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**Review of the scope, quality and robustness of
available evidence regarding putting the
clocks forward by one hour, the year round,
in the UK**

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Summary: evidence regarding putting the clocks forward by one hour, the year round, in the UK

This study looks at the scope, quality and robustness of available evidence that could be used to assess or monitor the potential effects of a policy to move the clock forward the year round in the United Kingdom.

Following the search of a range of sources, 118 references have been examined. These are studies based on the whole or parts of the United Kingdom and also those which have looked at the impact or potential impact in other countries.

The issues in these studies have been summarised and counted. Energy consumption and road traffic accidents are the two most commonly raised issues. Crime, health and leisure broadly summarise the others raised. Health has been looked at in relation to both physical health and also mental health. The impact on general “well-being” has also been raised on a number of occasions.

This study then looks at the data which have been used to measure the impact of the issues. It examines the data which could be used without reference to what conclusions have been drawn from the studies.

Data is used much more when looking at some issues than others. This partly reflects the difficulties of using data to examine an issue without having a change to examine an actual change. Some studies have sometimes been able to examine past “experiments” such as in the Great Britain in 1968 to 1971 or in some countries such as the USA and Australia where changes within the country allow some actual impact to be measured.

Data exists within the UK which could be used to measure the impact of any change on energy consumption and road traffic accidents. It is also there for crime (including fear of crime) and also for aspects of health (accidents). Existing data sources looking at physical activity would need to be modified to capture the impact better.

Opinion surveys have been used to measure impact. But this has been mainly impact which people or business estimate would happen, rather than a record of what has happened.

There are some difficulties in looking at the overall picture of the impact which might occur across a range of issues. Putting a monetary figure on the impact data is one way of doing this. Costs can be put on matters such as the impact of traffic accidents, energy consumption and crime. There are other issues, such as physical and mental health, where it is more difficult to put a monetary value on change.

Nationally, work has started on an overall well-being measure¹ but this is not yet complete enough at the time of writing to provide a way of measuring costs and benefits arising from different issues which might be impacted by a clock change.

Our overall conclusions are that we believe a formal ex ante cost-benefit analysis of the single/double summer time proposal would be possible, but that more research is needed to inform it, particularly in relation to how people would respond to the change in terms of carrying out different activities at different times.

¹ See para 1.4.23 for more information.

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ABBREVIATIONS

Abbreviation	Meaning
BIS	Department of Business Innovation and Skills
CET	Central European Time
DSC	David Simmonds Consultancy Limited
DST	Daylight Saving Time or Double Summer Time
GB	Great Britain
GDP	Gross Domestic Product
GMT	Greenwich Mean Time.
HWSS	Western Australian Health and Wellbeing Surveillance System
ONS	Office for National Statistics
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences
RTI	road traffic injuries
ST	Summer Time
SDST	Single/Double Summer Time (ie one hour ahead of GMT in winter, two hours ahead in summer)
UK	United Kingdom
USA	United States of America

1 INTRODUCTION

1.1 Background

1.1.1 This report has been undertaken by David Simmonds Consultancy Ltd (DSC)² in response to the request from the Department for Business, Innovation and Skills (BIS) for “a review of the evidence concerning the scope, quality and robustness of the available evidence regarding putting the clocks forward by one hour, the year round, in the UK”.

1.2 Specification of the study

1.2.1 The work requested by BIS was for a review of the scope, quality and robustness of available evidence that could be used to assess or monitor the potential effects of a policy to move the clock forward the year round in the United Kingdom. Such a change would effectively move the United Kingdom to “single/double summer time” or SDST, and would set clocks in the UK to the same time as those in the majority of Western European countries, ie matching Central European Time (CET).

1.2.2 This work is designed to identify an appropriate base of evidence which could be used in a full “ex ante” cost-benefit analysis of the impacts of a move to “single/double summer time” in the UK. An “ex-ante” cost-benefit analysis is an analysis that would be carried out before a move the clocks. It would be possible to carry out a cost-benefit analysis after a move in order to evaluate the impact after the move had taken place. If such an analysis (an “ex post” analysis) were planned then additional data could be commissioned to be collected before and during the trial period to facilitate the measurement of the impact.

