

## **Information paper**

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# **Census strategic development review Alternatives to a Census: Rolling Census**

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# Census strategic development review

## Alternatives to a Census: Rolling Census

### 1 Context

This report describes the background research on a rolling census, which has been largely undertaken as a project to examine the feasibility of such an approach replacing the traditional census. The report provides preliminary research that identifies the key benefits and drawbacks of carrying out some form of rolling census, under design strategies that are plausible and practical. It identifies areas for further research that will facilitate a more comprehensive assessment of these, and enable construction of a cost benefit analysis.

### 2 Introduction

A census of population and housing can be defined as a complete enumeration relating to a single time point. With restrictions on resources and public burden, such time points are generally 10 (or 5) years apart. The lack of enumeration between these time points is the obvious drawback of this approach. An alternative strategy is a complete enumeration relating to multiple time points.

This alternative to the traditional model involves enumerating the population by means of a continuous cumulative survey, covering the whole country over a period of time rather than on one particular day. There are a number of possible ways of selecting the sample to be enumerated each year, for instance covering one region in its entirety or sampling many smaller areas from all regions. There would never be a complete enumeration of the whole country at one time (unless a traditional census is carried out in tandem), but the data collected each year could be used to model more accurate inter-censal estimates than those using a traditional approach. There may also be scope for the creation of an annual modelled census database.

Rolling censuses have been a neglected subject, since they are perceived to be expensive and have fundamental drawbacks. Only France (Desplanques, 2003) has moved to a form of rolling census model. The US have moved to the use of a large continuous survey (the American Community Survey (ACS)) to provide their 'long form' census topics on a more regular basis, but they are still planning a decennial short form

census (see Griffin, 2003). Within a UK context, the Policy Evaluation and Reappraisal Review (PEAR) undertaken following the 1991 Census did carry out some limited research into rolling censuses (OPCS, 1992). This present report re-uses some of this work, albeit updated and expanded.

Theoretical papers on rolling censuses are few and far between. Kish (1987, 1990, 1999) represent the only considerations of alternative sample designs with specific reference to a census rather than a survey. Kish argues that:

*'Providing spatially detailed annual statistics for a variety of economic and social variables, not a mere population count of persons, would be the chief aim of rolling samples in many countries.'* (Kish, 1999).

He advocated a rolling sample design in a series of papers (Alexander, 2001), and this led to the recent development of the ACS replacing the long form in the US Census. More details of the French and US approaches can be found in the International Review carried out as part of the Census Strategic Development Programme (ONS, 2003).

This report firstly considers the high level benefits and drawbacks of any sort of rolling census, so that these issues are clearly identified and discussed. Secondly, the design strategy for a rolling census is examined, following some of the previous PEAR work and ideas presented by Kish. Many designs are possible, but only those with some possible merit are explored under two alternative approaches. Thirdly, the practicalities of implementing these two approaches are developed, with some initial indication of costs. Lastly, the design strategies, advantages, disadvantages and practicalities are summarised.

### 3 Potential high level benefits and drawbacks

#### 3.1 Outputs

The great advantage of the rolling census is the frequency with which information traditionally provided by a census are available, and thus improved population statistics in general. However, this is balanced by data being collected

for only a proportion of the country in one year. Thus the key disadvantage of this approach is that it no longer provides a snapshot of the whole population, complicating comparisons between areas due to different enumeration times.

Furthermore, the census collects data that relate to flows between areas such as travel to work statistics. Further research is required to assess the impact of sampling upon these flow data.

In order to compensate for the loss of a national snapshot, we need to look at ways of using the frequently collected data to produce population estimates for those areas not included in the sample. It is likely to be possible to produce good quality small area population estimates or a fully modelled (or imputed) person-level database that is consistent with the population estimates. The key questions are how much better are these estimates likely to be than those currently produced in the inter-censal period by conventional means, and to what level would the data allow us to model - for example, to what quality would we be able to create a fully modelled database? These issues are explored in conjunction with the design strategies as there is a close link. A feature of all output data is that they are all sample-based estimates, a feature likely to displease traditional census users.

A rolling census is able to include all usual census topics and there is the possibility of changing the question content throughout the period. This would allow the census results to be more responsive to changing user requirements, although there would be a reduction in comparability between successive periods if the content change is significant.

### 3.2 User acceptability

OPCS (1992) found that Local Authorities were generally opposed to a rolling census on the grounds of loss of comparability between areas. However, some users were attracted by the frequency of outputs from this approach. There are many possible design alternatives and, without a clear specification of what a rolling census would deliver, it would have been difficult for users to appreciate the possible benefits. Similar reactions were observed from initial meetings with users in March-June 2003 to discuss alternatives to a traditional census. It is clear that users would require a comprehensive demonstration of the advantages of a rolling census in order for them to support such an approach to census taking.

