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Projection of migrant family life-courses in England and Wales using multistate models and microsimulation

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Abstract

This study projects family life-courses of immigrants and their descendants in England and Wales by using microsimulation. While previous projections have estimated the size of ethnic groups, this is the first study to examine how family and age structures of migrant populations evolve over time. Such an exercise is novel and will improve our understanding of how migrant populations change across generations. Our model uses data from the 2011 census and partnership formation, dissolution and fertility rates from our previous research. The results show, first, significant heterogeneity in family patterns among migrant populations. Second, this heterogeneity is reduced among the descendants of immigrants, especially in fertility levels. Third, the descendants of immigrants will become the main group among minority populations over the next two decades. Finally, the differences between the majority population and people with a migrant family background are reduced, but they still persist, especially in partnership patterns. This study shows an increasing similarity in the family behaviour of majority and minority populations, but also that it may take a generation or two before the differences vanish. This study also demonstrates that microsimulation is a useful tool in projecting life histories and family structures of migrants and their descendants.

Keywords: Population projection · Migrants · Second and third generation · Partnership · Fertility · Microsimulation · United Kingdom · Family

1 Introduction

In recent decades there has been a significant rise in the share of immigrants and their descendants in European countries (Castles and Miller, 1998; Eurostat, 2023; Raymer et al., 2011). Hence, the demographic behaviours of immigrants and their descendants will increasingly shape Europe's future population structure. In the UK, immigrants and ethnic minorities made up over one fifth of the population in 2011 (ONS, 2015) rising to around one quarter in 2021 (ONS, 2021). Projections of the UK population by ethnic groups suggest that it will become increasingly diverse over the coming decades (Coleman, 2010; Rees et al., 2012). Coupled with research that shows heterogeneity in partnership and fertility patterns among immigrants to the UK and their descendants (Harrison et al., 2023; Mikolai and Kulu, 2022), it suggests that the ethnic composition of the UK population will be an important driver of its future family structure.

Migrant populations change over time, the first generation is gradually replaced by the second and the third generation. Previous research on migrant families in Europe shows that family patterns among the descendants of immigrants are often more similar to those of the native population, although the pace of change varies across migrant groups (Berrington, 2020; Kulu et al., 2024, 2019; Harrison et al. 2023). Briefly, the heterogeneity in family patterns that exists among immigrant populations is reduced among their children and it is likely to disappear among their grandchildren. With gradual assimilation of migrant populations across generations heterogeneity is expected to decline and differences to the native populations vanish (Alba and Nee, 2003).

The aim of this study is to understand how the age and family structure of immigrants and their descendants will change over future decades given their current age and family distribution. To achieve this, we develop a microsimulation model of the family life-courses of natives (UK-born individuals with two UK-born parents), immigrants, and their descendants in England and Wales. Previous studies have projected the size of ethnic minority populations; the novelty of our study is the projection of family distribution by age and migrant group. We apply our model to a 2011 base population to project future population structure to 2041 and validate the results of our model using external data sources. The focus of this study is not on predicting future migration streams and immigrant populations. Rather we examine how family and age structures of migrant populations living in England and Wales will evolve over time. Such an exercise will help us understand how migrant populations change across generations and whether and when they become similar to the native population.

1 Background

1.1 Projection of Ethnic Groups in the UK

Population projections in Europe (Lanzieri, 2011), the US (Frey, 2018; Vespa et al., 2018) and the UK (Coleman, 2010; Rees et al., 2012) suggest that there will be an increase in population diversity over the coming decades, largely driven by migration streams. In the UK, the magnitude of the estimated increase in population diversity is uncertain with significant variation between projection models (Rees et al., 2012). Possible explanations for these differences include varying assumptions of future migration streams, methodological variety, and the use of different data sources. For example, many studies group ethnicity into broad classes, such as White instead of White British, White Irish and White Other, due to data or computational constraints, despite the large heterogeneity within these groups (Coleman, 2010; Lomax et al., 2020). A notable exception is the work of Rees et al. (2012) which used all 16 ethnic groups in the 2001 Census for England and Wales.

Lomax et al. (2020) showed the importance of international migration on the future diversity of the UK population. They reported that increases in the Mixed, Pakistani and Bangladeshi ethnic groups are more likely to persist under reduced international migration compared to other ethnic groups, because of their age structure and higher fertility rates. They also showed that, under all migration scenarios, the UK population is likely to become increasingly diverse. We follow a similar approach in this paper by assuming no international migration, therefore isolating the effects of population age structure, fertility and partnership changes on future ethnic group populations. The study is novel in two aspects. First, to the best of our knowledge, this is the first study to separate ethnic groups into immigrants and their descendants despite the considerable heterogeneity in partnership and fertility patterns that exists between migrant generations (Mikolai and Kulu, 2022).

Second, we project family distribution by age and migrant group. The focus of previous projections has largely been in estimating population numbers of ethnic groups rather than their family structures. Many studies have highlighted the relevance of household and family projections to public policy by linking household and family structure with issues such as old age care, sustainability, welfare spending, housing development and water consumption (Börsch-Supan, 1986; Imhoff and Keilman, 1992; Keilman, 2003; Liu et al., 2003; Lo Conte et al., 2023; Reader et al., 2022; Rees et al., 2020). This work demonstrates that increasing our understanding of the drivers of UK family population structure has societal benefits. Whilst we do not explicitly model households in this paper, we make a first step towards doing so by being the first study to project family structures by migrant background.

1.2 Theories explaining the partnership and fertility patterns among immigrants and their descendants

Several theories have been put forward to explain the partnership and fertility behaviours of immigrants and their descendants (Kulu et al., 2019). For immigrants, the main focus is usually on the debate between socialisation versus adaptation. The socialisation theory argues that family preferences such as the timing of partnership formation and expected family size are developed early in life and shaped by the social environment during youth and young adulthood. This suggests that family patterns among immigrants after migration normally resemble those of the countries of origin rather than the host country (Kulu et al., 2019). In

contrast, the adaptation theory states that with time, immigrants' family behaviour such as partnership formation and family size will converge to the behaviour of the native population. Immigrants, particularly those who arrived at young ages, exhibit family behaviour more similar to that of natives than recently arrived immigrants or individuals living in the origin countries (Kulu et al., 2019).

For the descendants of immigrants, the main debate is about the extent to which mainstream society and the extent to which minority subculture shape their family patterns (Kulu et al., 2019). The second generation may grow up under the influences of mainstream society and are thus socialised into the norms and behaviours of the native population. Therefore, we expect to observe similar family patterns for the descendants of immigrants and the native population. In contrast, they may also grow up under the influences of a minority subculture and therefore exhibit family behaviour that is similar to those of immigrants and differs from family patterns of the native population (Kulu et al., 2019). Of course, it is likely that both mainstream society and the minority subculture are important; with different influences in school amongst peers compared to the influence of family. In such cases the descendants of immigrants would exhibit family patterns that are in-between those of immigrants and the native population (Kulu and González-Ferrer, 2014).

1.3 Heterogeneity in partnership and fertility patterns among immigrants to the UK and their descendants

Most research on immigrant partnerships and childbearing in the UK in the past decade has aimed to test one of the theories on migrant family formation and fertility. Hannemann and Kulu (2015) studied partnership formation among immigrants and their descendants in the UK, finding that migrants from Western European countries exhibited partnership behaviours similar to those of the native UK population. In contrast, cohabitation remained rare among immigrants from India, Pakistan and Bangladesh and their descendants. Many of the immigrants from these groups marry directly, although the share of individuals who cohabited or separated was larger among UK-born South Asians than among immigrants. Caribbean immigrants and their descendants exhibited specific patterns. They had high cohabitation rates, low marriage rates, and high divorce risks, which the authors attributed to the specific patterns of family dynamics that dominate in the Caribbean countries. Berrington (2020) studied expectations of family formation among the descendants of immigrants in the UK and showed that UK-born individuals of Bangladeshi or Pakistani origin still held low expectations of forming a cohabiting union and high expectations of marrying.

There is also growing literature on migrant fertility. Coleman and Dubuc (2010) studied the fertility of ethnic minority women in the UK and showed that their total fertility had declined significantly in the last decades of the 20th century. Fertility levels of the descendants of immigrants were lower than those of immigrants. Interestingly, while fertility was low among women of Indian and Black Caribbean origin, it was relatively high among women of Pakistani and Bangladeshi descent. A study by Kulu and Hannemann (2016) supported that fertility was lower among the descendants of immigrants than immigrants, but that fertility among women of Pakistani and Bangladeshi origin was still relatively high. Analysis of

fertility by parity showed little variation in first- and second-birth rates between groups, whereas third- and fourth-birth rates were elevated among UK-born Pakistani and Bangladeshi women. The high fertility among women of Pakistani and Bangladeshi origin was attributed to cultural factors, such as stronger religiosity and larger size of family of origin. Wilson and Kuha (2018) also reported high fertility among descendants of Pakistani and Bangladeshi immigrants and attributed it to factors related to childhood socialisation in residentially segregated ethnic communities. Berrington (2020) showed that among the cohorts born in the 1960s and 1970s, a large majority of UK-born Pakistani and Bangladeshi women had become mothers by age 30. In contrast, there has been a significant delay and less ethnic diversity in the timing of entry into motherhood among more recent cohorts. This trend is explained by the educational aspirations and the postponement of childbearing among all groups, even among women of Pakistani and Bangladeshi descent.

