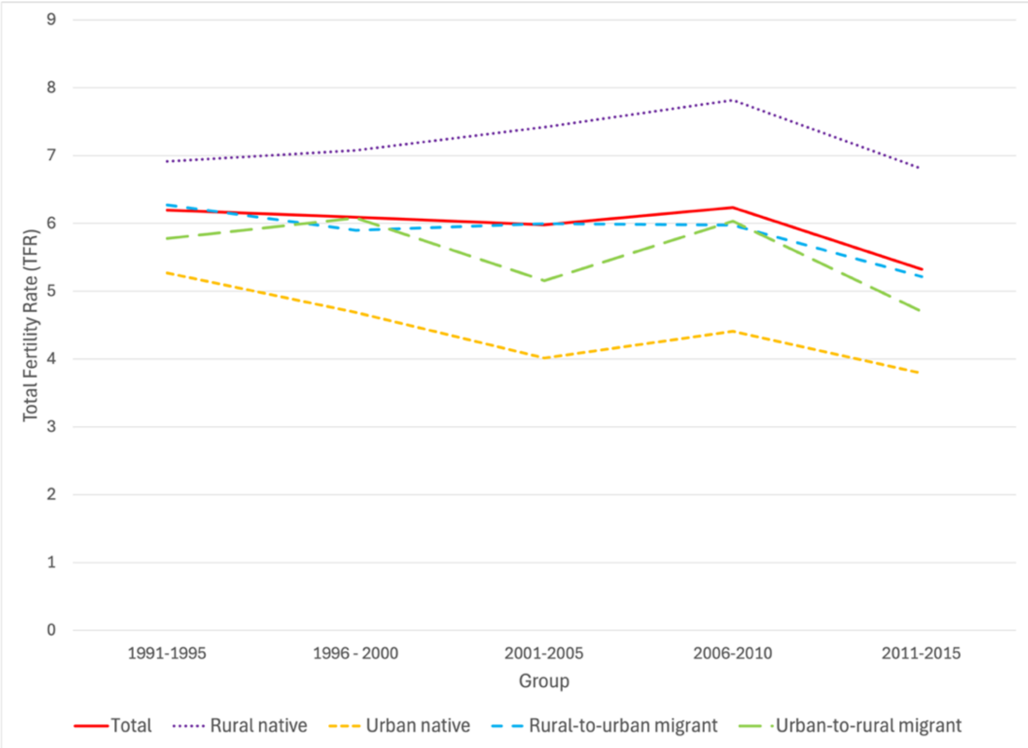

Figure 3: TFR by Group in Nigeria Over Time, Five-Year Intervals (Source: Nigeria DHS4, DHS5, DHS7)

Figure 4 presents the TFR for Zambia. From 1991 to 1995, the TFR for the entire population was 6.20 children per woman. This rate fluctuated over subsequent periods, decreasing to 6.09 in 1996-2000 and further to 5.98 in 2001-2005. There was a slight increase in the following period, bringing the TFR up to 6.23, but it declined notably in 2011-2015 to 5.32 children per woman. For rural native women, the TFR was 6.91 children per woman during 1991-1995. This rate increased to 7.08 in 1996-2000 and continued rising in subsequent periods, reaching 7.42 and then 7.82. However, there was a sharp decline in the most recent period (2011-2015), with the TFR dropping to 6.81, the lowest across all periods. Urban native women had a TFR of 5.27 children per woman in 1991-1995. This rate saw a significant decrease in the next period, falling to 4.69. Over the subsequent three periods, the TFR initially declined further to 4.02, then increased to 4.41, and finally decreased again, reaching its lowest point of 3.79 children per woman. For rural-to-urban migrants, the TFR was 6.27 children per woman during 1991-1995. This rate decreased to 5.90 in 1996-2000 and remained relatively stable in the following periods, with slight variations of 6.00 and 5.97, respectively. In the most recent period, the TFR decreased to 5.22 children per woman. Urban-to-rural migrants had an average TFR of 5.78 children per woman during 1991-1995. This rate increased to 6.08 in 1996-2000, then declined to 5.16 in 2001-2005. This declining trend was reversed in 2006-2010, with the

TFR rising to 6.03, similar to the levels observed in 1996-2000. In the latest period (2011-2015), the TFR decreased again to 4.70 children per woman.

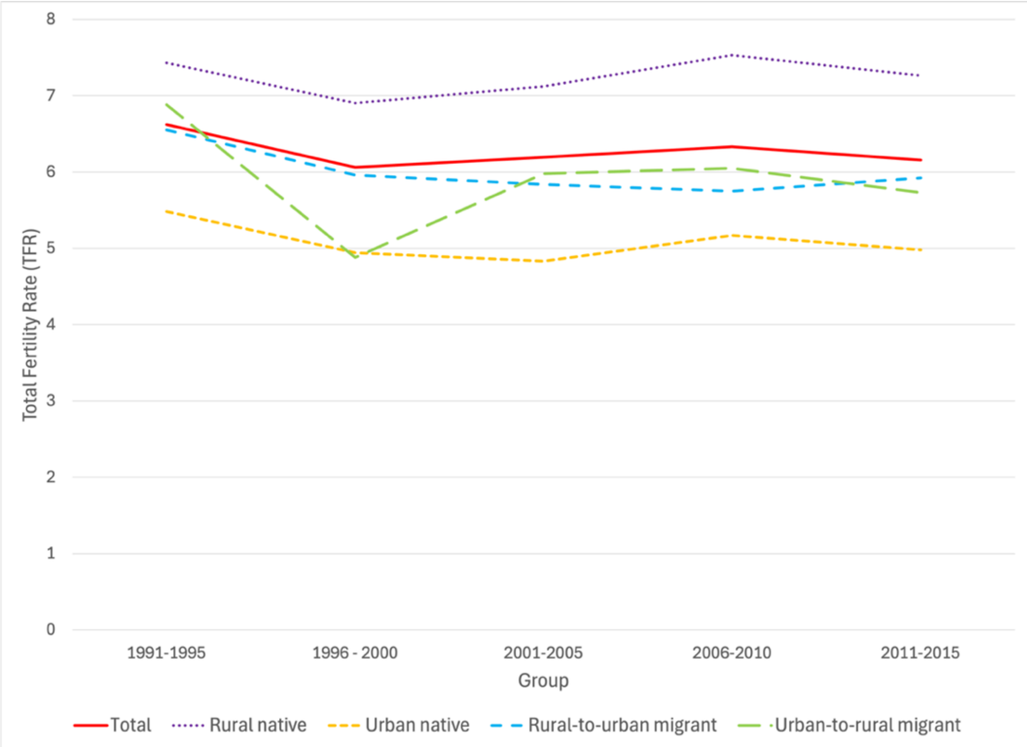

Figure 4: TFR by Group in Zambia Over Time, Five-Year Intervals (Source: Zambia DHS 3, DHS4, DHS5, DHS6, DHS7)

4.2. Kaplan-Meier Estimator

4.2.1. Overall Transition Across Different Birth Orders

The overall analysis of birth timing in Nigeria, as illustrated in Figure 5, reveals no statistically significant variations in the timing of births based on birth order, as indicated by the log-rank test statistic. According to the data, roughly 25% of women had their next child within 23 months of a previous birth, 50% gave birth between 27 and 28 months, and 75% delivered after 36 months. Nearly all women, across all birth orders, had given birth within five years.

In the case of Zambia, while the log-rank test statistic indicates some variation, it does not meet the stricter significance threshold at the 0.02 level (Figure 6). Therefore, the KPM survival estimates suggest that the timing between childbirths remains consistent across different birth orders at the national level. Approximately a quarter of women have their next child between the 25th and 26th months after the previous birth, half around the 33-month mark, and about three-quarters after 40 months. Nearly all women have another child within five years.

Log-rank test statistic: $x^2 = 8.9$, p = 0.2

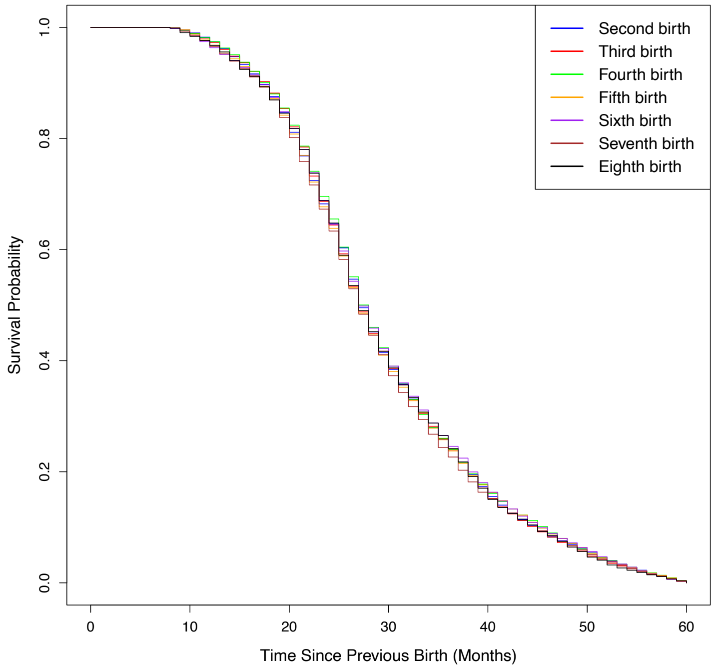

Figure 5: KPM Survival Estimates of the Proportion of Women Having Their First Through Eighth Births Since the Previous Birth, Nigeria

Log-rank test statistic: $x^2 = 13.4$, p = 0.04

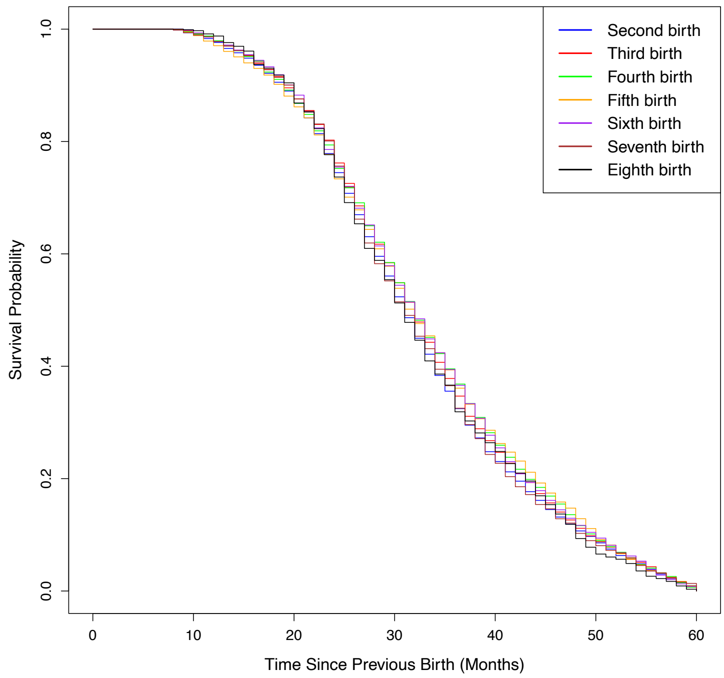

Figure 6: KPM Survival Estimates of the Proportion of Women Having Their First Through Eighth Births Since the Previous Birth, Zambia

4.2.2. Transition From First to Second Birth by Migrant Status

The KPM survival curves for different migrant groups in Nigeria, illustrating the transition from the first to the second birth, are shown in Figure 7. The log-rank test statistic indicates that the null hypothesis, which posits no statistically significant difference between the groups, is rejected. Rural native women typically have their second child within 23 months, with half giving birth after 28 months and 75% after 36 months. By the end of the observation period, all rural native women have had a second child. Urban native women display only a slightly different timing pattern: approximately 25% have their second child within 23 months of their initial birth, with half extending this period to 28 months. Three-quarters of urban native women have their second child after 38 months, and all women included in the observation period have given birth. Rural-to-urban migrant women have their second child within 20 months for 25% of them, with half extending this interval to 26 months and three-quarters giving birth within 34 months. However, not all women in this group gave birth within the observation period. Conversely, urban-to-rural migrant women follow a similar pattern: about 25% have their second child within 20 months, half within 26 months, and 75% within 34 months, with all urban-to-rural migrant women giving birth within the observation period.

In Zambia, the log-rank test statistic also leads to the rejection of the null hypothesis regarding the transition from the first to the second birth. This indicates that the differences observed in the KPM survival curves are statistically significant. Among rural native women, approximately 25% have their second child within 24 months of their first birth, with half extending this interval to around 30 months and 75% completing their second childbirth within 37 months. Nearly all rural native women have their second child within five years of the initial birth. In contrast, roughly 25% of urban native women experience their second childbirth within 26 months, with half extending this period to around 33 months and 75% within 44 months. For rural-to-urban migrants, a quarter have their second child within 25 months, with half extending this period to about 33 months and 75% completing the second childbirth after 43 months. All rural-to-urban migrants have given birth within the five-year timeframe. Among urban-to-rural migrants, a quarter have their second child approximately 26 months after the first, half extend this period to about 33 months, and around 75% give birth after 42 months. All urban-to-rural migrants also have given birth to a second child within five years (Figure 8).