### 3.3 Continuous operation

Continuous operations would bring some efficiencies and quality benefits. A rolling census creates an on-going operation, giving rise to benefits that are difficult to achieve or sustain within a decennial census environment, such as a permanent or semi-permanent fieldforce. It may be possible to use a semi-permanent field force if the fieldwork were more evenly spread across time (such as every quarter). A permanent regional management structure would allow expertise in running a rolling census to be retained and built up over time, creating a centre of excellence for the whole process. ONS will assess the possibility of and issues related to a permanent workforce based on experience of large continuing household surveys.

Similarly, the constant production of data would allow much more relevant and responsive relationships with users. These gains would allow continual methodological improvement.

A continuous field operation would, however, bring new risks. There may be increased risks of outside factors interfering with the census operations - for example, if there are local issues in an area such as a local election, the impact on the census series could be significant.

In terms of processing a rolling census, efficiencies are also obtainable in this area. A smaller but continuous processing operation and site would be required with the advantage of gains in experience. This continuous operation might make service contracts more attractive and possibly cheaper than is possible in a one-off operation. The systems themselves would be permanent with support to allow for evolutionary changes - again this provides ongoing expertise and experience.

### 3.4 Public perception

The main difference between a rolling and traditional census in public perception terms is that the impact of a concentrated national publicity campaign is lost. A traditional census is a recognisable brand, which gives the decennial operation a big advantage. A rolling census would dilute the census as a brand name since it would no longer be a national phenomenon, although it might become part of the national consciousness. The continual nature would lead to the loss of the decennial 'big bang' and 'historical significance' of the census, further reducing public buy-in. The consequences of this could be a loss of coverage. However, because a continual operation with a lower profile would

be less in the public eye, problems with negative national media coverage or anti-census groups might be less likely to occur.

### 3.5 Coverage

A rolling census brings new coverage issues other than a possible reduction in public buy-in. For instance, it is likely that a significant proportion of households would be counted more than once over the ten-yearly cycle because the population is not static. There is also the converse problem that some households might not be counted at all over the cycle if they are never resident in a sampled area. There may also be issues with dual residence households as they could always claim to live outside a sampled area, and count inflation due to persons being counted as usual resident in different places in different years. These additional coverage issues would need addressing and testing.

### 3.6 Legislation and confidentiality

Many designs of rolling censuses may require the passing of new primary legislation because of the increase in frequency of field operation. The current primary legislation stipulates that a census may be carried out within a period of 'not less than 5 years', and requires secondary legislation (the Census Order) to be laid detailing what the census will cover both in terms of geography and topics. Some potential designs may therefore require modified secondary legislation, some may require only more regular secondary legislation without a specific change. There may also be issues with non-compliance, as the current legal requirement for everyone to complete a census form may not be applicable or may be open to re-interpretation under a rolling census. Further work would be needed in this area.

### 3.7 Costs

A rolling census approach is likely to be more expensive than a traditional census. Some savings may be generated, the greatest of which could be the use of a permanent fieldforce. However, not all designs of a rolling census lend themselves to this feature. Most designs would require large start-up costs, and efficiencies may only begin to be realised after the first few years of operation once methodology, processes and people become established. Initial costing work indicates that a rolling census may cost about 10 per cent more than a traditional census over a decennial period, despite the savings due to continuity. Further work is required to evaluate the cost under different design assumptions, including the possibility of posting questionnaires to respondents.

## 3.8 Summary of benefits and drawbacks of a rolling census

### 3.8.1 Benefits

There are identified as:

- frequency of data;
- flexible topic set;
- efficiencies associated with continuous process; and
- possible use of permanent field force and processing site

### 3.8.2 Drawbacks

These are identified as:

- loss of snapshot feature;
- dilution of census brand and loss of 'big bang';
- increased risk of outside influence on fieldwork;
- users would require convincing;
- new legislation framework may be necessary; and
- may cost more than a traditional census.

