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Abstract

As immigration has become a global phenomenon in recent years, a number of European countries including Ireland have experienced an influx of immigrants, causing a shift in their national demographics. Therefore, it is important that the EU-LFS yield reliable labour force estimates not only for the whole population but also for the immigrant population.

This paper uses simulation techniques to compare the effectiveness of four different weighting mechanisms in order to improve the precision of the labour force estimates from the Irish component of the European Union Labour Force Survey (EU-LFS) called the Quarterly National Household Survey (QNHS). The four weighting methodologies for comparison include the original and the current weighting scheme of the QNHS as well as our two proposed alternative weighting schemes. The simulation results show that by modifying the current QNHS weighting mechanism, we can improve the accuracy of the labour force estimates of the immigrant population in Ireland without affecting the estimates of the whole population and the Irish nationals.

This paper highlights potential issues that other countries with new immigrant populations may face when using the EU-LFS for immigration research, and our recommendations may be useful to researchers and national statistical offices in such countries.

Key words: Quarterly National Household Survey, calibrated weights, post-stratification, raking ratio, non-response

1 Introduction

During the past two decades, Ireland has experienced large-scale immigration especially after the enlargement of the European Union (EU) in 2004. Along with the United Kingdom (UK) and Sweden, Ireland was one of only three Old Member States (OMS) that allowed nationals from New Member States (NMS) to directly access its labour market. That resulted in an influx of immigrants from the accession countries to Ireland post 2004. By 2014, approximately 12 per cent of its population were foreign nationals, putting Ireland in sixth place (after Luxembourg, Latvia, Cyprus, Estonia and Austria) among the 28 EU countries for the highest proportion of non-nationals in the population (Central Statistics Office 2015a, Eurostat 2015). Therefore, understanding Ireland's immigrants plays an important role in understanding Ireland's population as a whole.

Of all the national surveys in Ireland, the Quarterly National Household Survey (QNHS), conducted by the Central Statistics Office (CSO), is most widely used for immigration research. The QNHS is the Irish component of the EU Labour Force Survey (LFS) with the primary purpose of producing official statistics on the labour force in Ireland. Considering the significant amount of foreign nationals living in Ireland and the growing literature on their assimilation in the Irish society (for example: Barrett and Duffy 2008, O'Connell and McGinnity 2008, Barrett et al. 2011, Kingston et al. 2013), it is important for the QNHS to produce reliable estimates on the labour market participation of immigrants. This can be achieved by ensuring the representativeness of the QNHS samples not only for the whole population of Ireland but also for the main nationality groups.

Being a voluntary sample survey, the QNHS suffers from non-response and other sampling and non-sampling errors, leading to unrepresentative samples. To account for this, the CSO constructs weights for the QNHS such that weighted samples match population estimates on a number of variables of interest. Since the introduction of the QNHS in 1997, its weighting scheme was modified once in the third quarter (Q3) of 2006 to reflect the change in Ireland's demographics post EU enlargement. The effectiveness of the pre-Q3-2006 and the current (post-Q3-2006) QNHS weighting schemes for measuring main characteristics of the immigrant population in Ireland has been examined by Nguyen and Murphy (2015). By comparing the pre-Q3-2006 weighted estimates from the QNHS with the Census 2006 figures and comparing the post-Q3-2006 weighted estimates with the Census 2011, Nguyen and Murphy (2015) come to two conclusions. First, the pre-Q3-2006 weights are not reliable for immigration research. Second, the current weighting scheme performs better than the pre-Q3-2006 scheme with regards to matching the Census figures, but the improvement in performance is minor.

A limitation to the work of Nguyen and Murphy (2015) is its inability to directly compare the efficiency of the pre-Q3-2006 weighting scheme with that of the current scheme. It is not possible in that empirical study because the QNHS data sets do not come with both the pre-Q3-2006 and the post-Q3-2006 weights. Moreover, variables on strata and clusters used in the QNHS design are not available due to data confidentiality rules. Therefore, researchers are unable to calculate their own pre-Q3-2006 and post-Q3-2006 weights using a real QNHS sample. As a result, one can only compare the efficiency of these two weighting schemes using simulation.

In this paper, we re-examine the performance of the pre-Q3-2006 and the current weighting scheme of the QNHS on simulated samples, as well as extend the work of Nguyen and Murphy (2015) by proposing two other weighting schemes that can serve as the alternatives to the current QNHS weighting methodology. They are referred to as the Modified QNHS and the Raking Ratio scheme. We compare the effectiveness of the existing and the proposed QNHS weighting mechanisms for immigration research using simulation exercises.

It should be noted that this is the first time the effects of the QNHS weighting schemes have been examined using simulation and also the first time that alternative weighting schemes have been suggested for Ireland's QNHS. Within Europe, there are studies investigating the overall effectiveness of the LFS weighting schemes in Sweden (Hörngren 1992), Finland (Djerf and Väisänen 1993; Djerf 1997) and Norway (Thomsen and Holmøy 1998), as well as their effectiveness specifically for immigration research in Norway (Villund 2010) and in Spain (Martí and Ródenas 2012). These studies are similar to ours in their objectives, however, differences in survey designs and weighting methodologies of the LFS in these countries lead to differences in methods used in their studies and ours. In general, countries with extensive registers such as Sweden, Finland and Norway can have more complex weighting methodologies than those without population registers (i.e Ireland). Subsequently, weighting schemes that are proposed for these register countries may not be suitable to other countries.

In summary, the aim of this paper is to use simulation to compare the effectiveness of four different weighting methodologies in improving precision of the labour force estimates of Ireland's whole population and its main nationality groups. In Ireland, we group the nationalities into five main groups of Irish, UK, OMS, NMS and Other Nationals. The four weighting schemes are the pre-Q3-2006, the current QNHS, the Modified QNHS and the Raking Ratio weighting scheme.

We begin with a brief overview of the theory of calibration and a detailed description of the existing and proposed weighting schemes. This is followed by a description of the simulation procedure, corresponding results and conclusion.

2 Calibration Techniques

In survey sampling, calibration refers to the process of re-weighting samples such that the final weighted samples are consistent with the population with regards to characteristics of interest. In this section, we will start with the general theory of calibration and its notation, then describe in detail the four weighting methods for comparison.

Suppose that we have a population U of size N and an initial sample s of size n_s selected from population U using probability sampling ($s \subset U$, $n_s \leq N$). Let π_k be the probability of selection and d_k be the design weight of the k^{th} individual ($k \in s$) such that $d_k = 1/\pi_k$. In the ideal world without non-response and other sampling and non-sampling errors, the design weight would be the final weight. In reality, this is rarely the case for voluntary sample surveys. Suppose that only n_r individuals out of the initial n_s selected participants respond to the survey ($n_r \leq n_s \leq N$). Let r denote the sample of n_r respondents ($r \subset s \subset U$).