Finally, Kulu et al. (2024) studied simultaneously partnership and fertility changes among immigrants and their descendants in three European countries including the UK. Their analysis supported that migrants from other European countries and their descendants tend to cohabit prior to marriage, and their fertility (in unions) is often similar to that of the native population in those countries. In contrast, South Asians and Turkish populations exhibit marriage-centred family behaviour with somewhat elevated third-birth rates. Individuals of sub-Saharan African or Caribbean origin display higher rates of non-marital family transitions. The study also revealed some changes in partnership and childbearing patterns across migrant generations. Interestingly, these changes were stronger for fertility than for partnership patterns, which the authors attributed to different explanatory factors: cultural-normative factors are important in shaping partnership behaviour, whereas structural-economic factors may play a more important role in fertility decisions. This interpretation suggests that some patterns may persist across future migrant generations (e.g. preference for marriage vs cohabitation), whereas others are likely to vanish (e.g. large families).

Overall, previous studies show, first, a significant heterogeneity in partnership and fertility patterns among immigrants. Second, this heterogeneity is reduced among the descendants of immigrants, although this varies both by type and migrant group. Fertility among most migrant descendants is similar to that of the native population, whereas there is more heterogeneity in partnership behaviour with some groups exhibiting specific patterns.

2 Methods

2.1 Microsimulation

Microsimulation is an increasingly popular tool for performing population projections. Several studies have applied microsimulation to the investigation of family dynamics (Wilson and Rees, 2005; Bélanger et al., 2010; Thomson et al., 2012; Winkler-Dworak et al., 2019). Microsimulation involves simulating events at the individual level using Monte Carlo methods. The simulated life histories of individuals are then typically aggregated to produce population estimates. Microsimulation has several advantages over macrosimulation

approaches, including the ability to extract full event histories of individuals and to reduce the programming burden of large state spaces (Wilson and Rees, 2005). However, the computational complexity of microsimulation is much greater, often requiring the use of high-performance computing to reduce model run times particularly when assessing model uncertainty.

2.2 Model Structure

We program our microsimulation model in R (R Core Team, 2023) and use the *MicSim* package (Zinn, 2013) – see Appendix 8.1 for more details. The state space of our microsimulation model consists of four parity states: (1) no children, (2) one child, (3) two children and (4) three or more children; combined with four partnership states: (1) single, (2) cohabiting, (3) married and (4) separated; and one absorbing state: death. In total we have 17 states which individuals may occupy at any one time (Figure 1). Furthermore, we allow repeated partnership transitions, for example, it is possible to marry, separate, and remarry, which extends the state space to higher order partnerships.

We define movement between states using a transition matrix. From single, individuals may experience cohabitation, marriage, or birth; from cohabitation individuals may experience marriage, separation, or birth; from marriage, individuals may experience separation or birth; and from separation, individuals may experience cohabitation, marriage, or birth. For the purposes of our projections, which require consistency with Census data, persons who have never married and transition from cohabitation to single are considered single. For our projections of family life histories, which do not require consistency with Census data, they are considered separated. It is possible to experience death from any state. At age 50 individuals are censored as our focus is on family transitions which are largely complete by this age.

We run the model for each migrant origin and generation separately, using a sample size of 20,000 persons for each simulation. A person's migrant origin is assigned using the ethnic group variable in the 2011 census, while the country of birth variable is used to assign their generation. For example, a person of African ethnic origin born in the UK is assigned a migrant origin of Africa and a generation of 2G plus. In other words, they are the descendants of African immigrants. Whereas a person of African ethnic origin not born in the UK is assigned as an African immigrant. We do not allow mixed marriages.

Some migrant groups are small relative to others, therefore we choose to run each migrant origin and generation separately for computational efficiency. If we simulated all groups in a single simulation, we would need to use very large sample sizes to be able to extract meaningful results for each group. These separate simulations are combined in post-processing using scaling factors derived from 2011 population numbers for each of these groups. For example, to produce the results of 2G groups we combine 2G simulations with the births from the 1G and immigrant simulations using scaling factors and assume that these births take the same state space distribution as a 2G birth cohort. The population projection is run from year end 2011 to year end 2041. We also project family life histories, these are produced by applying our model transition rates to a birth cohort for each migrant group.

2.3 Estimation of Transition Rates

We use partnership and fertility transition rates by age, sex, birth cohort, migrant origin and migrant generation published (male transition rates unpublished) by Mikolai and Kulu (2022) who performed a multilevel multistate event history analyses of Waves 1–9 (2009–19) of the UK Household Longitudinal Study (UKHLS) (University of Essex, 2020), a large, nationally representative household panel. They included individuals born 1940–2003 in their analysis and we use an adjusted version of their rates which only includes individuals born in 1970–2003. We use ONS lifetables to model age- and sex-specific mortality transitions (ONS, 2024). We allow neither immigration nor emigration.

2.4 Estimation of 2011 Base Population

We constructed a base population by estimating the joint probability distribution of our state space by age, sex, migrant origin and generation from the Census 2011 Household Microdata sample for England and Wales (ONS, 2011). The microdata contains around 1.9 million persons aged under 50. We exclude those with missing country of birth or ethnicity variables which reduces the sample by around 40,000. Furthermore, around 300,000 persons have a missing number of dependent children in household variable with a disproportionate number of those being separated males. Therefore, listwise deletion of these individuals introduces significant bias in the base population estimates, specifically, underestimation of separated males. To reduce this bias, we impute this missing variable using multiple imputation. We assume that the missing variable is missing at random, that is when the variable is not missing at random but can be fully accounted for by observed variables. In other words, the missingness of the number of dependent children in household variable is not related to the value of this variable but only the value of the observed variables. Our multiple imputation uses a multinomial model of the form:

$$NDC = Age + Sex + Partnership\ Status + Ethnicity + Country\ of\ Birth \quad (1)$$

where, NDC is the number of dependent children in household. We impute 11 datasets which generates a distribution of the number of dependent children variable for each person from which we take the median. To validate our base population and imputation we compare the proportion of separated persons aged 16–50 in our estimates with ONS census data for 2011 (ONS, 2018). Our estimates were 5.1% and 8.7% for males and females, respectively. Whilst the ONS estimates are 5.1% and 8.8%, respectively.

The microdata does not contain a parity variable, so we use the number of dependent children in household variable as a proxy. This proxy variable is accurate for most individuals, but it is biased at younger and older ages. For example, at older ages it is more likely that children have left home which means that we will underestimate parity. Whilst at younger ages, we cannot distinguish between those who have left the parental home and had children and those who live with parents and have young siblings. To reduce this bias, we calibrate parity for those aged 20–44 to ONS data on the mean number of children per female by age (ONS,

2020a). For females, this is done by randomly assigning or removing children from persons in the microdata so that the mean number of children at each age group is equal to the mean number of children in the ONS data. As there is no equivalent data for males, we assume that males have the same mean number of children as females. This calibration step is complicated by the microdata grouping individuals with 3 or more dependent children in a household into a single group, therefore, the mean number of children cannot be estimated directly. To address this, we use ONS data on the distribution of women by number of live-born children, by age and year of birth of woman, to calculate the mean number of children for those with 3 or more (ONS, 2020a). For persons aged 45–49, because ONS data on mean number of children only extends to age 45, we arbitrarily assume that they have the same probability distribution of parity within partnership status as persons aged 40–44. While for persons aged less than 20, we arbitrarily assume that they do not have any children.

We validated the age distribution of our 2011 base population estimate using 2011 ONS data on the number of persons by age, sex and migrant origin and generation (ONS, 2015). This showed that the microdata underestimated the number of persons aged 15–20 (Figure A1). We speculate that this is due to difficulties in capturing those in higher education living in communal residences. In addition, for migrant origin and generation groups with smaller sample sizes there were larger differences in age distribution between the ONS data and our estimates. To remove these differences, we calibrated the age distributions of our base population to the ONS data.

