POPULATION AND MIGRATION STATISTICS (PAMS) COMMITTEE (SCOTLAND)

International Migration Distribution Methodology

1. Introduction

1.1 This paper provides a summary of work carried out to investigate the variant methods which have been used throughout the last decade to distribute international migrants both geographically, to NHS Board areas, and by age and sex. It suggests refinements to the current methods, particularly with regard to the age and sex distributions assumed. These distributions are incorporated into the Mid-year population estimates and in the published migration tables.

1.2 The views of the PAMS committee are sought on several proposed changes to current methodology outlined in this paper:

- **Geographic distribution of migrants**: To alter where in Scotland we assume out-migrants are leaving from by increasing the influence of where we know people from overseas move into.
- **Age-sex distribution of migrants**: To better estimate the age and sex of the people leaving Scotland for overseas by including a component based on the age and sex of in-migrants from overseas.
- **Sex ratio adjustment of migrants**: To make an adjustment to sex ratios of both in- and out- migrants so that they are closer to that seen on the Long Term International Migration estimates.

2. Background

2.1 The total number of international migrants assumed to enter Scotland from overseas or to leave Scotland in the year is derived from the International Passenger Survey (IPS) and adjustments, and since 2007 has been equivalent to the Long Term International migration (LTIM) estimate published by Office of National Statistics (ONS). Please refer to paper PAMS (07) 02 on the National Records of Scotland (NRS) website. ONS do not attempt to define the area of origin or destination within Scotland and also do not provide detailed information on age or sex.

2.2 The best data on migrants we have available at low geographic levels and by sex and single year of age comes from General Practitioner (GP) registrations picked up through the NHS Central Register (NHSCR) and Community Health Index (CHI). These are administrative data sources which have considerable limitations, particularly with respect to people leaving Scotland for overseas, where coverage is poor.

2.3 NHSCR migration data for several different groups have been used at different points in the last decade to approximate the proportions at each age and sex, and in each NHS Board area. This paper uses high-level breakdowns from the LTIM to suggest adjustments to the distributions currently used but does not consider novel sources for the base distribution data.

3. Summary of proposed changes

3.1 **Geographic distribution of migrants**: 'Alter the percentage of migrants leaving Scotland for overseas (out-migrants) assumed to come from different NHS Board areas by increasing the influence of which Health Board areas people register in when moving to Scotland from overseas'. This should mimic the group who originally came from overseas to Scotland and are now moving on.

Previous method: Equal weighting of a) In-migrants from overseas, b) out-migrants to Rest of UK and c) general population size.
Proposed method: Double weighting of In-migrants from overseas, single weighting of a) out-migrants to Rest of UK and b) general population size.

3.2 **Age-sex distribution of migrants**: 'Alter the proportions of migrants leaving Scotland for overseas (out-migrants) assumed to be each sex and a certain age by moving from just using the profile of people who leave Scotland' and register with a GP in the rest of the UK to including the age-sex profile of those who move into Scotland from overseas and register with a GP as a component.
The age-sex distributions would be worked out for each NHS Board separately using age profiles for those leaving or moving to that area. In-migrant data would account for half of the profile at Scotland level but have an effect proportionate to the number of overseas in-migrants to each NHS Board area.

Previous method: Use age-sex profile of people moving from each NHS Board to the rest of the UK.
Proposed method: Use a combination of a) the age-sex profile of people leaving that NHS Board for the rest of the UK and b) the age-sex profile of people moving into that NHS Board from overseas.

For example:
- 10,000 people left Scotland for overseas.
- We assume in Scotland as a whole half (5,000) are non-British and will follow the age distribution of in-migrants from overseas; and half (5,000) are British emigrants and will follow the age distribution of out-migrants to the rest of the UK.
- Our distribution to Health Boards (based on in-migrants, out-migrants to the rest of the UK and the general population) gives 20% of all out-migrants, or 2,000, leaving from Lothian and 3%, or 300, leaving from Highland.
- Looking at new in-migrants 25% moved to Lothian, therefore 1,250 (25% of the 5,000) will follow the age distribution of in-migrants to Lothian. Only 1% moved to Highland so 50 will follow the age distribution of in-migrants to Highland.
- This leaves 750 out-migrants from Lothian (2,000 minus 1,250) who will follow the age-distribution of people leaving Lothian for the rest of the UK. In Highland 250 (300 minus 50) will follow the age distribution for people leaving Highland for the rest of the UK.

