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The impacts of international migration on the UK's ethnic populations

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ABSTRACT

The United Kingdom faces demographic uncertainty, as negotiations for leaving the European Union (Brexit) proceed. Brexit has implications for international migration into and out of the UK, dependent on future immigration policy and on how attractive the UK will be as a labour market. At the same time, the UK population is experiencing ethnic diversification, consequent on past immigration. To explore the UK's future ethnic diversity, we run four projection scenarios. Three international migration scenarios, varying by the extent of the break with the EU, are implemented together with a reference projection assuming zero international migration. Ethnic groups are differently affected by these migration scenarios, depending on the contribution of international migration to population growth and the extent of demographic momentum. The White British and Irish lose population under all Brexit scenarios and the Black Caribbean population declines in all but one scenario. The White Other, Indian, Chinese, Other Asian and Other groups will show much lower growth under Soft and Hard Brexit scenarios. The growth of the Mixed, Pakistani, Bangladeshi, Black African and Black Other groups will only be affected marginally. Under every scenario, however, the UK's population is projected to continue to grow, age and diversify.

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Introduction

Population projections are essential for the effective planning of services and for understanding the impact that future population size and composition will have on society. International migration is the most volatile and least predictable component, given that it is influenced by economic conditions and policy decisions which are largely outside the control of the migrant. International migration makes a substantial contribution to population change in most developed countries. Varying the assumptions about future rates or flows of migration can have a sizeable impact on projection results. Variant projections are produced by statistical agencies around the world and are used by a wide range of organisations including government, business, utility companies and public/private health providers to plan for their service or product delivery. In an age where public resources are finite and business needs to develop targeted marketing strategies, the

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ability to plan for a range of future population scenarios is essential. This paper presents a range of projection scenarios for the United Kingdom (UK) by experimenting with different assumptions about future international migration, focussing on the sub-populations most affected by international migration, ethnic groups.

Substantial changes to migration policy have impacted on international migration to the UK in recent decades. In May 2004 ten countries joined the European Union (EU), and the UK was one of only three countries to allow near-unrestricted access to its labour market (Bauere et al. 2007). As a result, 2011 Census data reveal that 856,235 migrants from accession countries arrived between 2004 and 2011. Analysis of statistics from the International Passenger Survey/Long Term International Migration (IPS/LTIM) estimates produced by the Office for National Statistics (ONS 2017a, 2017b) shows that between 2012 and 2016, immigration to the UK by citizens of the EU has grown significantly while immigration by non-EU citizens has fallen substantially. This fall in non-EU immigration reflects a policy of restrictive migration management introduced by the UK Government in an attempt to achieve their target of reducing net international migration below six figures (Sims 2016). These relatively recent changes and their knock-on effects demonstrate the need for projections which take into account the impact that policy can have on international migration flows and hence future populations.

Further uncertainty about future international migration policy stems from the voters' decision, following a referendum vote in June 2016, that the UK should leave the European Union. The term Brexit has been adopted by UK and European leaders for the leaving process. One key part of a Brexit agreement will be the rights of UK and EU citizens to migrate between the UK and EU. At the time of writing, it is uncertain how liberal or restrictive will be the policies adopted by the UK and the EU. Since the Referendum result of June 2016, EU citizen immigration has fallen and emigration has risen (ONS 2017b), but the net balance is still positive.

Because demographic behaviour varies across sub-populations, national and sub-national projections are disaggregated by age and sex, with different fertility, mortality, internal and international migration rates used with each sub-group. These rates also vary substantially by ethnic group, sub-populations distinguished by racial, national or cultural attributes. Examples of ethnic group projections include the following: Frey (2015) provided analysis of and projections for ethnic population change in the USA; Coleman (2010) produced national ethnic group projections for the UK population; Wohland et al. (2010), Rees et al. (2012), Rees et al. (2017) produced UK sub-national projections by ethnic group in two rounds based on the 2001 and 2011 Censuses; and Kupiszewski, Kupiszewska, and Brunarska (2017) produced ethnic population projections for the Russian Federation. An ethnically disaggregated projection should perform better than one which is only disaggregated by age and sex because additional ethnic heterogeneity is taken into account within the model.

Many European national statistical agencies produce projections by foreign background (e.g. Statistics Netherlands 2018; Statistics Norway 2018). However, despite important ethnic differences in demographic rates, there are few examples of official projections by ethnic group, largely due to problems with data availability (Lanzieri 2011; Rees et al. 2017). Notable exceptions include national and sub-national projections by race and Hispanic origin produced by the US Census Bureau (Colby and Ortman 2015); national

and sub-national projections for four overlapping ethnicities produced by Statistics New Zealand (2017); national and provincial projections disaggregated by visible minority groups carried out by Statistics Canada (Morency, Malenfant, and Mac Isaac 2017); and an annual projection by ethnicity for London Boroughs by the Greater London Authority (GLA 2016).

Ethnic group projections are needed because an understanding of the future size and composition of national and sub-national populations by ethnicity is essential for ensuring equality of opportunity and in reducing discrimination. They are required for effective planning, because ethnic groups have varying needs for health care (Parliamentary Office of Science and Technology 2007), social care, particularly through the provision of informal care (Rees, Wohland, and Norman 2009) and education through language provision (Penn 2000). These differences in service need are highlighted by a recent comprehensive audit of all UK government data which differentiate by ethnic group, undertaken by the Cabinet Office (2017). The audit reveals that disparities are not uniform across all domains for all ethnicities. Chinese and Indian pupils perform better than White British pupils at school; those from Black, Pakistani, Bangladeshi or Mixed groups are more likely to be unemployed than the White British; while those from the Asian, Black and Other ethnic groups were most likely to be living in persistent poverty.

The GLA (2016) emphasise the importance of their projections by ethnicity for planning future service provision in London. We argue that similar data are needed for the whole country. In this paper, we produce a series of population projections for the UK, disaggregated by age, sex and ethnicity which take into account different international migration scenarios. While we have produced projections for all UK local authority areas, we focus on the national picture in this paper: our intention is to demonstrate how sensitive to international migration different ethnic group populations are. Our results can inform the debate on the implications of changing migration policy which is not easily measured using more aggregate projections.

Review

Direct and indirect effects of migration

International migration has both direct and indirect impacts on a country's population size and structure. Direct impact can be derived from the numbers of people who enter the country through immigration or leave through emigration. The cumulative direct impact is often quantified as a net effect, although this masks the differences between the composition of immigrant and emigrant groups. There is no such thing as a 'net migrant' (Rogers 1990). Bouvier, Poston, and Zhai (1997) use simulations for the USA and Germany to highlight the fallacy that assuming zero net international migration in population projections is equivalent to no international migration because immigrants differ from emigrants in their demographic and ethnic composition.