## 4 Design alternatives

### 4.1 Assumptions and approaches

This section examines possible design strategies for a rolling census. The previous rolling census research in OPCS (1992) and ideas presented by Kish (1990) highlights that there are numerous designs. Based on these papers, a number of design assumptions were identified:

- (a) Whatever the design, there is a strong requirement for a base from which the rolling census starts. Therefore we make the assumption that there would be a national census (at minimum a headcount) carried out in year 0, and the rolling census commencing in year 1. The traditional census would form the base set of counts and characteristics against which the rolling census then measures change - thus enabling updated statistics or even a rolled forward database.
- (b) It is difficult to imagine periodic samples selected without the existence of a robust and complete list of sample elements (essentially a sampling frame), and they become even more important for rolling samples (Kish, 1987). Any rolling census design would be able to use such frames as auxiliary data to improve estimates. Without relying on maps, the most likely

and useful of all the alternatives is some form of household or address register. Therefore it is also assumed that this would be developed, possibly using the data collected in the year 0 (headcount) census, although a change in census legislation (or the legal interpretation of existing legislation) may be required in order to use such a list. In practice, there may be many more sampling frames available, such as a population register.

(c) The key design element that establishes the primary features of a rolling census is the sampling unit. The units used are a compromise between the aim of greater spread for better local statistics and the need for economy in fieldwork (Kish and Verma, 1986). The possible sampling units could be (ordered by cluster size):

- Government Office Regions
- Local Authority Districts
- Wards
- Postcode Sectors
- Output Areas
- Postcodes
- Addresses
- Households
- Persons

A regional rolling census based around large areas such as Government Office Regions (GORs) can be argued to be of questionable benefit, as it would severely restrict the geographical spread and representativeness of each sample. At the other end of the scale a person or household-level rolling sample is impossible at present, as a suitable high quality sampling frame does not exist. An address level sample is also problematic because of the practicalities and higher costs of visiting disparate locations for delivery or follow-up. In between these extremes are the options that are more plausible - either whole Local Authorities are sampled, or samples of 'small' areas are drawn. Thus a rolling census would be some form of cluster sample.

The rolling census research therefore compares two alternative designs of rolling census that use different sampling units - whole Local Authorities, and small area units (such as 2001 Census Output Areas). Initial discussions and research have highlighted that these two alternatives not only produce different statistical

problems, but also would differ considerably in their practical implementation and the data they provide. Since these options would each have features that are advantageous over the alternative, we shall also consider a composite option that would attempt to get the best of both worlds. Therefore we will examine three approaches to a rolling census, each with a different set of advantages and disadvantages.

**Sections 4.2 to 4.4** consider these approaches and the main sub-options within them. Because the rolling census must provide information at a macro and micro level, the design is likely to be multi-purpose in nature. Therefore a number of sub-options exist for the design. Kish (1987) presents seven alternative design types for multi-purpose surveys, which include designs with some form of overlapping feature. Whilst efficient cumulation is achieved with little or no overlap between yearly samples, an overlapping design serves to reduce the variance of estimates of change. These reductions are important for variables that are stable over time, since the correlation across samples is strong, and thus this effect reduces variance. However, including an overlap can increase the variances for other estimates and thus any form of overlap must be carefully considered (Kish and Verma, 1986).

#### 4.2 Sampling whole Local Authority Districts

Under this approach Local Authority Districts (LAD) would form the sampling unit and a sample of them would be wholly enumerated each year, such that every LAD is chosen once in any 10-year period (that is, sampling without replacement, or a non-overlapping sample). LADs could be stratified, so that each year's selection provided good demographical and geographical representation.

The attraction of this approach is that each LAD would have a census carried out within it once during each decennial period. In intervening years data from the other sampled LADs could be used to better estimate population and characteristics for non-sampled LADs. The main disadvantage of this approach is that there would be no regular up-to-date data for non-sampled LADs, and without further data some assumptions are necessary in order to make inferences about the LAD in question.

Clearly there are many sub-options within this design framework – such as choosing 20 per cent every year to achieve a complete cumulation over five years, or including some form of overlapping feature to help overcome

the disadvantages discussed above. The main options that have been identified as having some merit are below. The use of a panel type sample (where a core set of the same sample units are always included to allow better estimates of micro level changes) has not been considered in great depth as it is unclear how this would fit into a census context. More research is required to ascertain whether this feature would be of use in reducing variances of estimates.

#### 4.2.1 Option 1: non-overlapping design with 10-year cycle

The base design for this option is the selection of LADs once and only once over a 10-year period. This would be implemented alone with no other complementary survey. Indirect estimates for non-sampled areas would be made, possibly relying on some form of area classification and comparison with the headcount census carried out in year 0.

#### 4.2.2 Option 2: non-overlapping design with 5-year cycle

An alternative is the selection of LADs over a quinquennial period. Quantification of the gains that would be made in accuracy of estimates using a much larger sample requires further work.