3.3 **Sex ratio adjustment of migrants**: **Introduce a sex-ratio adjustment that increases the number of male migrants at young adult ages** where there is a large majority of women seen in the NHSCR data, suggesting an under-representation of young men in moves in both directions.

Previous method: No adjustment. NHSCR data shows more GP registrations for women than men especially at age 18-25.

Proposed method: For each NHS Board area, separately, scale up the number of men in an age range between 16-30 where male migrants are in the minority in that area so that the total number of men at all ages is 5% higher for in-migrants and 10% higher for out-migrants.

4. Variant methods: Geographic Distribution

4.1 The overall flows of international migrants to and from Scotland over the period Census Day 2001 to Census Day 2011 were looked at. The distributions to NHS board areas were applied to the total migration for each year according to NHSCR flows in that year.

4.2 The total number of in-migrants has been distributed according to destinations of new in-migrants from abroad registering with a GP in Scotland as recorded on the NHSCR throughout the decade. Over the ten years the NHSCR inflow was 125% of the in-migration estimate used, which was assumed to be due to short-term migrants (staying for less than 12 months) registering with GPs during their visit. The data on in-migrants is assumed to be of reasonable quality and to largely reflect the destinations of long-term migrants.

4.3 The distribution may deviate from actual migration patterns due to differences in the geographic destinations of any short-term migrants included, potentially missing British in-migrants who did not de-register with their GP while living abroad, and differences in registration rates among different migrant groups which may vary reliably with geographic distribution (e.g. student areas, agricultural work).

4.4 For out-migration, using the distribution of those de-registering on the NHSCR (notifying their doctor that they are leaving the UK) is no longer used. The coverage of this data is poor, with only around a third of the outflow captured on the IPS recorded in this way. The rate of de-registration is also subject to variation in practises among NHS Boards and list-cleaning exercises, which mean proportions may not reflect the true share of migrants in the year.

4.5 The current method, used since 2007, gives equal weight to the distributions given by each of: out-migrants to the rest of the UK, in-migrants from overseas and the general population (the previous Mid-year estimate). An alternative method was then considered, keeping the three components currently used but double-weighting the in-migrants. This is based on the finding from the IPS that approximately half of out-migrants from Scotland are non-British (a proportion which seems to be increasing). Many of these out-migrants will have stayed in Scotland for a relatively short time and remain in the areas to which they arrived.

4.6 The allocation of migrants to Local Authorities within the Health Board area relies upon the use of 'donor records' within the CHI database associated with postcodes that can then be aggregated to different geographies. These are then constrained to the totals at health board levels.

4.7 Currently the donor records used to impute the locations of origin for international out-migrants are half out-migrants to the rest of the UK (origin postcodes) and half international in-migrants (destination postcodes). This method therefore already