Indirect impacts are cumulative over time, where the fertility, mortality and internal migration behaviour of the population depend on its composition, which is influenced substantially by international migration. Migration can alter the age structure of the population because migrants tend to be younger than the host population (Gavrilov and

Heuveline 2003). There is evidence that fertility rates vary by country of birth. Coleman and Dubuc (2010) find that, in the UK, foreign-born mothers have higher fertility than UK-born mothers in the same ethnic group and similar evidence exists for the USA, Netherlands, France and Sweden (Sobotka 2008). Most immigrant groups show higher levels of child bearing shortly after migration (Andersson 2004) with a decrease over time (Coleman and Dubuc 2010). Most international migrants who move for economic reasons are self-selecting which leads to a 'healthy migrant effect' (Razum, Zeeb, and Rohrmann 2000). However, this effect decreases with the length of residence (Fennelly 2007). Mortality rates vary between ethnic groups, although in the UK the rates must be indirectly estimated (Rees, Wohland, and Norman 2009). There is limited evidence that the internal migration rates of recent international migrants are different from those of established populations. Stillwell et al. (1999) identify a link between higher immigration and higher internal out-migration in the UK, while Lomax et al. (2013) report that there is a negative correlation between international and internal migration for sub-national areas in the UK, with areas which gain immigrants losing internal migrants. The combined direct and indirect impacts are often termed the total impact of migration (Bouvier, Poston, and Zhai 1997).

Ethnic differences in demographic components

Alongside international migration, the other components of a population projection are fertility, mortality and, for sub-national projections, internal migration. Norman, Rees, and Wohland (2014) report differences in ethnic fertility in the UK where, compared with a White British reference group, women from South Asian countries tend to have relatively higher fertility, Chinese have relatively lower fertility and the pattern is more varied for the Black groups. Differences are reported across other studies, e.g. Penn (2000) reports on relatively high levels of fertility for Pakistani women in the UK and Coleman and Dubuc (2010) report that Chinese and Indian women have lower fertility than the UK average. Rees, Wohland, and Norman (2009) find differences in ethnic mortality, estimating that life expectancies are highest for the Chinese group, above average for Other White and Other Ethnic groups, and lowest for the Bangladeshi, Pakistani and Other Black groups. They also find differences by sex, Indian women have below average life expectancy while Black African men have above average life expectancy. Mortality differences in the USA for ethnic groups born within and outside the country are found by Singh and Siahpush (2002).

Internal migration redistributes populations within the country. This is important because fertility and mortality vary between different geographies (Rogers 2008) and so spatial distributions can have an impact on overall population size. Using 2011 UK Census data, Lomax (2015) reveal differences in migration rates by ethnic group. Pakistani and Bangladesh groups are the least mobile and the White Other and Chinese groups are most mobile. Simpson and Finney (2009) concentrate on spatial patterns in Great Britain, arguing that prevailing notions of 'self-segregation', whereby a high concentration of an ethnic group attracts other migrants of the same group, are no longer true. Rather, using 2001 Census data, they find 'all ethnic groups except Chinese have been migrating away from areas of minority ethnic concentration for some time' (ibid, 53).

Scenario projections

A framework for testing the contribution of migration, fertility, mortality and age structure in a projection model was set out by Bongaarts and Bulateo (1999), who produced four projection variants for world regions. These variants were standard (all components); natural change (zero migration); replacement (by setting fertility to replacement levels and keeping migration at zero); and momentum (reflecting only the age structure). The work reveals that young age structures are the main driver of growth in all world regions except Europe, where momentum is negative. Similar results are reported by Lutz, O'Neill, and Scherbov (2003) who estimate momentum for EU countries, finding that it turned from positive to negative in the year 2000. They describe a model with constant mortality and zero net migration which would result in 88 million fewer people in the 15 EU countries by 2100. Bijak et al. (2007) undertake scenario population projections for 27 European countries. Using consistent fertility, mortality and economic activity assumptions, they test three migration scenarios (base, high and low) informed by the potential future policy change, as well as a zero international migration scenario. Under all scenarios the population of Europe ages.

Wilson and Rees (2005) argue that in research on the impact of migration, there is little concerned with projecting migration. Most studies focus on describing and explaining patterns in the recent past. They point to the importance of getting migration 'plausibly right' in a projection model, as well as the need for projection results for groups beyond age and sex, including ethnicity. For the UK, Rees, Wohland, and Norman (2013) produce hypothetical projections based on an extended version of the Bongaarts and Bulateo (1999) framework that adds internal migration. Crucially, Rees, Wohland, and Norman (2013) incorporate ethnic differences and undertake analysis at local authority scale. Immigration was found to have a positive impact on population size for virtually all combinations of ethnic groups and sub-national areas, while the differences between population change for groups and areas were due mainly to internal migration and momentum. Rees, Wohland, and Norman (2013) highlighted the importance of international migration as a driver of sub-national population change but did not go beyond a baseline and a zero net migration scenario. Our work builds on this by specifically focussing on international migration and providing scenarios in a framework of post-Brexit possibilities.

Data and methods

This section sets out the data used, the methodology for the cohort-component projection model and the assumptions used in each of the scenario projections.

Projection model and components

Local Authority District (LAD) populations by age, sex and ethnicity are projected using the ETHPOP bi-regional cohort-component model (specified in Rees et al. 2017). The model applies ethnic-specific mortality rates by age and sex for sub-national areas to a start of interval population. Births are generated by applying ethnic-specific fertility rates to female populations by age. Immigration and emigration to/from LADs by age, sex and ethnicity are input as flows. Internal migration is generated by the application of internal migration rates. Populations and components of change are disaggregated by

single year of age up to 100+, two sexes and by 12 ethnic groups. The model uses a one-year time interval and runs as a period-cohort projection.

Base period component estimates

First estimates of mortality rates by ethnicity are produced for the UK through summing LAD mortality rates weighted by the ethnic share of the LAD population. These first estimates, in turn, are applied to each group in a LAD and adjusted to match registered total deaths in 2011. Full details of this geographical distribution method are given in Rees, Wohland, and Norman (2009).

Fertility rates by ethnicity are estimated by triangulating data from: the Labour Force Survey (computing ethnic-specific fertility rates based on the ‘own-child method’) and LAD level information from the 2011 Census (adjusting all woman Total Fertility Rates using ethnic-specific child-woman ratios) and ONS data (all woman age-specific fertility rates). Initial estimated rates are applied to women of child-bearing years by ethnic group to output the number of births per group and then adjusted so that the number of births is consistent with ethnic group populations aged 0 in the 2011 Census and the births in the calendar year by LAD. (See supplemental online material SOM1 and Norman, Rees, and Wohland (2014) for more details.)

Internal migration rates by ethnicity are estimated from special tabulations of inter-LAD migration by ethnicity generated from the 2001 and 2011 Censuses. In- and out-migration rates by ethnicity were interpolated between the two censuses and adjusted to agree with ONS, National Records for Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA) internal migration flows for all ethnic groups. See Rees et al. (2017) for a description.

Estimates of *immigration and emigration* for the base year, mid-2010 to mid-2011, were developed using the International Passenger Survey (IPS) (ONS 2018c). The IPS is a survey of 300,000 interviews with people who make trips into and out of the UK, though only 1–2% of the sample identified as international migrants. The IPS survey returns are inflated using weights to upscale to population numbers, with additional estimates of asylum seekers and migrants between the UK and the Republic of Ireland, to produce the Long Term International Migration (LTIM) estimates released by the ONS. Issues related to UK migration statistics are documented elsewhere, for example, coverage issues in the IPS owing to small sample sizes (Salt 2015) and debate around the inclusion of students in the LTIM data (ONS 2017c).