Table 1 presents the population of England and Wales (or the base population) in 2011 by migrant origin and generation, age, sex, partnership status and parity. We see that immigrants and their descendants formed about 24% of the total population. The largest groups were those of European (and Western), Indian and Pakistani origin. The largest groups among people aged 15 to 50 were married and single individuals; the latter groups in census data also included those people who were separated from non-marital unions. As expected, a significant share of people had no children, followed by those with one, two and three or more children. This largely reflects the age structure of the population.

2.5 Model Validation

We validate the results of our simulations by comparing our results with external data sources. For marriage, we compare the results of our projection of family life histories for the native population with ONS estimates of the proportion of individuals who experience transition to first marriage by age and sex (ONS, 2020b). For parity, we compare the same results with ONS estimates of first births and average number of children by age among females (ONS, 2020a). Simulation results for transitions to first marriage in the native population lie approximately between the ONS 1970–74 and 1980–84 birth cohort (Figure 2). While the results for first births and for births per person are close to the ONS 1970–74 cohort (Figure 3). Overall, this is reassuring given that our transition rates are based on analysis of those born in 1970–2003.

3 Results

3.1 Projection of Family Life Histories

We can use our transition rates to illustrate family life courses of different groups by applying them to a birth cohort. We see that at age 15 everyone is single and childless (Figure 4). By age 50, most natives are married, they have one, two or three children. There are also individuals who are single or cohabiting and a significant share of those who have experienced separation. In contrast, most migrants from India and Pakistan are married by age 50; many of them have three or more children, especially immigrants from Pakistan, but a significant share has also smaller families. The share of single individuals is small and virtually no one cohabits or has experienced separation. Interestingly, the patterns are relatively similar among the descendants of Indian and Pakistani immigrants: most people are married by age 50, many still have three children, although the share of individuals with large families has significantly declined compared to immigrants, especially among Indians. There are also more people who are single or who have experienced separation. Interestingly, however, a very few cohabit before marriage.

Immigrants from Caribbean countries show specific patterns. Clearly, there is much more heterogeneity among this than any other group. By age 50, a significant share of individuals are married, but there are also many who are single or separated; cohabitation is also common among them. There are people with different family sizes, although, interestingly, the share of those with three children is the largest. The descendants of immigrants exhibit even more intra-group heterogeneity: although many are unpartnered at age 50, most people have been in union, but quite a large group has experienced separation. Their distribution by the number of children shows that various groups are of equal size.

Finally, immigrants from African and other European countries exhibit patterns relatively similar to those of the native population. Most of them are married by age 50, they have one, two or three children. There are also individuals who are single or cohabiting and those who have experienced separation. The patterns among their descendants are not that different, although compared to immigrants there are more people who are single (especially among Africans) or have experienced separation. The share of cohabitants is somewhat larger among the descendants of immigrants from Europe than Africa. The share of those with large families is significantly smaller among the descendants of African immigrants than immigrants.

3.2 Population Projections From 2011–2041

3.2.1 Population Aggregates

Our model estimates show a decrease in the England and Wales population aged under 50 between 2011 and 2041 of around 7% (Table 2). Overall, the share of immigrants and their

descendants only slightly changes from around 24% to 25%. The largest relative increases in migrant origin and generation groups are among the descendants of African and European and Western immigrants, mostly because of age structures these migrant groups had in 2011. Due to our model not including immigration, as expected, all first-generation groups decrease in size.

The age distribution of the population in 2041 is younger than in 2011, with around a 15% reduction in those aged 35–50. This is driven by ageing of Britain's population. There is a significant rise in the number of persons aged 5–10 and 30–35. While all other age groups remain similar in relative size. Between 2011 and 2041, the number of childless persons increases by 6%, while those with one child decreases by 29%. The number of persons with two children decreases by 9%, while those with 3 or more children decreases by 21%. Lower fertility rates of younger generations explains the decrease in average family size.

Between 2011 and 2041, we observe a reduction in the number of single persons, whereas the share of cohabiting individuals increases. We also observe a decrease in the number of married and separated persons. The lower number of married persons may also explain the decline in separations.

3.2.2 The Age, Sex and Generation Structure of Ethnic Groups

We see that population structure by age and generation varies across groups (Figure 5). While most Caribbeans were of second generation in 2011, immigrants predominated among Africans and Europeans. Indians and Pakistanis were in-between with immigrants forming a majority among older age groups and their descendants in younger ages. The age distribution in 2011 was largely a reflection of immigration history. Caribbean group was the first to arrive in the post-WWII UK followed by people from India and Pakistan; Africans and Europeans, in turn, are the most recent groups. It is still important to note that immigrants formed a large share among Indians and Pakistanis in 2011 because their immigration to the UK has continued until recently. In contrast, the flows of Caribbeans have declined over the years.

It is thus not surprising that, in 2041, there will be many among people of Caribbean, Indian and Pakistani descent whose grandparents moved to the UK. Interestingly, however, the third generation (or the descendants of descendants) mostly dominates among children and young adults, whereas the second generation prevails among people aged 30 and over. On the one hand, this is partly related to the assumption we had to make in this study, i.e. in 2011, there were only first and second generation; we were unable to determine individuals belonging to the third generation. Their size is thus underestimated. On the other hand, this exercise also illustrates how migrant populations will evolve and it will take some time before the third generation emerges. For African and European populations people of second generation dominate in 2041, although we observe an emerging third generation among children.

3.2.3 The Age, Sex and Partnership Status Structure of Ethnic Groups

Regarding population structure by partnership status we observe some consistency of patterns among people of Indian and Pakistani origin in 2011 and 2041, but also some changes (Figure 6). Most people older than 30 are married both in 2011 and 2041, there are very few who cohabit or who are separated. However, there are more single people projected in 2041 than observed in 2011 suggesting either the postponement of marriage or an increased share of single people or both. In contrast, heterogeneity is large and predicted to stay among people of African, European and particularly of Caribbean descent, as expected. This is partly related to the assumption of our models: we assume that all cohorts will follow the patterns observed among people born in 1970-2003, which will likely underestimate changes in the future. Second, it also shows some inertia and long-term nature of demographic processes. Even when we assumed that the third generation (or the descendants of descendants) will follow the observed patterns of the native British population (who also exhibit heterogeneity) there were virtually no changes across the models as individuals with immigrant grandparents were still mostly aged under 20 in 2041.

3.2.4 The Age, Sex and Parity Status Structure of Ethnic Groups

For fertility we project more changes between 2011 and 2041 than for partnerships. In all groups the share of individuals with three children is smaller in 2041 than in 2011 (Figure 7). This change is largely driven by smaller family size among the descendants of immigrants who will dominate among migrant groups in 2041. We also observe an increase in the share of childless people among all groups, which is attributed to changing population composition. Immigrants are gradually replaced by their descendants whose fertility behaviour is increasingly similar to the native population. Again, assuming that the third generation is identical to the native population will not change the patterns as most of them will be still children or young adults in 2041.

4 Discussion

The main objective of this study was to investigate how the age and family structure of immigrants and their descendants living in England and Wales might change in the coming decades. We developed a microsimulation model assuming a closed population (i.e. no migration). The aim of such an exercise was to improve our understanding of how migrant populations change across generations. Our study supported, first, significant heterogeneity in family patterns among migrant populations. We have continental Europeans and the Caribbean population who show family patterns similar to those of the UK native population: many of them cohabit prior to marriage; some experience dissolution of their first unions; some have a birth outside of a union; their fertility levels in unions are similar to those of the natives. In contrast, South Asians exhibit more conservative family patterns: they have high marriage rates and low separation levels; childbearing outside of marriage is uncommon. Many have three children. Second, we observed similarities between immigrants and their descendants in partnership patterns. For example, South Asian immigrants in the UK exhibited high marriage and relatively low cohabitation rates. However, cohabitation and

especially separation are more common among the descendants compared to immigrants. They also have smaller families.

Third, our projections using microsimulations showed that in the next two decades the descendants of immigrants will dominate among the ethnic minority populations aged 50 and below. For the well-established groups in England and Wales such as Caribbeans, Indians and Pakistanis the third generation gradually becomes prevalent, whereas for the groups with recent migration history such as Europeans and Africans the second generation will become the dominant group. Interestingly, we still see a variation in age-structure across migrant groups reflecting past migration history and age-distribution of migrants at arrival. Fourth, our projections showed that the distribution of migrants and their descendants by family structure will gradually become similar to that of the native population. The changes are expected to be faster for family size and somewhat slower for partnership patterns. Finally, our projections showed that the group differences decline, but some persist. These trends are largely driven by the family patterns among the descendants of immigrants who will form the core of the ethnic minority population in 2041.

Overall, our simulation exercise revealed that population processes involve some inertia, especially if driven by cohort changes. Our projections showed that differences across the groups are reduced, but still persist between individuals with migrant family background and the native population in the next two decades. The reason is that the descendants of immigrants are still the main group. Although, the share of individuals whose grandparents were immigrants will increase over time they will still be mostly in young age groups in 2041. If the behaviour of the latter group is similar to that of the native population, then the differences are expected to vanish once the third generation becomes the dominant group.