1.2.3 This report looks at:

- issues which have been raised by researchers and organisations when looking at administrative changes in, and the evidence which has been used to measure, the impact of a move to ‘single/double summer time’;
- the robustness of the evidence and its potential for use in a cost-benefit analysis;
- gaps where evidence is not available or where issues of robustness might limit its use in a cost-benefit analysis.

² Abbreviations used in the report are listed on page vi

1.3 Framework for the study

- 1.3.1 The work has been carried out within the context of the needs and administrative arrangements for different parts of the United Kingdom. This takes account of the political arrangements on government of and within the United Kingdom and also allows acknowledgement of the potential for different impact in parts of Great Britain dependent on geography. Care was taken to look at research which has been carried out on different parts of the United Kingdom – specifically England, Northern Ireland, Scotland and Wales.
- 1.3.2 Other parts of the United Kingdom with a different legislative base – Guernsey, Jersey and the Isle of Man - were kept informed of the study and sent copies of draft work. In particular the Government of Jersey had held a referendum on the issue in 2008 (States of Jersey, 2008).
- 1.3.3 The Government of the Republic of Ireland was kept informed of the study.

1.4 Research Strategy and Method

- 1.4.1 The first task in carrying out the research was to establish how evidence would be gathered. A search strategy was implemented based on four key elements:
- a review of the evidence and issues identified through previous or existing studies;
 - the application of a search strategy for further published evidence;
 - an intelligence gathering exercise from relevant academic and other institutions (including the UK government and its departments and administrations);
 - intelligence gathering from other parties who may have relevant evidence.
- 1.4.2 In order to see which search terms would be most productive a review was made of 11 publications which in the main were summary / review publications. These publications are listed in full in Appendix 2.
- 1.4.3 The descriptive terms used for the matter were recorded from these publications and those that occurred most frequently were used to seek further references and publications. These terms were:
- “single/double summer time”
 - “clock change”
 - “clocks forward”, and
 - “changing the clocks”
- 1.4.4 As the research was carried out and further references read an additional term – “daylight saving time” - was added to the above list.
- 1.4.5 One result of the search strategy was that references were included which referred to the impact of daylight savings time adjustments to clock systems. These are the timing adjustments in many countries which take place in the Spring and the Autumn. If a clock change were examined which moved the clocks forward but, from that forward base, still had Spring and Autumn changes then these impacts

might still occur. However clock change has in the past also taken the form of moving the clocks forward and then keeping the same time throughout the year. So the inclusion of these references also allows consideration of data which might be used in those circumstances.

- 1.4.6 The search terms defined above were used through a number of search engines to identify published research and information of relevance to the project. The search terms were applied to a number of search engines, for example including the Cochrane Library's six databases³ that contain different types of high-quality, independent evidence to inform healthcare decision-making:
- Cochrane Database of Systematic Reviews
 - Cochrane Central Register of Controlled Trials
 - Cochrane Methodology Register
 - Database of Abstracts of Reviews of Effects
 - Health Technology Assessment Database
 - NHS Economic Evaluation Database.
- 1.4.7 The search also made extensive use of resources available through Cambridge University Library and its Databases⁴. Cambridge University Library is a legal deposit library and is entitled to claim without charge a copy of all books, journals, printed maps and music published in Britain and Ireland.
- 1.4.8 Searches were also made using internet search engines with the key words and phrases identified.
- 1.4.9 A further key resource in the search for evidence was to follow references which were quoted in other studies. A number of studies which were particularly helpful were other reviews of the issue, for example Bennett (2012a) and Aries and Newsham (2008).
- 1.4.10 A number of articles have started with a section reviewing the issues, before progressing on to the research the authors are carrying out. These review sections have been used to follow up articles quoted.
- 1.4.11 Three further approaches were used to seek additional relevant references, in two stages.
- 1.4.12 Firstly, a general introduction to the study was circulated round a number of different networks which might have organisations or members with knowledge about relevant data. In particular, messages were sent to the following networks:
- parts of the Local Authorities Research and Intelligence Association networks (particularly in Scotland and Wales); and
 - Public Health Observatory Network⁵.