Log-rank test statistic: $x^2 = 30.9$, p = 0.0000009

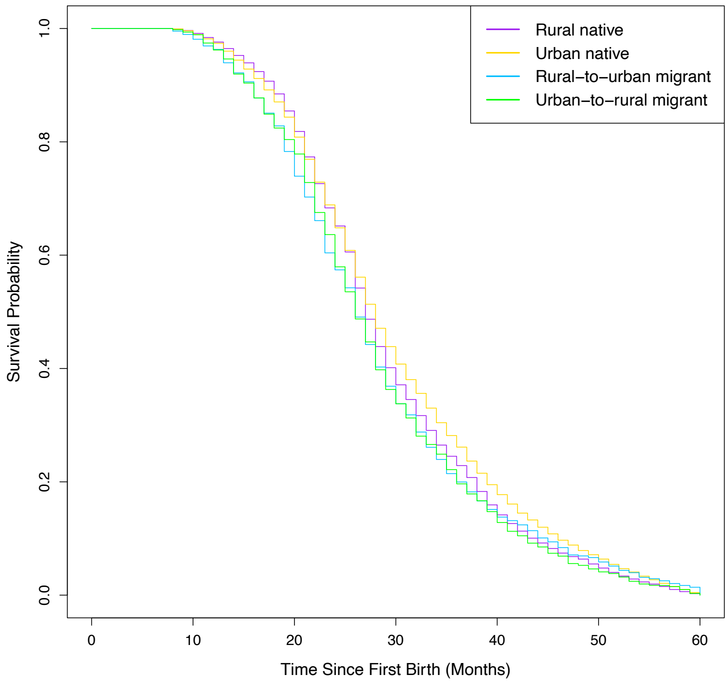

Figure 7: KPM Survival Estimate of the Proportion of Women Having a Second Birth Since the First Birth, by Migration Status, Nigeria

Log-rank test statistic: $x^2 = 57.6$, p = 0.000000000002

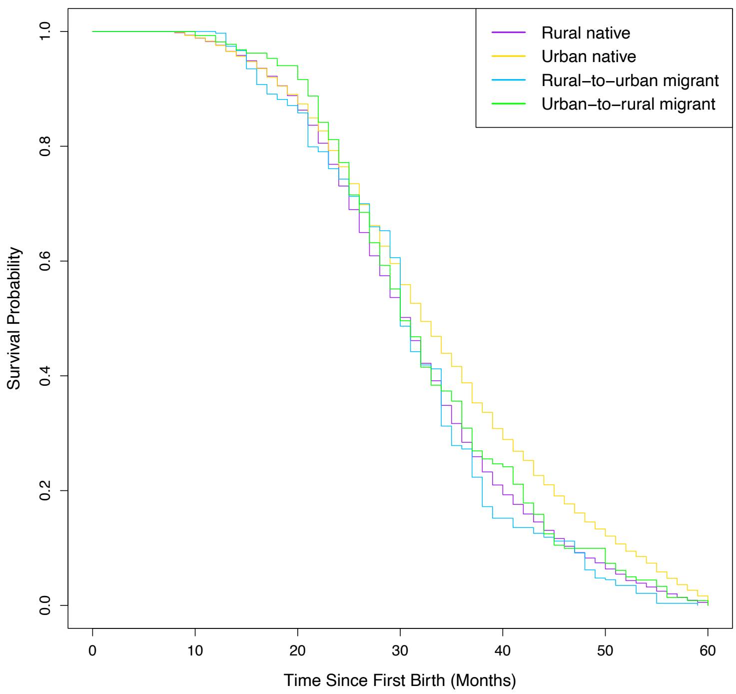

Figure 8: KPM Survival Estimate of the Proportion of Women Having a Second Birth Since the First Birth, by Migration Status, Zambia

4.3. Discrete-Time Hazard Model

4.3.1. Transition Across Different Birth Parities by Migration Status

First, the baseline hazard for the different migrant statuses is plotted without considering other covariates, modeling the hazard solely as a function of time. This plotted hazard function illustrates how the risk of having a second birth changes over the years since the first birth, independent of any other factors. The hazard for Nigeria, as depicted in Figure 9, reveals distinct patterns over time. Initially, during the first two years, hazard rates are similar across all groups. However, by the third year, urban natives have the lowest hazard rate, a trend that continues throughout the observation period. For other groups, hazard rates remain relatively stable without significant deviations until the fourth year. At this point, urban-to-rural migrants exhibit the highest hazard rates compared to all other groups, a pattern that continues through the fifth year. In contrast, rural-to-urban migrants and rural natives show comparable hazard rates during the fourth and fifth years, reflecting a similar likelihood of having a second child in these periods.

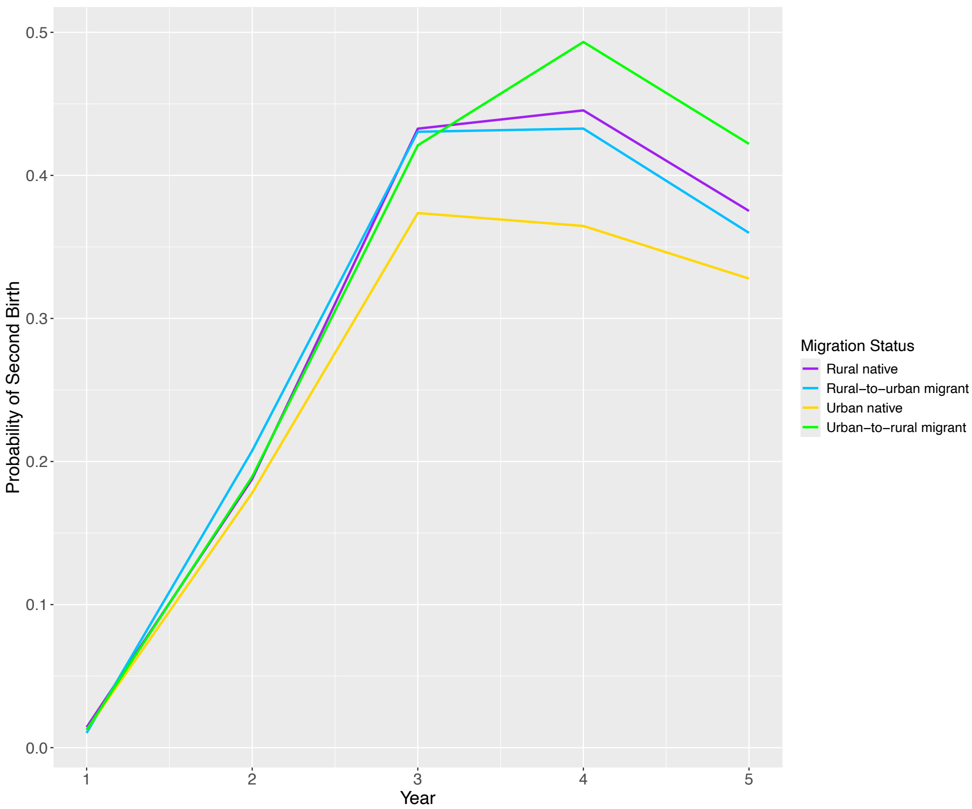

Figure 9: Hazard of Having a Second Birth by Year After First Birth and Migration Status, Nigeria

Figure 10 illustrates the hazard of having a second birth among different migrant groups for Zambia. Throughout the observed years, rural natives consistently have the highest hazard rate for a second birth. Urban natives, on the other hand, generally exhibit the lowest hazard rates, with the exception of the second year, where the hazards for urban natives, rural-to-urban migrants, and urban-to-rural migrants converge to nearly the same level. During the first three years, the hazard rates for rural-to-urban migrants and urban-to-rural migrants are quite similar. However, as time progresses, their patterns begin to diverge. In the initial two years, both migrant groups align their hazard rates more closely with urban natives. By the third year, the hazard rates of these migrant groups become indistinguishable, not distinctly aligning with either rural or urban natives. In the fourth and fifth years, a noticeable shift occurs: urban-to-rural migrants' hazard rates start to resemble those of rural natives more closely, while rural-to-urban migrants continue to maintain a hazard rate that is closer to that of urban natives.

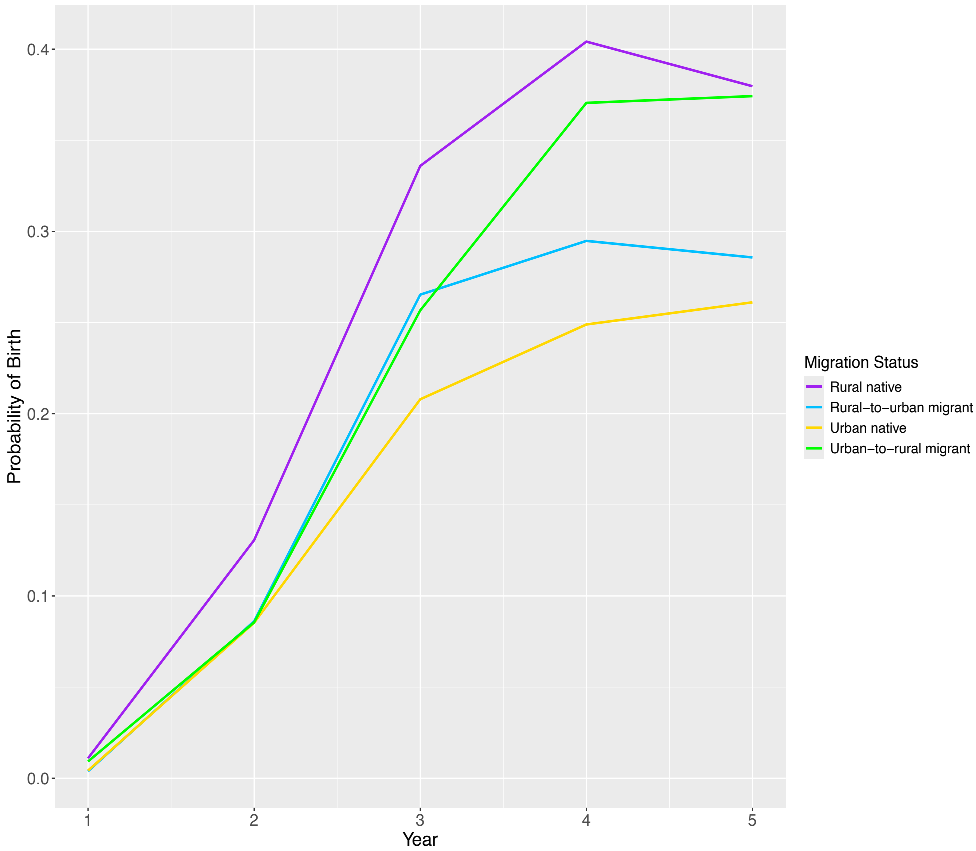

Figure 10: Hazard of Having a Second Birth by Year After First Birth and Migration Status, Zambia

The logistic regression analysis exploring the hazard of having a second birth over time by migration status, while also accounting for education, wealth, and religion, is presented. For a graphical representation of these findings, including the visual depiction of the coefficients and their confidence intervals, forest plots can be found in Appendix D. Additionally, the logistic regression output tables for the transitions from the second to the third child and from the third to the fourth child can be found in Appendix F.

The detailed logistic regression output for Nigeria is provided in Table 1 with a pseudo-R^2 value for the model of 0.28. For migration status, urban natives have a significantly lower hazard of having a second birth compared to rural natives, with a coefficient of -0.08 translating to an odds ratio indicating a 7.69% lower hazard. In contrast, rural-to-urban migrants show no significant difference in hazard relative to rural natives, with a coefficient of 0.08, suggesting that their risk of having a second birth is similar. Urban-to-rural migrants, however, have a higher hazard, as evidenced by a coefficient of 0.10 and an odds ratio reflecting a 10.52% increased hazard. Regarding education, the coefficient for primary education is -0.04, which is not statistically significant, indicating no substantial difference in the hazard of having a second birth compared to those with no education. Conversely, women with secondary or higher education have a significantly lower hazard, with a coefficient of -0.10 corresponding to a 9.81% reduction in hazard. In terms of wealth, middle wealth does not significantly alter the hazard of a second birth compared to poor wealth, as indicated by a coefficient of -0.04. However, women with rich wealth have a significantly lower hazard of having a second birth, with a coefficient of -0.14 translating to a 12.81% decrease in hazard. Finally, the analysis of religion shows that being Muslim is associated with a significantly higher hazard of having a second birth compared to being Catholic. The coefficient of 0.23 results in an odds ratio that suggests a 25.76% higher hazard for Muslim women.

The logistic regression analysis of the hazard of having a second birth in Zambia, detailed in Table 2, shows a pseudo-R^2 value of 0.29, indicating a moderate model fit. For migration status, urban natives have a coefficient of -0.20, highly significant, indicating an 18.1% lower hazard of having a second birth compared to rural natives. In contrast, rural-to-urban migrants show a coefficient of -0.19, which is not statistically significant, suggesting no substantial difference from rural natives. Urban-to-rural migrants have a coefficient of -0.12, significant at the 0.01 level, reflecting an 11.54% lower hazard of having a second birth compared to rural natives. Regarding education, the coefficient for primary education is -0.05 and not significant, while secondary or higher education shows a highly significant coefficient of -0.31, corresponding to a 26.66% lower hazard. In terms of wealth, those with middle wealth have a coefficient of -0.09, significant, indicating an 8.9% lower hazard, whereas rich individuals have a highly significant coefficient of -0.26, translating to a 23.09% lower hazard. Finally, the coefficient for Islam is -0.16, which is not statistically significant, suggesting no significant difference in hazard compared to Catholics.