We distinguish immigration and emigration flows by 3 citizenships (British, European Union and Non-European Union) and 12 UK regions giving 36 citizenship-UK region categories. Uncertainties surrounding these citizenship estimates are outlined in the supplemental online material (SOM2), demonstrating that further disaggregation (e.g. by more detailed citizenship) is not possible in our work due to small sample sizes in the IPS. The IPS and LTIM data on international migration are used to make future assumptions about national immigration and emigration flows by three citizenship groups. These assumptions need to be converted into future assumptions by the local authority, ethnicity and age. The estimation method is explained in SOM2. To implement the conversion, we employed estimated probabilities of ethnicity given citizenship, for the 12 UK regions. These probabilities were derived from the 2011 Census Individual Microdata for England

and Wales, grouping categories of the variables ‘passports held’ into the 3 citizenship groups. Comparable data are not available for Scotland or Northern Ireland so we used the probabilities for Wales, a region with similar low ethnic minority shares of the population. A lookup of citizenship and region to ethnicity was calculated to create probabilities of ethnicity given citizenship and region. These probabilities were applied to convert migration flows by region and citizenship for future years into flows by region and ethnicity.

The UK region-ethnic group estimates and assumptions for immigration and emigration were allocated to local authority district (LAD) ethnic group-age-gender populations using shares derived from 2011 Census aggregate tables for the population. The resulting LAD immigration and emigration flows were adjusted for the base year, 2010–11 to the ONS estimates of total LAD immigration and emigration by age and sex. The immigration estimates were checked against 2011 Census tables of immigrants by ethnicity and found to be close across LADs. In all cases, we assumed the UK total and citizenship trends were followed in each UK region, as regional shares had been stable over the 1991–2014 period. Further details about international migration assumptions are provided in the supplemental online material (SOM2).

Projection assumptions for fertility, mortality and internal migration

Assumptions were set for each component for leading indicators for the long-term. The long-term was deemed to start by 2019–2020. Short-term trends linked estimates for 2014 to the long-term constants.

These constant leading indicators are adopted from the ONS 2014-based National Population Projections (NPP), principal variant. Assumptions set for the UK were converted into LAD assumptions using the ratio of LAD values to the leading indicator for the UK. For example, the ratio of LAD total fertility rate (TFR) to the UK TFR for 2011 is multiplied by the NPP assumption for TFR to 2061. For the long-term projection, the TFR was assumed to be 1.89 children per woman. TFRs are apportioned to ages using the ratios in the baseline 2011 estimates. The leading indicator used for mortality is the rate of mortality decline of 1.2% per annum assumed in the NPP. This is based on the average decline over the hundred years 1914–2014 and is applied to all ages and LADs. Internal migration rates used a 2006–2011 average and were held constant for each ethnic group-age-LAD group.

The projection model allows for the emergence of mixed ethnic groups through the allocation of ethnicity to a new-born infant. Births are generated to women of reproductive age by multiplying the relevant population at risk by ethnicity and age by a forecast fertility rate with the 2011 estimates are held constant to 2061. New-borns are allocated an ethnicity using probabilities generated from the 2011 Census tables in which children aged 0 at the 2011 Census (new-borns surviving the year prior to Census date) are classified by their recorded ethnicity and that of their mother. The highest probabilities are mostly found in the table diagonal (where the new-born has the same ethnicity as the mother) but for some ethnicities (e.g. Black Caribbean or White Irish) many children are allocated to groups other than the mother. This re-allocation is a major source of population change for mixed ethnic groups. Information about changes in ethnicity of older populations could be generated from the ONS Longitudinal Study but analysis showed that the resulting probabilities were not robust (Simpson, Jivraj, and Warren 2016).

International migration assumptions

We present four scenarios in this paper, under which the international migration assumption is varied. The headline assumptions are laid out in [Table 1](#). International migration assumptions are set as future time series of immigration and emigration flows separately. This method for setting assumptions for international migration is judged to be the best of several alternatives set out in [Rees et al. \(2015\)](#). In the No Brexit and Soft Brexit scenarios, each citizenship-UK region category follows the national trend, while in the Hard Brexit scenario, different trends are developed for each citizenship category.

[Figure 1](#) graphs assume headline immigration and emigration flows under the three scenarios in each year of the projection, with an increase or decrease to the required level in 2031–32, after which the flows are held constant. This use of constant migration is consistent with methods used with national statistical agencies when projecting migration and is the best choice when facing substantial uncertainty. Further discussion about changing ethnic composition in the longer term is discussed in the supplemental online material (SOM2). Assumptions for each of the scenarios were developed as follows.

For the *No Brexit* scenario, logistic models were fitted to the UK total immigration and emigration flows for 1991–2014, extracted from tables in the IPS/LTIM. The logistic asymptote levels were adopted as the long run immigration and emigration from 2019 to 20 onwards. These long-run flows were allocated to 12 UK regions, converted to ethnicity and shared across 389 LADs as described above. Linear interpolation was used for years between the base year and the year beyond which the long run assumption of a ceiling was assumed constant.

For the *Soft Brexit* scenario, the long-term assumption for net international migration in the 2014-based ONS National Population Projections of +185 thousand per year was converted to immigration and emigration flows using ratios for 2010–2011 reported in the LTIM and adopted as long-run constant assumptions from 2019 to 2020. Our Soft Brexit scenario assumes an overall reduction in migration compared to the No Brexit scenario but does not specify different assumptions for EU and non-EU migration. This is because it represents a situation where the UK maintains a policy of free movement, which is the current EU position if the UK wishes to retain access to the single market ([The Economist 2018](#)) but nonetheless through a combination of factors becomes less attractive to migrants. This scenario takes into account the fall in immigration since June 2016 for EU following the referendum result ([ONS 2017b](#)), a trend which may continue post-Brexit.

For the *Hard Brexit* scenario, we linked immigration and emigration flows to potential future policy. Before the 2010 General Election, the Conservative Party included a pledge

Table 1. Summary of migration assumptions used in each projection scenario.

Scenario	International migration assumption
No Brexit	Net International Migration trended to = +252k in 2031–32, then constant. Annually, In = 621k, Out = 362k
Soft Brexit	Net International Migration trended to = +185k in 2031–32, then constant. Annually, In = 518k, Out = 333k
Hard Brexit	Net International Migration trended to = +100k in 2031–32, then constant. Annually, In = 349k, Out = 249k
No International Migration	Set to zero

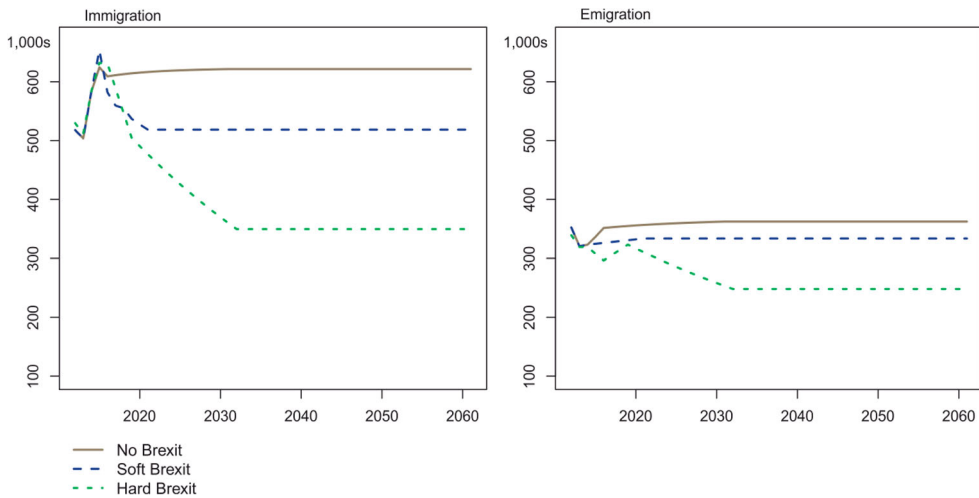


Figure 1. Illustration of international migration assumptions under three Brexit scenarios.