#### 4.2.3 Option 3: non-overlapping design with varying cycle lengths

A variation on options 1 and 2 is to vary the sampling regularity for different LADs. For instance, the country could be split into strata that partition LADs into groups that have similar rates of change (such as areas of large change, areas of medium change and areas of little change). Samples could then be drawn from within these strata at different rates, such as once every two years, once every five years and once every ten years. This design recognises that areas that change quickly are likely to require data more regularly, and therefore less reliance is placed on the estimation of change (as there would be less need for it to be accurate over long timeframes). A strategy would be required for swapping LADs between strata if their characteristics change significantly.

#### 4.2.4 Option 4: partial overlap design with 10- (or 5-) year cycle

Sample LADs as for option 1 or 2. Carry out a postcode based sample survey within the previous year's sampled LADs. This overlap would allow more up to date measurement of change within the previous year's data, rather than relying alone on comparisons with the base

census data. Therefore the estimation of change in non-sampled areas would be made up of recent change trends as identified by the survey, as well as the change measured by the current year's LAD enumeration.

#### 4.2.5 Option 5: non-overlapping design with 10- (or 5-) year cycle and sub-sample

Sample LAs as for option 1 or 2. Carry out a national (possibly postcode based) survey each year across all LADs with the aim of measuring change since the last enumeration - this could be achieved via the Continuous Population Survey (CPS) currently under development within ONS, or an extension to that survey. This survey would allow an overlap to provide assessments of change within all previous years' data, and could also form the post-enumeration survey (PES) for the currently sampled LADs. This extends the idea of sub-option 4 to provide data allowing an assessment of change within every LAD each year. The main disadvantage here is cost (unless the CPS is a suitable vehicle in which case there is no additional cost to ONS), but this option may provide enough data to allow good low level estimates.

#### 4.2.6 Further research

These sub-options will require further research in order to be able to compare their relative benefits and costs. Cost and benefit research to date has concentrated on general practical and statistical issues associated with a design that samples whole LADs over a 10-year period (option 1 above). These are described in **Annex A**.

### 4.3 Sampling small areas

Rather than sample and enumerate whole statutory areas such as Local Authorities Districts, which is fairly close in nature to a traditional census, an alternative is to draw a sample within each statutory area every year. This provides data for all authorities every year. For example, a 10 per cent sample of Output Areas would be sampled from every LAD and wholly enumerated each year such that all OAs were chosen once over a 10-year period (that is, sampling without replacement or a non-overlapping sample). The OAs would be initially stratified within LAs, so that each year's selection would have good demographical representation.

The advantages of this method are: the collection of data within every LAD each year; the representativeness of the annual data is easier to control; and the sample design can be LAD-specific. Practically it is more difficult, as it is

more akin to a sample survey in nature. Because of this, it also has issues similar to those of a sample survey, such as the potential for non-response bias, lower response rates, etc.

Clearly there are many options within this design framework - such as choosing 20 per cent every year to achieve a complete cumulation over five years. The main options that have been identified as having some merits are set out below.

#### 4.3.1 Option 1: non-overlapping design with 10-year cycle

The base design for this option is the selection of a fixed proportion of OAs within all LADs once and only once over a 10-year period. This could be implemented alone with no other complementary survey. Estimates for non-sampled OAs would have to be made, possibly relying on some form of area classification and comparison with the headcount census carried out in year 0.

#### 4.3.2 Option 2: non-overlapping design with 5-year cycle

An alternative is the selection of a fixed proportion of OAs within all LADs over a quinquennial period. An assessment of the gains that would be made in accuracy of estimates using a much larger sample requires further research.

#### 4.3.3 Option 3: non-overlapping design with varying cycle length

A variation on options 1 and 2 is to vary the sampling regularity for different OAs. For instance, the country could be split into strata that partition OAs into groups that have similar rates of change (such as areas of large change, areas of medium change and areas of little change). Samples could then be drawn from within these strata at different rates, such as once every two years, once every five years and once every ten years. This design recognises that areas that change quickly are likely to require data more regularly, and therefore less reliance is placed on the estimation of change (as there would be less need for it to be accurate over long timeframes). A strategy would be required for swapping OAs between strata if their characteristics change significantly.

#### 4.3.4 Option 4: partial overlap design with 10- (or 5-) year cycle

Sample OAs as for option 1 or 2, but also carry out a sample survey of the previous years sampled OAs. This overlap would allow more

up to date and direct measurement of change within the previous year's data, rather than relying alone on comparisons with the base census data or similar areas. Therefore the estimation of change in non-sampled OAs would be made up of recent change trends as identified by the survey, as well as the change measured by current year's OA enumeration.

#### 4.3.5 Further research

These sub-options will require further research in order to be able to compare their relative benefits and costs. Cost and benefit research to date has concentrated on general practical and statistical issues associated with a design that samples small areas within LADs over a 10-year period (option 1 above). These are described in **Annex B**.