³ See <http://www.thecochranelibrary.com/view/0/index.html>

⁴ See <http://www.lib.cam.ac.uk/>

⁵ see <http://www.apho.org.uk/>

- 1.4.13 These were invitations for contributions to the evidence.
- 1.4.14 In addition to the circulation of this message to potentially interested parties, messages announcing the study were placed in a number of internet forums / networks which would be used by potentially relevant members. In particular, messages were sent to the following LinkedIn groups:
- the Local Authorities' Research and Intelligence Association Group (187 members at time of posting);
 - Improving UK Local & Regional Government Forum (2,342 members at time of posting);
 - ONS Regional and Local Statistics (747 members at time of posting);
 - Local Transport Today Group (>900 members).
- 1.4.15 A message was also sent to the Local Government Association Knowledge Hub⁶.
- 1.4.16 The above search strategy was used to find as many relevant references as possible within the resources for the project.
- 1.4.17 Each reference identified through the search strategy was subject to scrutiny to ensure it supported the key objective of the study - to identify data which might be able to be used in a cost benefit study. An extremely wide definition was taken at the outset on what might be included meeting this definition. The essential criteria were:
- an element of quantitative information,
 - an element of external information (i.e. not just the opinion of the author).
- 1.4.18 There is frequently an element of duplication between articles where there is the same author. Where articles dealt with the same data and were by the same author and were published within a few years of each other then only one reference was used. Where an author had revisited a topic after several years and written the work as an "update" then both could be included. The reason for this is that there will have been changes in data availability and the methods that might be used, and these will often appear in the updated study.
- 1.4.19 Articles in the media were included if they made reference to the opinion of citizens or companies or bodies external to the newspaper or media source. Articles which only expressed the opinion of the author were excluded. This is also true of articles or references which could be described as "letters of support" or "campaign letters" or leaflets, they were included only if they referred to quantitative measures in some form.
- 1.4.20 Quantitative measures of opinion which were used in the references were based on two main methods or sources. The first was from opinion surveys carried out to randomly drawn samples of people or organisations from different groups or populations. Secondly, other quantitative measures of opinion were given to consultation based exercises where people or organisations were asked to communicate their views, and these were then summarised.

⁶ <https://knowledgehub.local.gov.uk/home>

- 1.4.21 References were included if they referred to data where - even if there is no simple relationship to cost-benefit analysis from a “traditional” economic perspective – it is not simple or obvious to put a sum of money to the impact (whether cost or benefit). To give two examples, references have been included where they measure public opinion and where they refer to “general well-being”.
- 1.4.22 A key reason for this approach was the view expressed in Parliament from politicians that it was important that reviews of this issue “examine all aspects of how people would be affected by the proposal, not just the ones that can be monetised⁷”. So, the issues and evidence in this report are not just those to which a financial figure can be put. But the monetisation will be an additional element to the reporting of issues.
- 1.4.23 The Office for National Statistics is developing new measures of national well-being which could potentially be used for future studies. Figure 1 shows a draft framework⁸ described by the proposed domain names, and the central role of individual wellbeing.