weights the international in-migrants at 50%, similar to the alternative proposed, but does not take into account general population distribution at all.
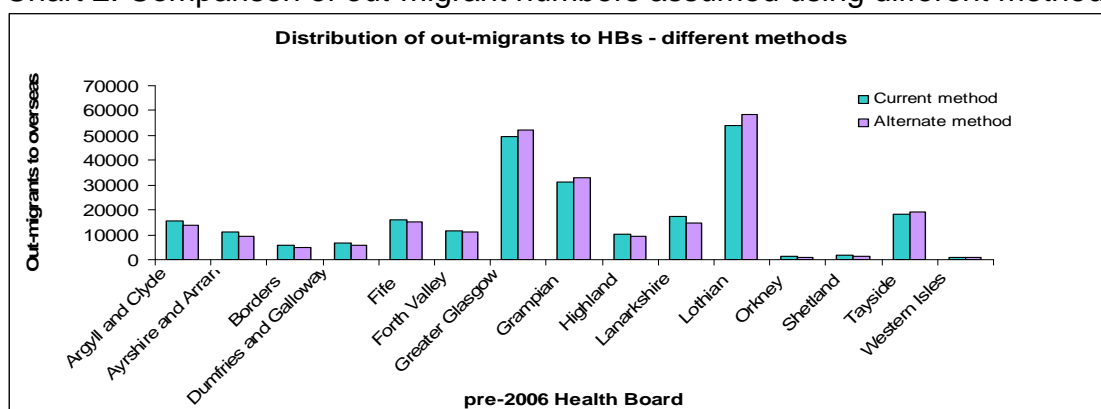
Option 1: Continue using half out-migrants to UK and half in-migrants as donor records on the CHI to distribute to Council areas.

Option 2: Instead use 50% in-migrants, 25% out-migrants to UK and 25% the currently registered population.

5.   Impact of proposed methods: Geographic Distribution

5.1   As shown in the graph below, alongside the current method, increasing the influence of in-migrant distributions on the method would have the effect of slightly increasing the proportion of out-migrants allocated as coming from Greater Glasgow, Lothian and Grampian over the decade, as these are the areas which see the majority of in-migration from overseas.

5.2   Chart 2: Comparison of out-migrant numbers assumed using different methods

5.3   The current method already shows a considerable increase in the out-migrants assumed to come from Greater Glasgow compared with what was used earlier in the decade, while Grampian saw a decrease. If the new method had been used since 2001, it would therefore have had the effect of reducing the population size in Greater Glasgow and Lothian in our rolled-forward estimates. As Edinburgh and Glasgow were two areas which had a lower population on the census than our rolled-forward estimates this suggests this method could have been more accurate.

6.   Conclusion & Recommendations: Geographic Distribution

6.1   The in-migrants should continue to be distributed based on the destinations of new GP registration from overseas.

6.2   In light of the number of out-migrants who are not British, 'increasing the influence of the international in-migrant distribution would be a minor adjustment to the current method that may more closely reflect the population of out-migrants'. This would have had a small effect on the origins assumed for out-migrants in the last decade.

7.   Variant Methods: Age-sex distribution of migrants

7.1   To form part of the mid-year estimates, the migrants must be split by sex and single year of age. This is done by applying the distributions of these characteristics seen in NHSCR flows to the in- and out-migrants assigned to each individual NHS Board area.

7.2   Since 2005 we have used overseas inflows from the NHSCR to give the age-sex distribution of the in-migrants. This data has good coverage, accounting for 125% of in-migration as measured on the IPS, however, the data may include some short-term migrants whose age-sex profile may differ from long-term migrants. GP registration rates among immigrants may also differ by age and sex, skewing the profile towards those more likely to register with a doctor.

7.3   For out-migrants, data on de-registrations (people notifying their GP that they are leaving the UK) is poor and only covers around a third of the out-migrants counted on the IPS. We currently use data from the NHSCR on out-migration to the rest of the UK only, with the assumption that people making the decision to leave Scotland for other constituent countries may have a similar profile to those moving abroad.

7.4   Another population which may resemble that of international out-migrants is international in-migrants, as used in the geographic distributions.

7.5   ONS have introduced a method for England & Wales which estimates the number of British and Non-British out-migrants for different groups of LAs, based on their in-migrant population share. Non-British out-migrants are assumed to follow the age distribution of international in-migrants on the NHSCR 'aged on by two years'. This reflects previous immigrants returning home and is based on the length of stay for non-British out-migrants in the IPS.

7.6   For British emigrants ONS performed cluster analysis on two groups of council areas to produce two characteristic age profiles based on the IPS. These are then constrained to IPS age-sex profiles at National level. It would not be possible to replicate this technique in Scotland because there are so few migrant contacts on the IPS, making the age-sex profile unreliable even at national level.