to reduce net international migration (NIM) to ‘tens of thousands’ (Sims 2016), interpreted here as a target floor of 100,000 net international migration. Between 2010 and 2014 the UK Coalition Government introduced stricter regulations and higher costs on Non-EU immigrants. But this policy could not apply to EU citizens, under the Freedom of Movement provisions in the Treaties establishing the European Union. The consequences of the policy were a reduction in immigration from outside the EU, which was counterbalanced by a substantial rise in the immigration of EU citizens after 2012 when economic recovery from the severe recession of 2009–2011 began. We argue that following the 2016 Referendum, we could expect to see the previously observed decline in Non-EU citizen immigration replicated in a decline for EU citizens thereafter. After testing alternative extrapolative models and experimenting with different calibration intervals, a simple exponential model was calibrated for Non-EU citizens using the UK immigration and emigration series for 2010–2014. The rates of decline were applied to both Non-EU and EU citizens, with immigration and emigration by British citizens assumed constant at 2010–14 levels. These assumptions determined the short-term trends to a long-term limit of net international migration of 100,000 per year. The limit was achieved in 2031–32 and assumed to continue to 2060–61.

Although this estimation process is dependent on many approximations, it delivers plausible immigration and emigration estimates and conditional assumptions by ethnicity, age and sex for LADs required for projecting LAD populations.

Definition of ethnic groups

Ethnic identity in the UK is based on self-identification. In the census, a range of tick box responses are offered, as well as the option to provide a write in answer. In our projections, we have identified 12 ethnic groups which are consistent across all census tables required to produce UK projections. These are identified in Table 2 along with the abbreviations used in subsequent figures. While there are more detailed ethnic group categories in

some census tables, these are not consistently available, especially when combining data for all the UK's constituent countries. Table 2 also reports the size, average age and total fertility rate of each ethnic group in 2011.

Figure 2 demonstrates the age structure of each of the ethnic groups in 2011. Age structures vary substantially between ethnic groups, for example, the White British and Irish group and the Black Caribbean group have a high proportion of older people, while the Mixed group has a large share of its population in younger age groups. These structures immediately reveal that some groups are more susceptible to ageing if migration is restricted and the information will be useful when interpreting the projection results in the next section.

The categorisation of ethnicity is not without criticism. Finney and Simpson (2008, 65) outline that, despite the emphasis on self-identification, 'the very asking of a question and the construction of ethnic group categories assumes the importance of ethnic group for an individual, and can be considered prescriptive'. Nor are the ethnic groups used in the UK always comparable to those used elsewhere. For example, race is the term favoured by researchers in the USA (see Frey 2015). The ethnic groups presented in this paper are widely used in UK research and policy and represent the broadest number possible that are consistent across all data sources used.

Results

The direct impact of migration

The direct impact of migration can be measured by summing up the total immigration and emigration over a given period. Table 3 demonstrates the direct impact that migration has over the projection period mid-2011 to mid-2061 for each ethnic group. Across all three scenarios, the White British and Irish group have negative net international migration, losing more people under the Soft Brexit scenario than under the No Brexit scenario. The smallest loss for this group occurs under the Hard Brexit scenario. This is largely due to the emigration assumptions used in each scenario,

Table 2. Ethnic Group definitions, 2011 populations (1000s), average ages and total fertility rates.

Ethnicity	Census Response Groups	Total Population Mid-2011	Average Age Mid-2011	Total Fertility Rate 2011
WBI	White: British, Irish, Gypsy, Irish Traveller	52,462	41.4	1.83
WHO	White: Other White	2714	33.2	2.06
MIX	Mixed or Multiple Ethnic Groups	1251	21.8	1.49
IND	Asian or Asian British: Indian	1455	34.1	2.20
PAK	Asian or Asian British: Pakistani	1177	27.0	3.20
BAN	Asian or Asian British: Bangladeshi	453	25.5	3.47
CHI	Asian or Asian British: Chinese	434	31.9	1.26
OAS	Asian or Asian British: Other Asian	863	31.2	2.09
BLA	Black or Black British: Black African	1024	27.5	2.64
BLC	Black or Black British: Black Caribbean	602	38.7	1.75
BLO	Black or Black British: Other Black	283	25.8	1.23
OTH	Other Ethnic Group	581	30.3	1.77
ALL		63,299	39.5	1.93

Source: Authors' computations from ONS Births, 2011 Census Data, Census Microdata and the Annual Population Survey.

Adapted from Rees et al. (2017).

Note: *TFR* Total Fertility Rate.

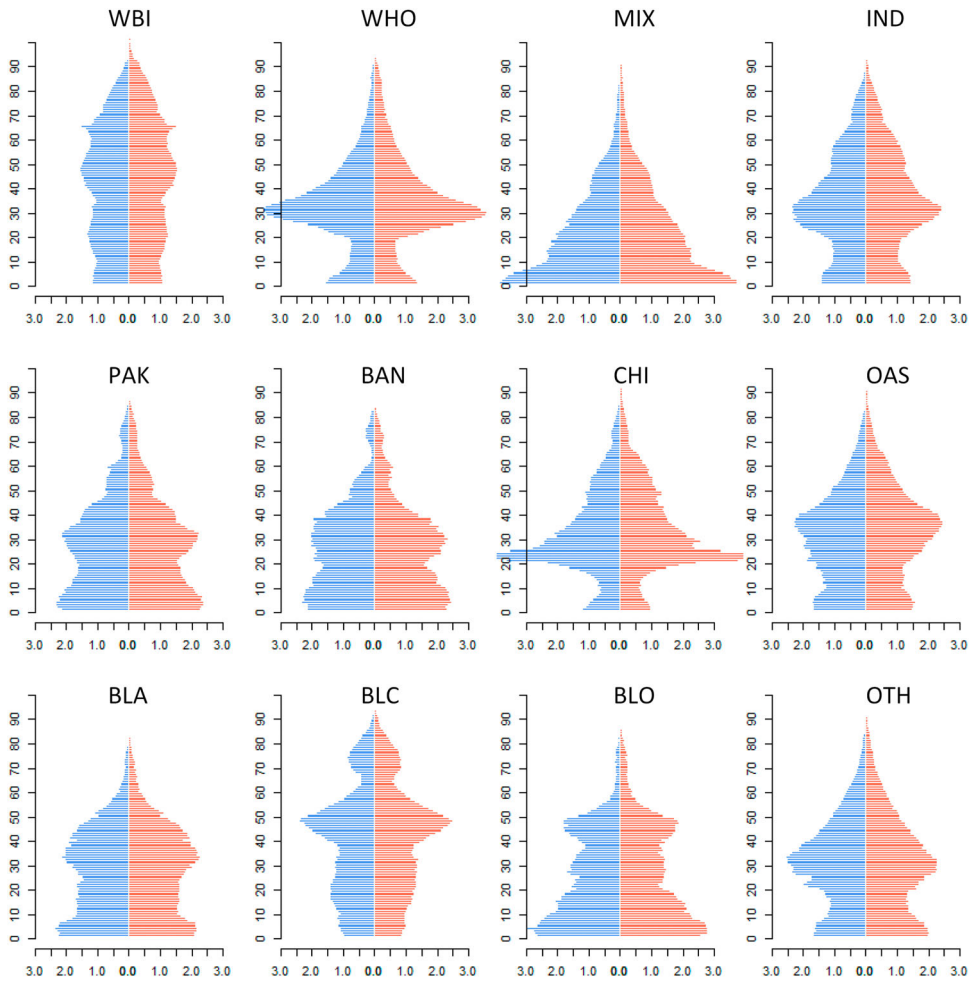


Figure 2. The age and sex structure of each ethnic group in 2011.