Second, there is significant heterogeneity in family patterns among the native population, and this heterogeneity may only increase. If migrant populations will become similar to the natives in their family patterns it is clear that they will also exhibit a significant intra-group heterogeneity in partnership and childbearing behaviour. This heterogeneity is a natural part of contemporary European societies, but may also be a sign of segmentation of societies characteristic to both the native and ethnic minority populations, especially if coupled with inequalities in other life domains such as labour market attachment.

Third, the notion of the ‘third generation’ also requires some clarification. In this study, we used this notion only for analytical purposes to distinguish the descendants of descendants of immigrants from a middle-term projection perspective. However, conceptually the use of the category is not without a problem and certainly needs some discussion. In high-income countries with long-term migration history such as the US, Canada or Australia such a definition is hardly if ever used in the literature for various reasons; for example, it is difficult to determine the ‘native population’. Naturally, the native population consists of everyone who, for example, are US-born with US-born parents (wherever their grandparents come from). However, in Europe, where nation states have a long history, the use of the ‘third generation’ is common (Weber et al. 2024). This is supported by research in Britian on minorities, which mostly focuses on ethnicity (or ‘minority ethnic groups’) (Khattab and Johnston 2015). For example, a UK-born individual with two UK-born parents may still be considered as a member of a ‘minority ethnic group’ rather than the ‘white British majority’.

This approach is supported by the collection of information on individuals' ethnicity and also the institutionalisation of ethnicity for administrative purposes (e.g. to monitor inequalities).

The study has limitations. First, we assume that future transition rates will remain constant when they are likely to change. For example, fertility rates in the UK have been declining steadily for the last few decades and are projected to continue to decline over the coming decades (ONS, 2022). Therefore, we are likely to overestimate fertility. Similarly, marriage is increasingly delayed until older ages and cohabitation is rising in popularity, therefore we are likely to overestimate marriage and underestimate cohabitation (Hannemann and Kulu, 2015). Our microsimulation model may thus be further developed to explore various what-if-scenarios. For example, to investigate the effect of the (increased) educational level of the population family structure or that of reduced number of siblings. Second, our simulation model does not consider mixed partnerships. This limitation would affect the results of the groups where mixed marriages are increasingly common such as people of European or Caribbean origin. However, the results for South Asians would not be influenced as much since intra-group marriages dominate both among immigrants and their descendants (Kulu and Hannemann, 2019). Finally, our input rates are based on model estimates which are subject to sampling error. Future research should explicitly incorporate uncertainty in microsimulation models. This includes the uncertainties associated with our model input rates, estimation of our base population and assumptions around how our input rates will evolve in the future.

This is the first study to project family structure for migrants and their descendants. The study shows that differences between migrant populations and the native population in England and Wales are reduced over the next two decades, but they still persist, especially in partnership patterns. The reasons for that is that the descendants of immigrants will be the main group among the minority population. The differences are expected to vanish with the emergence of the descendants of migrant descendants; however, they are beyond the horizon of our projection. We have also demonstrated that microsimulation is a useful tool in projecting life courses and family structures of migrants and their descendants.

5 References

Alba, R., Nee, V., 2003. Remaking the American Mainstream: Assimilation and Contemporary Immigration, Cambridge, MA and London, England: Harvard University Press.

Bélanger, A., Jean-Dominique, M., Spielauer, M., 2010. A Microsimulation Model to Study the Interaction between Fertility and Union Formation and Dissolution: An Application to Canada and Quebec. Can. Stud. Popul. 37. https://doi.org/10.25336/P6D047

Berrington, A., 2020. Expectations for family transitions in young adulthood among the UK second generation. J. Ethn. Migr. Stud. 46, 913–935. https://doi.org/10.1080/1369183X.2018.1539276

Börsch-Supan, A., 1986. Household formation, housing prices, and public policy impacts. J. Public Econ. 30, 145–164. https://doi.org/10.1016/0047-2727(86)90042-3

Castles, S., Miller, M.J., 1998. The Age of Migration. Macmillan Education UK, London. https://doi.org/10.1007/978-1-349-26846-7

Coleman, D., 2010. Projections of the Ethnic Minority Populations of the United Kingdom 2006–2056. Popul. Dev. Rev. 36, 441–486. https://doi.org/10.1111/j.1728-4457.2010.00342.x

Coleman, D., 2006. Immigration and Ethnic Change in Low-Fertility Countries: A Third Demographic Transition. Popul. Dev. Rev. 32, 401–446.

Eurostat, 2023. migr_pop3ctb Population on 1 January by age group, sex and country of birth [WWW Document]. URL https://doi.org/10.2908/MIGR_POP3CTB (accessed 12.8.23).

Frey, W.H., 2018. Diversity Explosion: How New Racial Demographics are Remaking America. Brookings Institution Press.

Hannemann, T., Kulu, H., 2015. Union formation and dissolution among immigrants and their descendants in the United Kingdom. Demogr. Res. 33, 273–312. https://doi.org/10.4054/DemRes.2015.33.10

Harrison, J., Keenan, K., Sullivan, F., Kulu, H., 2023. Union formation and fertility amongst immigrants from Pakistan and their descendants in the United Kingdom: A multichannel sequence analysis. Demogr. Res. 48, 271–320.

Imhoff, W.V., Keilman, N.W., 1992. LIPRO 2.0: An Application of a Dynamic Demographic Projection Model to Household Structure in the Netherlands. Popul. Fr. Ed. 47, 1321. https://doi.org/10.2307/1533950

Keilman, N., 2003. The threat of small households. Nature 421, 489–490. https://doi.org/10.1038/421489a

Khattab, N., Johnston, R. (2015). Ethno-religious identities and persisting penalties in the UK labor market. Social Science Journal 52(4): 490–502.

Kulu, H., González-Ferrer, A., 2014. Family Dynamics Among Immigrants and Their Descendants in Europe: Current Research and Opportunities. Eur. J. Popul. 30, 411–435. https://doi.org/10.1007/s10680-014-9322-0

Kulu, H., Hannemann, T., 2019. Mixed marriage among immigrants and their descendants in the United Kingdom: Analysis of longitudinal data with missing information. Popul. Stud. 73, 179–196. https://doi.org/10.1080/00324728.2018.1493136

Kulu, H., Hannemann, T., 2016. Why does fertility remain high among certain UK-born ethnic minority women? Demogr. Res. 35, 1441–1488. https://doi.org/10.4054/DemRes.2016.35.49

Kulu, H., Mikolai, J., Delaporte, I., Liu, C., Andersson, G., 2024. Family trajectories among immigrants and their descendants in three European countries: A multistate approach in comparative research. Popul. Stud. 0, 1–21. https://doi.org/10.1080/00324728.2024.2345059

Kulu, H., Milewski, N., Hannemann, T., Mikolai, J., 2019. A decade of life-course research on fertility of immigrants and their descendants in Europe. Demogr. Res. 40, 1345–1374. https://doi.org/10.4054/DemRes.2019.40.46

Lanzieri, G., 2011. Fewer, older and multicultural? : projections of the EU populations by foreign/national background. Publications Office, LU.

Liu, J., Daily, G.C., Ehrlich, P.R., Luck, G.W., 2003. Effects of household dynamics on resource consumption and biodiversity. Nature 421, 530–533. https://doi.org/10.1038/nature01359

Lo Conte, M., Corsetti, G., De Rose, A., Marsili, M., Meli, E., 2023. The Future of the Italian Family: Evidence from a Household Projection Model, in: Schoen, R. (Ed.), The Demography of Transforming Families, The Springer Series on Demographic Methods and Population Analysis. Springer International Publishing, Cham, pp. 93–118. https://doi.org/10.1007/978-3-031-29666-6_6

Lomax, N., Wohland, P., Rees, P., Norman, P., 2020. The impacts of international migration on the UK's ethnic populations. J. Ethn. Migr. Stud. 46, 177–199. https://doi.org/10.1080/1369183X.2019.1577726

Mikolai, J., Kulu, H., 2022. Partnership and fertility trajectories of immigrants and descendants in the United Kingdom: A multilevel multistate event history approach. Popul. Stud. 0, 1–20. https://doi.org/10.1080/00324728.2022.2144639

ONS, 2024. National life tables: UK [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/datasets/nationallifetablesunitedkingdomreferencetables (accessed 10.1.23).

ONS, 2022. National population projections, fertility assumptions: 2020-based interim [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/methodologies/nationalpopulationprojectionsfertilityassumptions2020basedinterim (accessed 12.20.23).