7.7   The proportion of British and non-British out-migrants is estimated on the LTIM at Scotland Level. This could give us the total number of non-British out-migrants across the country.

Option 1: Use a three-year average to avoid wide fluctuations (in 2009-2011 this was 52% British).
Option 2: Assume 50% British/Non-British but note that this is subject to change: increasing numbers of out-migrants may become non-British as immigration increases.

7.8   The total number of 'non-British' out-migrants would be distributed across Health Boards (according to the in-migrant geographic split discussed above). Areas which have a large proportion of the country's in-migrants would therefore also have a large share of out-migrants modelled on them e.g. if 25% of in-migrants from overseas

arrived in Lothian then 25% of the total 'non-British' out-migrants would be assumed to leave from Lothian.

7.9 We can assume that these non-British out-migrants have the same age-sex distribution as in-migrants to that health board, but aged on by two years, as in ONS's method. ONS then make an adjustment for one and two year olds.

Issue: How best do we apply this across the full age range? Migration at age one/two likely to be first emigration. Likely to be characteristic patterns around school starting age which may be disrupted.

7.10 The remainder of out-migrants for each Health Board (based on the geographic distribution) would be assumed to be British emigrants. In areas with little in-migration these will be the majority. The 'British' emigrants could be assumed to have the same age-sex distribution as:

Option 1: out-migrants from that health board to Rest of UK (RUK) as currently used for out-migrants;
Option 2: the average of out-migrants to RUK and the resident population for the previous year (as with the geographic distribution method).
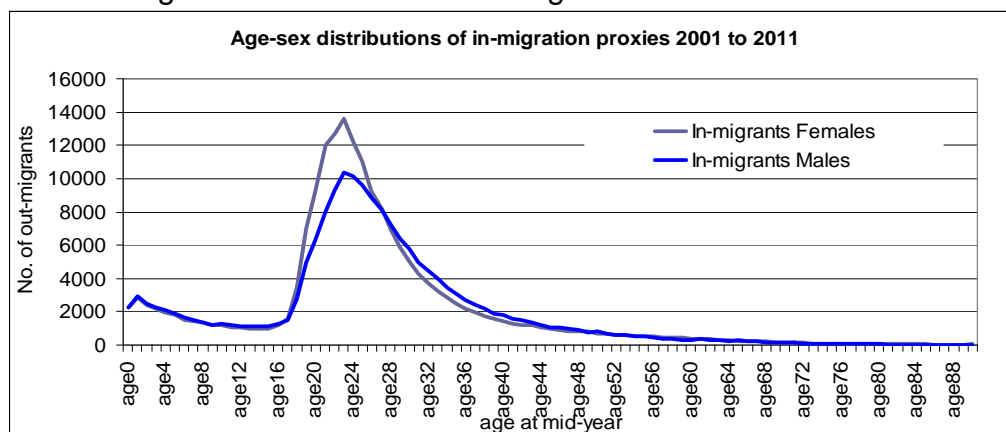
7.11 To investigate the methods, each set of NHSCR moves recorded in each health board for each year from 2001 to 2011 were produced using the statistical software SAS and the distributions seen in the four methods featured above were applied to the total number of out migrants as used in the MYE series. The totals for each age-sex group across the decade were then considered.

7.12 The new out-migrant method looked at in the section below uses a 50:50 split for the two distributions and uses RUK distributions only for the 'British' Out-migrants.