### 4.4 Composite designs

The main approaches outlined above would clearly provide different benefits and drawbacks. Whilst sampling whole LADs provides easier comparisons within a local authority, it does not provide any sample for all local authorities at once. In order to attempt to gain both of these benefits it is sensible to examine composite designs that use both approaches. Some of the sub-options within the two approaches move towards this type of idea, such as a complementary national survey alongside a rolling LAD based census (option 5 at **Section 4.2.5**).

Using the two approaches simultaneously is essentially the sort of design proposed in France, with a combined design that samples both whole aggregate areas and individual households. The French design does not, however, have any overlap between these two methods. The French equivalent of local authorities, 'communes', are wholly sampled if they fall below a size threshold of 10,000 population. Larger communes have household samples drawn from them at a lower sampling rate than the small communes. Because there are many communes, some of which have a very small population, a different type of approach within England and Wales is likely to be required, but such a design could be adapted for the England and Wales context. LADs could be split into strata according to the level of change (such as migration), and different rolling designs applied within each stratum. Areas with highest change could have a small area sample each year whereas the slowest changing areas could be wholly sampled once over a 10-year period.

Such composite options will require further

research to establish practicalities and statistical properties as well as monitoring and evaluation of the French design and experience.

#### 4.5 Future research

Given the absence of substantial academic literature, or a substantial variety of international examples, it is clear from this piece of initial research that the full picture is far from complete. Further work is needed to flesh out the alternatives presented in this paper, including their impact and interface with other population statistics developments, such as increased use and availability of administrative data, the possibility of a population register and the plans for a Continuous Population Survey.

Whilst it is possible to identify some clear benefits and drawbacks from a rolling census approach, the quantification of these will require a significant program of research and testing. This would be required for a number of the alternatives presented in this paper to enable a clearer comparison between the options. The key areas identified for further research and testing to date are:

- likely coverage levels for different models;
- estimation and modelling methods;
- precision and statistical properties of estimates under different designs;
- fieldwork methodology for each approach;
- costs; and
- public and user perceptions of a rolling census for different approaches.

#### 5 Conclusions

An examination of alternative approaches to a rolling census has highlighted that the key distinguishing feature for a rolling census is the sampling unit. The two most feasible approaches use either whole Local Authority Districts or small area units such as Census Output Areas. These approaches have many sub-options, most of which have been identified. However, at this early stage the statistical merits of each approach and sub-option have yet to be established. Practical issues associated with either approach have been considered, and the early indications are that a rolling census is feasible, but nevertheless a significant challenge.

The key benefit is the continuous collection of information, which facilitates much more frequent and timely population statistics which

are likely to be more accurate than intercensal statistics currently produced. This is balanced against the loss of a snapshot (that is, less direct comparability between small areas), more extensive use of modelling that would be required, and moderately higher costs.

It is also clear that implementation of a rolling census approach is not feasible without an initial snapshot census. Therefore the earliest starting point for a rolling census would be 2012, assuming that a traditional census were carried out in 2011.

There are many uses of census data for which the loss of comparability in data collected via a rolling census would present a significant problem. In particular, in the annual resource allocation processes from central to local government, there would be significant debate about the extent and implications of population changes in Local Authority Districts that had not been recently sampled. For this reason, the use of a rolling census alone is not recommended without sufficiently robust additional sources to enable an accurate population count on a comparable basis.

No such additional source currently exists, but with the potential development of population and address registers, a rolling census becomes a possibility after 2011, to provide the detailed characteristics of the population that such registers would not provide. It may be that a large sample survey, perhaps an enlarged Continuous Population Survey, would be sufficient to provide the level of accuracy required. Further research is recommended as register development and administrative data linkage progress, with a review by 2007 of how best to meet user needs beyond 2011.

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## **Annex A: Sampling Local Authority Districts in a rolling census: Statistical and practical considerations**

### **A1 Rolling census sample design**

The proposed design would be to sample each Local Authority District (LAD) once in a 10-year cycle. Therefore, each year this equates to collecting data from 5.2 million persons, although with the variability in sizes of authorities this is more likely to be within a range of about 4.8m to 5.5m persons. Rather than select a completely random sample within this size constraint, it would be desirable to spread the sample geographically, and if possibly demographically. This would therefore provide data each year for most types of area and region that would add benefit.

Therefore it is sensible to stratify the sample so that a mix of area types are sampled each year, although with size and sampling without replacement this may be problematic to implement. A simple stratification such as that used in the 1991 Census outlined below may go some way to approximate this desirable feature without violating the size and rolling constraints.