The aim of calibration is to find the final weights w_k ($k \in r$) that are "as close as possible" to the design weights d_k such that the resulting weighted samples match known population estimates for a select number of characteristics (Deville and Särndal 1992). These known population estimates, referred to as auxiliary data, are retrieved from external sources such as the Census, population registers and other administrative sources. It is well-known in survey sampling that proper use of auxiliary information at the estimation stage can reduce bias, improve precision of variables of interest and impose consistency with results from other sources (Zhang 2000, Särndal and Lundström 2005, Särndal 2007). In the following subsections, we will discuss two specific calibration techniques called post-stratification and raking ratio and their application to the QNHS.

2.1 Post-stratification

Post-stratification is a classical technique used in survey sampling to adjust for non-response bias and improve precision of estimates of variables of interest (Thomsen 1973, Thomsen 1978, Holt and Smith 1979, Jagers 1986). Its concept is similar to that of stratification but strata (referred to as post-strata) are formed after the samples are taken, rather than at the design stage.

Post-stratification is a type of calibration approach as it calculates calibrated weights under the constraint that the weighted samples match population estimates broken down by post-strata. These post-strata are formed from the cross-tabulation of the auxiliary variables. For example, if we want to post-stratify a sample by three age groups and sex, we obtain a cross-tabulated table of six cells. These are the six post-strata, and sex and age are the two auxiliary variables. Post-stratification requires a known population count for each of these cells. It then constructs calibrated weights to ensure a perfect match between the sample weighted total and the actual population total for all the cells in the tabulated table. Hence, post-stratification is commonly referred to as *calibration on known cell counts* (Deville and Särndal 1992, Deville et al. 1993).

The post-strata are H disjoint groups such that $U = \bigcup_{h=1}^{H} U_h$ and $r = \bigcup_{h=1}^{H} r_h$. The population size and the sample size of the h^{th} post-stratum are N_h and n_{r_h}, respectively. Assume that the population total N_h is known for each post-stratum $h = \{1, 2, ..., H\}$. In post-stratification, the design weight d_k for each $k \in r_h$ is adjusted by a factor of $N_h/(\sum_{k \in r_h} d_k)$, which is the ratio between the true population count and the estimated population count from the sample. The new calibrated weight has the form $w_k = d_k \left(N_h/(\sum_{k \in r_h} d_k) \right)$. When these calibrated weights w_k are used, the weighted sample will match the population totals for all post-strata.

Post-stratification is straightforward to implement and widely used by National Statistical Institutes (NSIs) around the world including the CSO in Ireland.

2.1.1 The QNHS Pre-Q3-2006 Weighting Scheme

Between 1997 and Q3 2006, the CSO used simple post-stratification to construct its weights based on Age, Sex and Region. Specifically, the QNHS samples were post-stratified by 18 age groups (in five year increments from 0 to 85+ years), sex and eight NUTS3 regions (Border, Dublin, Midland, Mid-East, Mid-West, South-East, South-West, and West). This resulted in calibration of 288 post-strata, and the weighted samples matched population estimates for all of these post-strata. In Ireland, population estimates are obtained from the latest Census adjusted for migration and vital statistics (Central Statistics Office 2014).

Within the EU, a number of countries such as Belgium, Czech Republic, Greece, Cyprus, Luxembourg, Poland, Slovenia, Slovakia, Malta and Germany currently use post-stratification in their calculations of weights for the LFS (Eurostat 2014).

2.1.2 The Current QNHS Weighting Scheme

Since Q3 2006, the CSO has constructed weights using two different criteria. The first criterion is exactly that used in the pre-Q3-2006 weighting scheme. In the second criterion, an additional 20 cells are introduced. The QNHS samples are simultaneously post-stratified by two age groups (under 15, 15+), sex and five broad nationality groups (Irish, UK, OMS, NMS and Other). The criteria used in the construction of the pre-Q3-2006 and the current QNHS weights are illustrated in Figure 1. The CALMAR 2 macro in SAS (Sautory 2003) is used to ensure that the current QNHS weights satisfy both criteria simultaneously.

Within the EU, other countries such as Bulgaria, Spain, Italy, Lithuania, the Netherlands, Portugal, Romania and Macedonia also calibrate their LFS samples using multiple criteria similar to Ireland's current weighting scheme (Eurostat 2014).

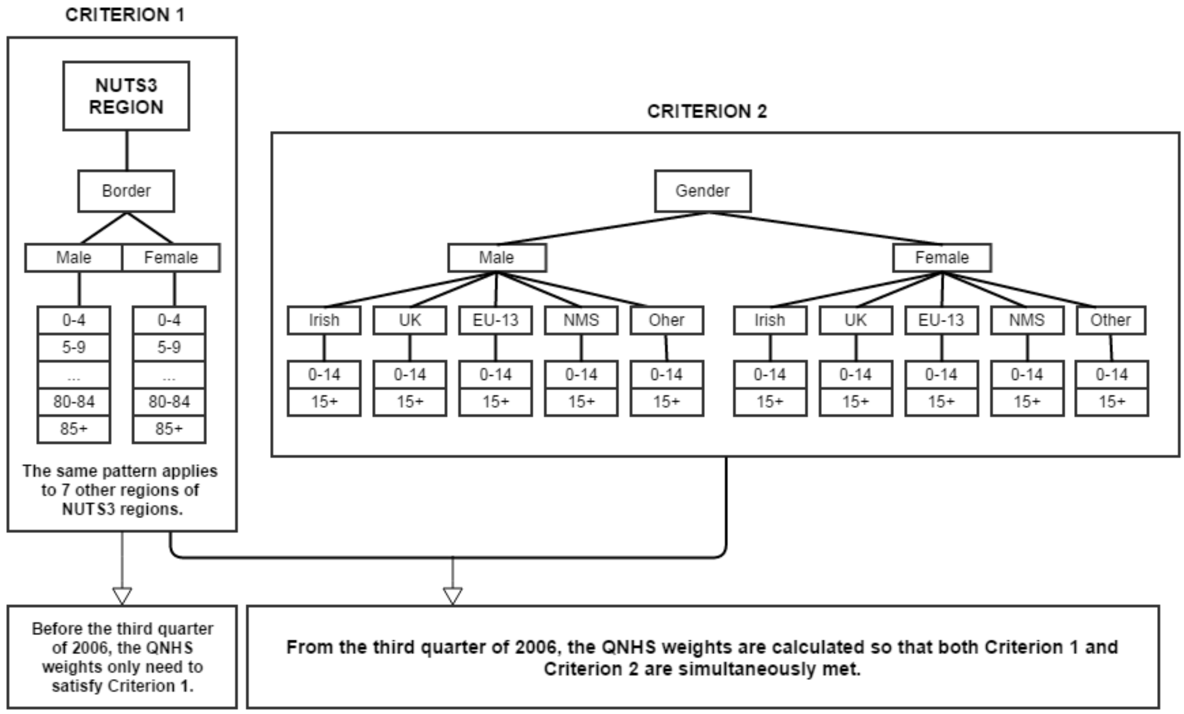

Figure 1: Diagram of the construction of the QNHS weights (Nguyen and Murphy 2015)

2.1.3 The Modified QNHS Weighting Scheme

We now propose a modified version of the current QNHS weighting scheme. This new method involves an adjustment to the second criterion while making no change to the first criterion. The second criterion is extended to match population estimates by four age groups (under 15, 15-24, 25-49, 50+). The sex and nationality groups remain unchanged. The weights must now satisfy both of these criteria, i.e simultaneous calibrations of 288 cells and 40 cells. As before, this is implemented using the CALMAR 2 macro in SAS. We now introduce another scheme before examining this.