	General Model: Transition First to Second Birth Nigeria	
	Coef.	SE
Urban native	-0.08 **	(0.03)
Rural-to-urban migrant	0.08	(0.05)
Urban-to-rural migrant	0.10 **	(0.03)
Education: Primary	-0.04	(0.03)
Education: Secondary or higher	-0.10 **	(0.04)
Wealth: Middle	-0.04	(0.02)
Wealth: Rich	-0.14 ***	(0.04)
Religion: Islam	0.23 ***	(0.02)
Pseudo R2		0.28

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 1: Logistic Regression Results for Transition from First to Second Birth, General Model, Nigeria

	General Model: Transition First to Second Birth Zambia	
	Coef.	SE
Urban native	-0.20 ***	(0.04)
Rural-to-urban migrant	-0.19	(0.10)
Urban-to-rural migrant	-0.12 *	(0.06)
Education: Primary	-0.05	(0.05)
Education: Secondary or higher	-0.31 ***	(0.06)
Wealth: Middle	-0.09 *	(0.04)
Wealth: Rich	-0.26 ***	(0.05)
Religion: Islam	-0.16	(0.19)
Pseudo R2		0.29

*** p < 0.001; ** p < 0.01; * p < 0.05.

Table 2: Logistic Regression Results for Transition from First to Second Birth, General Model, Zambia

4.3.2. The Interaction Effect Between Education, Migration and Fertility

The interaction plot in Figure 11 illustrates the relationship between education level and migration status on the likelihood of having a second birth in Nigeria. Detailed p-values for the significance levels are provided in Appendix G. Across all four migration statuses, the trends are consistent: the probability of a second birth rises sharply from the first to the third year, reaching a peak around year 3, and then slightly declines after year 4. Individuals with no education consistently show a higher probability of having a second birth compared to those with some education, regardless of migration status. This pattern suggests that lower education levels may be linked to higher fertility rates during the transition to a second birth. The difference between the solid and dashed lines within each migration status indicates that education exerts a consistent moderating effect. However, a closer look at the output table in Appendix G reveals that none of the interaction effects are statistically significant for any of the categories.

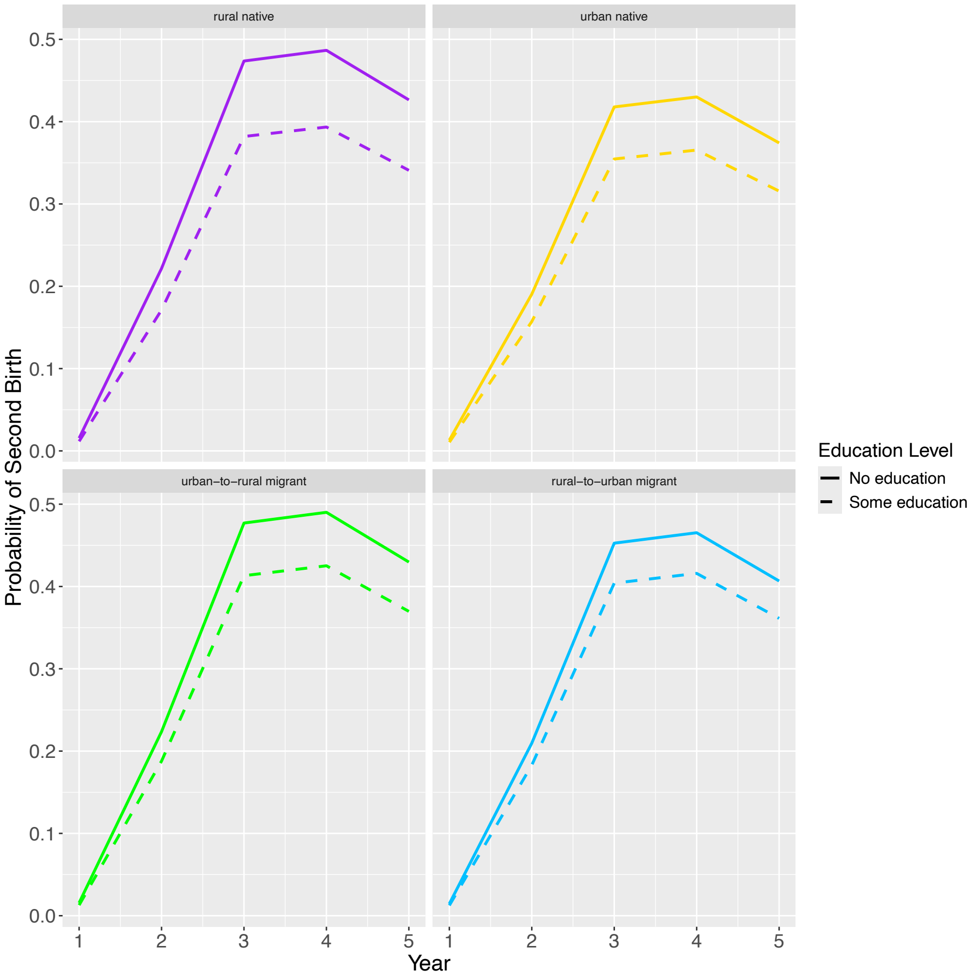

Figure 11: Interaction Plot for Interaction Effect between Education and Migration on Transition from First to Second Birth, Nigeria

For Zambia, the interaction plot in Figure 12 reveals a distinct pattern, with corresponding p-values provided in Appendix G. Across all four migration statuses, the probability of having a second birth rises from the first year, peaks around the fourth year, and then stabilizes in the final year observed. In all migration statuses, individuals with some education consistently show a lower probability of having a second birth, indicating that higher educational attainment may be linked to reduced fertility. The most significant negative impact of education on the likelihood of transitioning to a second birth is seen among urban-to-rural migrants, followed by urban natives and rural-to-urban migrants. Education appears to have a moderating effect on fertility across different migrant statuses, with this effect being more pronounced in some groups (e.g., urban-to-rural migrants). However, while the interaction effects are significant for most groups, the effect for rural-to-urban migrants is not statistically significant.

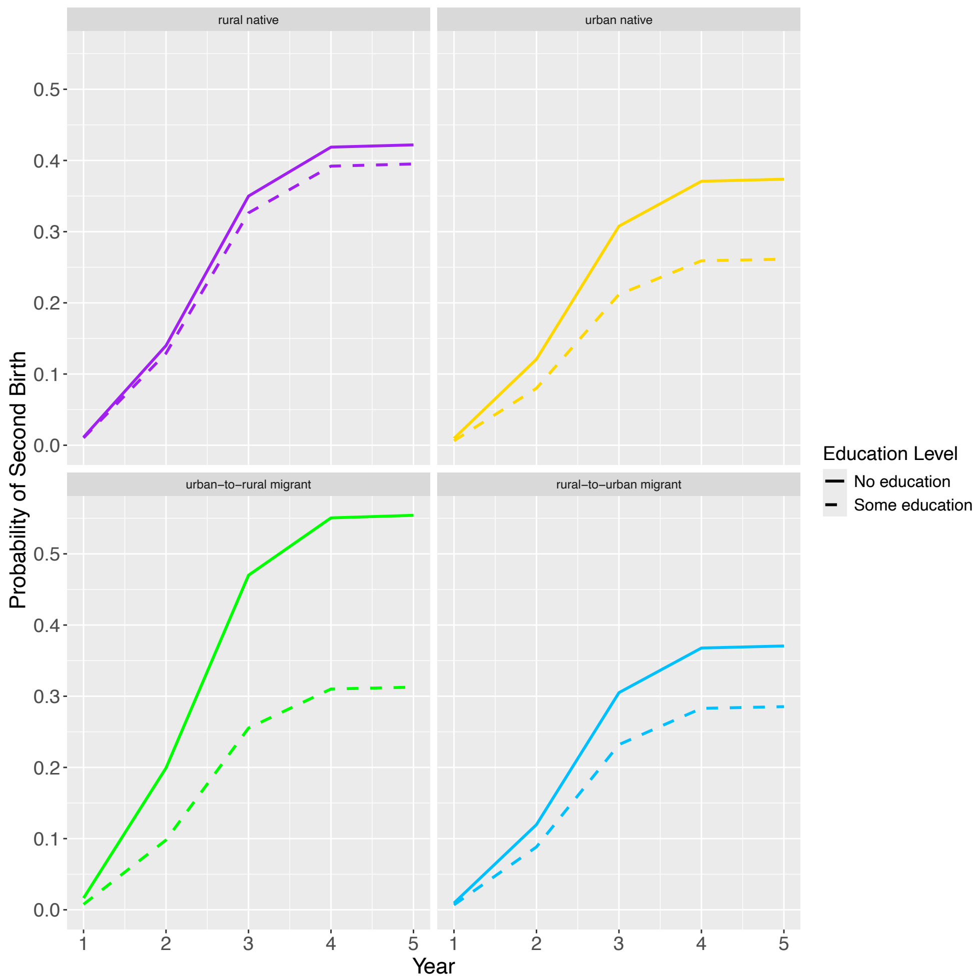

Figure 12: Interaction Plot for Interaction Effect between Education and Migration on Transition from First to Second Birth, Zambia

5. Discussion

The first hypothesis, which predicts differences in overall fertility behavior between internal migrants and non-migrants based on the indicators ASFRs and TFRs, is examined. For Nigeria, rural-to-urban migrants displayed intermediate ASFRs, initially closer to those of rural natives but increasingly aligning with urban natives, particularly from the 30-34 age group onward. Urban-to-rural migrants initially had higher ASFRs in the middle age groups (30-39), but their ASFRs progressively aligned with urban natives, particularly in the older age groups.

For Zambia, rural-to-urban migrants initially exhibited ASFR patterns similar to those of rural natives, especially among younger women, but their rates gradually converged with those of urban natives as they aged. Urban-to-rural migrant women, on the other hand, generally had higher ASFRs than urban natives. Their fertility rates varied by age group, initially reflecting urban natives in the younger age brackets and increasingly aligning with urban natives in the older age groups over time.

Throughout the study period, rural natives in Nigeria consistently had higher TFRs compared to rural-to-urban migrants. Initially, between 1991 and 1995, the gap was 0.88 children per woman. As the TFR for rural natives increased while the TFR for rural-to-urban migrants remained relatively stable, the disparity widened, peaking at 1.78 children per woman during 2006-2010. Although the gap narrowed slightly in the most recent period (2011-2015), it remained significant at 1.34 children per woman. Conversely, urban natives consistently had lower TFRs than urban-to-rural migrants. At the start of the study, the gap was substantial, at 1.40 children per woman. Over time, this gap narrowed significantly as urban-to-rural migrants experienced a considerable decline in TFR between 1996 and 2000, bringing their TFR to just 0.06 children per woman lower than that of urban natives in the following period. However, from 2001 to 2015, urban-to-rural migrants experienced a rebound in their TFR, leading to a renewed widening of the gap, which reached 0.75 children per woman by 2011-2015.

When comparing rural natives with rural-to-urban migrants in Zambia, rural natives consistently showed higher TFRs. Initially, the difference was modest, with rural natives having an advantage of 0.64 children per woman. However, between 1996 and 2010, while the TFRs for rural natives increased, those for rural-to-urban migrants remained stable, causing the gap to widen. By the 2011-2015 period, this difference had grown to 1.59 children per woman. In contrast, the trend between urban natives and urban-to-rural migrants differed. Urban-to-rural migrants consistently had higher TFRs across all periods. Initially, urban natives experienced a two-step decline in TFR, while urban-to-rural migrants saw an initial increase, followed by a decrease, another increase, and finally another decrease. By 2011-2015, the TFR gap between these two groups had widened to 0.91, up from 0.51 in 1991-1995.

These findings confirm the hypothesis, showing clear differences in fertility behavior between internal migrants and non-migrants in Nigeria and Zambia. Therefore, regardless of whether migration is from rural to urban areas or vice versa, migrants tend to adopt the fertility behavior of their current place of residence. This observation is supported by Brockerhoff's (1995) study, which analyzed thirteen DHS surveys on fertility and migration to urban places in African countries, including Nigeria and Zambia. Brockerhoff concludes that adaptation in fertility behavior is influenced by factors such as initial unmarried status, high rates of partner separation among married migrants, heightened use of family planning methods, and the ongoing practice of prolonged postpartum abstinence common in rural areas. These factors contribute to lower fertility rates, particularly in the initial years after migration, even when compared to long-term urban residents. Gyimah (2006) found comparable results in his study in Ghana, indicating that migrants adjust to the fertility levels of their destination, regardless of whether they move from urban to rural areas or vice versa. While the reasons for the adaptation process in urban settings align with Brockerhoff's explanation, Gyimah attributes the higher fertility rates in rural areas to the fact that migration there is often driven by agricultural reasons. The new location offers economic benefits for increased farm labor, which consequently leads to increased childbearing.

Whereas the adaptation process remained relatively consistent over time for both groups, urban-to-rural migrants exhibited a smaller magnitude of change in fertility behaviors compared to rural-to-urban migrants. This difference may be attributed to urban-to-rural migrants retaining some urban practices or having characteristics that set them apart from rural natives, which can hinder their full adoption of rural fertility norms. Additionally, since urban women often have higher levels of education than rural women (Burger, 2011) and higher education is generally associated with lower fertility rates (Bongaarts, 2020), it is less likely that urban-to-rural migrants will fully align with the higher fertility rates typical of rural areas.

Next, the hypothesis concerning whether internal migrant women have different birth spacing intervals compared to non-migrant groups is addressed. In the fields of demography and reproductive health, examining the interval between births serves as a valuable fertility indicator (Banougnin, 2019).

Increasing the birth spacing between consecutive births results in fewer children for a woman, which can benefit the size of the population and improve the well-being for both mothers and children (Yohannes et al., 2011). However, as discussed by Ajayi & Somefun (2020), excessive birth spacing is also associated with negative health effects and complications for both mothers and babies.