- Inner London
- Outer London
- Metropolitan Cities
- Non-metropolitan cities
- Other areas

One important practical design consideration is that because of the rolling nature, there would have to be an ordered schedule of LADs. This may not be acceptable to users if such a schedule were imposed upon them. It would therefore be important that the stratification, and possibly the resulting schedule were consulted upon widely. Once this were completed and the final design published, it should be made clear to all users that it would then be fixed and changes would not be considered unless certain conditions were encountered. These conditions are another area that would require careful consideration and consultation. For instance, areas that change enough so that they can be considered for swapping between strata would be able to be swapped, provided they do not compromise the sample design, or the frequency of sampling for areas. Such a strategy would have to be published and robust.

A second practical consideration is that of boundary changes. LAD boundaries do change (although infrequently with long lead-in time) and therefore a strategy would be required for when this occurred. This would be important if the LAD or its surrounding LADs had been sampled recently – there may be some areas due to the boundary change that would not be sampled, in which case they may need to be included as a separate ‘LAD’ to enable them to be included.

### **A2 Field methodology**

Since we are sampling large statutory areas of the country, this design allows an adaptation of the newly proposed traditional census fieldwork method - postout/postback. There would be little additional work for the adaptation, as this would just be a scaled down version that is applied every year.

One area that might bring efficiencies to the fieldwork is the use of a permanent fieldforce. However, sampling whole LADs does not lend itself easily to this. It may be possible to be able to use a semi-permanent field force if the sample were spread somehow (such as every quarter). However, the sample is not likely to be geographically consistent (therefore creating travelling issues for the fieldforce) and the fieldwork method does not lend itself to an even workload over time. This would therefore seem to rule out this possibility. However, there might be scope for a permanent regional management structure – thereby allowing expertise in running the census to be retained and built up over time.

Field follow-up staff would be only 10 per cent of the size for a full census, but would need to be recruited for each new area each year. The scaling down might make use of agencies more viable. With such a non-permanent fieldforce, everything would have to be built up and run down each year. It may still be more difficult to recruit in some areas than others, although there is a potentially bigger ‘applicant to post’ ratio as the numbers of field staff required would be lower.

The fieldwork operations would be able to be more tailored for individual regions, so that response rates could be maximised and the

operation could be viewed as more relevant by the public in particular areas. Different strategies could be applied in rural, semi-rural and urban LADs. The LAs themselves could be encouraged to help with the Census in their area – as it would be in their interest to get accurate data. These are similar issues to a traditional census, although continuous operations may allow gains in these initiatives.

The publicity strategy would be able to be similar to that proposed in the revised traditional census design, although the publicity would be restricted to targeting each year's sampled LADs only, with no national media coverage (such as TV advertisements). This targeted publicity would thereby allow members of the public to buy into the Census – they would see only a little difference between a rolling and decennial census, unless they migrated frequently between LADs. Furthermore, the reduced scale of publicity might allow for a more focused campaign within the LADs, increasing local awareness and relevance. However, there would still not be the 'national' scale of traditional census publicity.

For this specific design, there would inevitably be householders who were unsure or confused by whether they should be included, for instance if they were close to a LAD boundary. Thus helplines would need to be slightly larger than a simple scaled down option (that is 10 per cent of the size for traditional census), and may need to be set-up anew each year. Furthermore, a strategy would be required to ensure that people in neighbouring LADs were not included and for dealing with people who think they should be included.

### A3 Legal and political issues

New legislation for this approach may need to be required because of the increase in frequency of censuses. Current legislation stipulates an interval of 'not less than 5 years' between censuses, and requires distinct details of what the census will cover both in terms of geography and topics. Under this, we would have to specify which areas would be sampled every year in a separate order. The effort to do this every year seems unworkable, so some change in legislation would be required. However, it is noted that the change would not be as significant for this approach compared to other alternatives.

The ordering of the sample would be the most politically sensitive issue. Some LADs might object to being 'last' in the cycle, although some

might equally object to being 'first' given that there would also be a decennial census in year 0. The method for making intercensal population estimates may also be problematic, since some areas would be concerned that the most recently sampled areas would 'gain' funding due to their estimates being benchmarked. Thus there may be problems with producing nationally consistent estimates – an important feature of ONS population estimates that should not be understated.

Due to more regular data collections, the census would be more in the public eye than before and therefore the confidentiality of census data may be more of an issue. However, the continuous nature of the operation would also keep the safeguards in the public eye, which may reduce anxieties. Nevertheless, procedures for maintaining and enforcing confidentiality would have to be extremely robust, although they may be no different than those used in a decennial census or government survey.