where there are fewer emigrants under Hard Brexit, while, under Soft Brexit, emigration is similar to No Brexit. The only other ethnicity to show net loss under the No Brexit and Soft Brexit scenarios is the Black Caribbean group. This group shows a small gain under the Hard Brexit scenario because immigration is higher and emigration lower than under the other scenarios. The largest net gain under all scenarios is for the White Other group, although this gain is 3.6 million lower under the Hard Brexit scenario compared with No Brexit. It is likely that the White Other group will be heavily impacted by migration policy arising from Brexit given that EU migrants are heavily represented within this group. This cumulative migration forms one component of the projection scenarios, discussed in the next section.

Population projection results under four scenarios, 2011–2061

Measuring the total impact of migration reveals substantial differences in projected populations under the four scenarios. **Figure 3** shows the total population in each year up to

Table 3. The direct effect of international migration: cumulative immigration, emigration and net migration for 2011–2061 by ethnic group.

Ethnicity	No Brexit			Soft Brexit			Hard Brexit		
	Immig	Emig	Balance	Immig	Emig	Balance	Immig	Emig	Balance
WBI	6979	8633	-1655	5924	8009	-2085	4615	5,482	-867
WHO	11,242	4052	7189	9617	3764	5853	7857	3701	4156
MIX	884	480	404	761	446	315	599	381	218
IND	2584	835	1749	2211	776	1435	1397	755	642
PAK	1188	554	635	1026	515	511	689	399	290
BAN	293	256	37	253	238	16	245	168	76
CHI	2281	855	1425	1943	794	1149	868	402	465
OAS	2054	870	1185	1762	808	954	1275	668	607
BLA	1508	461	1046	1290	428	862	1295	692	603
BLC	196	333	-138	169	311	-142	211	177	34
BLO	181	129	52	156	120	36	173	113	60
OTH	1364	463	900	1163	429	734	849	433	416
ALL	30,754	17,922	12,831	26,277	16,638	9639	20,072	13,370	6702

Note: Immig = Immigration in 1000s, Emig = Emigration in 1000s, Balance = Net International Migration in 1000s = Immigration - Emigration.

2061 under each of the four migration scenarios for the total UK population. The brown line demonstrates the trajectory of growth under the No Brexit scenario. This scenario shows continuous population growth throughout the projection period, with a population in 2061 of 86.9 million. Under the Soft Brexit scenario (dashed blue line) the UK population continues to grow, but at a slower rate than the No Brexit scenario, and the total population in 2061 is projected to be 82.9 million. Under the Hard Brexit scenario (dotted green line) population growth is slower, reaching 78.1 million in 2061. The No International Migration scenario (dashed black line) is substantially different from the No Brexit scenario: population grows very slowly in early years and then begins to fall after 2045. The result is a population of 65.7 million in 2061, only 1.9 million higher

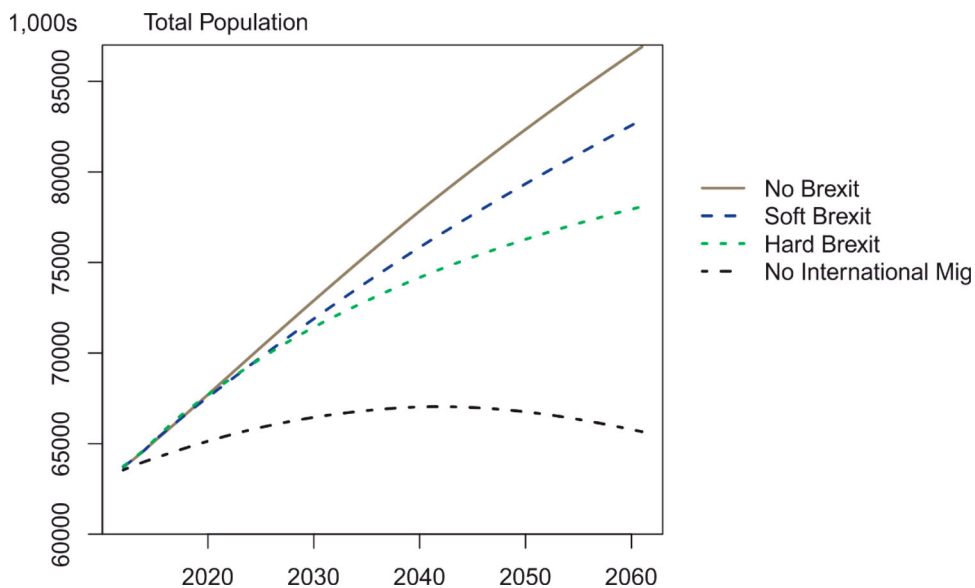


Figure 3. National Projections of total population under four migration scenarios.

than the population in 2011. The decline seen in the No International Migration scenario is because the population, which is predominantly White British and Irish, is ageing over the period and deaths start to overtake births. Deaths increase because baby boomers, born between 1946 and 1971 when the total fertility rate exceeded replacement, reach the ages of high mortality risk between 2031 and 2061. There are substantial differences between ethnic groups under these four scenarios, and these are discussed below.

When compared with the ONS variant projections for 2041 (the last year for variants in the ONS data), our No Brexit and Soft Brexit are closest to the ONS high variant (77 million) while our Hard Brexit scenario is closest to the ONS Principal (72.9 million). In 2061, our projection is higher than the ONS principal variant of 76.3 million. This is largely due to different long term migration and fertility assumptions laid out in the supplementary material.

The shares of each ethnic group population at the end of the projection period under the four migration scenarios are presented in [Table 4](#), compared with values in 2011. The White British–Irish population is the largest in 2011, representing 82.4% of total. This share declines under every scenario, dropping to 57.9% of total population in 2061 under the No Brexit scenario. While the decline is smaller under other scenarios, no matter which migration assumption is used the White British and Irish group is set to decline in relation to all other groups combined. The largest gain in share under the No Brexit, Soft and Hard Brexit scenarios is for the White Other population, which, from 4.5% of total UK population in 2011, increases its share to 12.9%, 11.8% and 10.0% under the No Brexit, Soft Brexit and Hard Brexit scenarios respectively. The share of the White Other group declines under the No International Migration scenario. The impact on the share of total population of a Hard Brexit compared with a No Brexit scenario are negative for most ethnic minority groups, notably Chinese (1.4% of the total population compared with 2.6%). Indian (3.8% compared with 5.2%) and Other Asian (2.5% compared with 3.1%).