When comparing birth spacing across different birth parities in the general population, Nigerian women tend to have shorter intervals between births than Zambian women. In the broader context of SSA, key factors influencing birth spacing include age, maternal education, and contraceptive use (Ajayi & Somefun, 2020). Younger women typically have shorter birth intervals, likely due to lower contraceptive use compared to older women, while more educated women generally prefer longer birth intervals because they have a better understanding of contraceptives, allowing them to avoid unplanned pregnancies and plan their families more effectively (Ajayi & Somefun, 2020). Based on the latest DHS data, Nigerian women have a median of 6.5 years of schooling, while Zambian women have a median of 6.8 years. However, 35% of women in Nigeria lack any formal education, whereas only 8% of women in Zambia are uneducated. Additionally, the contraceptive prevalence rate is 17% among currently married women and 37% among sexually active unmarried women in Nigeria, whereas in Zambia, these rates are 50% and 44%, respectively (Nigeria Population Commission, 2019; Zambia Statistics Agency, Ministry of Health Zambia, & ICF, 2019). These disparities in education and contraceptive use likely account for the variations in birth spacing observed.

When looking at the transition from the first to the second birth, in Nigeria, rural and urban native women generally have childbirth intervals about two to three months longer than rural-to-urban and urban-to-rural migrants during the first half of the interval. Beyond the 50% mark, the pattern shifts: urban native women consistently have longer intervals compared to rural native women, who begin to reduce their spacing relative to urban natives. Consequently, the difference in spacing between rural native women and the migrant groups decreases. Throughout the whole observation period, both migrant groups exhibit approximately the same patterns of spacing.

In Zambia, only small differences in birth spacing—ranging up to plus or minus one month—are observed between rural natives, urban natives, and rural-to-urban migrants, who show slight fluctuations up to the 25% mark. The only group with notably longer birth intervals is urban-to-rural migrants. However, by the 50% mark, the gap between urban and rural natives widens to approximately three months and continues to do so over time. Both rural-to-urban and urban-to-rural migrants increasingly align with the birth spacing patterns of rural natives as the observation period progresses.

The findings indicate variation in birth intervals between internal migrant groups and non-migrants in both countries, supporting the hypothesis, though the extent of variation differs. In Nigeria, while the differences among groups are minimal, both migrant groups have shorter birth intervals compared to their native counterparts. Additionally, no significant difference is observed between rural and urban native women until the 27th month. In Zambia, urban-to-rural migrants do not display a clear pattern of adaptation or socialization, whereas rural-to-urban migrants maintain birth spacing practices consistent with their rural origins.

The findings for Nigeria and Zambia contradict those reported in the literature, which clearly demonstrates adaptation in birth spacing practices among migrant women in SSA (e.g., Banougnin, 2019; Brockerhoff, 1995). For Nigeria, Ajayi & Somefun (2020) found a very unusual pattern. More educated women have a higher likelihood of having shorter birth intervals, which contrasts with typical patterns in other SSA countries. Since urban women are generally more educated than their rural counterparts (Burger, 2011), this might account for the minor differences in birth spacing between rural and urban areas. Additionally, female migrants in Nigeria are often young, with over 30% migrating under the age of 18 (Poufon et al., 2021). This youthfulness could explain why both internal migrant groups tend to have shorter birth intervals compared to urban and rural women. In Zambia, while no clear pattern is observed for urban-to-rural migrants, the lack of adaptation among rural-to-urban migrants may be attributed to the recent nature of migration. As Banougnin (2019) notes, the adaptation process tends to be slow and incremental rather than immediate. Over time, the birth spacing practices of migrant women might slowly begin to align with those of non-migrant women.

The following section explores the results from the discrete-time hazard model analysis, concentrating on the hypothesis that the likelihood of having a subsequent birth differs among various migrant groups when accounting for different socio-demographic factors. Detailed tables for additional parities are provided in Appendix F.

Consistent with existing literature and research, individuals born in urban areas of both countries are less likely to have a second child. This trend can be attributed to the higher costs of raising children in urban settings and the diminished economic value of children as labor compared to rural regions. Additionally, urban environments often offer greater access to family planning programs, and there is a widespread acceptance of the cultural shift towards smaller families (White et al., 2008). These findings hold true across different birth orders, though the disparity in likelihood between rural and urban natives decreases with each subsequent birth. The larger negative coefficient for Zambia can be explained by the generally greater discrepancy between urban and rural fertility rates compared to Nigeria.

For rural-to-urban migrants, the analysis yields varied results in Nigeria and Zambia. In Nigeria, the coefficient for rural-to-urban migrants is positive but not statistically significant, indicating no significant difference in the likelihood of having a second birth compared to rural natives, indicating no adaptation to urban fertility behavior. As parity increases, the coefficient decreases, but remains statistically insignificant across other parities. Given that socio-demographic factors have been controlled for, the issue likely stems from the characteristics of urbanization in Nigeria. As outlined in the theoretical section, the rapid pace of urbanization in Nigeria has overwhelmed cities, making sustainable urbanization more challenging. Effective housing policies are especially critical in this context. The swift increase in population and urban expansion has caused a significant shortage of adequate housing, resulting in issues like overcrowding, deteriorating living conditions, insufficient infrastructure, homelessness, and heightened poverty levels (Jiboye, 2011). Therefore, the factors typically responsible for lower fertility rates in urban settings may be less effective in influencing rural-to-urban migrants in Nigeria due to the overwhelming challenges posed by rapid urbanization.

In contrast, in Zambia, the coefficient for rural-to-urban migrants is negative but not statistically significant, indicating no substantial difference in the likelihood of having a second child compared to rural natives. However, as parity increases, the negative coefficient becomes more pronounced and statistically significant. This suggests that while migration is less common among individuals with children—most migrants likely relocate before having their first child (Brockerhoff & Eu, 1993)—the adaptation process among Zambian rural-to-urban migrants is gradual. This observation aligns with Banougnin's (2019) assertion that adaptation is a gradual process rather than an abrupt one, which also explains the KPM analysis results, where no significant adaptation process was observed among Zambian rural-to-urban migrants for the transition to the second birth. The better adaptation of rural-to-urban migrants to the fertility rates of urban natives in Zambia, compared to Nigeria, might be explained by the differences in urbanization rates. Urbanization in Nigeria has progressed steadily, while Zambia has experienced more fluctuations in its urbanization rates (Figure 2). As a result, Zambian cities have not faced the same rapid and intense urbanization challenges as Nigeria.

In Nigeria, urban-to-rural migrants are significantly more likely to have a second child compared to rural natives. However, for additional births beyond the second, there are no significant differences in fertility rates between migrants and rural natives. Due to the limitations of DHS data, which do not capture circular migration, Menashe-Oren & Sánchez-Páez (2023) assume that many urban-to-rural migrants are returnees. This assumption implies that these migrants were initially socialized in rural environments and did not adapt to urban fertility behaviors during their time in cities. Consequently, after experiencing disruptions during migration, these women may adjust their reproductive strategies to compensate for lost time (Lindstrom & Saucedo, 2002), leading to a higher likelihood of having a second child while maintaining similar fertility rates for subsequent births. Assuming urban-to-rural migrants are not returnees, the adaptation hypothesis would be more relevant in this context.

In Zambia, urban-to-rural migrants are significantly less likely to have a second child compared to rural natives. Moreover, this negative trend intensifies for additional births: the likelihood of having subsequent children decreases even further, with the negative coefficient becoming more pronounced and statistically significant compared to both rural and urban natives. Assuming again, as Menashe-Oren & Sánchez-Páez (2023) suggest, that many urban-to-rural migrants are returnees, these individuals carry the fertility behaviors they adopted while living in urban areas back to their rural regions. In contrast to Nigeria, where adaptation to urban fertility behaviors is not existing, these migrants exhibit even lower likelihoods of having subsequent births compared to both rural and urban natives. This reduced fertility for additional births may be attributed to the disruptions and adjustments associated with the migration process. For migrants who are not returnees, the socialization hypothesis is relevant, indicating that their reproductive behaviors are shaped by the urban environment in which they were socialized.

In summary, the hypothesis that the likelihood of having a subsequent birth varies among different migrant groups, even when accounting for various socio-demographic factors, has been confirmed. Specifically, for Nigerian rural-to-urban migrants, the socialization hypothesis is more prevalent whereas for urban-to-rural migrants, the applicable hypothesis depends on whether they are returnees: returnees are more likely to exhibit patterns consistent with the socialization hypothesis, while non-returnees are more influenced by the adaptation hypothesis, reflecting a shift towards rural fertility norms and behaviors. In Zambia, rural-to-urban migrants tend to adapt their fertility behavior to align with urban norms, while urban-to-rural migrants largely maintain the fertility behaviors they experienced in their urban settings. However, if the urban-to-rural migrants are returnees, they would have adapted to urban fertility behaviors during their time in the city, and this adaptation persists even after moving back to a rural setting. Overall, this indicates that differences in fertility behavior among these groups are not solely attributable to socio-demographic characteristics but are also influenced by other factors related to their migrant status. For a comprehensive understanding, the socio-demographic factors are also examined.

The first variable discussed is education. The literature generally finds that increased education leads to lower fertility rates. This reduction in fertility rates is driven by several factors, such as enhanced independence, shifts in family planning practices and gender norms, increased involvement in the labor market (which raises the opportunity costs of having children), and a delay in the age at marriage (Channon & Harper, 2019).

The effect of education on the likelihood of having additional children is fairly consistent across both countries. Only secondary or higher education significantly reduces the likelihood of having a second child compared to no education. This effect becomes even more pronounced for subsequent births in both countries, with a particularly strong impact observed in Zambia. Additionally, primary education also reduces the likelihood of further births in both countries, though to a much lesser extent. Liu & Raftery (2020) support this finding, concluding that primary education generally has only a small impact on fertility compared to the completion of secondary education. Thus, it is particularly the attainment of secondary education that contributes more significantly to accelerating fertility decline.

Furthermore, the greater impact of education on fertility in Zambia in comparison to Nigeria can be explained by Martin (1995), who concludes that in SSA the influence of women's education is largely dependent on the country's socioeconomic development and the stage of its fertility transition. As shown in Figure 1, Zambia is more advanced in its fertility transition, which likely accounts for the significant effect of education on fertility rates.

Turning to the role of wealth, the relationship between income and fertility is intricate because income is linked to multiple facets of economic and social development. These include educational opportunities, women's participation in the workforce, availability of goods and services, and the costs associated with time (National Research Council et al., 1993).

While there are minor differences between the countries, the overall trends align. In Nigeria, only individuals classified as rich exhibit a significant and negative coefficient for the transition from the first to the second child. For the transition to the third child, there is no significant difference between wealthier and poorer individuals. However, for the transition to a fourth birth, individuals with middle wealth status show a slight but significant increase in likelihood. In Zambia, both middle and rich wealth statuses have significant and negative coefficients for the transition from the first to the second child. For the transition to the third child, there is no significant difference between individuals with middle or rich wealth statuses and those with no wealth. Notably, for the transition to a fourth child, individuals with middle wealth status display a small positive coefficient compared to those with no wealth.

The decreased likelihood among wealthier individuals for the transition from the first to the second birth might be explained by the indirect effects wealth has on fertility such as the labor market participation of women or increased education. In contrast, the increase in the likelihood of subsequent births among wealthier individuals has been observed also in other studies (e.g., Skirbekk, 2008). However, if wealthier countries had higher fertility rates overall, this trend would be apparent, but it is not observed (Kebede et al., 2022). The relationship between wealth and fertility is rather complex, particularly since wealth is considered a time-invariant factor in the analysis. Therefore, it is concluded that income affects fertility through a combination of direct and indirect mechanisms, with its impact being either positive or negative depending on the specific context (Mueller & Short, 1983).

Lastly, the impact of religion on the transition to subsequent births is discussed. In Nigeria, individuals who practice Islam are more likely to transition from the first to the second birth compared to Christians. However, this increased likelihood diminishes with each subsequent birth transition and becomes insignificant for the final parity. In contrast, in Zambia, there is no significant difference in birth transitions between individuals of different religious affiliations and Christians across all three birth parities.

In Nigeria, where Muslims and Christians are roughly evenly distributed (Robinson et al., 2023), Adebowale and Palamuleni (2024) found that polygamous marriages are more common among Muslims than Christians, potentially explaining differences in fertility rates. In the broader scope of SSA, the Muslim population is associated with higher fertility, misconceptions about contraception, earlier marriage, and a higher prevalence of polygyny (Westoff et al., 2015), which confirms the finding. The contrasting results observed in Zambia may be due to the small share of Muslims within the dataset, as Muslims represent only a minority of the population in Zambia (2023 Report on International Religious Freedom: Zambia, n.d.).

The final hypothesis explored in this paper examines whether a significant interaction exists between education and migration status in influencing the transition to a second birth. In Nigeria, although a minor interaction effect is observed, it is not statistically significant across all migrant groups. In contrast, in Zambia, a significant interaction effect is found among urban-to-rural migrants while for rural-to-urban migrants, this interaction effect does not reach statistical significance.

In Nigeria, one reason for the notable absence of a moderation effect among high-educated and low-educated rural-to-urban migrants may be related to the job market, specifically the scarcity of wage jobs, with only 15% of employed Nigerians holding such positions (Lain & Pape, 2024). This shortage often forces even educated rural-to-urban migrants into low-paying, unstable, or informal work that does not utilize their skills effectively. The mismatch between education and job quality can limit the economic benefits typically associated with higher education. As a result, the economic pressures faced by these migrants—such as financial instability and limited access to resources—may overshadow the influence of education on their fertility decisions. In a case study by Adebowale et al. (2020), women from low-income households had more children than those from high-income households, underscoring how economic constraints can significantly impact reproductive choices. Further, another explanation could be that, as noted by Aliu et al. (2021), more than 50% of Nigeria's urban inhabitants live in informal settlements. The scarcity of formal housing options often compels many rural-to-urban migrants to settle in these areas, where the availability and quality of family planning services can be inconsistent (Idowu, 2013). This variability in service provision may diminish the observable impact of education on fertility behavior for migrants.