ONS, 2021. RM010 - Country of birth by ethnic group [WWW Document]. URL https://www.nomisweb.co.uk/datasets/c2021rm010 (accessed 9.23.24).

ONS, 2020a. Childbearing for women born in different years, England and Wales - Office for National Statistics [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/conceptionandfertilityrates/bulletins/childbearingforwomenbornindifferentyearsenglandandwales/2020 (accessed 10.1.23).

ONS, 2020b. Marriages in England and Wales - Office for National Statistics [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/marriagecohabitationandcivilpartnerships/bulletins/marriagesinenglandandwalesprovisional/latest (accessed 10.1.23).

ONS, 2018. CT0786_2011 Census, Sex by age by living arrangements by marital and civil partnership status, England [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/adhocs/008259ct07862011censussexbyagebylivingarrangementsbymaritalandcivilpartnershipstatusengland (accessed 12.8.23).

ONS, 2015. CT0476_2011 Census - Sex by age by country of birth by ethnic group - England and Wales - Office for National Statistics [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/adhocs/004552ct04762011censussexbyagebycountryofbirthbyethnicgroupenglandandwales (accessed 12.8.23).

ONS, 2011. Secure microdata - Office for National Statistics [WWW Document]. URL https://www.ons.gov.uk/census/2011census/2011censusdata/censusmicrodata/securemicrodata (accessed 10.1.23).

R Core Team, 2023. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Raymer, J., de Beer, J., van der Erf, R., 2011. Putting the Pieces of the Puzzle Together: Age and Sex-Specific Estimates of Migration amongst Countries in the EU/EFTA, 2002–2007. Eur. J. Popul. Rev. Eur. Démographie 27, 185–215. https://doi.org/10.1007/s10680-011-9230-5

Reader, M., Portes, J., Patrick, R., 2022. Does Cutting Child Benefits Reduce Fertility in Larger Families? Evidence from the UK's Two-Child Limit. https://doi.org/10.2139/ssrn.4114776

Rees, P., Clark, S., Nawaz, R., 2020. Household Forecasts for the Planning of Long-Term Domestic Water Demand: Application to London and the Thames Valley. Popul. Space Place 26, e2288. https://doi.org/10.1002/psp.2288

Rees, P., Wohland, P., Norman, P., Boden, P., 2012. Ethnic population projections for the UK, 2001–2051. J. Popul. Res. 29, 45–89. https://doi.org/10.1007/s12546-011-9076-z

Thomson, E., Winkler-Dworak, M., Spielauer, M., Prskawetz, A., 2012. Union instability as an engine of fertility? A microsimulation model for France. Demography 49, 175–195. https://doi.org/10.1007/s13524-011-0085-5

University of Essex, 2020. Understanding Society: Waves 1-11, 2009-2020 and Harmonised BHPS: Waves 1-18, 1991-2009: Special Licence Access. [data collection]. 15th Edition. UK Data Service. [WWW Document]. URL https://beta.ukdataservice.ac.uk/datacatalogue/doi/?id=6931#!#11 (accessed 10.1.23).

Vespa, J., Medina, L., Armstrong, D.M., 2018. Demographic Turning Points for the United States: Population Projections for 2020 to 2060. Current Population Reports. Washington, DC: U.S. Census Bureau, 2018. US Census Bur.

Weber, R., Ferry, M. & Ichou, M. 2024. Which Degree for Which Occupation? Vertical and Horizontal Mismatch Among Immigrants, Their Children, and Grandchildren in France. Demography. https://doi.org/10.1215/00703370-11670148.

Wilson, B., Kuha, J., 2018. Residential segregation and the fertility of immigrants and their descendants. Popul. Space Place 24, e2098. https://doi.org/10.1002/psp.2098

Wilson, T., Rees, P., 2005. Recent developments in population projection methodology: a review. Popul. Space Place 11, 337–360. https://doi.org/10.1002/psp.389

Winkler-Dworak, M., Beaujouan, E., Giulio, P.D., Spielauer, M., 2019. Simulating Family Life Courses: An Application for Italy, Great Britain, and Scandinavia. VID Work. Pap., VID Working Papers.

Zinn, S., 2013. The MicSim Package of R: An Entry-Level Toolkitfor Continuous-Time Microsimulation. Int. J. Microsimulation 7, 3–32. https://doi.org/10.34196/ijm.00105

6 Tables

Table 1. Demographic characteristics of the UK 2011 base population estimate (n = 37.4 million).

Demographic characteristic	Number of persons (1000s)	Proportion
Migrant origin and generation		
African#1G	577	0.02
African#2G	320	0.01
Bangladeshi#1G	173	0.00
Bangladeshi#2G	231	0.01
Caribbean#1G	89	0.00
Caribbean#2G	338	0.01
EW#1G	1,897	0.05
EW#2G	494	0.01
Indian#1G	505	0.01
Indian#2G	599	0.02
Native	28,302	0.76
Other#1G	1,325	0.04
Other#2G	1,581	0.04
Pakistani#1G	359	0.01
Pakistani#2G	626	0.02
Age		
(0,5]	4,160	0.11
(5,10]	3,088	0.08
(10,15]	3,327	0.09
(15,20]	3,626	0.10
(20,25]	3,788	0.10
(25,30]	3,851	0.10
(30,35]	3,575	0.10
(35,40]	3,875	0.10
(40,45]	4,107	0.11
(45,50]	4,017	0.11
Sex		
Male	18,845	0.50
Partnership Status*		
Cohabiting	3,994	0.15
Married	9,407	0.35
Separated	1,765	0.07
Single	11,673	0.43
Parity*		
0	10,654	0.40
1	6,795	0.25
2	5,034	0.19
3+	4,355	0.16

*For those aged (15,50]

Table 2. Projected migrant origin and generation populations 2011 to 2041 by demographic characteristics. Number of persons (1000s).

Demographic characteristic	2011	%	2041	%	Difference	% Difference
Migrant Origin and Generation						
African#1G	577	1.5	140	0.4	-438	-76
African#2G+	320	0.9	704	1.9	385	120
Bangladeshi#1G	173	0.5	22	0.1	-151	-87
Bangladeshi#2G+	231	0.6	400	1.1	169	73
Caribbean#1G	89	0.2	16	0.0	-73	-82
Caribbean#2G+	338	0.9	343	0.9	5	2
European & Western#1G	1,897	5.1	326	0.9	-1,571	-83
European & Western#2G+	494	1.3	1,591	4.3	1,097	222
Indian#1G	505	1.3	72	0.2	-432	-86
Indian#2G+	599	1.6	860	2.3	262	44
Native	28,302	75.6	26,055	69.6	-2,247	-8
Other#1G	1,325	3.5	322	0.9	-1,003	-76
Other#2G+	1,581	4.2	2,632	7.0	1,050	66
Pakistani#1G	359	1.0	58	0.2	-300	-84
Pakistani#2G+	626	1.7	1,138	3.0	511	82
Age						
(0,5]	4,160	11.1	4,078	10.9	-82	-2
(5,10]	3,088	8.3	3,296	8.8	208	7
(10,15]	3,327	8.9	3,133	8.4	-195	-6
(15,20]	3,626	9.7	3,330	8.9	-296	-8
(20,25]	3,788	10.1	3,446	9.2	-342	-9
(25,30]	3,851	10.3	3,528	9.4	-323	-8
(30,35]	3,575	9.6	3,919	10.5	344	10
(35,40]	3,875	10.4	3,104	8.3	-770	-20
(40,45]	4,107	11.0	3,314	8.9	-792	-19
(45,50]	4,017	10.7	3,529	9.4	-488	-12
Sex						
Male	18,845	50.4	17,506	50.5	-1,338	-7
Partnership Status*						
Cohabiting	3,994	14.9	4,201	17.4	207	5
Married	9,407	35.0	8,964	37.1	-443	-5
Separated	1,765	6.6	1,104	4.6	-661	-37
Single	11,673	43.5	9,903	41.0	-1,770	-15
Parity*						
0	10,654	39.7	11,326	42.2	673	6
1	6,795	25.3	4,840	18.0	-1,954	-29
2	5,034	18.8	4,575	17.0	-459	-9
3+	4,355	16.2	3,430	12.8	-925	-21
TOTAL	37,415	100.0	34,678	100.0	-2,736	-7

*For those aged (15,50]

7 Figures

Figure 1. State transition diagram of family dynamics. Cohab = Cohabitation, Mar = Marriage, Sep = Separation. Adapted from Mikolai and Kulu 2022.