[Table 4](#) also reports the index of diversity (see the table notes) for the UK. An index of zero represents no diversity (i.e. all people belong to a single ethnic group) while an index of 0.92 represents complete diversity when there are 12 groups, where all groups are equally represented. Under all scenarios, the UK population becomes more ethnically diverse in 2061 than it was in 2011. It is most diverse under the No Brexit scenario with a score of 0.64, which is double that of 2011 (0.32). The population is projected to be least ethnically diverse in 2061 under the No International Migration scenario where the score is 0.42, but this is still substantially higher than in 2011. This increase in diversity across all scenarios is driven by the decline of the White British and Irish population and by the increase in other ethnic group populations.

The projections by ethnic group can be split into four broad clusters ([Figure 4](#)), depending on their growth trajectories under the different migration scenarios. Cluster 1 (noted as C1 in [Figure 4](#)) comprises five groups which are very reliant upon international migration to continue growing; Cluster 2 (C2) comprises two groups which are somewhat reliant on international migration to grow; Cluster 3 (C3) comprises three groups which continue to grow under all scenarios; and Cluster 4 (C4) comprises two ethnic groups where the population is projected to decline under all scenarios. The graphs within this figure demonstrate the demographic momentum of each ethnic group as the difference between the population under each migration scenario and the No International Migration (natural increase

Table 4. The share of the UK population and the diversity index by ethnicity in 2011 and 2061 under four migration scenarios.

Ethnicity	2011 Population	2061 Population Scenario			
		No Brexit	Soft Brexit	Hard Brexit	No International Migration
WBI	82.4	57.9	59.6	64.5	75.6
WHO	4.5	12.9	11.8	10	4
MIX	2	4.9	4.9	4.8	4.3
IND	2.4	5.2	5	3.8	2.7
PAK	1.9	5.1	5.1	4.9	4.6
BAN	0.7	1.5	1.6	1.8	1.8
CHI	0.7	2.6	2.4	1.4	0.6
OAS	1.4	3.1	3	2.5	1.6
BLA	1.7	3.7	3.7	3.5	2.5
BLC	0.9	0.5	0.6	0.8	0.9
BLO	0.4	0.6	0.6	0.7	0.6
OTH	0.9	1.8	1.7	1.4	0.8
Total	100	100	100	100	100
Total Pop.	63,743	86,902	82,883	78,087	65,659
Diversity	0.32	0.64	0.62	0.57	0.42

Note: Population shares are percentages of the total UK population. The total populations are in 1000s.

The Diversity Index is computed as $1 - \sum_e (P_e/P_+)^2$, where P_e is the number of people in an ethnic group and P_+ is the total population.

only) projection, which serves to highlight how sensitive ethnic group populations are to migration assumptions. Note that the scales for each graph are different. Here we are interested in presenting the *trajectory* of growth or decline under each scenario, rather than the absolute numbers, which are reported in Table 4.

C1 groups are those which are very reliant upon international migration to maintain current growth levels. This is evident because, as the migration assumption becomes more restrictive under different Brexit scenarios, growth quickly slows. Under the No International Migration scenario growth stalls and then becomes negative over the projection period. These are the groups with the lowest demographic momentum because they decline quickly in the absence of migration. The White Other group are younger than average at the start of the period (33.2 years compared with 39.5 years) but this population is maintained largely by migration. While this group demonstrates the largest net international migration gain under the No Brexit scenario (see Table 3), the White Other group also has very high immigration and emigration flows, suggesting that the turnover of population is maintaining younger age structures seen in the No Brexit scenario. This group is hit particularly hard when immigration assumptions become more restrictive. This is the group we project to grow the most under all three Brexit scenarios, because of very high recent immigration. The difference in the size of the White Other group in 2061 between the No Brexit scenario and the No International Migration scenario is particularly stark: 11.2 million compared with 2.6 million.

The Indian group is the third oldest at the start of the period with an average age of 34.1 years. While fertility rates are relatively high (a TFR of 2.2), this is also a group where the direct impact of migration is very high over the period. The Indian group exhibits the second largest net migration gain after the White Other group under the No Brexit scenario. The Chinese group exhibits the third largest net gain when assessing the direct impact of migration. This group has the second lowest fertility of all groups (with a TFR of 1.26). The Other Asian and Other groups also exhibit relatively high net gains under a No Brexit scenario.

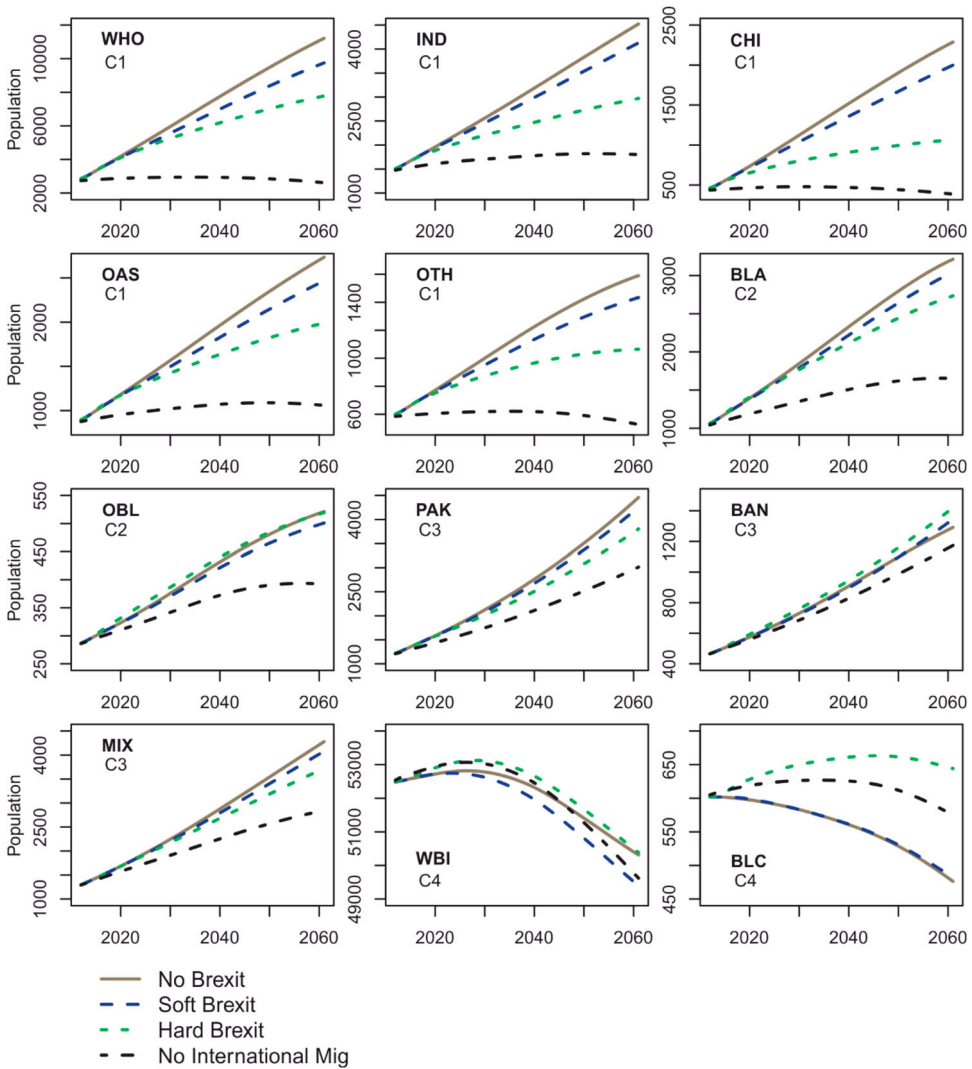


Figure 4. National projections of 12 ethnic group populations under four migration scenarios. Note: C1 = populations which are very reliant on international migration to continue growing; C2 = populations *somewhat* reliant on international migration to continue growing; C3 = populations which continue to grow under all migration scenarios; C4 = populations which *decline* under all scenarios.