The non-significant moderation effect between higher-educated and lower-educated urban-to-rural migrants may be explained by the fact that higher-educated women often breastfeed for shorter durations while using contraception to extend the interval between births (Ajayi & Somefun, 2020). However, having only limited access to family planning services and contraception in rural areas (Nigeria Population Commission, 2019), combined with shorter breastfeeding periods, might undermine the effectiveness of this strategy. As a result, the fertility outcomes for higher-educated migrant women could end up being similar to those of their less-educated counterparts.

In the case of Zambia, the lack of a significant effect for rural-to-urban migrants is likely due to the same factors reflected in the single coefficient for rural-to-urban migration in the general model. The adaptation process for these migrants may take time, and for the transition from the first to the second birth, no significant interaction effect is observed, regardless of educational level. To gain a deeper understanding, it would be valuable to examine other birth parities as well.

For urban-to-rural migrants, the negative and significant effect on the likelihood of having a second child may be attributed to the fact that educated migrants tend to retain the fertility norms and values they acquired in urban areas. Compared to women without education, these educated individuals are more likely to continue prioritizing urban ideals even after relocating to rural settings, resisting the higher fertility expectations common in rural environments. Additionally, educated migrants generally have better access to information about family planning and reproductive health (Kim, 2023). This access to knowledge may empower them to maintain control over their fertility choices, making them less likely than their less educated counterparts to conform to the higher fertility norms in rural areas.

In conclusion, the hypothesis regarding the relationship between migration and education is supported in Zambia, where a notable interaction is evident among urban-to-rural migrants. Conversely, in Nigeria, the hypothesis is not supported, as no significant interaction is observed.

5.1. Limitations

Given the inherent limitations and assumptions within this study, the results must be interpreted with caution. One of the most significant concerns related to the DHS data, and by extension this analysis, is that while birth history is collected retrospectively, migration status is not. This discrepancy introduces potential bias, particularly in cases of circular or repeated migration, where individuals move back and forth between locations over time. Such migration patterns are likely to have a substantial impact on the results, as they are not adequately captured by the data. This limitation could lead to multiple instances of adaptation to the fertility norms of different locations, thereby influencing the findings (Pongi Nyuba, 2019, as cited in Menashe-Oren & Sánchez-Páez, 2023).

Additionally, the DHS data does not define what constitutes rural or urban areas; instead, these classifications are based on definitions provided by each individual country (Bridgette-DHS, 2013). This means that the distinction between rural and urban areas is determined by each country's specific criteria, which can vary significantly from one country to another. As a result, making comparisons between countries becomes more challenging due to these differing definitions.

A further limitation to consider is that the wealth variable included in the time-discrete hazard model is a time-invariant covariate, measured only at the time of the interview. However, it is uncommon for an individual's wealth to remain unchanged throughout their life course (Goda & Streeter, 2021). Despite this limitation, the inclusion of this factor in the model is expected to offer more insights than it would otherwise.

Lastly, due to the substantial decrease in the number of observations at higher birth parities, the time-discrete hazard model was limited to examining the transition up to the fourth birth. Considering that the TFR is 5.2 for Nigeria and 4.4 for Zambia (see Figure 1), a significant number of women in these countries have more than four children. Therefore, incorporating data on women with higher birth parities would provide more valuable insights, leading to a more comprehensive understanding of the fertility behavior of migrant women across all stages of their reproductive lives.

6. Conclusion

This paper aimed to investigate various aspects of fertility among different migrant groups in SSA, utilizing DHS data from Nigeria and Zambia. It examined how the fertility patterns of internal migrant women compare to those of non-migrant women and aimed to explain the observed differences. Analysis of cumulative fertility through TFRs and ASFRs in both countries shows a distinct adaptation to regional fertility norms among rural-to-urban and urban-to-rural migrants. The adaptation is more pronounced in rural-to-urban migrants, while urban-to-rural adaptation is limited, likely due to the influence of higher education among urban women.

Additionally, birth spacing between the first and second births was analyzed, revealing distinct patterns in each country that challenge established literature. In Nigeria, both migrant groups experienced shorter intervals between births compared to non-migrants, which may be attributed to the younger age of migrants, often linked to lower contraceptive use. In Zambia, urban-to-rural migrants showed no clear pattern of adaptation or socialization, while rural-to-urban migrants aligned more closely with the socialization hypothesis. This suggests a more gradual adaptation process rather than an immediate one, potentially not evident in the transition to the second birth.

The final section of the paper employed a discrete-time hazard model to analyze the probability of having additional children among different migrant groups, considering various socio-demographic factors. In both countries, urban residents are less likely to have a second child, with this trend persisting across subsequent birth parities. This pattern is likely due to urban lifestyle and norms, aligning with findings from existing literature. The effect is less pronounced in Nigeria than in Zambia, reflecting a smaller overall difference between rural and urban fertility rates compared to Zambia.

Rural-to-urban migrants in Nigeria show no significant adaptation to urban fertility behaviors, a trend consistent across all birth parities. This lack of change is likely due to the severe strain on urban infrastructure and living conditions caused by rapid urban expansion, which diminishes the typical factors that usually reduce fertility rates in urban areas. In contrast, an adaptation process is observed in Zambia for higher birth orders, becoming more pronounced with increasing parity, suggesting a gradual rather than immediate adaptation. The difference likely stems from Zambia’s less intense urbanization compared to Nigeria’s rapid and severe urban growth, resulting in fewer urbanization challenges.

Urban-to-rural migrants in Nigeria are more likely to have a second child than rural natives but show no difference in fertility rates for subsequent births. This trend may be due to these migrants being returnees who haven't fully adapted to urban fertility norms, combined with the effects of migration-related disruptions. In Zambia, however, urban-to-rural migrants are significantly less likely to have a second child, with the trend strengthening for additional births, likely because returnees bring urban fertility behaviors back to rural areas. For non-returnees, the socialization hypothesis suggests that their reproductive behaviors are influenced by their prior urban experiences.

The final section of the paper is expanded to include a model that examines the interaction between migration status and education in relation to fertility behavior. In Nigeria, no significant interaction effect is observed across any migrant statuses. For rural-to-urban migrants, this lack of significant interaction may be attributed to inadequate provision of family planning services, compounded by a high prevalence of informal settlements. Additionally, factors related to the job market could also be influencing these outcomes. For urban-to-rural migrants, the duration of breastfeeding may play a central role in the observed effects. In Zambia, the patterns are more pronounced. Rural-to-urban migrants exhibit minimal changes in fertility behavior, likely due to a gradual adaptation process that is unaffected by their educational level. In contrast, urban-to-rural migrants with higher education are more likely to maintain urban fertility norms and benefit from better access to family planning resources, leading to a lower likelihood of subsequent births even after moving to rural areas.

To summarize, the paper demonstrates that internal migrants exhibit different fertility behaviors compared to non-migrants, with the extent of these differences varying by country, highlighting the context-dependent nature of the findings. Contradictory conclusions in the literature often arise from variations in time, context, migration types examined, and methodological differences (Kulu, 2005). Consequently, drawing broad conclusions about other SSA countries based solely on these findings could be misleading due to the unique contexts and variables involved. Still, this paper provides valuable insights into the dynamics of migration and fertility.

Given the rising urbanization rates across most SSA countries and their significant impacts on development and future trajectories, policymakers should prioritize the effective inclusion and integration of migrants and marginalized people into urban environments, which will ultimately lead to lower fertility levels (Martine, 2013). Moreover, education plays a crucial role in advancing fertility transition in SSA. It not only positively influences fertility outcomes, such as through its impact on desired fertility (Kebede et al., 2022), but also enhances adaptation benefits for rural-to-urban migrants. At the same time, more educated urban-to-rural migrants are less likely to adapt to rural fertility settings. Therefore, policymakers should invest in ensuring that women receive not only primary but also secondary education, as the impact on reducing fertility rates is even greater. Special attention should be given to rural areas, anticipating that many residents will eventually migrate to urban areas. This enhanced educational foundation will further benefit rural-to-urban migrants, facilitating their adaptation and supporting more effective fertility transitions as they integrate into urban settings.

6.1. Future Research and Recommendations

Future research on the interplay between migration and fertility should incorporate longitudinal data. Utilizing longitudinal data would allow researchers to account for repeated and circular migration, as well as the impact of disruptions caused by the migration process. While this study controlled for selection using various socio-demographic variables, longitudinal data would facilitate the inclusion of additional control variables as time-variant covariates, like the use of contraception or the desired family size, enhancing the robustness of the analysis. Additionally, future studies should address both observable and unobservable selection factors, such as aspiration and risk-taking behavior (Nuhoḡlu Soysal and Cebolla-Boado, 2020).

7. Appendix

7.1. Appendix A

Abstract German

Subsahara-Afrika (SSA) weist die weltweit höchsten Geburtenraten auf und erlebt eine rasante Urbanisierung (Njoh, 2003). Typischerweise weisen ländliche Gebiete höhere Geburtenraten auf als städtische Zentren, was darauf schließen lässt, dass die Migration vom Land in die Stadt den Fruchtbarkeitsübergang in der Region beschleunigen könnte (Brockerhoff und Yang, 1994). Diese Studie untersucht die komplexe Beziehung zwischen Migration und Fruchtbarkeit in SSA und konzentriert sich dabei auf Nigeria und Sambia, die aufgrund ihrer unterschiedlichen Fruchtbarkeits- und Urbanisierungsprofile ausgewählt wurden. Die Studie untersucht Fruchtbarkeitsmuster unter Binnenmigrantinnen und wie sich diese von Nichtmigrantinnen unterscheiden. Sie untersucht, ob Migrantinnen neue Fruchtbarkeitsgewohnheiten annehmen oder solche aus ihrem Kindheitsumfeld beibehalten, und bewertet die Rolle der Bildung bei der Abmilderung der Auswirkungen der Migration auf die Fruchtbarkeit. Die Methodik umfasst eine Basisfruchtbarkeitsanalyse der gesamten und altersspezifischen Fruchtbarkeitsraten, eine Überlebensanalyse unter Verwendung von Kaplan-Meier-Techniken zur Untersuchung der Übergangszeit von der ersten zur zweiten Geburt und ein zeitdiskretes Modell zur Bewertung der Wahrscheinlichkeit nachfolgender Geburten nach Geburtenparität unter Berücksichtigung sozioökonomischer Faktoren. Ein erweitertes zeitdiskretes Modell untersucht das Zusammenspiel zwischen Migration, Fruchtbarkeit und Bildung weiter.

Die Ergebnisse zeigen, dass Binnenmigranten im Vergleich zu Nichtmigranten ein anderes Fruchtbarkeitsverhalten zeigen. Die Basisfruchtbarkeitsanalyse zeigt in beiden Ländern starke Anpassungsmuster, insbesondere unter Migranten vom Land in die Stadt. Nigerianische Migranten erleben im Vergleich zu Einheimischen kürzere Abstände zwischen der ersten und zweiten Geburt, während sich sambische Migranten vom Land in die Stadt allmählich anzupassen scheinen, was darauf hindeutet, dass die Sozialisierungshypothese zumindest für den Übergang zur zweiten Geburt zutrifft. Migranten vom Land in die Stadt in Nigeria zeigen keine signifikante Anpassung des Fruchtbarkeitsverhaltens, wenn soziodemografische Faktoren kontrolliert werden, während sambische Migranten eine allmähliche Anpassung

zeigen, insbesondere bei höherer Geburtenparität. Migranten vom Stadt-in-Land in Nigeria zeigen je nach Rückkehrstatus gemischte Muster, während diese Migranten in Sambia eher zur Sozialisierung als zur Anpassung neigen. Bildung moderiert das Fruchtbarkeitsverhalten von Migranten vom Stadt-in-Land in Sambia erheblich, aber dieser Effekt ist in Nigeria nicht zu beobachten. Diese Ergebnisse werden auf Nigerias geringere Fertilitätslücke zwischen Stadt und Land und die schnellere Urbanisierung im Vergleich zu Sambia zurückgeführt. Die Ergebnisse legen nahe, dass sich die politischen Entscheidungsträger in SSA auf die Integration von Migranten in städtische Gebiete konzentrieren und in die Sekundarschulbildung von Frauen investieren sollten, insbesondere in ländlichen Regionen, um die Fertilitätsraten zu senken und den Fertilitätsübergang zu unterstützen.