2.2 Raking Ratio

While post-stratification is a popular calibration technique, there are two scenarios in which it cannot be implemented. The first scenario is when a sample post-stratum r_h is empty or has extremely small sample size. The second scenario is when the population count of the post-stratum N_h is unknown or not reliable. In these situations, survey statisticians may opt for a technique called raking ratio to calibrate their samples.

Formalised originally by Deming and and Stephan (1940), raking ratio is a classical method of calculating survey weights when the marginal population count for each auxiliary variable is known, but not the detailed population count for each cell in the cross-tabulated table formed by these auxiliary variables. For example, suppose we want to post-stratify a sample by three age groups and sex. Assume that we do not know the population counts for all of these six cells, post-stratification is therefore not possible. Suppose that from the latest Census, we know the marginal population totals (i.e the number of males and females in the population, the number of people in each of the three age brackets in the population). In this case, we can use the raking ratio method, a reliable alternative technique to post-stratification, to calculate the survey weights (Deville et al. 1993). Hence, raking ratio can be referred to as *incomplete post-stratification* or *calibration on known marginal counts* (Deville and Särndal 1992, Deville et al. 1993).

Suppose that we want to calibrate a sample using two auxiliary variables with I and J number of levels, resulting in a cross-tabulated table of $I \times J$ cells. Let N_{i+} (for $i = \{1, 2, ...I\}$) denote the marginal population count for the i^{th} row, and let N_{+j} (for $j = \{1, 2, ...J\}$) denote the marginal population count for the j^{th} column of the cross-tabulated table. Assume that N_{i+} and N_{+j} are known. Raking ratio uses iterative steps to obtain the calibrated weights such that the final weighted marginal counts from the sample for all I rows and J columns match their corresponding marginal population counts. This procedure can be easily extended to more than two auxiliary variables (Kalton 1983).

2.2.1 Raking Ratio for the QNHS

The CSO uses post-stratification to calculate the pre-Q3-2006 and the current QNHS weights. However, post-stratification cannot be implemented in two scenarios, first when the post-strata are empty and second when the population counts of the post-strata are unknown or unreliable.

The first scenario can happen but is most likely not a problem for the QNHS due to their large quarterly sample sizes of approximately 45,000 to 60,000 individuals. In our simulation study, we estimate that empty post-strata occur about one per cent of the time.

The second scenario in which post-stratification is not recommended is when the population counts of the post-strata are unknown or not reliable. This was and is still potentially an issue in Ireland, where estimates of population counts are obtained from the latest Census adjusted for migration and vital statistics (Central Statistics Office 2014). The migration statistics come principally from the QNHS. It means that if the QNHS is not reliable to capture the migration flow, the migration statistics are not reliable, which subsequently affects the intercensal population estimates. When the Census 2011 figures were released, they revealed that the annual migration statistics between 2006 and 2011 had been underestimated by 75 per cent or 87,000 people (Ireland 2012). The CSO has since incorporated various administrative data sources to improve its measure of migration statistics, hence, intercensal population estimates. It is, however, not the aim of this paper to examine the reliability of Ireland's intercensal population estimates .

When the above scenarios occur, we propose using raking ratio to calculate the QNHS weights. Specifically, raking ratio can be performed using the marginal population counts for 33 margins: 18 age groups (in five year increments from 0 to 85+ years), two sex groups, eight NUTS3 regions and five nationality groups (Irish, UK, OMS, NMS and Other Nationals). We choose Age, Sex, Region and Nationality for this weighting method because these four variables are used in the current and the proposed Modified QNHS weighting schemes, thus allowing comparability.

It is noted that raking ratio also depends on reliable marginal population counts, so it faces the same issue discussed in the second scenario. However, potentially unreliable intercensal population estimates have a lesser effect on raking ratio than on post-stratification because the former does not require detailed cell counts.

Within the EU, the raking ratio method is used by Austria and Hungary for their LFS weighting methodologies (Eurostat 2014).

2.3 Comparison of Weighting Methodologies for the QNHS

Using the CALMAR 2 macro in SAS, we compute the calibrated weights for each of the following weighting schemes and compare the results. The four schemes are:

1. Pre-Q3-2006 QNHS weighting scheme: Complete post-stratification by Region (8 NUTS3 regions), Sex and Age (18 age groups).

2. Current QNHS weighting scheme: Simultaneous calibrations to allow post-stratification by Region (8 NUTS3 regions), Sex and Age (18 age groups), as well as post-stratification by Sex, Age (under 15, 15+) and Nationality groups (Irish, UK, OMS, NMS, Other).

3. Modified QNHS weighting scheme: Simultaneous calibrations to allow post-stratification by Region (8 NUTS3 regions), Sex and Age (18 age groups), as well as post-stratification by Sex, Age (under 15, 15-24, 25-49, 50+) and Nationality groups (Irish, UK, OMS, NMS, Other).

4. Raking Ratio: Calibration on known marginal counts of Region (8 NUTS3 regions), Sex, Age (18 age groups), and Nationality groups (Irish, UK, OMS, NMS, Other).

We measure the performance of each method by calculating the total Mean-Squared Error (MSE) and the total Coefficient of Variation (CV) for all categories of the Principal Economic Status (PES). Initially, we also consider bias as a measure of performance. However, our simulation results show that there is no significant difference in bias across the four weighting schemes. It follows that the weighting scheme with the smallest total MSE and the smallest total CV is considered to be the best method.

It should be pointed out that the QNHS is a household survey which means that households, not individuals, are the final sampling units. However, the pre-Q3-2006 and the current QNHS weighting schemes involve direct adjustment at individual level instead of household level. To be consistent with the existing QNHS schemes, our two proposed weighting methodologies also perform weight adjustment at individual level. This is a common practice among NSIs conducting the EU-LFS. There are only a few countries such as Spain, Italy, Hungary and Lithuania that adjust the EU-LFS weights at both individual and household levels (Eurostat 2014).

3 Simulation Procedure and Measures of Performance

3.1 Simulation Procedure

The primary purpose of constructing calibrated weights is to attempt to account for non-response bias and other sampling and non-sampling errors. Therefore, we generate samples with non-response to evaluate the performance of the four weighting schemes.

First, 900 samples each of approximately 25,000 observations are drawn from an anonymised subset (10%) of the 2011 Irish Census (Minnesota Population Center 2014). These samples are selected using the same two-stage stratified cluster sample design as the QNHS (Central Statistics Office 2011). In the first stage, Primary Sampling Units (PSUs), each containing approximately 75 households, are selected using Probability Proportional to Size Sampling. In the second stage, 15 households are selected from each PSU using Systematic Sampling. All individuals in the selected households are included in the samples.