C2 ethnic groups are identified as being *somewhat* reliant upon international migration to maintain their population growth, Black African and Black Other, which continue to grow under all Brexit scenarios. There is a substantial slowdown in this growth under the No International Migration scenario, but the populations continue to grow for much of the period. Both groups have younger age structures at the beginning of the projection period. For the Black African group the average age is 27.5 years in 2011; for the Black Other group, this is 25.8 years.

C3 groups are projected to continue growing under all migration scenarios and we conclude that these are groups with strong demographic momentum. All have relatively low

average ages at the start of the period (see Table 2). The Pakistani and Bangladeshi groups have by far the highest fertility rates, with TFRs of 3.20 and 3.47 respectively. For these groups, a combination of younger age structure and higher fertility results in continued growth. The Mixed group has low fertility (TFR is 1.49) but is the youngest group so has strong momentum carrying the population forward.

The two C4 ethnic group populations experience a lower population in 2061 than 2011 under all scenarios (White British and Irish) or most scenarios (Black Caribbean). The White British and Irish group begin to decline rapidly from 2030 onwards. This is an ageing population, the oldest of all ethnic groups with an average age of 41.4 in 2011. Natural decrease begins to have an effect after 20 years of the projection. Having No International Migration slows this decline slightly in early years – the White British group has seen net loss for decades, so stemming this has some effect. The Black Caribbean group exhibits net emigration under all except the Hard Brexit scenario. A large proportion of the Black Caribbean group in the UK is made up of people who arrived in the 1950s and 1960s to work, in response to post-war labour shortages and industrial prosperity (Peach 1968, 1991). This is a group with a high average age at the beginning of the projection period (38.7 years, the second highest after White British and Irish) and thus one which continues to age in place, so part of the population decline can be attributed to deaths. The Black Caribbean group also has relatively low fertility rates, with a TFR of 1.75 at the beginning of the period. This combination characterises a group without the demographic momentum to grow under any of the scenarios, with brief respite offered under a Hard Brexit scenario which has the effect of reducing emigration.

Table 5 summarises the impact of net international migration on population change for the 12 ethnic groups. The contribution percentages are computed using the cumulative net international migration (NIM) balances of Table 3 expressed as a percentage of the total population change for each Brexit scenario reported in columns two through four of Table 5. Subtracting the NIM contribution percentages from 100 yields the share of growth due to natural increase. The NIM percentage is highest for the Black Caribbean, Other Ethnic, White Other, Chinese and Other Asian, being above 50% under all scenarios. Aside from Black Caribbean, these populations all belong to Cluster 1 (those very reliant on migration). The NIM contribution is lowest for the Bangladeshi, Mixed and Pakistani

Table 5. The contribution of net international migration to population change under different scenarios.

Ethnicity	Population Change (1000s)			Contribution of Net International Migration (%)		
	No Brexit	Soft Brexit	Hard Brexit	No Brexit	Soft Brexit	Hard Brexit
WBI	-2183	-3042	-2055	76	69	42
WHO	8360	6827	4860	86	86	86
MIX	2982	2749	2390	14	11	9
IND	3017	2575	1420	58	56	45
PAK	3240	3020	2567	20	17	11
BAN	826	782	853	4	2	9
CHI	1827	1483	550	78	77	85
OAS	1839	1543	1065	64	62	57
BLA	2152	1894	1589	49	46	38
BLC	-126	-139	20	109	102	170
BLO	234	208	226	22	17	27
OTH	991	800	433	91	92	96
ALL	23,159	18,698	13,918	55	52	48

groups (between 9% and 11%) who are all members of Cluster 3, populations which continue to grow under all scenarios. Overall (see the bottom row of [Table 5](#)) the NIM contribution falls as the scenarios progress from No Brexit (55%), to Soft Brexit (52%) to Hard Brexit (48%). This table serves to further highlight the substantial contribution that international migration makes to population change for many groups. It is also revealing that, overall, NIM contributes more than half of total change under the No Brexit and Soft Brexit scenarios but falls to a contribution of less than half under the No Brexit scenario.

Population ageing under the three Brexit scenarios

A United Nations (2000) research report asked whether immigration could prevent population ageing in developed countries. In that report and subsequent analyses for European populations, Kupiszewski (2013) showed that, at best, population ageing could be slowed a little in countries most attractive to immigrants. Prior to the June 2016 Referendum, the UK was such a country of attraction. In a projection analysis of EU member states and regions, Rees et al. (2010) showed that by 2050 the UK would have become the country with the highest population in the EU. As reversion to a No Brexit scenario seems highly unlikely at the time of writing, it is improbable that the UK will win the 'European population championship' in the next 50 years. Therefore, it is of interest to examine the impacts of the different scenarios on ageing for ethnic populations with very different current age structures. In [Table 6](#), we present one set of ageing indicators for the UK's ethnic populations which reports percentage distribution of the population in three age bands, covering childhood, work and retirement. A threshold age for entry into retirement of 70 is used. This anticipates planned increases in the age threshold for payment of the state pension over the period 2011–2061. More refined thresholds have been proposed such as the 'prospective' age when 15 years of further life can be expected (Sanderson and Scherbov 2010) or a threshold of 74 (Balachandran et al. 2017). But a political consensus on such a high threshold does not (yet) exist in the UK. By dividing the working ages percentage by the old age percentage, you obtain the Potential Support Ratio (PSR), which gives an indication of the viability of the 'Pay-As-You-Go' state pension system. The PSR statistics are given in columns seven and fourteen of [Table 6](#).

The White British and Irish majority experience a PSR shift from 4.8 working age persons per older person in 2011–2.2 in 2061, irrespective of the migration scenario. All other ethnic sub-populations except the Black Caribbean have much higher PSRs in 2011, reflecting their younger age structures. The Mixed, Bangladeshi, Chinese, Other Asian, Black African Black Other and Other ethnic groups all have a PSR of over 20 in 2011. By 2061 this difference between the White British and Irish and other groups in PSR has transformed dramatically, irrespective of scenario, through a process of cohort replacement. Under the Hard Brexit scenario, several groups most dependent on immigration for growth (White Other, Indian, Chinese, Other Asian, Black African, Black Caribbean, Other) reach PSRs which are below that of the White British and Irish group in 2011. Over the period 2011–2061 the advantageous age structure (the demographic dividend) of ethnic minority groups will wind down. All groups will face the challenge of an aged society in the later decades of the twenty-first century.