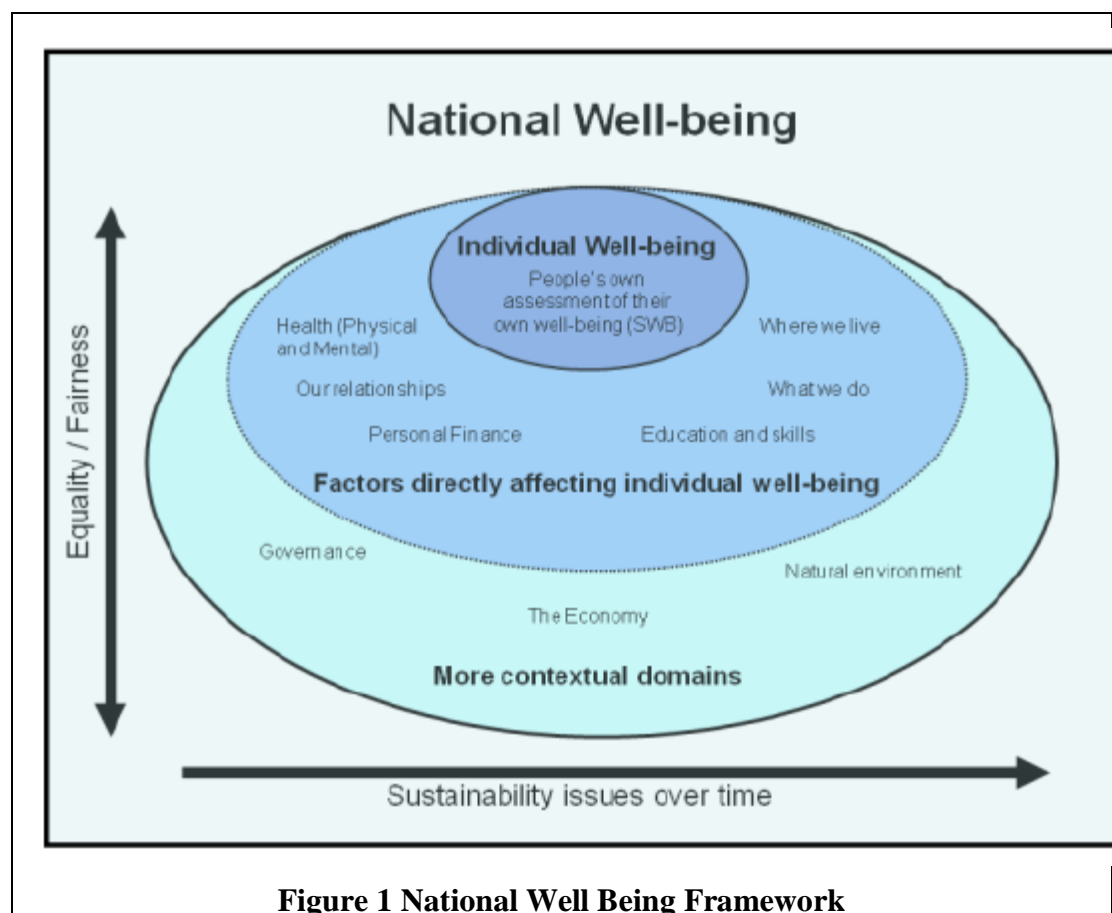


Figure 1 National Well Being Framework

⁷ Quoted in Bennett, O. (2012b), page 6

⁸ Beaumont, J. (2011) Measuring National Well-being -Discussion paper on domains and measures, Office for National Statistics, [Internet] Available at: < <http://www.ons.gov.uk/ons/rel/wellbeing/measuring-national-well-being/discussion-paper-on-domains-and-measures/measuring-national-well-being---discussion-paper-on-domains-and-measures.html>> [Accessed June 30th 2012]

- 1.4.24 A final influence on inclusion or exclusion in the study was the applicability of the data to any potential change in “clock hours”. Any direct measurement of the impact of a change is limited. It has been possible in some nations which have introduced clock change or have had periods in which different systems have been used. The most relevant occasion was for Great Britain when a three year experiment was introduced from 1968-1971 when summer time (GMT+1) applied throughout the year. This report looks at evidence and research that has examined at the impact of that change.
- 1.4.25 There is some research available from other countries’ experiences. For example, Daylight Savings Time operates in most of the USA but not in much of the State of Indiana⁹ (Kotchen, and Grant, 2011). Arrangements to facilitate the 2000 Olympics in Australia created a quasi-experiment which allows comparison between states. Typically, three of Australia’s six states observe DST beginning in October. To assist the 2000 Olympics in Sydney, two of these three states began DST two months earlier than usual.
- 1.4.26 Portugal adopted CET in 1966–76 and 1992–96 and then on each occasion moved back to Western European Time. However the work in producing this report has not been able to find any published evidence which looked at the impact of the changes in Portugal.

1.5 Countries Studied by References

- 1.5.1 Table 1-1 (page 7) shows the main geographical areas of focus from the referenced sources found for this study. The UK is the area for 47 (36%) of the geographical areas in the studies, with an additional 11 studies looking at geographical areas within the United Kingdom – England, Northern Ireland, Scotland or Wales. The USA is the area outside the UK which the largest number of studies include (32 studies). 16 other individual countries are mentioned specifically in the references used in this study.
- 1.5.2 As the final part of the search strategy it should be clearly stated that nothing was ruled out simply because the research showed that a move to double summer time would be beneficial or would not be beneficial. The impact of the data has not been taken into account. Some of the references quoted claims that a move might have some disadvantages, some claim there are some advantages. Findings in some references are contradicted or not accepted by other studies. This may be due to the same subject being studied but with different data or the different use of similar data.
- 1.5.3 Many studies report different advantages and disadvantages applying to different groups of people or businesses (e.g. young people and old people, construction companies compared to businesses related to tourism). Many studies also conclude there may be different advantages or disadvantages applying to the impact in mornings compared to afternoons and evenings. The studies may then report the net effect of the two.