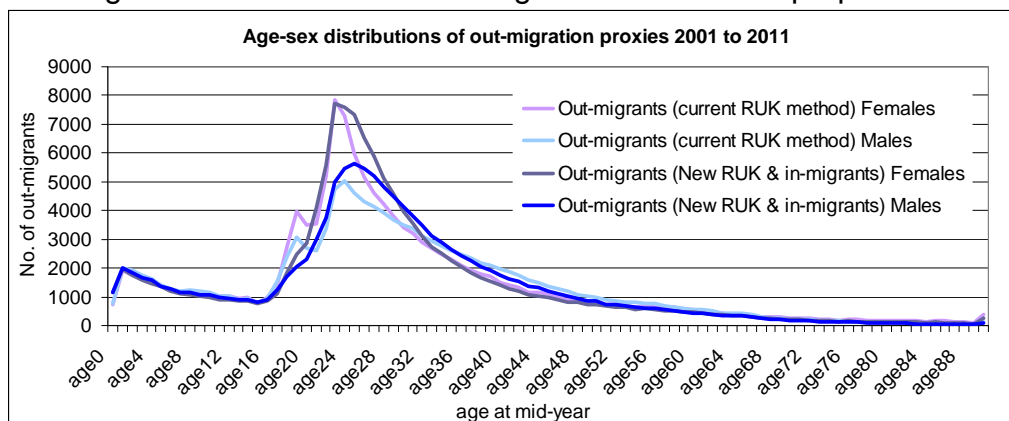## 8. Impact of proposed methods: Age-sex distribution of migrants

8.1 The chart below shows the characteristic age curve for in-migrants across Scotland using international in-migration data from the NHSCR (2005-2011 method). This shows a steep peak in migration at age 23, with high migration throughout the twenties and low migration in other age groups.

8.2 Chart 3: Age-sex distributions of in-migrants

8.3 Immigration is slightly higher for females than for males (52% female overall) and the curve for women appears shifted to a slightly earlier age, however, it is difficult to tell if this reflects a real pattern in migration or is a result of increased GP registration by female migrants.

8.4 Chart 5: Age-sex distributions of out-migrants: current and proposed method.

8.5 For out-migrants the current method gives a steep peak in migration at 23, however, there is also a smaller peak at 19. This is likely to reflect Scottish students moving to England for university and it is likely that migration overseas at this age is lower. The IPS suggests that only around 1000 people left Scotland mainly for formal study overseas in 2010-11.

8.6 Out-migration also appears higher for females, which again may be due to a higher likelihood of women to register with a doctor rather than increased migration.

8.7 Looking at the new method over the period 2001 to 2011 this technique has the effect of increasing out-migrants in their late twenties and early thirties and leaves only a slight bulge at age 18-19. The pattern for children and older adults remains similar to the current (RUK out) method. Using this technique does, however, slightly increase the proportion of female migrants.

8.8 The new method used assigns more than half of the migrants to the non-British group in Lothian, Grampian, Glasgow and Tayside. This is due to the fact that a greater proportion of overseas in-migrants have these places as a destination than the proportion of migrants who move to rest of the UK who leave from here. For example, Grampian receives 16% of Scotland's in-migrants from abroad but has only 12% of the out-migrants to the rest of the UK.

9. Conclusion & Recommendations: Age-sex Distribution

9.1 The in-migrants should continue to be distributed based on the age and sex distributions of new GP registration from overseas but an adjustment of the sex ratio should be considered.

9.2 In light of the number of out-migrants who are not British, 'adopting a method which incorporates international in-migrant distribution may more closely reflect the population of out-migrants'. Using this method would have decreased the numbers of

out-migrants to overseas assumed to be aged 16 to 20 and increased the numbers aged 21 to 34, not showing a peak at age 19.

9.3   This would also increase the consistency between methods and assumptions used in Scotland and other parts of the UK as it is similar to the method used by ONS.

10.   Variant Methods: Sex Ratio adjustments for international migrants

10.1 No sex ratio adjustments have been applied to any of the distributions used for international migration flows at any point in the last decade. This means that the numbers of men and women migrating have reflected the proportions for GP registrations of various groups recorded on the NHSCR. As this is an administrative source it will be affected by real-life usage unrelated to migration patterns.

10.2 We have seen by the examination of the age-sex ratios given by different methods that for both in and out migration there is a majority of women seen whatever proxy distribution is used. It is difficult to tell if this reflects a real pattern in migration or is a result of increased GP registration by female migrants. It has been suggested that GP registration rates are higher among women due to the higher likelihood of ongoing healthcare needs, particularly around menstruation, contraception, pap smear screening, pregnancy etc.