### A4 Costs

Ballpark costings for this form of rolling census have been estimated from the work carried out on the traditional census design, as many of the components are similar albeit on a smaller scale. The following assumptions are made for each yearly sample, based on a single enumeration date:

- paper forms are adopted and postout/postback methodology is employed;
- publicity targets the selected LADs only;
- newly set up helplines each year – roughly 15 per cent the size of a full census operation;
- newly recruited and trained follow-up staff – 10 per cent of the size of a full census operation;
- permanent processing centre and continuous operation – 12 per cent of the size required for a full census operation; and
- permanent HQ staff structure and permanent systems support.

Based upon these assumptions, initial cost estimates are at least 10 – 15 per cent more, overall, than for a traditional decennial Census.

Costings were also considered for an operation that was spread across the year, thus facilitating the use of a permanent fieldforce and computer based capture, rather than paper forms. This

concluded that using similar pay rates for Social Survey interviewers resulted in costings that were 20 per cent greater over a 10-year period compared to a traditional census design.

#### **A5 Statistical considerations**

Further research is needed to establish the methodology for making estimates for non-sampled LADs, and the properties of these estimates. Kish (1987, 1999) suggests different weighting schemes for cumulating periodic surveys. Three alternatives are outlined, each for producing statistics from a specific geographical or demographical domain. For instance, national estimates of highly fluctuating variables could be produced using only the most recently collected data (that is, weights of 1 for the most recent sample and 0 for all previous data). Alternatively, an equally weighted average over time may be a good strategy for variables without time-related trends or small domains. These are both extreme weighting schemes that arise from model based weights where the weights for the most recent sample are always at least as large as those for the previous year (that is, non-decreasing).

Clearly, further research is required to test these, and other approaches and assess the precision associated with them. Another area for research is the building of a rolling census database where we try to update the census data to take account of migration and changes over non-sampled years.

One issue of particular concern under this design is that the year-by-year sample would, generally, not be nationally representative, as we are sampling whole LADs, which are large areas. However, the size of the sample should at least allow all area types and population groups to be included each year.

Given the additional data collection, these estimates are more than likely to produce better intercensal population estimates than at present, simply through using LADs sampled each year to benchmark them against.

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## **Annex B: Sampling within Local Authority Districts in rolling census: Statistical and practical considerations**

### **B1 Rolling census sample design**

The proposed design would be to sample, without replacement, one tenth of each LAD every year. Each LAD would therefore be enumerated in its entirety over a decennial period. This equates to collecting data from approximately 5.2 million persons each year, across England and Wales. The sampling units would be, for example, 2001 Census Output Areas (approximately 125 households or 300 people) or some unit of a comparable size, such as wards or postcode sectors.

It is important that, as far as possible, a representative sample should be taken of each LAD every year, although in the case of sampling without replacement this may be difficult to implement, due to change over time. Some kind of stratification would be needed, preferably at local level, although the more detailed the stratification the more potential there would be for it to become quickly outdated.

It would very important that the sampling order (that is, which areas are sampled in which year) were drawn up in consultation with local authorities. The areas need to not only be representative, but also seen to be representative. Given the small size of the sampling units, there may be some scope for swapping areas between strata during the cycle, for example, due to a new housing estate or an influx of workers at a new employer; thus close contact with local authorities would need to be maintained.

### **B2 Field methodology**

The postout/postback method proposed for a traditional census would potentially be problematic, depending on the sampling units chosen. If postcode sectors, or a similar address-based unit, were used, this method would be possible with a good address list. This may also be true of wards, since they are defined by statute. However, it may be more problematic for output areas as it would rely on a highly accurate grid-referenced address or household database. This falls within the remit of the Geographic Referencing Initiative (GRI), and therefore may be a possibility. Drop off/postback would probably be the best method to use in this case.

Since every LAD would be sampled every year, this design lends itself to a permanent or semi-permanent field force. This would depend partly on whether the enumeration were concentrated around one particular date each year or whether it were spread more evenly throughout the year (for example, quarterly or monthly). One significant advantage of this design would be that the same enumerators could be employed in their local area from one year to the next, alleviating recruitment difficulties that are a risk for a traditional-type operation. An alternative to a permanent census field force may be to use regular ONS Social Survey interviewers.

The field staff would probably be approximately 10 per cent of the size used in the 2001 Census, but would be more than 10 per cent of the size proposed for a traditional census in 2011 due to the likely requirement to use of drop-off rather than postout for form delivery. Nevertheless, the 'applicant to post' ratio could be expected to be higher than for a traditional census, and even those areas where recruitment is most difficult should see some improvement as the field force required would be reduced by the same factor in all LADs.