7.2. Appendix B

ASFRs by Group and Country, Five-Year Intervals

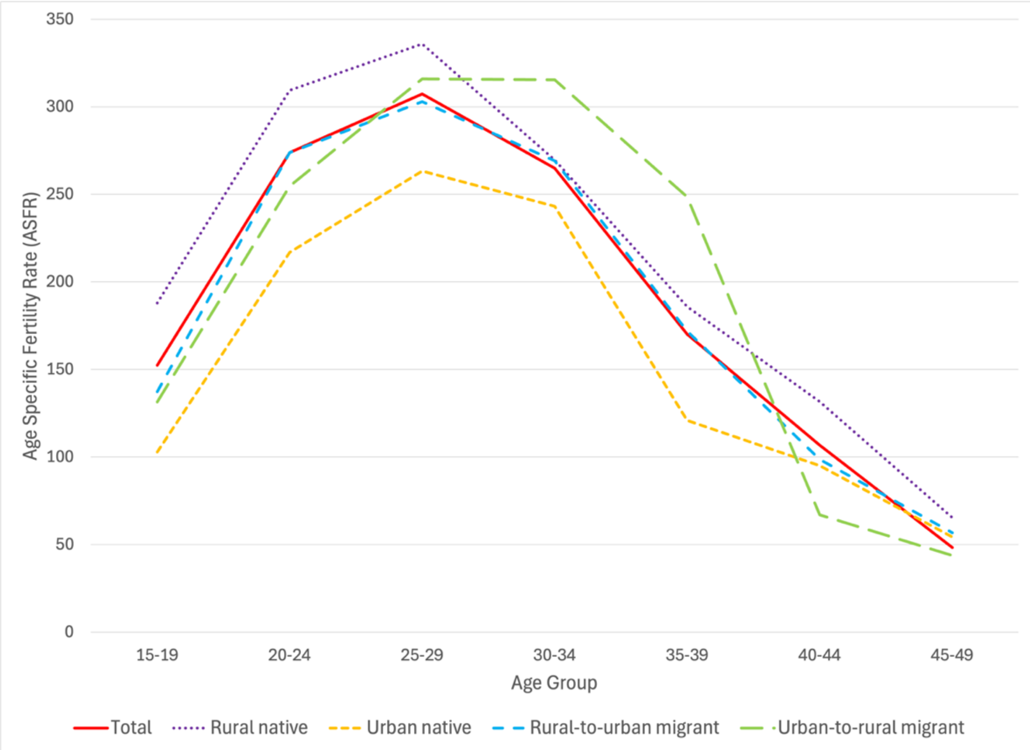

Figure 13: ASFRs by Group in Nigeria, 1991 – 1995 (Source: Nigeria DHS4)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	152,35	188,04	102,89	137,35	131,44
20-24	273,86	309,48	216,94	273,94	254,68
25-29	307,38	335,87	263,35	303,00	315,87
30-34	264,99	269,65	243,15	269,20	315,42
35-39	170,02	185,84	120,92	171,93	248,60
40-44	106,80	131,68	95,07	98,61	66,90
45-49	48,32	65,34	54,34	56,73	43,75

Table 3: ASFRs by Group in Nigeria, 1991 – 1995 (Source: Nigeria DHS4)

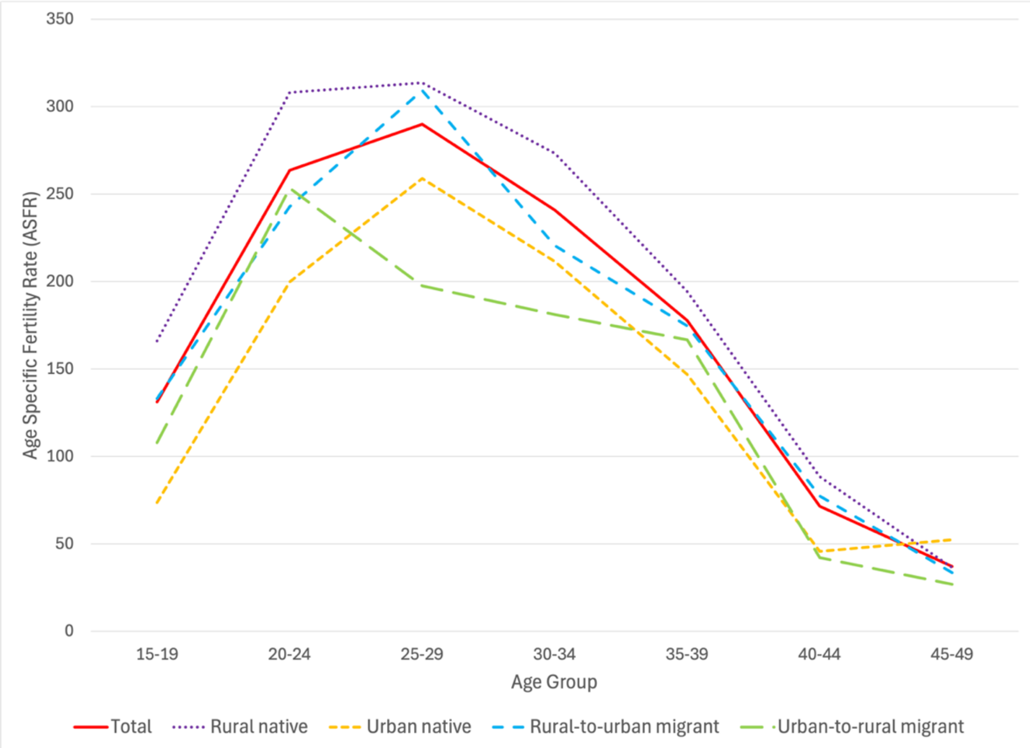

Figure 14: ASFRs by Group in Nigeria, 1996 – 2000 (Source: Nigeria DHS4)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	131,14	166,04	73,57	133,12	107,91
20-24	263,58	308,20	199,73	242,83	253,46
25-29	289,92	313,59	258,94	309,23	197,45
30-34	240,94	273,39	211,50	220,64	181,04
35-39	177,76	194,28	146,89	174,70	166,61
40-44	71,56	88,44	45,63	77,38	42,09
45-49	37,16	36,43	52,41	33,56	26,92

Table 4: ASFRs by Group in Nigeria, 1996 – 2000 (Source: Nigeria DHS4)

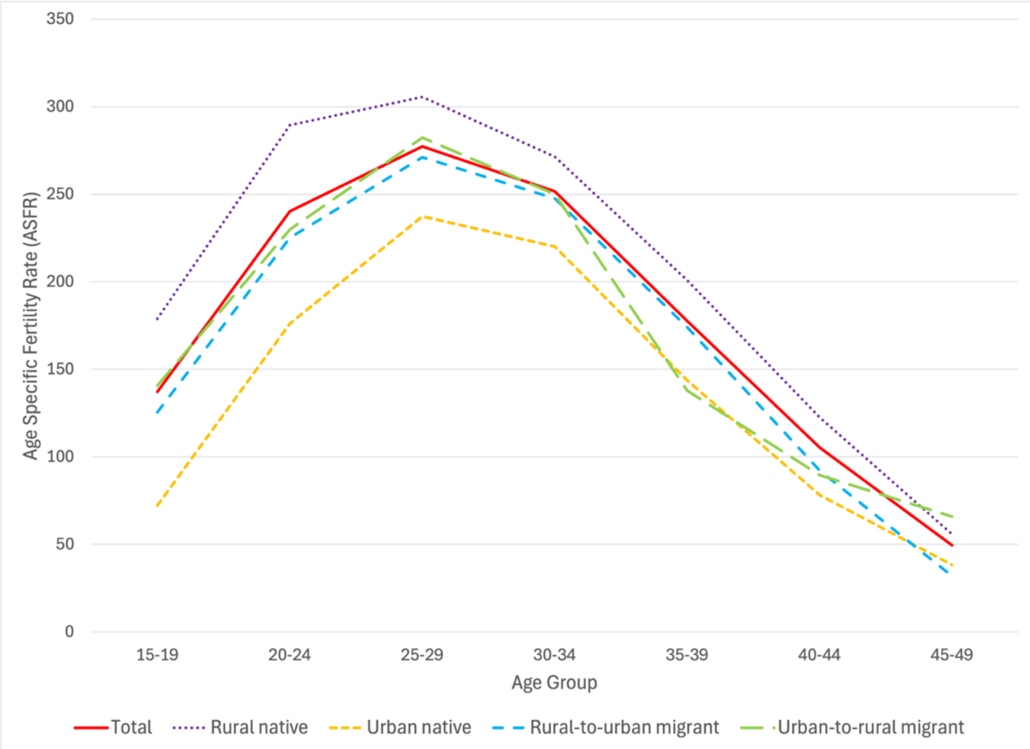

Figure 15: ASFRs by Group in Nigeria, 2001 – 2005 (Source: Nigeria DHS5)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	137,19	178,92	72,26	125,45	140,63
20-24	240,22	289,44	176,18	225,21	229,91
25-29	277,38	305,62	237,43	271,12	282,31
30-34	251,59	271,46	220,12	247,61	249,97
35-39	177,63	200,81	143,69	173,93	137,74
40-44	105,33	122,46	78,11	92,23	89,48
45-49	49,45	55,83	38,33	31,91	65,81

Table 5: ASFRs by Group in Nigeria, 2001 – 2005 (Source: Nigeria DHS5)

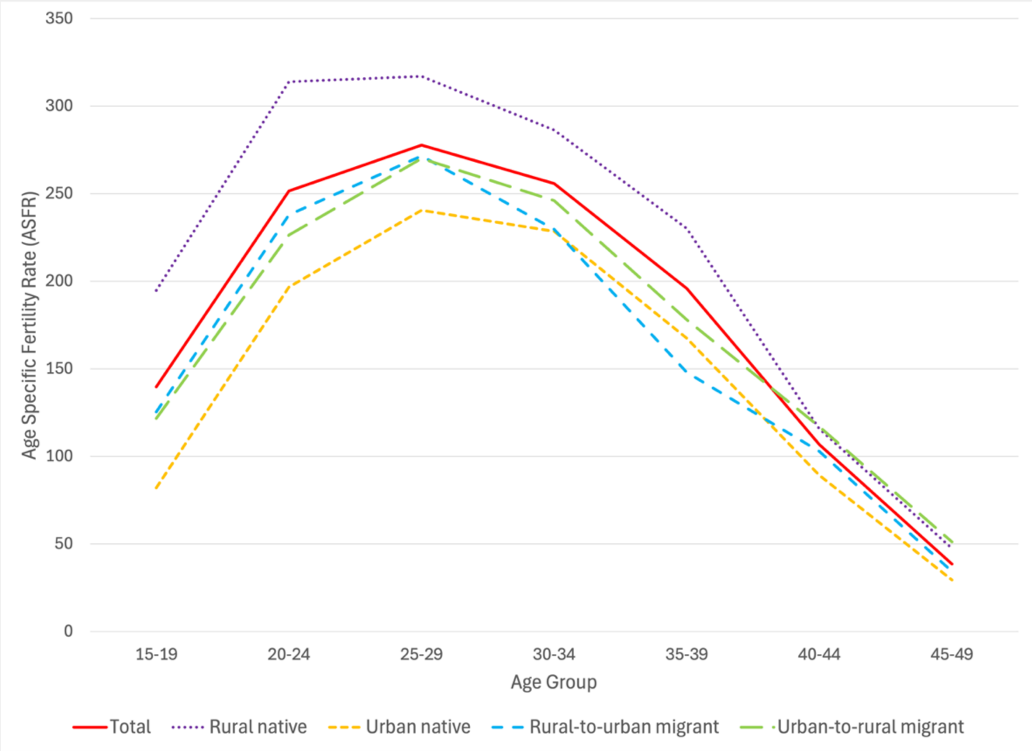

Figure 16: ASFRs by Group in Nigeria, 2006 – 2010 (Source: Nigeria DHS7)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	139,58	194,70	82,02	125,35	121,59
20-24	251,62	313,92	196,71	237,98	226,46
25-29	277,79	317,00	240,53	271,48	270,04
30-34	255,80	286,32	228,55	229,68	246,05
35-39	195,90	230,15	167,39	147,88	177,91
40-44	106,72	115,57	89,10	102,78	117,00
45-49	38,43	47,43	29,34	34,34	51,23

Table 6: ASFRs by Group in Nigeria, 2006 – 2010 (Source: Nigeria DHS7)

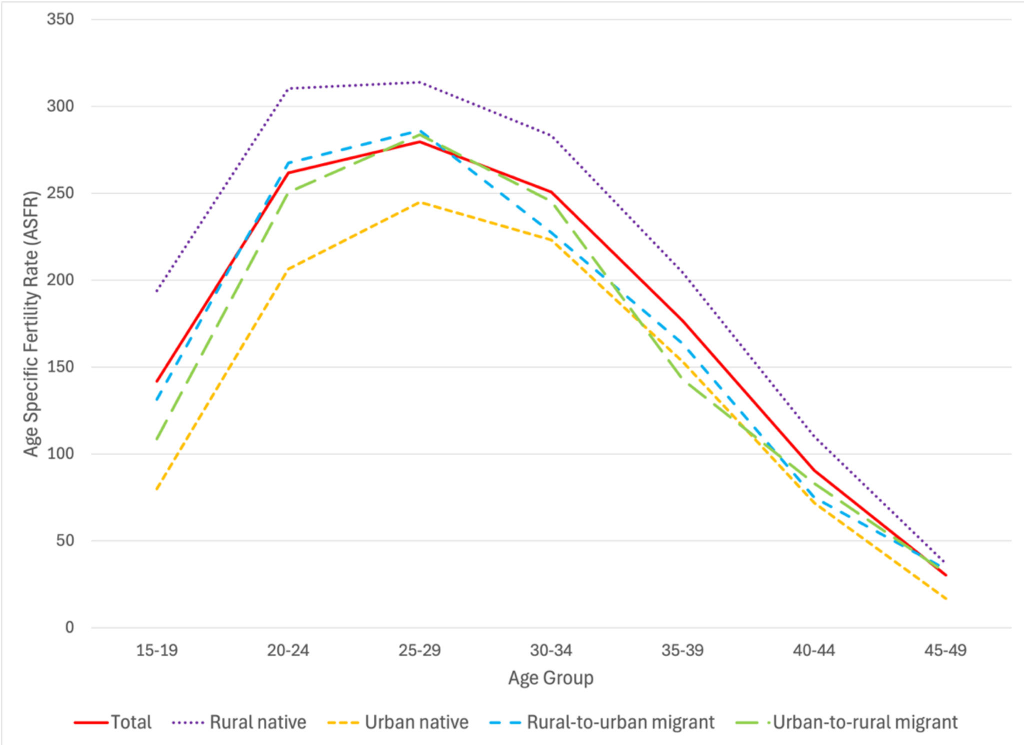

Figure 17: ASFRs by Group in Nigeria, 2011 – 2015 (Source: Nigeria DHS7)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	141,75	193,95	79,87	131,33	108,72
20-24	261,78	310,41	206,42	267,44	250,64
25-29	279,74	313,92	244,91	286,12	283,69
30-34	250,76	283,21	223,20	227,35	245,46
35-39	176,53	204,27	152,95	163,41	142,83
40-44	90,45	109,90	71,84	74,85	83,07
45-49	30,27	36,88	16,77	33,72	31,59