10.3 Independent evidence on rates of migration (particularly international migration) is available from the Long Term International Migration estimates at Scotland level. These figures suggests the proportion of male in-migrants is 51% over the period 2002 to 2011 (for parts of the UK outside England & Wales) suggesting that using NHSCR data may underestimate the proportion of male migrants. For out-migration the deviation is even more extreme. LTIM estimates the proportion of men at 54% compared with 49% on the new NHSCR outflows to the rest of the UK/international inflows data.

10.4 While LTIM data is based on a small sample and shows high variability in sex ratios from year to year this does suggest there is not the consistent bias towards female migrants seen in the NHSCR flows. Taken over a ten year period, the number of men that would be estimated by using the LTIM proportions in each year for in-migrants was 1.05 times the number estimated by using NHSCR proportions, and 1.10 times the number for out-migrants. This is summarised in the table below.

10.5 Table 1: Sex ratios of migration flows using NHSCR and LTIM

	Total migration used 2001 to 2011	Applying NHSCR proportions		Applying LTIM proportions		Ratio of LTIM to NHSCR
		No. Males	% Males	No. Males	% Males	
In-migrants	363,900	176,045	48%	185,130	51%	1.05
Out-migrants	251,500	123,938	49%	135,785	54%	1.10

10.6 One way of introducing a sex adjustment would be to increase the number of males given by the NHSCR flows by the proportion given above and then scale numbers for both sexes down to the agreed LTIM totals. This would have the benefit of varying over time and in different health boards according to the sex ratio suggested by the NHSCR, as the LTIM sex ratio itself, even if averaged across several years to reduce volatility, would only provide a national figure. This does however make the

assumption that the same gap between male and female GP registration would be the same across the country. This may not be the case due to the different nature of migrant groups in for example, student cities or rural areas.

10.7 Sex ratios in the data are currently equal for children and for older adults. This is consistent with the fact that there are likely to be higher registration rates generally among these groups and with the fact that children will not make their own migration or registration decisions and so these should not vary with gender. We do not therefore wish to apply an adjustment to all age ranges.

10.8 Increasing the proportion of males in a specific age range should have the effect of countering male under-registration in the groups in which this has the largest effect. It is acknowledged that there may also be age-specific differences in GP registration rates which affect both males and females but we do not have good alternative data on the age profile of migrants to understand the extent of this and do not propose any further adjustment.

10.9 The technique used was to increase the total number of males in each health board and each year to 1.05 or 1.10 times the value given by the NHSCR. The numbers outside of the age range chosen were unaltered, so that the entire difference was added to the specific ages. This was divided amongst these ages according to the proportion of migrants at these ages they accounted for in the original NHSCR distribution.

Option 1: Adjust for males aged 16-60. This would correspond to the broader working age population. Migration over the age of 60 is at very low levels and the sex ratio is approximately equal.
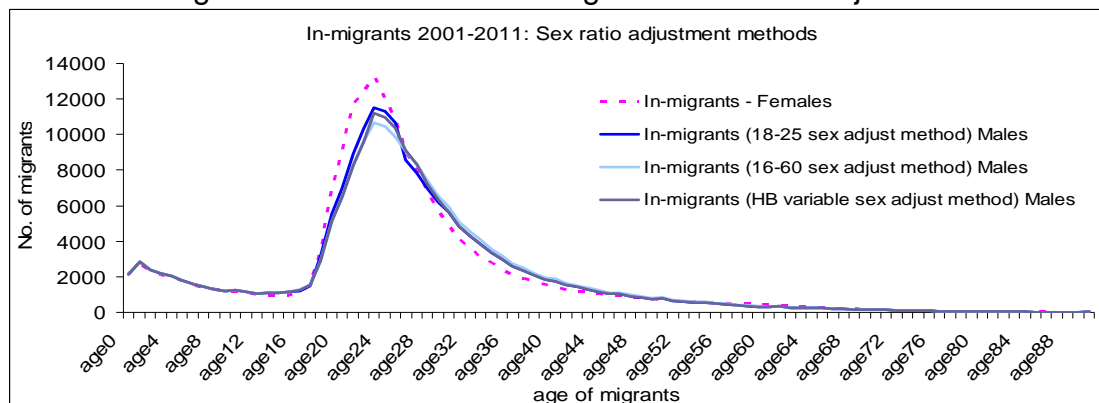
Option 2: Adjust for males aged 18-25 for in-migrants and 18-29 for out-migrants. This is the age range with very high migration and where the large difference between the sexes is seen. Before age 18 and after age 25/29 migration is already higher for men than women on the NHSCR.