⁹ Helpful graphics on this are shown in “YouTube” in Grey, C.G.P. (2011)

1.5.4 The search strategy outlined resulted in 110 references.

Table 1-1 Main Geographical Areas of Focus from Referenced Sources

Sources for References	Number	Sources for References	Number
Australia	5	Netherlands	1
Bangladesh	1	New Zealand	1
Belgium	1	Norway	1
Canada	4	Sweden	4
Europe	4	Turkey	1
Finland	4	UK – as a whole	47
France	1	England	1
Germany	3	Northern Ireland	2
India	1	Scotland	6
Ireland, Republic of	1	Wales	2
Japan	1	USA	32
Jordan	1	Worldwide	4
Total			129

Note – the total of 129 geographical areas is larger than the total number of references used (118) as some studies consider more than one area in detail e.g. Kamstra, Kramer, and Levi, (2002) refers to Canada, Germany, the USA and the UK.

- 1.5.5 The initial information was circulated to 32 parties for comment and review. They were UK Government Departments, Devolved Administrations and some interested parties who had published or made representations on the issues. The list of the bodies is given in Appendix 3. An additional four bodies¹⁰, also listed in Appendix 3, were sent the information as a matter of courtesy, and any comments made were taken on board in this study.
- 1.5.6 The process of consultation resulted in an additional eight references being added to the initial list. So, the findings and conclusions in this study have been based on 118 references in total.
- 1.5.7 The references used in the study are listed in Appendix 1.
- 1.5.8 It is recognised that more references on the issue exist, but this list of 118 references represents the largest number used in any one study looking at this specific issue¹¹.

¹⁰ The Governments of the Republic of Ireland, Isle of Man, Guernsey, and Jersey

¹¹ a review of the evidence concerning the scope, quality and robustness of the available evidence regarding putting the clocks forward by one hour, the year round, in the UK

1.6 Sources for References

- 1.6.1 These references come from a range of sources, and these are summarised in Table 1-2 below. This has been done to give an overview of the evidence used to underpin this study.

Table 1-2 Number of References Used, by Indication of Source

Sources for References	Number	Percentage of Total
Academic Journals	56	47%
Commissioned Research	16	14%
Government Reports	12	10%
Interested Parties	15	13%
Media	19	16%
Total Number of references in Study	118	

- 1.6.2 Just under half of the references used in the study come from academic journals. These are mainly articles and so subject to “peer review”, but the references in academic journals do also include some letters. The criterion for inclusion in this study was the reference to some data, as it is the identification of robust data which is the key objective of this study. The quotation of data in a reference does not in itself make that data set robust, but does provide a starting point.
- 1.6.3 Commissioned research refers to that available in publications from private companies or organisations (for example “Think Tanks”). Government reports are those produced by Government Departments or Commissions. Material by “interested parties” refers to other material by organisations or individuals but written through their interest in the issue, for example letters in response consultation activity, or organisations such as The Lighter Later campaign¹². Media references are generally published in newspapers or by journalists.

1.7 Publication dates for References

- 1.7.1 To assist the understanding of the references used in the study Table 1-3 shows the publication dates of the references. 62 or just over half of the references used have been published in 2008 or more recently.
- 1.7.2 As a way in to looking at what data might be used to measure the impact of a clock change, the issues that were raised or mentioned in the references in relation to daylight saving time were recorded. The next Chapter looks at these issues.

¹² <http://www.lighterlater.org/who-we-are.html>

Table 1-3 Date of Publication of References in Study

Date of Publication	Number Published
2012	7
2011	13
2010	24
2009	7
2008	11
2007	7
2006	4
2000 – to end of 2005	19
1990's	12
1980's	8
1970's	4
No Date	2
Total	118

2 ISSUES WHICH MIGHT BE AFFECTED BY CLOCK CHANGES

2.1 Introduction

- 2.1.1 The 118 references which form the basis of this study were read to examine what data was used in them. In order to help understand and communicate this information this was done in a two stage process. The first stage was to record the issues raised in the references.