Next, we generate non-response for each sample. Since the QNHS is a household survey, non-response is generated at the household level, instead of the individual level. We consider the following six non-response (NR) scenarios:

- NR1: We randomly remove 20% of households from the samples. This is consistent with the general non-response level of the QNHS.
- NR2: We generate non-response based on NUTS3 regions as reported for the QNHS 2013 (Eurostat 2013). The non-response rates for the eight NUTS3 regions are: Border (24.10%), Midland (16.64%), West (27.30%), Dublin (26.54 %), Mid-East (22.70%), Mid-West (23.22%), South-East (18.45 %) and South-West (19.20%).
- NR3: Non-response is generated for the two NUTS2 regions reported for the QNHS 2013 (Eurostat 2013). The non-response rates for the Border-Mid-West region and for the South-East region are 23.67% and 22.65% respectively.
- NR4: Non-response rates are generated for different household types. There are four types of households: Cohabiting partners without children, Cohabiting partners with children, Lone parents with children, and Other. Their non-response rates are estimated using the QNHS 2011 (Q2) and the Irish Census 2011 samples. The estimated non-response rates for these four types of households are 16.37%, 15.14%, 23.18% and 17.53%, respectively.

- NR5: Non-response rates depend on urbanicity estimated from the EU-SILC 2011 and the Irish Census 2011 samples. The non-response rate for urban areas is 25%, and that for the rural areas is 13%. This is consistent with literature that shows that rural areas are more likely to participate in surveys than urban areas (United Nations 2005, King et al. 2009, Pérez-Duarte et al. 2010).

- NR6: Non-response rates vary for Irish households and immigrant households. We categorise a household as an immigrant household if two thirds or more than two thirds of its members are foreign nationals. We then estimate the non-response rates for Irish households and immigrant households using the QNHS 2011 (Q2) and the Census 2011. They are 17% and 39%, respectively.

In each of the six non-response scenarios, we obtain 900 final samples. For each of the 900 samples, we compute calibrated weights using the four weighting schemes described in Section 2.3. We then obtain the overall PES distribution and that for each of the five nationality groups (Irish, UK, OMS, NMS and Other). In the following subsection, we describe the two measures of performance used to determine the best weighting scheme for the QNHS.

3.2 Measures of Performance

The PES indicates the status of each individual in the labour force. It has three categories: Employed, Unemployed and Inactive. Suppose that their corresponding population percentages are p_1, p_2 and p_3. Let $\hat{p}_1$, $\hat{p}_2$ and $\hat{p}_3$ be the weighted sample estimates (in percentage) of those employed, unemployed and inactive, respectively. Let the estimated mean over the Monte Carlo simulations for each PES category be:

$$\bar{\hat{p}}_i = \frac{1}{900} \sum_{k=1}^{900} \hat{p}_{ik} \quad \text{for} \quad i = 1, 2, 3$$

and the estimated sampling variance be:

$$\hat{V}\left(\hat{p}_i\right) = \frac{1}{899}\sum_{k=1}^{900}\left(\hat{p}_i - \bar{\hat{p}}_i\right)^2 \quad \text{for} \quad i = 1, 2, 3$$

In our study, we use the MSE and the CV as measures of performance. The MSE measures the accuracy of an estimator and is equal to the average squared distance between each sample estimate and the corresponding true population percentage. On the other hand, the CV measures the relative variability of an estimate and is equal to the ratio of the standard error of the estimate and the estimate itself. We estimate the MSE and the CV using the following formulae, with index i indicating the category of PES and k indicating the simulation index.

1. Estimated Mean Squared Error (MSE)

$$\hat{\text{MSE}}\left(\hat{p}_i\right) = \frac{1}{900}\sum_{k=1}^{900}\left(\hat{p}_{ik} - p_i\right)^2 \tag{1}$$

$$\hat{\text{MSE}}\left(\text{PES}\right) = \sum_{i=1}^{3}\hat{\text{MSE}}\left(\hat{p}_i\right) = \sum_{i=1}^{3}\left[\frac{1}{900}\sum_{k=1}^{900}\left(\hat{p}_{ik} - p_i\right)^2\right] \tag{2}$$

2. Estimated Coefficient of Variation (CV)

$$\hat{\text{CV}}\left(\hat{p}_i\right) = \frac{\sqrt{\hat{V}\left(\hat{p}_i\right)}}{\bar{\hat{p}}_i} \times 100\% \tag{3}$$

$$\hat{\text{CV}}\left(\text{PES}\right) = \sum_{i=1}^{3}\hat{\text{CV}}\left(\hat{p}_i\right) = \sum_{i=1}^{3}\left[\frac{\sqrt{\hat{V}\left(\hat{p}_i\right)}}{\bar{\hat{p}}_i}\right] \times 100\% \tag{4}$$

We consider the best weighting scheme to be the one with the smallest $\hat{\text{MSE}}\left(\text{PES}\right)$ (2) and the smallest $\hat{\text{CV}}\left(\text{PES}\right)$ (4).

3.3 MSE and CV Estimation in NSIs

In this paper, we use Monte Carlo simulations to estimate the MSE and the CV, which are functions of the sampling variance. In reality, NSIs around Europe estimate the sampling variance not only based on Monte Carlo simulation but also based on analytic or replication methods.

Variance estimation in a complex sample survey is a challenging task. It depends on the type of sampling design, the type of estimator, the type of non-response corrections and the form of statistics (Eurostat 2002). With the QNHS, it is almost impossible to use exact analytic methods to calculate the sampling variance. This is due to its complex two-stage stratified cluster sample design and its complex weighting scheme. Moreover, our interest in the estimation of the PES distribution for subpopulations (i.e five nationality groups) makes the exact calculation of the sampling variance and hence the MSE and the CV even more unfeasible.

Within the EU, some common variance estimation methods employed by countries for their LFS are the Taylor linearisation, Jackknife, Bootstrap, balanced repeated replication and random groups method. Apart from the Taylor linearisation method, these are replication methods which require intensive computer power. of all, the Jackknife method for variance estimation is recommended by Eurostat's Task Force to all countries except Luxembourg (Eurostat 2002). Currently, the Irish CSO is also using the Jackknife method for the QNHS (Central Statistics Office 2015b). If our proposed weighting schemes were to be adopted for the QNHS, we suggest the use of the Jackknife method to estimate the sampling variance and hence the MSE and the CV.

4 Results

As mentioned previously, we use the MSE and the CV as measures of performance in this paper. The weighting method with the smallest $\widehat{\text{MSE}}\,(\text{PES})$ (2) and the smallest $\widehat{\text{CV}}\,(\text{PES})$ (4) is considered the best weighting scheme for the QNHS. We will start this section by discussing the MSE, followed by the CV results.