Option 3: Variable adjustments for each Health Board according to the sex ratio seen in each age group over the ten year period. The adjustment would be applied to a contiguous age range between 16 and 30 in which migration on the NHSCR is higher for women. For example: for in-migrants this was 16-26 in Fife, but 19-28 in Highland.
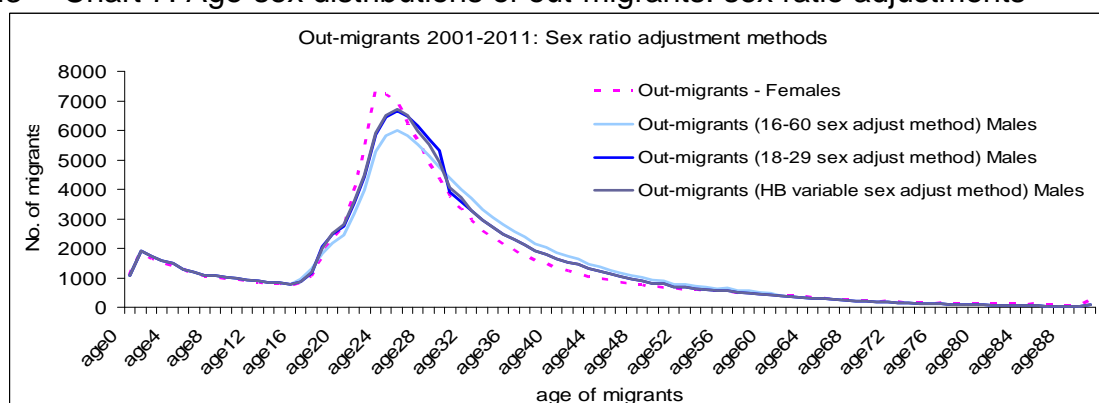
11. Impact of proposed methods: Sex ratio adjustment of migrants

11.1 All of the options above are based on the same principle, and each of them produces the same total number of male and female migrants in each given year and each Health Board. The age distribution of the female migrants and the sex ratio at young and old ages is unaffected. The age distribution of the male migrants is different in each case, with a slightly higher proportion at the age range considered.

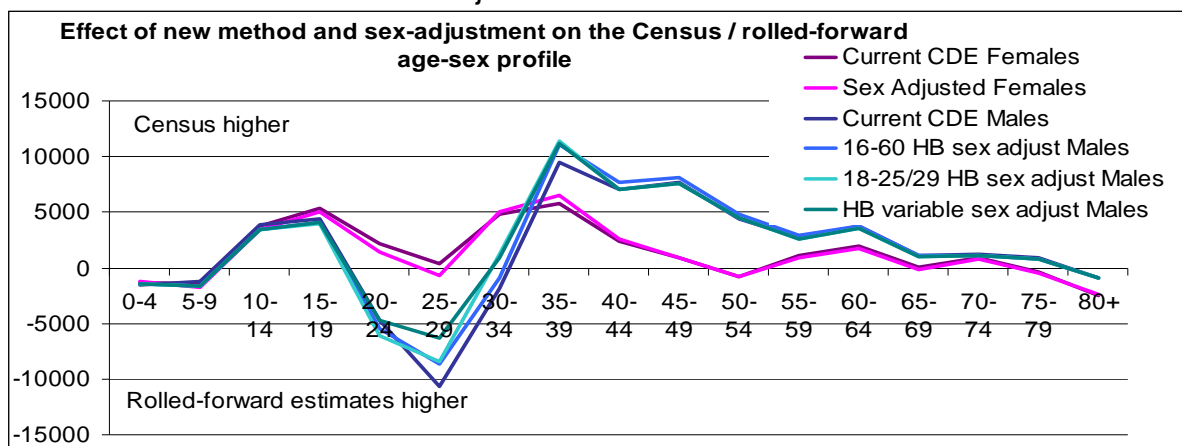11.2   Chart 6: Age-sex distributions of in-migrants: sex ratio adjustments