Table 7: ASFRs by Group in Nigeria, 2011 – 2015 (Source: Nigeria DHS7)

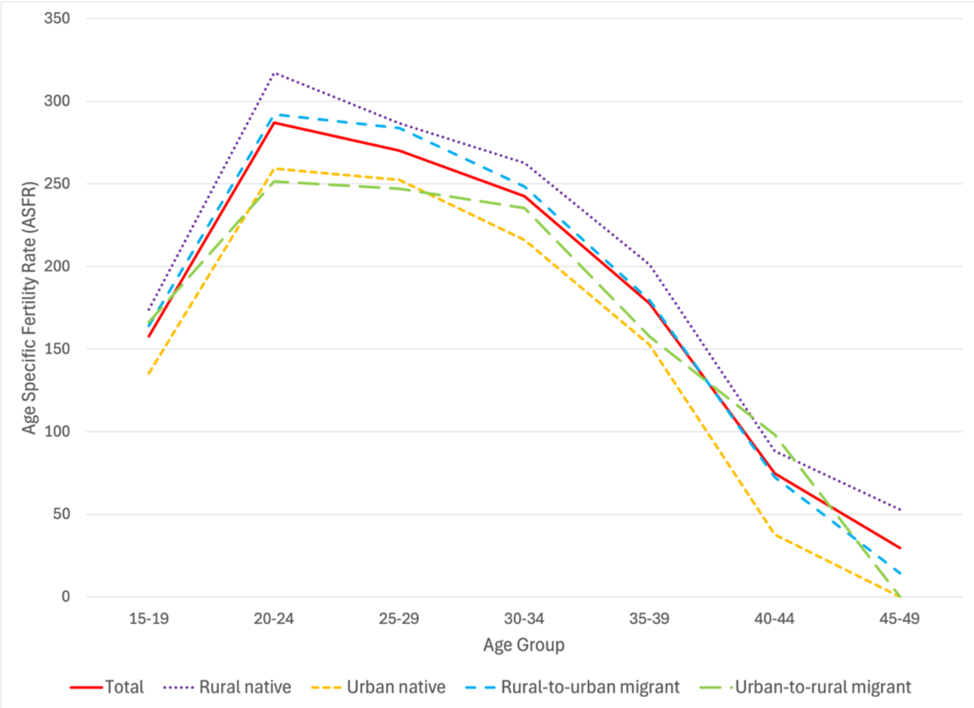

Figure 18: ASFRs by Group in Zambia, 1991 – 1995 (Source: Zambia DHS3)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	157,81	173,95	135,29	164,08	166,37
20-24	287,06	317,16	259,33	292,00	251,42
25-29	270,06	286,66	252,49	283,76	247,06
30-34	242,54	262,58	216,01	248,32	235,32
35-39	177,62	201,12	152,54	179,55	157,58
40-44	74,75	88,25	37,78	72,41	98,14
45-49	29,65	52,88	0,00	14,41	0,00

Table 8: ASFRs by Group in Zambia, 1991 – 1995 (Source: Zambia DHS3)

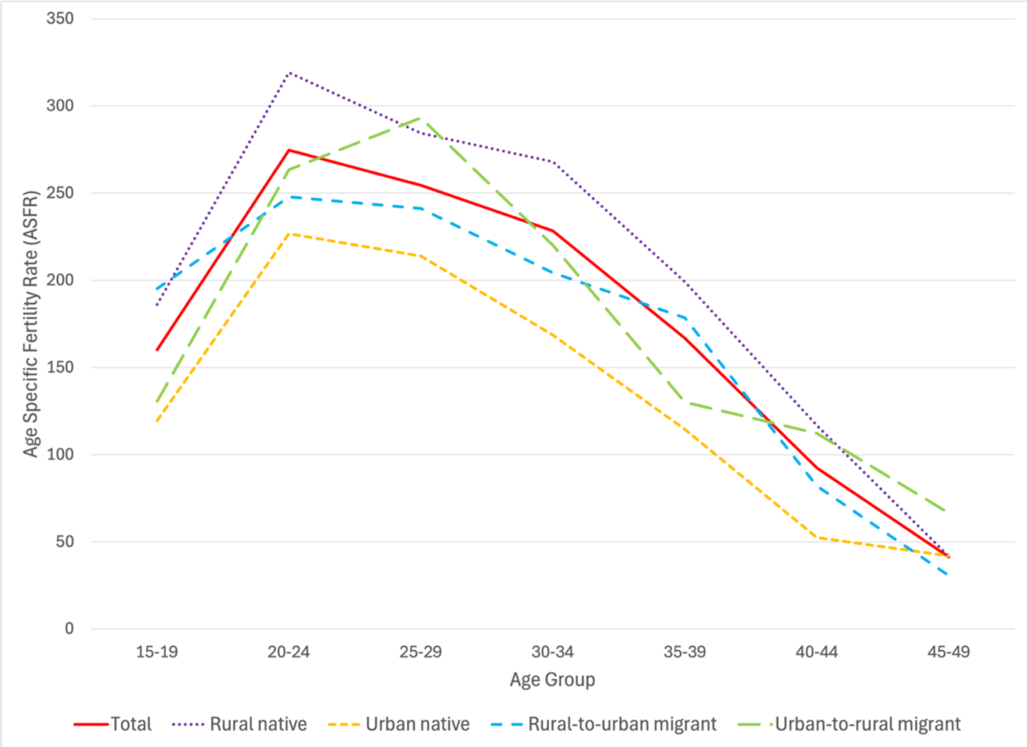

Figure 19: ASFRs by Group in Zambia, 1996 – 2000 (Source: Zambia DHS4)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	160,15	186,16	119,58	195,21	130,57
20-24	274,67	319,17	226,79	247,82	263,40
25-29	254,56	284,42	213,90	241,22	293,25
30-34	228,29	267,96	168,68	204,34	220,13
35-39	166,86	199,16	114,49	178,46	130,16
40-44	92,47	116,78	52,52	82,00	112,21
45-49	41,33	41,55	41,91	30,63	66,52

Table 9: ASFRs by Group in Zambia, 1996 – 2000 (Source: Zambia DHS4)

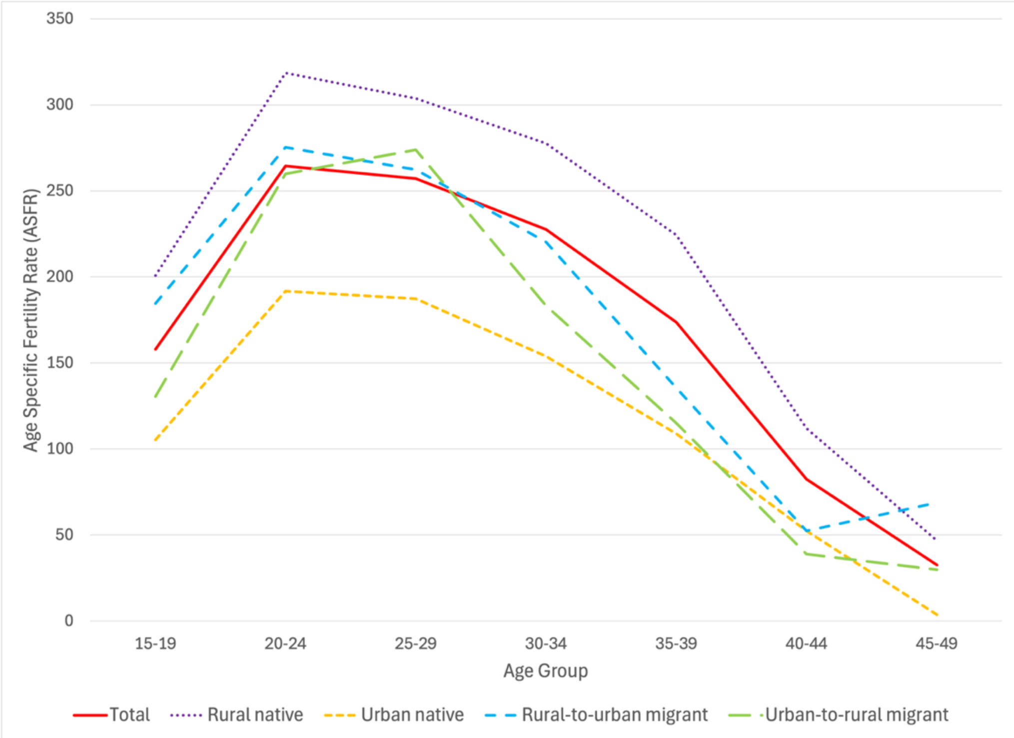

Figure 20: ASFRs by Group in Zambia, 2001 – 2005 (Source: Zambia DHS5)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	157,97	200,85	105,34	184,64	130,52
20-24	264,47	318,52	191,65	275,29	259,92
25-29	257,20	303,74	187,26	262,41	273,82
30-34	227,58	277,67	153,92	220,37	183,20
35-39	173,76	224,40	108,84	135,44	115,02
40-44	82,46	111,92	52,33	52,34	38,96
45-49	32,61	46,69	3,63	68,75	29,84

Table 10: ASFRs by Group in Zambia, 2001 – 2005 (Source: Zambia DHS5)

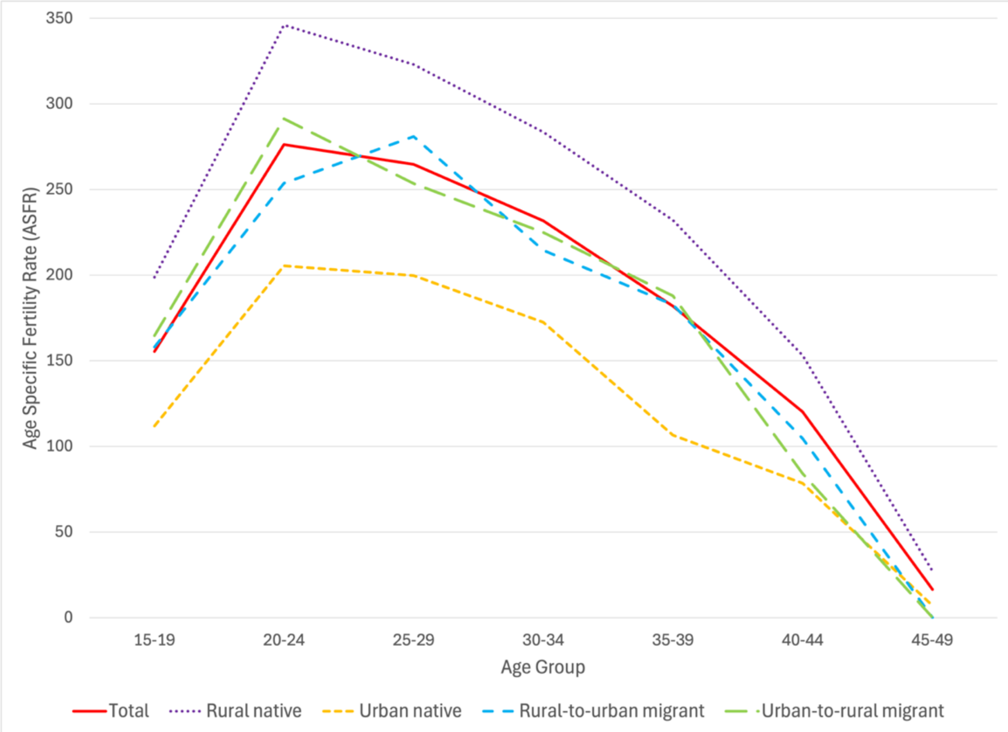

Figure 21: ASFRs by Group in Zambia, 2006 – 2010 (Source: Zambia DHS6)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	155,38	198,74	111,92	157,99	164,64
20-24	276,26	346,02	205,36	253,72	291,39
25-29	264,75	323,03	199,72	281,01	253,55
30-34	231,75	283,55	172,47	214,53	224,84
35-39	181,91	232,11	106,46	182,74	187,85
40-44	120,24	153,13	78,42	104,61	84,17
45-49	16,34	27,12	6,91	0,00	0,00

Table 11: ASFRs by Group in Zambia, 2006 – 2010 (Source: Zambia DHS6)