The MSE is made up of two components, bias and sampling variance, and there is usually a trade-off between these components. In official statistics, interest often lies with obtaining point estimates of the population and subpopulations so having small bias is desirable. However, our simulation indicates that there is no significant difference in bias across the four methods either for the whole population or any nationality group (results not shown). It is the difference in the sampling variance that contributes to the difference in the MSE across the four weighting schemes. The MSE results are presented in Table 1 to Table 6.

Table 1: $\widehat{\text{MSE}}\,(\text{PES})$ for the Whole Population

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	0.30	0.30	0.30	0.30
NR2	0.31	0.31	0.31	0.31
NR3	0.31	0.31	0.31	0.31
NR4	0.33	0.32	0.32	0.33
NR5	0.31	0.31	0.31	0.31
NR6	0.30	0.30	0.30	0.29

(Apply to all tables) Within each row, the figure(s) shaded in gray is (are) the smallest. It indicates the best weighting scheme in each non-response scenario.

Table 2: $\hat{\text{MSE}}$ (PES) for the Irish Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	0.36	0.36	0.35	0.36
NR2	0.38	0.38	0.37	0.38
NR3	0.37	0.37	0.37	0.37
NR4	0.43	0.41	0.41	0.40
NR5	0.38	0.37	0.35	0.38
NR6	0.49	0.36	0.34	0.36

Table 3: $\hat{\text{MSE}}$ (PES) for the UK Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	10.97	10.91	10.01	10.79
NR2	11.77	11.69	10.43	11.63
NR3	11.95	12.00	10.97	11.76
NR4	11.70	11.66	10.62	11.59
NR5	11.24	11.23	10.12	11.01
NR6	14.20	13.25	11.51	13.41

Table 4: $\hat{\text{MSE}}$ (PES) for the OMS Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	23.50	22.89	18.70	23.32
NR2	24.11	23.59	19.21	23.96
NR3	23.61	23.14	18.94	23.33
NR4	24.61	23.90	20.18	24.47
NR5	24.63	24.21	19.07	24.59
NR6	27.79	27.38	22.35	27.88

Table 5: $\hat{\text{MSE}}$ (PES) for the NMS Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	6.46	6.42	6.28	6.41
NR2	6.85	6.77	6.62	6.78
NR3	7.19	7.12	6.94	7.15
NR4	6.76	6.70	6.61	6.70
NR5	7.20	7.13	6.95	7.16
NR6	8.78	8.61	8.48	8.65

Table 6: $\hat{\text{MSE}}$ (PES) for Other Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	8.31	8.21	7.15	8.24
NR2	8.76	8.64	7.39	8.72
NR3	8.55	8.41	7.11	8.47
NR4	8.66	8.59	7.32	8.60
NR5	8.68	8.56	7.34	8.60
NR6	10.52	10.24	8.90	10.18

There are a number of things to notice from Tables 1-6. First of all, the proposed Modified QNHS weighting scheme produces the smallest $\hat{\text{MSE}}$ (PES) in 34 out of 36 scenarios presented (six non-response scenarios for six groups - the whole population and five nationality groups). In the remaining two scenarios (NR6 for the whole population and NR4 for the Irish nationals), the difference between the $\hat{\text{MSE}}$ (PES) produced by the Modified QNHS weighting scheme and that of the best method in that case is not material. This result is very encouraging because by making a small change to the current QNHS weighting scheme, the Modified QNHS scheme repeatedly gives the most accurate estimates.

When we examine Tables 1-6 closely, we do not a material difference in the $\hat{\text{MSE}}$ (PES) among the four weighting schemes for the whole population in Table 1. In Table 2, even though the Modified QNHS method produces the smallest MSE in five out of six non-response scenarios, the difference among the MSE figures across the four weighting mechanisms is quite small. This is not surprising since the Irish nationals make up the majority of the population, thus their behaviour should mimic that of the population. On the other hand, the Modified QNHS weighting method consistently produces a large reduction in the MSE for the four immigrant groups - UK, OMS, NMS and Other Nationals.

Additionally, Tables 1-6 show that the current QNHS weighting method does indeed improve the accuracy of the pre-Q3-2006 scheme. This is expected because the current QNHS weighting method takes nationality of the respondents into account, while the pre-Q3-2006 scheme does not (Nguyen and Murphy 2015). For the same reason, the Raking Ratio method also performs better than the pre-Q3-2006 weighting scheme since the former also calibrates samples on nationality. When compared with the performance of the current QNHS weighting scheme, the Raking Ratio method has a relatively alike performance.

A similar pattern is observed with the CV results. The $\hat{\mathrm{CV}}$ (PES) for the whole population and the five nationality groups can be seen in Tables 7-12. The tables show that the Modified QNHS weighting scheme produces the smallest $\hat{\mathrm{CV}}$ (PES) across the board except for the NR6 scenario of the whole population. Overall, the CV findings agree with the MSE results that the Modified QNHS weighting scheme is the best out of the four considered weighting mechanisms.

Table 7: $\hat{\mathrm{CV}}$ (PES) for the Whole Population (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	3.76	3.77	3.75	3.76
NR2	3.81	3.81	3.80	3.80
NR3	3.88	3.88	3.87	3.88
NR4	3.73	3.73	3.72	3.73
NR5	3.70	3.70	3.70	3.71
NR6	3.67	3.70	3.69	3.71

Table 8: $\hat{\mathrm{CV}}$ (PES) for the Irish Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	4.22	4.22	4.20	4.20
NR2	4.27	4.28	4.24	4.26
NR3	4.30	4.30	4.26	4.29
NR4	4.20	4.20	4.18	4.21
NR5	4.17	4.15	4.11	4.17
NR6	4.12	4.11	4.07	4.12

Table 9: $\hat{\mathrm{CV}}$ (PES) for the UK Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	20.68	20.64	20.11	20.56
NR2	21.37	21.34	20.63	21.28
NR3	21.55	21.56	21.00	21.42
NR4	21.24	21.16	20.63	21.15
NR5	20.95	20.94	20.32	20.76
NR6	22.13	21.95	21.26	21.98

Table 10: $\hat{\mathrm{CV}}$ (PES) for the OMS Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	37.28	36.95	35.10	37.16
NR2	37.99	37.78	35.89	37.93
NR3	37.45	37.19	35.41	37.33
NR4	37.92	37.55	36.07	37.79
NR5	38.11	37.83	35.74	37.96
NR6	40.70	40.51	38.63	40.67

Table 11: $\hat{CV}$ (PES) for the NMS Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	18.42	18.31	18.14	18.32
NR2	19.15	19.00	18.77	19.06
NR3	19.44	19.28	19.06	19.37
NR4	18.96	18.86	18.61	18.86
NR5	19.36	19.23	19.00	19.26
NR6	21.41	21.24	20.99	21.36

Table 12: $\hat{CV}$ (PES) for Other Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
NR1	17.18	17.10	16.37	17.13
NR2	17.51	17.43	16.63	17.45
NR3	17.40	17.28	16.40	17.31
NR4	17.18	17.09	16.35	17.15
NR5	17.61	17.52	16.71	17.53
NR6	18.74	18.59	17.78	18.58

5 Discussion and Conclusions

Our simulation results have shown that the Modified QNHS weighting scheme gives the best results out of the four weighting methodologies as demonstrated by its consistently smallest MSE and CV. We also notice that the current QNHS scheme performs better than the pre-Q3-2006 one. However, as the pre-Q3-2006, the current and the Modified QNHS weighting schemes all use the post-stratification technique, they cannot be implemented when samples contain empty post-strata or when the population counts for post-strata are unknown or unreliable. When these scenario occur, we suggest using the Raking Ratio method as an alternative weighting scheme. As we discussed in Section 4, the Raking Ratio method performs better than the pre-Q3-2006 weighting scheme and similarly to the current one.