11.3   Chart 7: Age-sex distributions of out-migrants: sex ratio adjustments

11.4   For the 16-60 sex-adjustment, this has a small effect at any individual age as the additional males are distributed over such at large range. There remains a large female bias in the young adult ages with almost 16,000 more women than men aged 18 to 25 assumed to have entered the country over the last ten years. For out-migrants there remain a majority of women between ages 19 and 27.

11.5   For 18-25/29 sex-adjustment the effect in this age range is far more pronounced, reducing the gap in in-migrants at these ages to around 8000 more women and reversing the trend for out-migrants so that it appears there are more men than women leaving Scotland at these ages. However, the age profile is not smooth with a jerky transition at the end of the adjusted age range.

11.6   For variable sex-adjustments in each NHS Board the effect is very similar to the 18-25/29 adjustment, but appears smoother for both in- and out-migrants

11.7   One way of assessing the success of these methods in reflecting actual migration patterns is to assess the effect using these techniques would have had on the 2011 Mid-year estimates and see how well this relates to the age-sex structure of the population seen in the census.

11.8   The chart below shows the effect the sex adjustment methods would have on the age-sex structure of the population in 2011. In general the population was higher in the census, however, the number of males aged 25-29 was far higher in the 2001-based 2011 mid-year estimates than in the 2011 Census. Each of these techniques

would have reduced that difference at age 25-29 due to the higher male out-migration at these ages. They would, however, also have slightly reduced the number of males aged 35-39, an age group at which there were far more males seen on the census.

11.9 Chart 8: Effect of sex ratio adjustments on difference from census

11.10 The three techniques each have a small effect on the female age distribution, slightly increasing numbers of women aged 20-29 and decreasing those aged 30-39. The largest effect on men would have been by using the variable adjustments for each Health Board. This would reduce the difference between the rolled forward and census estimates for males aged 25-29 from almost 11,000 to just over 6,000 more men in the rolled forward estimates, while increasing the difference in men aged 35-39 from 15,000 to 17,000 fewer in the rolled forward estimates.

11.11 The adjustment used for males was a factor of 1.05 or 1.10 based on the comparison of LTIM and NHSCR sex ratios over ten years, however, applying this to the inflow and outflow for each year did not produce the same sex ratio over the entire ten year period as was seen in the LTIM. This was midway between the original and the LTIM ratio at 50% male for in-migrants and 51% male for out-migrants.

12. Conclusion & Recommendations: Sex ratio adjustment

12.1 A sex-ratio adjustment to increase the proportion of men in adult age ranges should be introduced for both in- and out- migrants.

12.2 This should be 'based around ages 16 to 30 but varied slightly according to the ages at which male migrants seem to be in the minority in flows for that NHS Board area'. This would give a smooth age profile and bring sex-ratios closer to that seen in the IPS.

12.3 This paper does not have the scope to consider whether a similar effect operates on internal migration figures and whether this technique would improve our estimates of local migration. Once census data on previous address becomes available it should be possible to see if there is a noticeable difference between actual and recorded migration rates by age and sex for internal moves.

13.   Views from the PAMS Committee are sought on:

13.1   Whether members are content with the new methods outlined in the summary and paper being adopted for the 2011 and 2012 mid-year estimates.

13.2   Whether the members have any views or suggestions on the points outlined as options and issues in the main body of the text.

NRS: Population and Migration Statistics
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