Discussion and conclusions

This paper has focussed on reporting the effects of alternative international migration scenarios on the total population of the UK and the populations of its constituent ethnic groups. The overall effect of setting migration to zero in our reference scenario is slow population growth which turns negative near the end of our projection period. This contrasts with the projected increase under all three Brexit scenarios which demonstrates how important is the role of international migration is for maintaining the UK population. Population growth is strongest under the No Brexit scenario, followed by the Soft Brexit scenario then Hard Brexit.

Under all migration scenarios, the overall share of the majority White British and Irish population as a proportion of total population is projected to decline. This is most apparent under the No Brexit Scenario but none of the more restrictive migration scenarios stop this from happening. Under all scenarios, the UK population is projected to become more ethnically diverse and the population structure shifts to one which is older. The migration scenarios affect the pace of ageing rather little for the White British majority but do have significant effects for those ethnic minority groups dependent on international migration for growth. In 2061 all groups will face the challenge of fewer persons of working age compared with more persons in older ages.

Some groups are more reliant upon international migration to sustain their growth than others. The White Other, Indian, Chinese, Other Asian and Other groups would quickly decline if there were no international migration. The Mixed, Pakistani and Bangladeshi ethnic minority groups will continue to grow, irrespective of which Brexit migration scenario is used, because of their demographic potential and high fertility rates. Running scenarios of international migration provide an understanding of which groups (classified by ethnicity, age or locality) are affected and which are not. Scenarios can also reflect possible outcomes of policies about international migration (No Brexit, Soft Brexit or Hard Brexit) and so inform decision making about future measures to enable or discourage such migration flows.

There are major uncertainties associated with these UK projections. The sequence No Brexit to Hard Brexit provides a plausible range of outcomes but formally assigning probabilities to the scenarios is beyond the scope of this paper. It is always the case that new statistics are published which might point to a need for new scenarios. Recent statistics on EU international migration into and out of the UK (ONS 2018a, 2018b, 2018c) have pointed to a downturn in immigration, which is built into the Hard Brexit scenario. There was also a steep upturn in emigration, which we had not anticipated. Part of this might be attributed to return migration, driven by the growth of origin country economies. However, it might also be a sign that EU citizens are voting with their feet following the referendum. The statistics show that they are not coming to work in the UK in as large numbers and are leaving to work elsewhere in larger numbers. This serves to highlight the difficulties of making assumptions about future migration trends. We would caution the reader that what we present in this paper are scenarios based on well-informed inputs. While we can't validate results from the projection, we can draw comparisons with the results of other models which have broadly similar aims to our own.

Table 6. Age indicators 2011 and 2061 by ethnicity under three migration scenarios.

Ethnicity	Year	Scenario	% 0–19	% 20–69	% 70+	PSR	Ethnicity	Year	Scenario	% 0–19	% 20–69	% 70+	PSR
WBI	2011	Base pop	22.4	64.3	13.3	4.8	CHI	2011	Base pop	20.1	76.5	3.3	22.8
	2061	No Brexit	22.9	53.7	23.3	2.2		2061	No Brexit	14.9	75.7	9.4	7.1
	2061	Soft Brexit	22.7	53.7	23.6	2.2		2061	Soft Brexit	14.7	74.2	11.0	6.7
WHO	2061	Hard Brexit	20.8	55.4	23.8	2.2	OAS	2061	Hard Brexit	7.8	36.5	55.7	3.0
	2011	Base pop	18.6	77.0	4.3	17.7		2011	Base pop	28.2	69.1	2.7	25.2
	2061	No Brexit	12.8	72.2	15.0	4.5		2061	No Brexit	21.5	62.3	16.3	3.6
MIX	2061	Soft Brexit	12.7	70.5	16.8	4.0	BLA	2061	Soft Brexit	21.5	60.8	17.7	3.4
	2061	Hard Brexit	10.7	42.7	46.6	3.2		2061	Hard Brexit	19.0	48.3	32.7	2.7
	2011	Base pop	53.4	44.6	1.9	23.1		2011	Base pop	36.5	62.1	1.4	42.8
IND	2061	No Brexit	35.5	56.7	7.7	7.0	BLC	2061	No Brexit	27.2	55.7	17.1	3.2
	2061	Soft Brexit	34.8	57.1	8.1	6.9		2061	Soft Brexit	27.2	54.7	18.1	3.3
	2061	Hard Brexit	28.7	59.6	11.7	6.4		2061	Hard Brexit	24.8	48.2	27.0	3.0
PAK	2011	Base pop	24.0	70.6	5.4	13	BLO	2011	Base pop	22.8	66.7	10.5	6.4
	2061	No Brexit	24.2	60.9	14.9	3.9		2061	No Brexit	25.1	43.8	31.0	1.4
	2061	Soft Brexit	24.2	59.6	16.2	3.6		2061	Soft Brexit	24.7	43.7	31.7	1.5
BAN	2061	Hard Brexit	22.0	47.7	30.4	2.6	OTH	2061	Hard Brexit	19.7	50.8	29.5	1.9
	2011	Base pop	39.3	57.5	3.1	18.3		2011	Base pop	44.7	53.2	2.1	25.0
	2061	No Brexit	38.2	52.6	9.2	5.5		2061	No Brexit	25.0	59.1	15.9	3.6
BAN	2061	Soft Brexit	38.3	52.1	9.5	5.3	OTH	2061	Soft Brexit	24.6	58.8	16.6	3.6
	2061	Hard Brexit	37.8	49.8	12.4	4.8		2061	Hard Brexit	19.6	59.1	21.3	3.6
	2011	Base pop	41.5	55.9	2.7	21.0		2011	Base pop	29.4	67.7	2.9	23.2
BAN	2061	No Brexit	38.0	48.5	13.5	3.5	OTH	2061	No Brexit	14.1	66.4	19.5	3.2
	2061	Soft Brexit	38.0	48.1	13.8	4.4		2061	Soft Brexit	13.8	64.7	21.5	3.0
	2061	Hard Brexit	36.2	47.5	16.3	4.4		2061	Hard Brexit	9.6	46.4	44.0	2.3

Note: PSR = Potential Support Ratio, calculated by dividing the percentage of population aged 20–69 by the percentage of population aged 70+.

Werpachowska and Werpachowski (2017) construct a dynamic micro-simulation model for a sample of 5 million individuals classified by age, sex and ethnicity drawn from decennial censuses and Labour force surveys, which is grossed up to the 56 million population in 2011 of England and Wales. The model incorporates probabilities of international return migration to produce alternative scenarios for British and EU citizen populations in England and Wales. The citizenship migration streams are converted into ethnic group international migration. Although an exact comparison of methods and assumptions with our results is not possible, the direction of travel of the total populations and ethnic groups are broadly similar. Their Status Quo projection corresponds with our No Brexit scenario and their Hard Brexit projection corresponds with our Hard Brexit scenario. However, their Soft Brexit scenario generates results very close to their Hard Brexit scenario, while our Soft Brexit scenario projects higher populations.

This paper has focussed on the national results of our scenario projections. In further work, we intend to analyse the local implications of our results and the process of population ageing deserves further analysis, drawing on these projections. We have not built in future changes in marrying or partnering outside one's group. Further research is required to develop these assumptions as they will have implications for the composition of population especially of the mixed ethnic group. The paper has concentrated on the UK's demographic futures which have significant implications for the labour force and economy. Addition of a labour force participation analysis would be very valuable, matching the country level research of Kupiszewski (2013) and Loichinger (2015).

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