While we consider the best weighting method to be the one with the smallest $\hat{\text{MSE}}\,(\text{PES})$ (2) and the smallest $\hat{\text{CV}}\,(\text{PES})$ (4), we also provide the estimated MSE (1) and the estimated CV (3) for each of the three categories of the PES (i.e Employed, Unemployed and Inactive) in the Appendix A (Tables A.1-A.12). Interestingly, while the Modified QNHS weighting scheme outperforms other methods in most scenarios, the Raking Ratio method performs better or just as well as the Modified QNHS scheme for the Unemployed category of the four immigrant groups (Tables A.5-A.12).

While the simulation has shown strong performances and encouraging results, it should be noted that the information on the PSU to which each person or household belongs is not available to us. Therefore, in simulating the 900 QNHS samples (Section 3.1), we have to generate artificial PSUs. Because of the artificial PSUs, the clustering effect in our samples is not the same as the real clustering effect.

In reality, it is well-known that immigrants usually cluster together in some geographical areas (Robinson 2006, O'Boyle 2009). It means that the proportion of immigrants in some real PSUs would be higher than that in our artificial PSUs. This is because in this study we randomly allocate households among the artificial PSUs, so each artificial PSU would contain approximately the same amount of immigrants.

To understand the effect of artificial PSUs on the robustness of our proposed weighting methods in the estimation of the immigrant population, we have simulated another set of artificial PSUs under an extreme scenario. Instead of being randomly allocated to PSUs as previously done, households are now allocated to either "immigrant" PSUs or Irish PSUs based on their status. A household is classified as an "immigrant" household if two thirds or more than two thirds of their members are foreign nationals. Otherwise, it is classified as an Irish household. All "immigrant" households are randomly allocated to "immigrant" PSUs with each PSU containing approximately 75 households. Similarly, all Irish households are assigned to Irish PSUS, each of 75 households as well. This set-up represents the extreme scenario in which all PSUs are homogeneous with regards to nationality (Irish or non-Irish). When every household in the Census sample is designated to one PSU, another 900 samples are drawn with the same procedure as described in Section 3.1. Of the six non-response scenarios considered previously, we pick the sixth non-response scenario (NR6) for demonstration of results because it is directly linked to immigrants' non-response propensity. The $\hat{\text{MSE}}$ (PES) and the $\hat{\text{CV}}$ (PES) for the NR6 scenario under this new "extreme" PSUs allocation can be seen in Table 13 and Table 14. The estimated MSE and CV for each category of PES in this case are provided in the Appendix B (Table B.1-B.2).

Table 13: $\hat{\text{MSE}}$ (PES) for NR6 with "extreme" PSUs

Nationality Group	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
Population	0.28	0.28	0.28	0.28
Irish	0.50	0.32	0.30	0.31
UK	14.98	13.97	11.92	14.21
OMS	27.83	27.55	22.15	27.80
NMS	8.94	9.05	8.79	9.03
Other Nationals	10.91	10.78	9.23	10.70

Table 14: $\hat{\text{CV}}$ (PES) for NR6 with "extreme" PSUs (%)

Nationality Group	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
Population	3.71	3.74	3.74	3.74
Irish	4.14	4.05	4.00	4.03
UK	22.66	22.49	21.74	22.53
OMS	40.82	40.74	38.49	40.77
NMS	21.42	21.48	21.02	21.43
Other Nationals	19.02	18.92	17.92	18.92

From Tables 13-14, we see that our Modified QNHS weighting scheme also performs the best out of the four weighting methods for all five nationality groups (Irish, UK, OMS, NMS and Other Nationals) in terms of both MSE and CV. With regards to the distribution of PES for the whole population, all four weighting methods perform equally well on the MSE criterion, but the pre-Q3-2006 weighting scheme produces the smallest CV. However, the difference between the estimated CV under the pre-Q3-2006 scheme and the Modified one is minor. The results show the robustness of our proposed Modified QNHS weighting scheme to the clustering effect of immigrants.

In conclusion, our study has demonstrated that the proposed Modified QNHS weighing scheme is the best weighting method for obtaining the labour force estimates of the main foreign-national groups while not affecting the estimates on the population and the Irish nationals. Considering that foreign nationals make up a significant portion of Ireland's population and the growing interest in understanding their characteristics, we recommend using our proposed Modified QNHS weighting scheme in place of the current scheme for more reliable estimates on Ireland's labour force. In the event that post-stratification is not possible as previously discussed, we recommend using the Raking Ratio method, whose performance is similar to that of the current QNHS scheme, as an alternative weighting scheme.

Although our data are entirely Irish, this study highlights potential issues that other countries may face when using the EU-LFS for immigration research. In recent years, migration has become a global phenomenon with Europe at its centre. A number of European countries have seen an influx of immigrants from other European and non-European states. That causes a shift in their population demographics that is similar to Ireland's post EU enlargement. As such, there is growing interest in understanding the characteristics of immigrants and their labour market participation. With its high frequency, large sample sizes and a certain level of harmonization among EU countries, the LFS is a popular data source for immigration research. Even though the traditional objective of the EU-LFS is to produce official statistics on the labour force for the whole population, we believe that it is important for the EU-LFS to also produce reliable statistics for the immigrant population.

Other than for Ireland, we have not examined in detail the effectiveness of the EU-LFS weighting schemes for immigration research in other countries. However, an overview of the individual weighting schemes used in the EU-LFS raises some concerns to us. For example, countries with a large number of immigrants such as the UK and Italy, each with a foreign national population of approximately five millions (Eurostat 2015), do not have Nationality included in their EU-LFS weighting schemes (Eurostat 2014). Other smaller countries such as Cyprus and Latvia, which rank second and third respectively among the 28 EU countries for the highest proportion of non-nationals in the population (Eurostat 2015), also do not use Nationality as a calibration variable (Eurostat 2014). Our study demonstrates that by making changes to the current LFS weighting schemes, we can achieve more reliable labour force statistics not only for the whole population but also for the immigrant one. Therefore, we recommend other NSIs revisit their EU-LFS weighting schemes for immigration research.