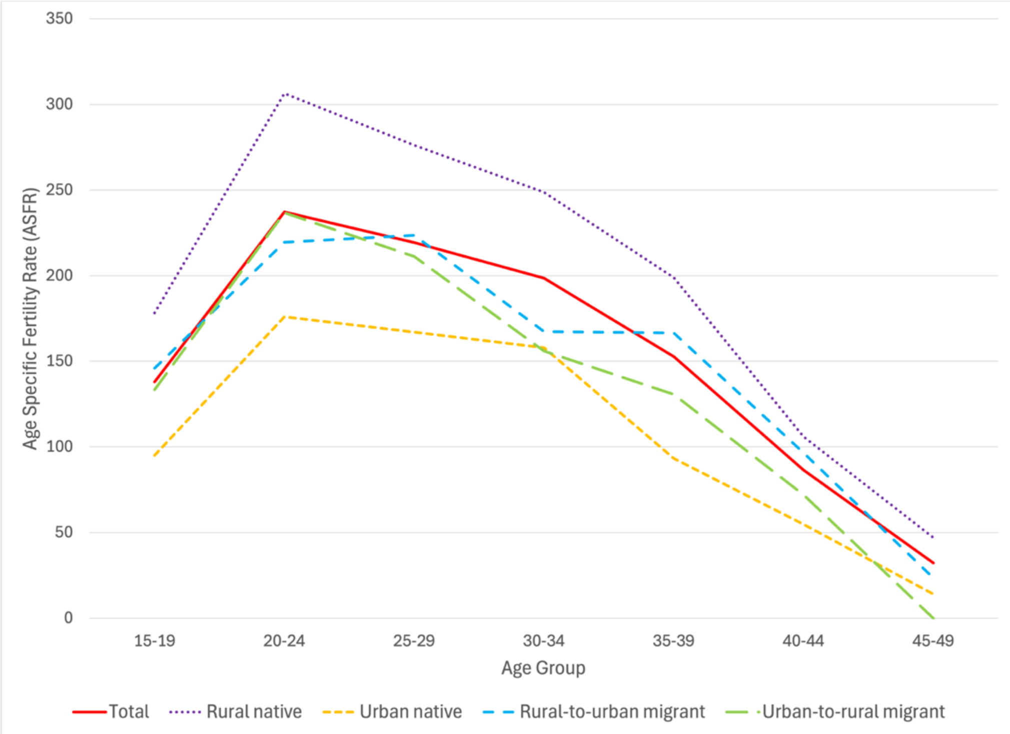

Figure 22: ASFRs by Group in Zambia, 2011 – 2015 (Source: Zambia DHS7)

Age Group	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
15-19	137,90	178,26	95,13	145,90	133,44
20-24	237,24	306,33	175,90	219,54	236,65
25-29	219,34	276,11	167,05	223,59	211,25
30-34	198,62	248,72	157,97	167,31	155,98
35-39	152,72	198,81	93,31	166,53	130,66
40-44	86,50	105,94	54,74	96,57	72,02
45-49	32,23	46,99	14,08	23,55	0,00

Table 12: ASFRs by Group in Zambia, 2011 – 2015 (Source: Zambia DHS7)

7.3. Appendix C

TFRs by Group and Country, Five-Year Intervals

Year	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
1991-1995	6,20	6,91	5,27	6,27	5,78
1996-2000	6,09	7,08	4,69	5,90	6,08
2001-2005	5,98	7,42	4,02	6,00	5,16
2006-2010	6,23	7,82	4,41	5,97	6,03
2011-2015	5,32	6,81	3,79	5,22	4,70

Table 13: TFR by Group in Nigeria Over Time, Five-Year Intervals (Source: Nigeria DHS4, DHS5, DHS7)

Year	Total	Rural native	Urban native	Rural-to-urban migrant	Urban-to-rural migrant
1991-1995	6,62	7,43	5,48	6,55	6,88
1996-2000	6,06	6,90	4,94	5,96	4,88
2001-2005	6,19	7,12	4,83	5,84	5,98
2006-2010	6,33	7,53	5,17	5,75	6,05
2011-2015	6,16	7,26	4,98	5,92	5,73

Table 14: TFR by Group in Zambia Over Time, Five-Year Intervals (Source: Zambia DHS 3, DHS4, DHS5, DHS6, DHS7)

7.4. Appendix D

Forest Plots Logistic Regression Results for Transition from First to Second Birth

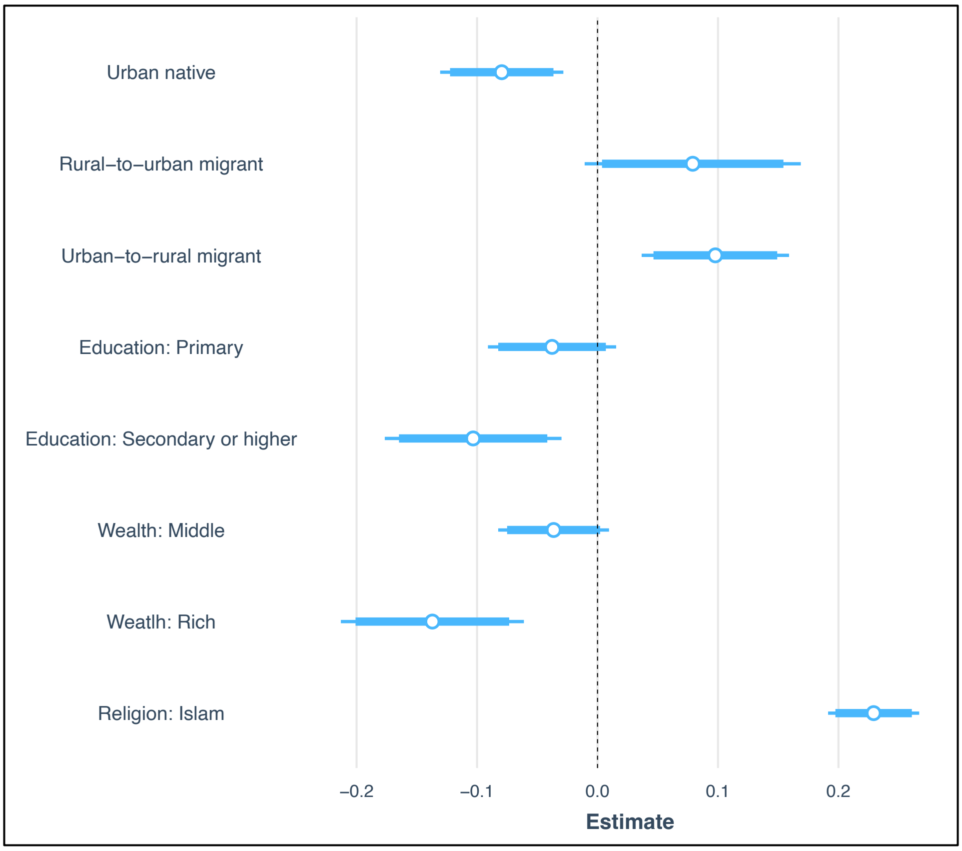

Figure 23: Forest Plot Logistic Regression Results for Transition from First to Second Birth, General Model, Nigeria

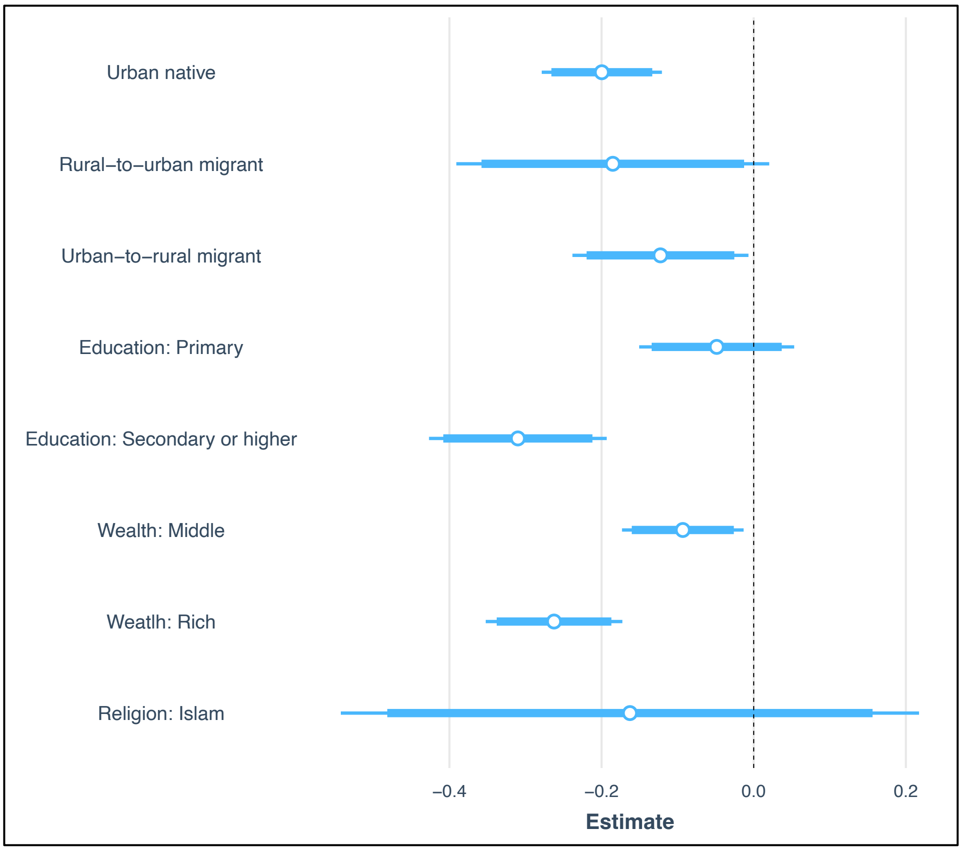

Figure 24: Forest Plot Logistic Regression Results for Transition from First to Second Birth, General Model, Zambia

7.5. Appendix E

Odds Ratios and Confidence Intervals for Transition from First to Second Birth, General Model

Variable	Odds Ratio	CI Lower	CI Upper
Urban native	0,9236	0,8775	0,9721
Rural-to-urban migrant	1,0822	0,9893	1,1839
Urban-to-rural migrant	1,1028	1,0372	1,1724
Education: Primary	0,9630	0,9130	1,0156
Education: Secondary +	0,9019	0,8381	0,9706
Wealth: Middle	0,9642	0,9208	1,0096
Wealth: Rich	0,8719	0,8081	0,9408
Religion: Islam	1,2576	1,2109	1,3061

Table 15: Odds Ratios and Confidence Intervals for Transition from First to Second Birth, General Model, Nigeria

Variable	Odds Ratio	CI Lower	CI Upper
Urban native	0,8190	0,7566	0,8865
Rural-to-urban migrant	0,8309	0,6761	1,0211
Urban-to-rural migrant	0,8846	0,7878	0,9934
Education: Primary	0,9525	0,8600	1,0549
Education: Secondary +	0,7334	0,6524	0,8245
Wealth: Middle	0,9110	0,8409	0,9870
Wealth: Rich	0,7691	0,7029	0,8416
Religion: Islam	0,8498	0,5806	1,2439

Table 16: Odds Ratios and Confidence Intervals for Transition from First to Second Birth, General Model, Zambia

7.6. Appendix F

Logistic Regression Results for Further Birth Orders Transitions, General Model

	General Model: Transition Second to Third Birth Nigeria	
	Coef.	SE
Urban native	-0.06 **	(0.02)
Rural-to-urban migrant	0.09	(0.05)
Urban-to-rural migrant	-0.02	(0.04)
Education: Primary	-0.07 **	(0.03)
Education: Secondary or higher	-0.30 ***	(0.03)
Wealth: Middle	-0.01	(0.02)
Wealth: Rich	0.00	(0.03)
Religion: Islam	0.05 *	(0.02)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 17: Logistic Regression Results for Transition from Second to Third Birth, General Model, Nigeria

	General Model: Transition Third to Fourth Birth Nigeria	
	Coef.	SE
Urban native	-0.06 *	(0.03)
Rural-to-urban migrant	0.04	(0.05)
Urban-to-rural migrant	-0.05	(0.04)
Education: Primary	-0.07 **	(0.03)
Education: Secondary or higher	-0.33 ***	(0.03)
Wealth: Middle	0.05 *	(0.03)
Wealth: Rich	-0.02	(0.03)
Religion: Islam	-0.02	(0.02)

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Table 18: Logistic Regression Results for Transition from Third to Fourth Birth, General Model, Nigeria

	General Model: Transition Second to Third Birth Zambia	
	Coef.	SE
Urban native	-0.22 ***	(0.05)
Rural-to-urban migrant	-0.35 *	(0.14)
Urban-to-rural migrant	-0.37 ***	(0.07)
Education: Primary	-0.16 **	(0.05)
Education: Secondary or higher	-0.50 ***	(0.06)
Wealth: Middle	-0.01	(0.04)
Wealth: Rich	-0.07	(0.06)
Religion: Islam	0.15	(0.13)
*** p < 0.001; ** p < 0.01; * p < 0.05.		

Table 19: Logistic Regression Results for Transition from Second to Third Birth, General Model, Zambia

	General Model: Transition Third to Fourth Birth Zambia	
	Coef.	SE
Urban native	-0.15 *	(0.07)
Rural-to-urban migrant	-0.48 ***	(0.10)
Urban-to-rural migrant	-0.29 ***	(0.08)
Education: Primary	-0.17 **	(0.05)
Education: Secondary or higher	-0.65 ***	(0.06)
Wealth: Middle	0.10 *	(0.05)
Wealth: Rich	0.04	(0.07)
Religion: Islam	0.32	(0.32)
*** p < 0.001; ** p < 0.01; * p < 0.05.		

Table 20: Logistic Regression Results for Transition from Third to Fourth Birth, General Model, Zambia

7.7. Appendix G

Logistic Regression Results for Interaction Effect between Education and Migration on Transition from First to Second Birth

	Migration & Education Model Nigeria	
	Coef.	SE
Urban native - some education	0.08	(0.05)
Rural-to-urban migrant - some education	0.14	(0.09)
Urban-to-rural migrant - some education	0.09	(0.08)
*** p < 0.001; ** p < 0.01; * p < 0.05.		

Table 21: Logistic Regression Results for Interaction Effect between Education and Migration on Transition from First to Second Birth, Nigeria

	Migration & Education Model Zambia	
	Coef.	SE
Urban native - some education	-0.35 **	(0.12)
Rural-to-urban migrant - some education	-0.23	(0.19)
Urban-to-rural migrant - some education	-0.68 ***	(0.15)
*** p < 0.001; ** p < 0.01; * p < 0.05.		

Table 22: Logistic Regression Results for Interaction Effect between Education and Migration on Transition from First to Second Birth, Zambia

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