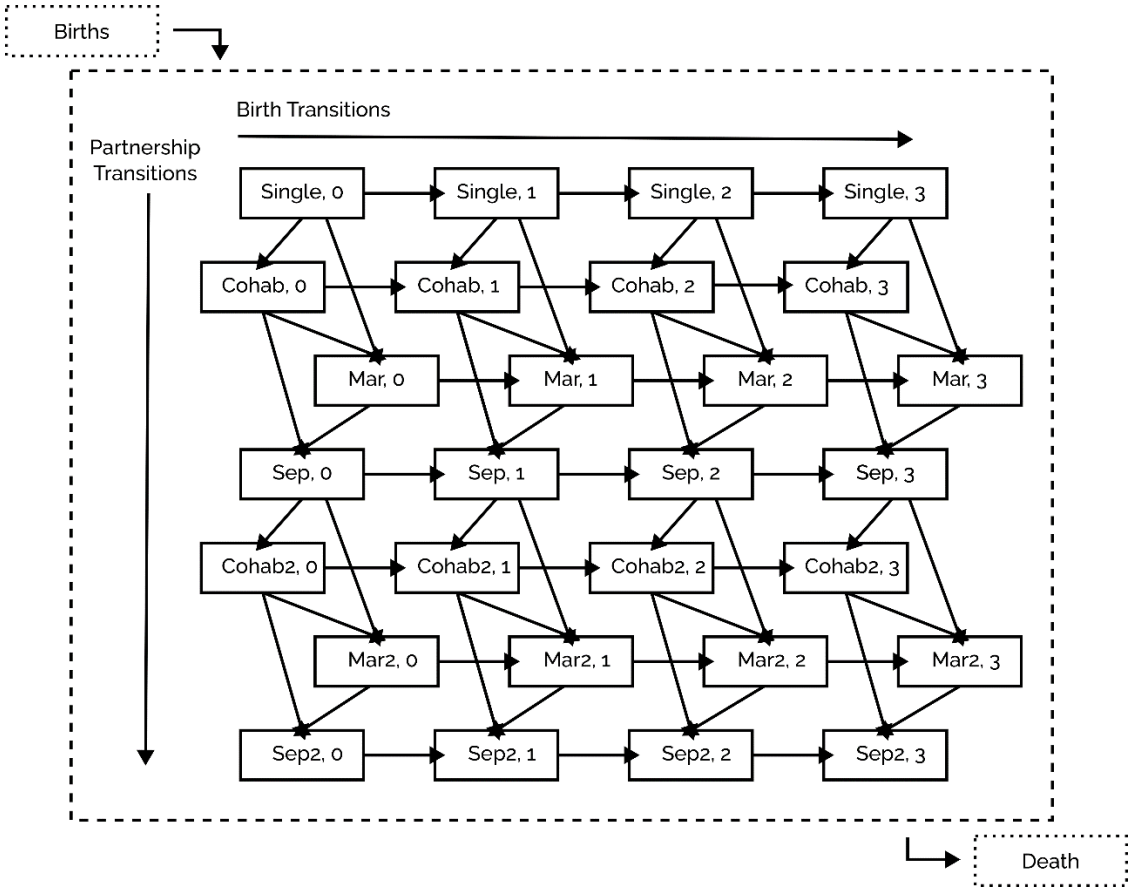


Figure 2. External validation of first marriage for our native family life history (birth cohort) simulation using ONS data (ONS, 2020b).

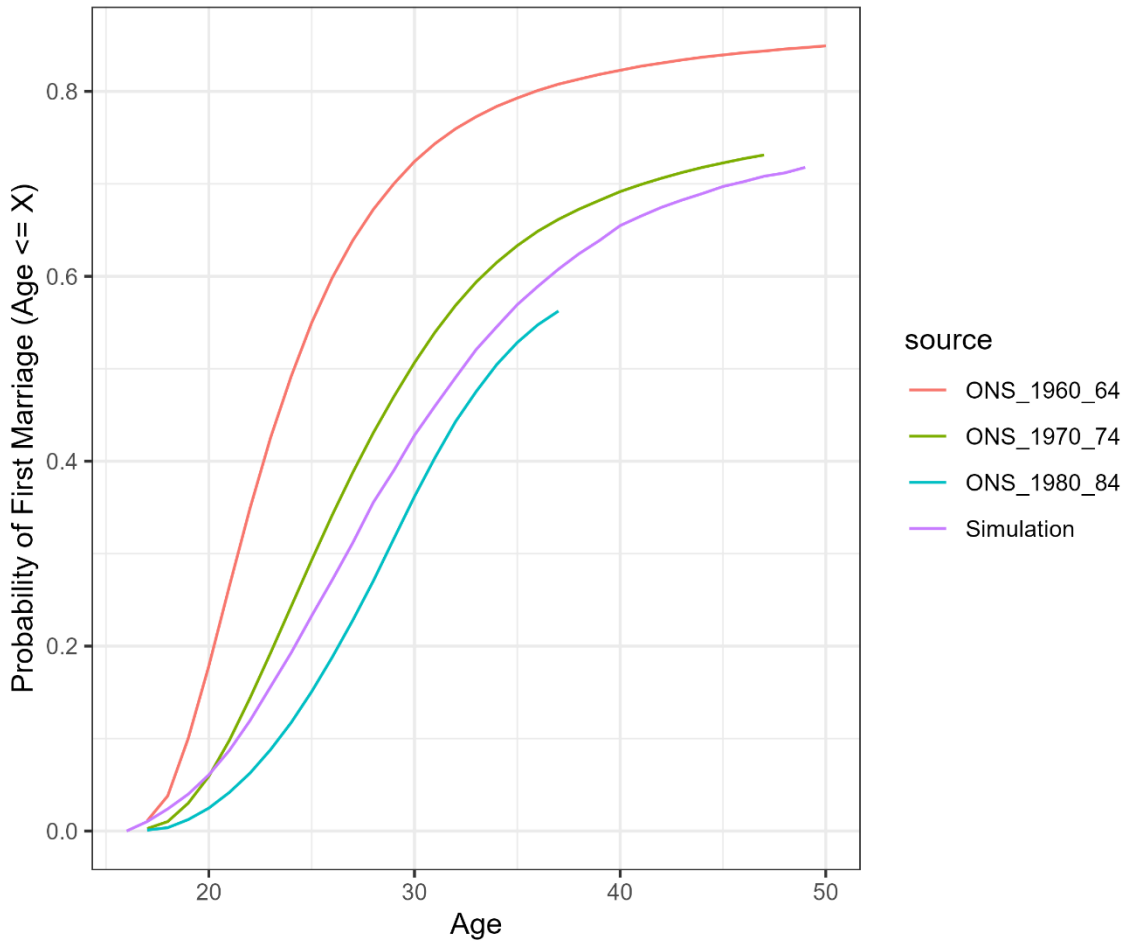


Figure 3. External validation of first marriage for our native family life history (birth cohort) simulation using ONS data (ONS, 2020a).

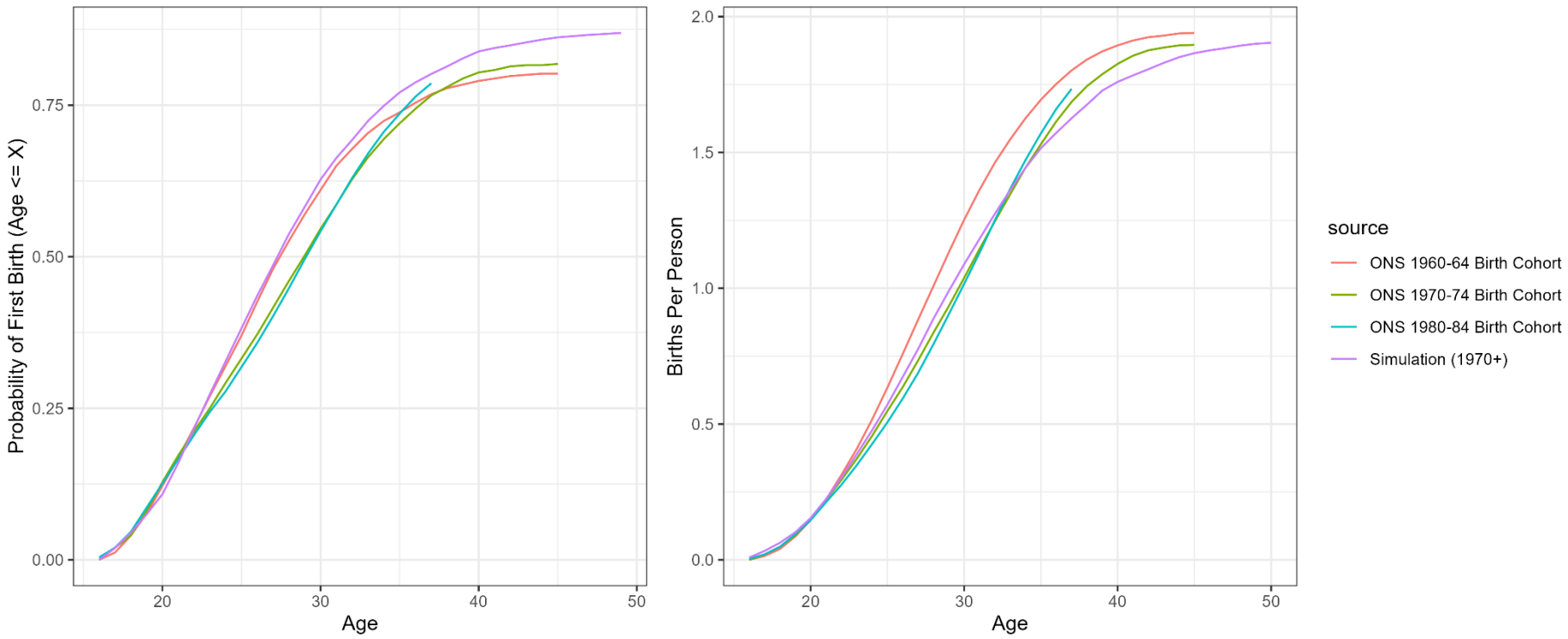


Figure 4. Prevalence of partnership and parity states for birth cohorts by migrant origin and generation using model transition rates, conditional on not having died.