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A Appendix

A.1 Whole Population

Table A.1: MSE for the Whole Population

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	0.13	0.13	0.13	0.13
NR2	0.14	0.14	0.14	0.14
NR3	0.14	0.14	0.14	0.14
NR4	0.15	0.15	0.15	0.15
NR5	0.14	0.14	0.14	0.14
NR6	0.13	0.13	0.13	0.13
State 2: Unemployed				
NR1	0.07	0.07	0.07	0.07
NR2	0.07	0.07	0.07	0.07
NR3	0.07	0.07	0.07	0.07
NR4	0.09	0.08	0.08	0.09
NR5	0.07	0.07	0.07	0.07
NR6	0.07	0.07	0.07	0.07
State 3: Inactive				
NR1	0.10	0.10	0.10	0.10
NR2	0.10	0.10	0.10	0.10
NR3	0.10	0.10	0.10	0.10
NR4	0.09	0.09	0.09	0.09
NR5	0.10	0.10	0.10	0.10
NR6	0.10	0.10	0.10	0.09

(Apply to all tables) Within each row, the figure(s) shaded in gray is (are) the smallest. It indicates the best weighting scheme in each non-response scenario.

Table A.2: CV for the Whole Population (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	0.73	0.73	0.73	0.73
NR2	0.75	0.75	0.75	0.75
NR3	0.74	0.74	0.74	0.74
NR4	0.72	0.72	0.72	0.72
NR5	0.72	0.72	0.72	0.72
NR6	0.72	0.73	0.72	0.72
State 2: Unemployed				
NR1	2.21	2.22	2.20	2.21
NR2	2.21	2.21	2.20	2.21
NR3	2.31	2.31	2.30	2.32
NR4	2.20	2.20	2.19	2.21
NR5	2.16	2.16	2.16	2.18
NR6	2.13	2.16	2.15	2.18
State 3: Inactive				
NR1	0.82	0.82	0.82	0.82
NR2	0.85	0.85	0.85	0.84
NR3	0.83	0.83	0.83	0.82
NR4	0.81	0.81	0.81	0.80
NR5	0.82	0.82	0.82	0.81
NR6	0.82	0.81	0.82	0.81

A.2 Irish Nationals

Table A.3: MSE for the Irish Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	0.16	0.16	0.15	0.16
NR2	0.17	0.17	0.16	0.17
NR3	0.16	0.16	0.16	0.16
NR4	0.20	0.18	0.19	0.18
NR5	0.17	0.17	0.16	0.17
NR6	0.20	0.16	0.15	0.16
State 2: Unemployed				
NR1	0.08	0.08	0.08	0.08
NR2	0.08	0.08	0.08	0.08
NR3	0.08	0.08	0.08	0.08
NR4	0.10	0.10	0.10	0.10
NR5	0.07	0.07	0.07	0.08
NR6	0.08	0.07	0.07	0.07
State 3: Inactive				
NR1	0.12	0.12	0.12	0.12
NR2	0.13	0.13	0.13	0.13
NR3	0.13	0.13	0.13	0.13
NR4	0.13	0.13	0.12	0.12
NR5	0.14	0.13	0.12	0.13
NR6	0.21	0.13	0.12	0.13

Table A.4: CV for the Irish Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	0.80	0.80	0.79	0.80
NR2	0.83	0.83	0.81	0.83
NR3	0.82	0.82	0.80	0.81
NR4	0.80	0.80	0.79	0.80
NR5	0.81	0.81	0.79	0.81
NR6	0.80	0.80	0.78	0.80
State 2: Unemployed				
NR1	2.53	2.53	2.53	2.53
NR2	2.53	2.53	2.53	2.52
NR3	2.57	2.57	2.57	2.58
NR4	2.51	2.51	2.51	2.52
NR5	2.45	2.44	2.44	2.47
NR6	2.43	2.42	2.42	2.43
State 3: Inactive				
NR1	0.89	0.89	0.88	0.88
NR2	0.92	0.92	0.90	0.91
NR3	0.91	0.91	0.89	0.90
NR4	0.89	0.89	0.88	0.89
NR5	0.91	0.90	0.88	0.90
NR6	0.89	0.89	0.87	0.89

A.3 UK Nationals

Table A.5: MSE for the UK Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	4.52	4.49	4.13	4.45
NR2	4.93	4.87	4.32	4.86
NR3	4.93	4.96	4.52	4.87
NR4	4.86	4.82	4.38	4.81
NR5	4.58	4.56	4.07	4.48
NR6	6.09	5.62	4.77	5.69
State 2: Unemployed				
NR1	2.12	2.13	2.12	2.11
NR2	2.25	2.27	2.26	2.25
NR3	2.30	2.29	2.29	2.28
NR4	2.27	2.27	2.27	2.27
NR5	2.20	2.21	2.20	2.18
NR6	2.31	2.30	2.29	2.29
State 3: Inactive				
NR1	4.33	4.29	3.76	4.23
NR2	4.59	4.55	3.85	4.52
NR3	4.72	4.75	4.16	4.61
NR4	4.57	4.57	3.97	4.51
NR5	4.46	4.46	3.85	4.35
NR6	5.80	5.33	4.45	5.43

Table A.6: CV for the UK Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	4.49	4.48	4.29	4.46
NR2	4.69	4.66	4.39	4.66
NR3	4.69	4.71	4.49	4.66
NR4	4.64	4.62	4.41	4.62
NR5	4.52	4.51	4.26	4.47
NR6	4.78	4.74	4.55	4.76
State 2: Unemployed				
NR1	10.91	10.92	10.89	10.87
NR2	11.24	11.28	11.25	11.23
NR3	11.36	11.34	11.33	11.32
NR4	11.21	11.18	11.20	11.18
NR5	11.11	11.13	11.10	11.05
NR6	11.41	11.35	11.31	11.33
State 3: Inactive				
NR1	5.28	5.24	4.93	5.22
NR2	5.44	5.39	4.99	5.39
NR3	5.50	5.51	5.18	5.44
NR4	5.39	5.36	5.02	5.35
NR5	5.32	5.30	4.96	5.24
NR6	5.94	5.86	5.40	5.90

A.4 OMS Nationals

Table A.7: MSE for the OMS Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	10.43	10.15	8.16	10.33
NR2	10.77	10.53	8.51	10.67
NR3	10.37	10.18	8.21	10.23
NR4	10.87	10.56	8.78	10.78
NR5	10.91	10.74	8.27	10.93
NR6	12.54	12.40	10.01	12.61
State 2: Unemployed				
NR1	3.14	3.14	3.16	3.12
NR2	3.33	3.33	3.37	3.32
NR3	3.20	3.21	3.25	3.20
NR4	3.23	3.21	3.27	3.20
NR5	3.30	3.30	3.34	3.26
NR6	3.84	3.87	3.95	3.83
State 3: Inactive				
NR1	9.93	9.60	7.38	9.87
NR2	10.01	9.73	7.33	9.97
NR3	10.04	9.75	7.48	9.90
NR4	10.51	10.13	8.13	10.49
NR5	10.42	10.17	7.46	10.40
NR6	11.41	11.11	8.39	11.44