Publicity would need to be radically rethought. Because no contiguous area larger than 125 households would be enumerated in any one year, there would be little or no scope for TV, radio, press or billboard advertising. It would also not be possible to use the helpline to determine households that did not receive a form, as people would be unlikely to know whether or not they were in a sampled area. Publicity would therefore need to be concentrated on individual households, perhaps starting with an information leaflet a few weeks before the form is delivered, and personal contact with enumerators could be very important. If there were a single census day it may be possible to have an advertising campaign to encourage those who had received a form to return it, although this may cause more problems than it would solve, with people who are not in the sample trying to obtain a form.

There would, in any case, still need to be a helpline, for people who were having trouble

filling out their form or who had lost or damaged the form, but the telephone number would only need to be given to households in the sample. The helpline resource would need to be approximately 10 per cent of the size needed for a traditional census – possibly bigger so as to deal with members of the public who were not in the sample but were worried because they had not received a form.

High-quality maps would be of vital importance for this model, especially if Output areas were used as sampling units. It would also be important that the enumerators determined accurately where the boundary is on the ground, and which households lie inside and outside. In addition, since there would be no mechanism for householders who had not received a form to receive one, it would be even more important than for a conventional census that the enumerator located every household within the area. A good address list would help, but this could never be 100 per cent accurate.

There would be the opportunity here for a ‘high tech’ solution within a delivery and postback methodology – enumerators could be equipped with handheld computers with a global positioning system (GPS) to determine if the household at which they were standing was included within each sampled OA. If so, they could then generate a unique identifier on a sticker to apply to the delivered form. This would require more research, but gives an indication to the sorts of possibilities that may be opened up.

### **B3 Legal and political issues**

New legislation for this approach would almost certainly be required. Current legislation stipulates an interval of ‘not less than 5 years’ between censuses in any one area, and requires distinct details of what the census will cover both in terms of geography and topics. Under this, we would have to specify which areas would be sampled every year in a separate order. This would almost certainly be impractical at such a low level, especially if the sampling units are entities such as Output Areas, which have no statutory boundaries. In addition, if a sampling unit were moved from one stratum to another between cycles it may be necessary to re-enumerate the same area within less than five years.

Since all LADs would be sampled every year, there would be less political issues than for the sampling whole LADs model. However, the

drawing of samples would still have the potential to be controversial, especially if there were large change in an area which was not due to be sampled for some time, and it would be very important that LADs should be continuously consulted and kept on board. This would be a very large undertaking with 376 LADs being sampled every year.

Due to more regular data collections, the census would be more in the public eye than before and therefore the confidentiality of census data may be more of an issue. However, the continuous nature of the operation would also keep the safeguards in the public eye, which may reduce anxieties. Nevertheless, procedures for maintaining and enforcing confidentiality would have to be extremely robust, although they may be no different than those used in a decennial census or government survey.

### **B4 Costs**

Ballpark costings for this form of rolling census have been estimated. The following assumptions are made for each yearly sample, based on enumeration across the year (or a 2.5 per cent sample every quarter):

- 10 per cent sample each year within every LAD;
- permanent fieldforce similar to Social Survey interviewers with similar pay rates;
- computer-assisted interviewing, approximately 1.25 hours/interview;
- data downloaded to permanent processing operation; and
- permanent HQ staff structure and permanent systems support.

Based upon these assumptions, initial cost estimates are slightly lower than for a traditional decennial census.

### **B5 Statistical considerations**

Further research would be needed to establish the methodology for making estimates for non-sampled areas, and the properties of these estimates. Kish (1987, 1999) suggests different weighting schemes for cumulating periodic surveys. Three alternatives are outlined, each for producing statistics from a specific geographical or demographical domain. For instance, national estimates of highly fluctuating variables could be produced using only the most recently collected data (that is, weights of 1 for the most recent sample and 0 for all previous data). Alternatively,

an equally weighted average over time may be a good strategy for variables without time-related trends or small domains. These are both extreme weighting schemes that arise from model-based weights where the weights for the most recent sample are always at least as large as those for the previous year (that is, non-decreasing). Clearly, further research is required to test these, and other approaches and assess the level of precision associated with them. Another area for research is the building of a rolling census database where we try to update the census data to take account of migration and changes over non-sampled years.

Since we would be sampling at a very low level, each year's sample should be reasonably representative at national and LAD level. Clearly, the lower the geographic level, the harder it would be to produce unbiased estimates, and so it is important to be able to measure population change from one year to the next at as low a level as possible (possibly using administrative records or a smaller sample survey).

These estimates are likely to produce better intercensal population estimates than at present, since a large sample would be taken from every LAD every year rather than records-based estimates being benchmarked every ten years.