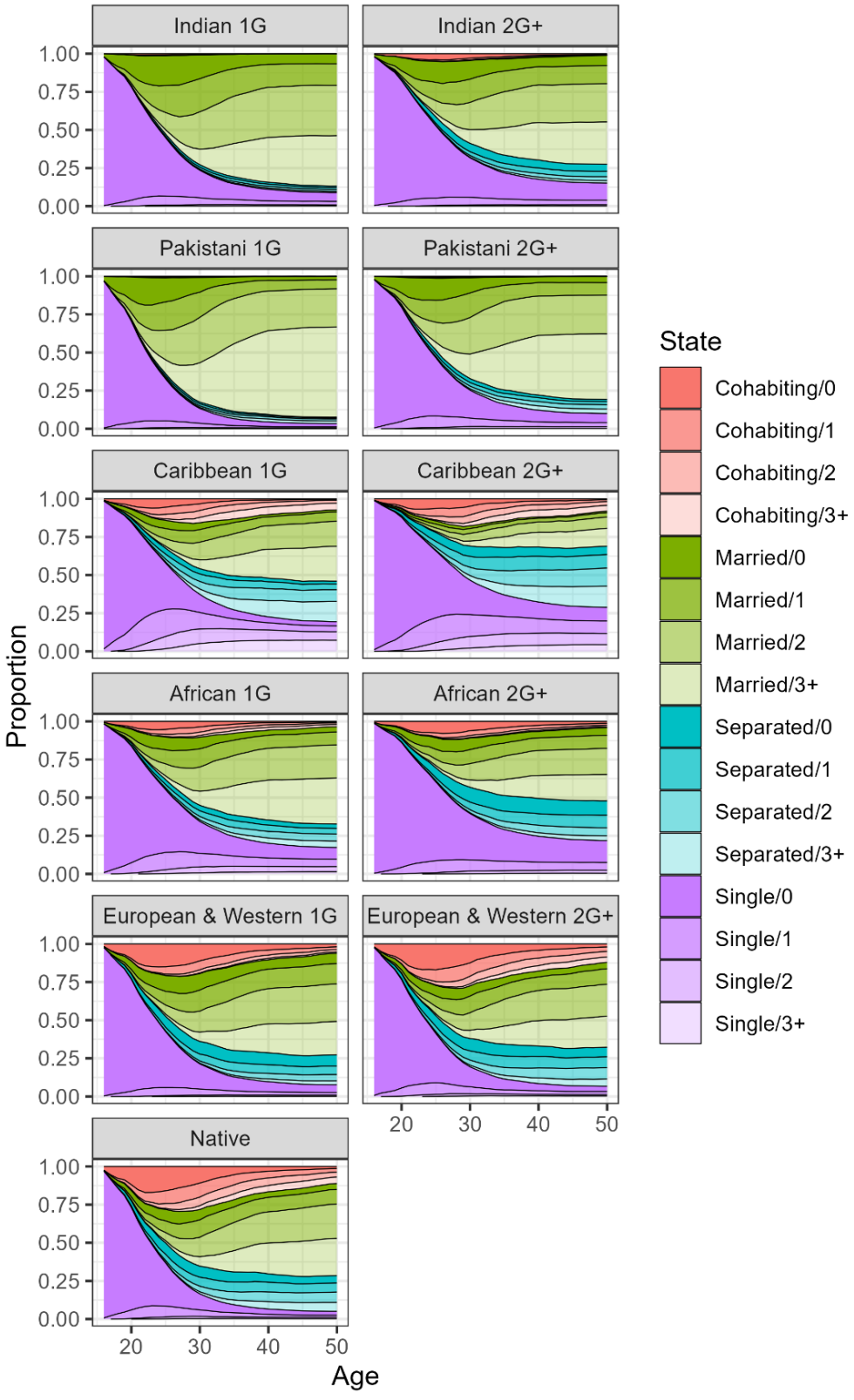


Figure 5. Population structure by migrant origin and generation.

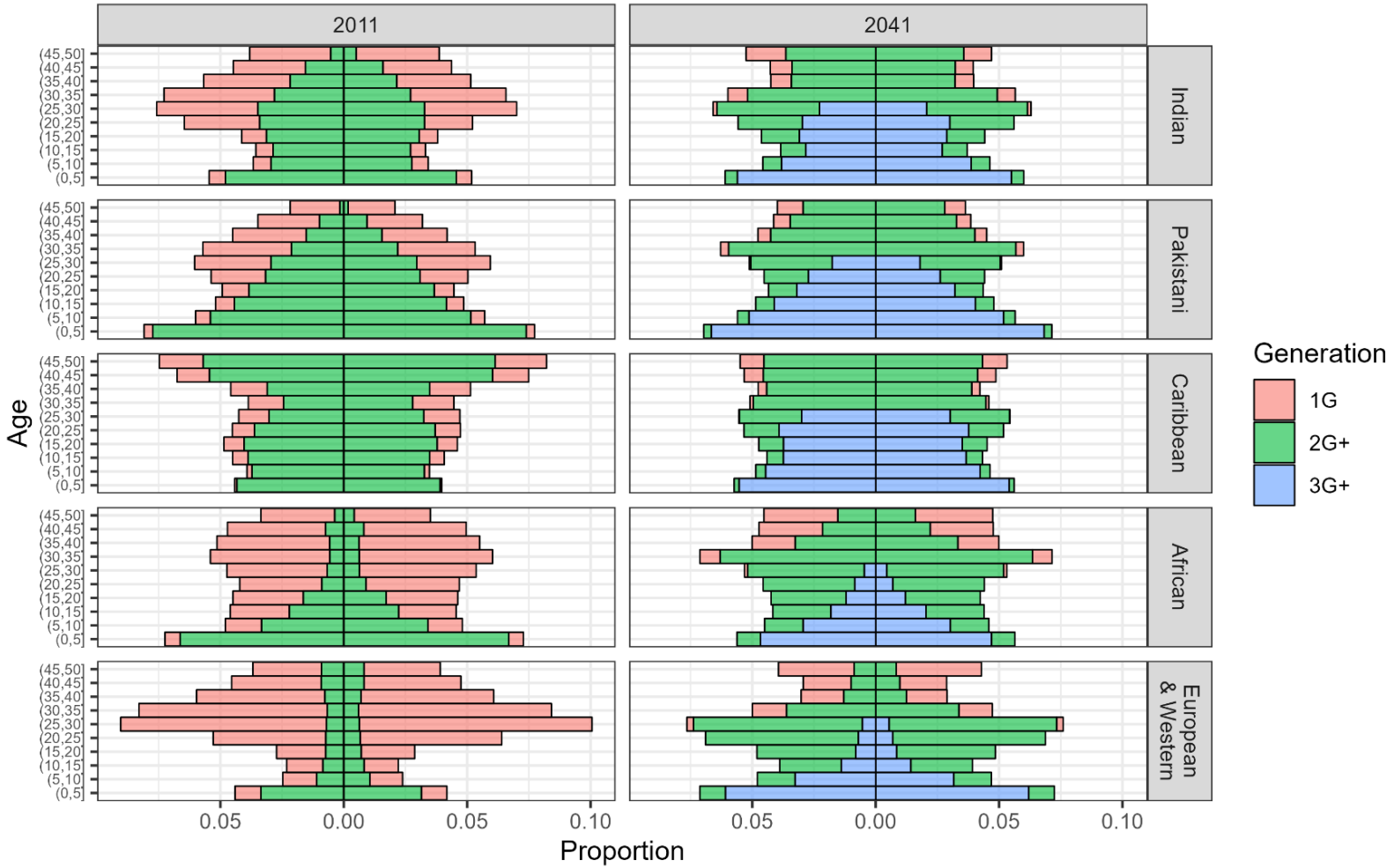


Figure 6. Population structure by partnership state and migrant origin.