Table A.8: CV for the OMS Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	5.06	4.99	4.47	5.03
NR2	5.14	5.09	4.57	5.12
NR3	5.05	5.00	4.49	5.01
NR4	5.17	5.09	4.64	5.14
NR5	5.18	5.13	4.50	5.18
NR6	5.57	5.52	4.96	5.57
State 2: Unemployed				
NR1	20.81	20.73	20.80	20.75
NR2	21.41	21.41	21.53	21.39
NR3	20.93	20.88	21.04	20.92
NR4	21.04	20.94	21.19	20.96
NR5	21.36	21.26	21.43	21.23
NR6	22.99	22.95	23.23	22.95
State 3: Inactive				
NR1	11.41	11.23	9.83	11.38
NR2	11.44	11.28	9.79	11.42
NR3	11.47	11.31	9.88	11.39
NR4	11.71	11.51	10.24	11.70
NR5	11.57	11.44	9.81	11.55
NR6	12.14	12.04	10.44	12.15

A.5 NMS Nationals

Table A.9: MSE for the NMS Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	3.01	3.01	2.92	2.99
NR2	3.12	3.09	3.01	3.09
NR3	3.31	3.29	3.18	3.30
NR4	3.07	3.05	3.01	3.04
NR5	3.37	3.34	3.24	3.36
NR6	4.05	3.97	3.91	3.97
State 2: Unemployed				
NR1	2.08	2.07	2.06	2.07
NR2	2.20	2.20	2.19	2.18
NR3	2.40	2.40	2.38	2.38
NR4	2.23	2.23	2.22	2.22
NR5	2.32	2.32	2.31	2.31
NR6	2.90	2.89	2.89	2.87
State 3: Inactive				
NR1	1.37	1.34	1.30	1.35
NR2	1.53	1.48	1.42	1.51
NR3	1.48	1.43	1.38	1.47
NR4	1.46	1.42	1.38	1.44
NR5	1.51	1.47	1.40	1.49
NR6	1.83	1.75	1.68	1.81

Table A.10: CV for the NMS Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	2.59	2.59	2.56	2.58
NR2	2.63	2.62	2.59	2.62
NR3	2.71	2.70	2.67	2.71
NR4	2.64	2.63	2.61	2.62
NR5	2.70	2.70	2.67	2.70
NR6	3.02	3.00	2.98	3.00
State 2: Unemployed				
NR1	7.33	7.32	7.29	7.31
NR2	7.54	7.55	7.52	7.51
NR3	7.88	7.88	7.85	7.84
NR4	7.59	7.59	7.58	7.57
NR5	7.75	7.75	7.73	7.73
NR6	8.63	8.61	8.61	8.58
State 3: Inactive				
NR1	8.50	8.40	8.29	8.43
NR2	8.98	8.83	8.66	8.93
NR3	8.85	8.70	8.54	8.82
NR4	8.73	8.64	8.42	8.67
NR5	8.91	8.78	8.60	8.83
NR6	9.76	9.63	9.40	9.78

A.6 Other Nationals

Table A.11: MSE for the Other Nationals

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	3.25	3.21	2.74	3.22
NR2	3.61	3.55	2.94	3.59
NR3	3.37	3.30	2.69	3.35
NR4	3.51	3.47	2.93	3.49
NR5	3.56	3.52	2.89	3.53
NR6	4.16	4.07	3.55	4.08
State 2: Unemployed				
NR1	1.85	1.86	1.86	1.85
NR2	1.86	1.88	1.90	1.85
NR3	1.87	1.88	1.89	1.85
NR4	1.86	1.88	1.87	1.85
NR5	1.87	1.87	1.91	1.87
NR6	2.27	2.26	2.24	2.22
State 3: Inactive				
NR1	3.21	3.14	2.55	3.17
NR2	3.29	3.21	2.55	3.28
NR3	3.31	3.23	2.53	3.27
NR4	3.29	3.24	2.51	3.26
NR5	3.25	3.17	2.54	3.20
NR6	4.09	3.91	3.11	3.88

Table A.12: CV for the Other Nationals (%)

Scenario	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
NR1	3.84	3.81	3.53	3.82
NR2	4.05	4.01	3.66	4.04
NR3	3.91	3.87	3.49	3.90
NR4	3.99	3.96	3.65	3.98
NR5	4.03	4.00	3.62	4.00
NR6	4.36	4.30	4.00	4.31
State 2: Unemployed				
NR1	8.56	8.55	8.58	8.55
NR2	8.61	8.63	8.70	8.57
NR3	8.63	8.62	8.66	8.58
NR4	8.39	8.39	8.47	8.38
NR5	8.77	8.76	8.83	8.76
NR6	9.05	9.03	9.07	9.01
State 3: Inactive				
NR1	4.78	4.72	4.26	4.76
NR2	4.85	4.79	4.27	4.84
NR3	4.86	4.79	4.25	4.83
NR4	4.80	4.74	4.23	4.79
NR5	4.81	4.76	4.26	4.77
NR6	5.33	5.26	4.71	5.26

B Appendix

Table B.1: MSE for the NR6 Scenario with "extreme" PSUs

Nationality Group	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
Population	0.12	0.12	0.12	0.12
Irish	0.20	0.14	0.13	0.13
UK	6.37	5.96	5.02	6.03
OMS	12.58	12.47	9.92	12.62
NMS	4.25	4.32	4.21	4.32
Other Nationals	4.30	4.31	3.74	4.28
State 2: Unemployed				
Population	0.07	0.07	0.07	0.07
Irish	0.08	0.08	0.07	0.07
UK	2.55	2.54	2.51	2.49
OMS	3.91	3.94	3.93	3.90
NMS	2.79	2.82	2.84	2.80
Other Nationals	2.26	2.22	2.20	2.19
State 3: Inactive				
Population	0.09	0.09	0.09	0.09
Irish	0.22	0.11	0.10	0.11
UK	6.05	5.47	4.39	5.69
OMS	11.34	11.13	8.31	11.28
NMS	1.91	1.91	1.74	1.91
Other Nationals	4.35	4.24	3.28	4.23

Table B.2: CV for the NR6 Scenario with "extreme" PSUs

Nationality Group	*Pre-Q3-2006*	*Current QNHS Weights*	*Modified QNHS Weights*	*Raking Ratio*
State 1: Employed				
Population	0.69	0.70	0.70	0.70
Irish	0.76	0.74	0.73	0.73
UK	5.06	4.99	4.74	5.02
OMS	5.56	5.53	4.94	5.57
NMS	3.11	3.12	3.08	3.12
Other Nationals	4.43	4.43	4.12	4.41
State 2: Unemployed				
Population	2.23	2.25	2.25	2.25
Irish	2.51	2.48	2.47	2.48
UK	11.66	11.66	11.65	11.55
OMS	23.13	23.11	23.12	23.07
NMS	8.37	8.37	8.40	8.38
Other Nationals	9.09	9.00	8.97	9.01
State 3: Inactive				
Population	0.79	0.79	0.79	0.79
Irish	0.87	0.83	0.80	0.81
UK	5.94	5.84	5.36	5.96
OMS	12.13	12.10	10.43	12.14
NMS	9.94	9.99	9.54	9.94
Other Nationals	5.50	5.49	4.84	5.50