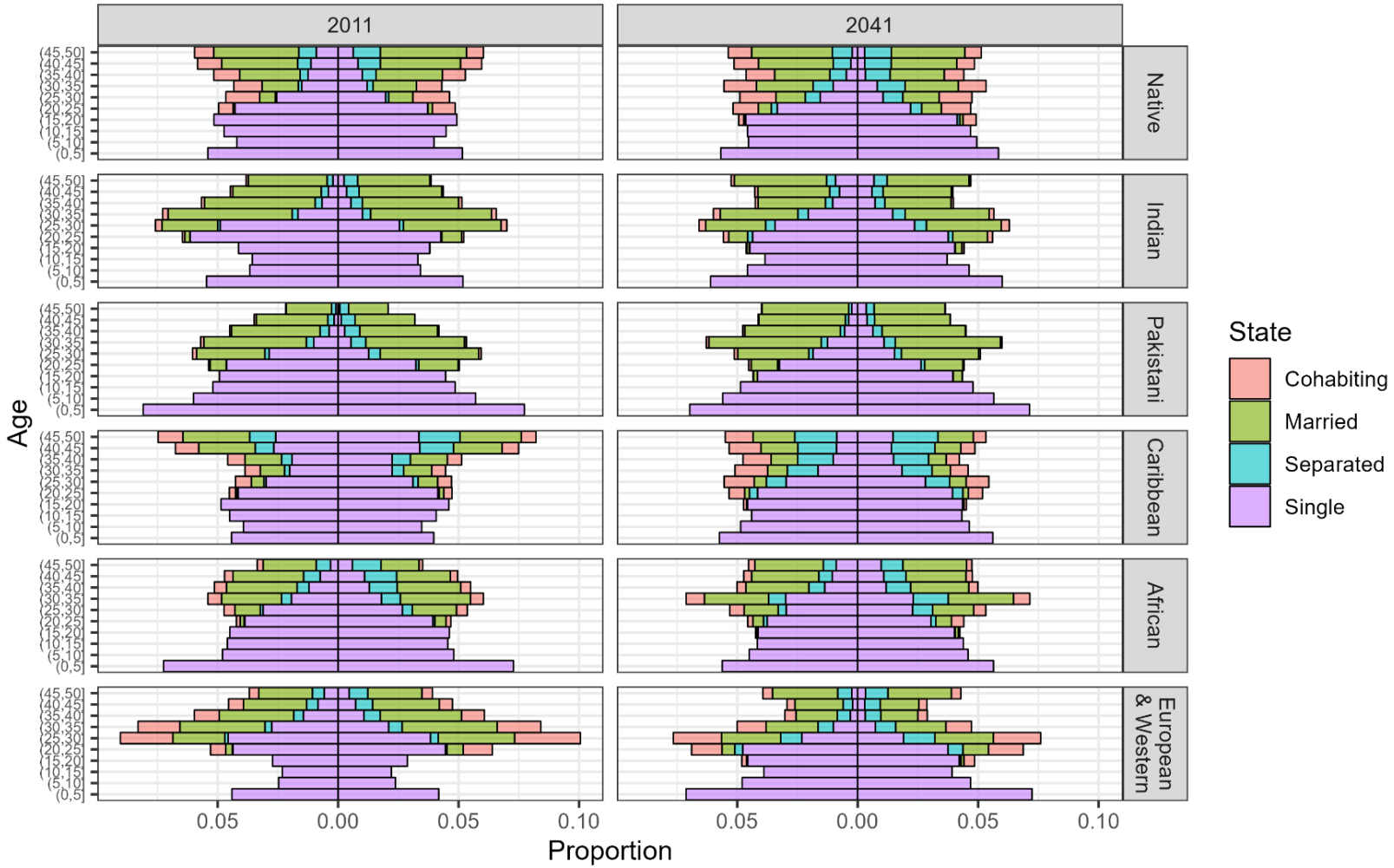
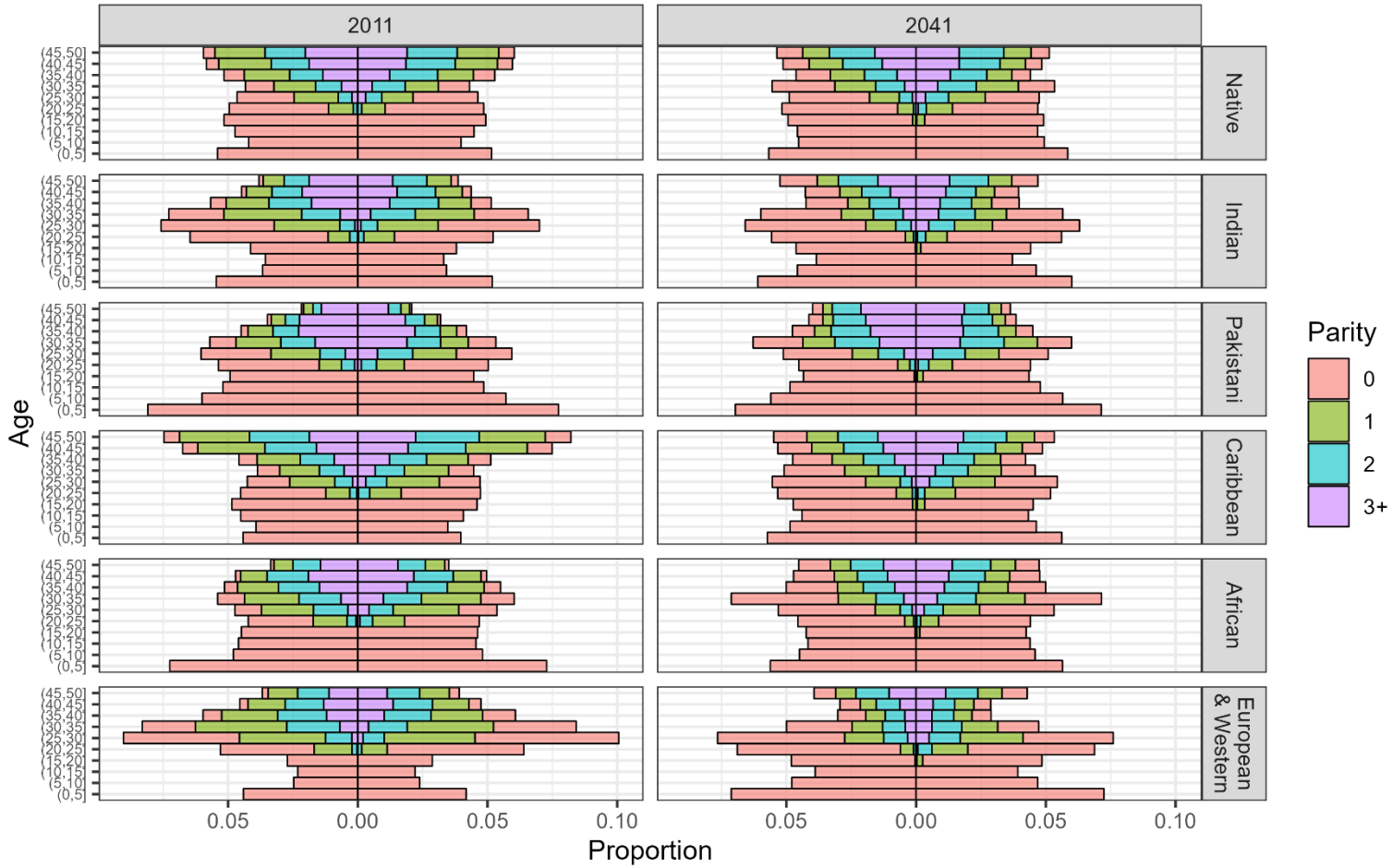


Figure 7. Population structure by parity and migrant origin.



8 Appendix

8.1 Software for Implementation of the Microsimulation Model

Our model consists of six scripts: (1) read_pop.R reads in the population data; (2) init_pop.R processes the population data into the desired format for the MicSim package; (3) transition_rates.R reads in the transition rates data and defines the transition functions; (4) simulation_parameters.R defines simulation parameters, such as transition matrices, the start and end date of the simulation and the number of individuals to simulate; (5) main.R runs the microsimulation model and stores results; and (6) results.R processes and graphs the results of the simulations.

Figure A1. Comparing the age distribution of our 2011 base population estimated from Census 2011 microdata for England and Wales with 2011 ONS data for Egland and Wales on the number of persons by age, sex and migrant origin and generation.