2.2 Recording Whether References Used data

- 2.2.1 The issues were recorded in total whether or not data was used. But, for each issue so recorded, it was noted whether or not data was used or referred to.
- 2.2.2 The definition of data in this study was wide and simple – was there a number attached to the information? It is taken that this is a minimum requirement for contributing to a cost-benefit analysis. Issues were recorded as having data whether or not there was a monetary value attached to it, and an additional note was made if a monetary value was recorded.
- 2.2.3 The reasons for recording issues for which no data is available are simple. The aim of the study is to examine robust data which might be used in a cost-benefit analysis to look at the implications of a move to double summer time. Recording issues which have been suggested as being possibly impacted by such a clock change, but where no data has yet been used to measure the impact, leaves open the option of future studies commissioning, obtaining, or using additional data to measure these possible impacts. Where issues are raised but data has not yet been found to measure the impact quantitatively this indicates the potential requirement for new work to produce a quantitative impact.
- 2.2.4 Again, it should be stated that the recording of whether data was used took no account of the findings of the study as to what the impact was (positive, negative or both).
- 2.2.5 Paragraph 1.5.2 noted that some issues might be recorded as positive by some authors and negative by others (perhaps using different data or methods). The same issue might have one impact in one part of the world and a different one in another part of the world. The most obvious example is the use of electricity where the use for air conditioning in warmer countries can contribute to a different total impact than in those countries where it is not so used. Another aspect to consider when looking at issues is when the issue was recorded. Although 80% of the references in this study have been published this century, some of the issues were recorded more in earlier studies than in later ones, indicating that the perceived impact may have changed (agriculture is the most obvious example).

- 2.2.6 It is the case that social, legal and other relevant factors may well have changed since a study was carried out. A clear example from the UK would be changes affecting road traffic accidents. These changes would include seat belt legislation (front seats, rear seats, seats for children), laws around the use of alcohol and driving, speed limits, and changed safety features in cars. All these changes would mean that new studies would be recommended, even if using the same data on road traffic accidents.
- 2.2.7 The issues raised are shown in Table 2-1. This table shows the number of times the issues were raised in total and also the number of occasions they were raised with data and without data.

2.3 Classifying or Grouping Issues

- 2.3.1 The recording of issues raised was simply based on the words used in the studies. In each reference an issue was counted once (with the exceptions set out in the next paragraph) however many times it was raised or mentioned in that reference. Issues raised were put into 16 categories (given in Table 2-1).

Table 2-1 Number of Times Issue Raised in References in Study

Issue	Number of times raised – with data	Number of times raised – without data	Total number of times raised	Number of time issues raised as a % of total
Agriculture / Farming	1	18	19	5%
Business	16	14	30	8%
Children	10	13	23	6%
Crime	9	15	24	6%
Energy-related impacts	45	10	55	15%
Employment	5	1	6	2%
Health - general / well-being	8	20	28	7%
Health - mental health	7	13	20	5%
Health - physical health	7	12	19	5%
Leisure and sports	5	15	20	5%
Older People	5	7	12	3%
Religious practices	0	2	2	1%
Road Traffic Accidents	41	11	52	14%
Public Opinion	11	2	13	3%
Tourism	20	7	27	7%
Trade, Transport & Communications	4	21	25	7%
Total	194	181	375	

- 2.3.2 There was some attribution of detailed issues to more generalised descriptions which were used in other references. For example, if a reference referred to football and tennis then this would have been recorded as one issue under the heading “Leisure and sports”. There is some overlap between the descriptions of the issues – for example between agriculture, tourism and businesses. When issues relating to businesses which serve tourists were raised they were classified under tourism only (so do not appear under the “business heading” or “agriculture” if relevant). A more accurate description of the “business” category would therefore be – business, apart from agriculture or tourism.
- 2.3.3 The exceptions to the unique recording of issues under one heading apply to those which referred to children, older people and also employment. So, for the sake of clarity, being a child or an older person is not an issue in itself but a label which has been applied to an issue where it is stated that there could be impact on those particular demographic groups. In these cases the issue could be recorded twice. So if a reference was made to the older people and fear of crime then this was recorded both under “older people” and “crime”. The same would also be true of the recording of an issue referred to as children and road traffic accidents. If a reference was made to tourism as an issue it would be recorded under tourism; if a reference was made to an impact on tourism and an estimate was given of the number of jobs which could be affected then the issue would appear as tourism and also employment.
- 2.3.4 Using the method outlined, 375 issues were recorded and placed in 16 categories.
- 2.3.5 The listing of the issues raised also noted whether data was referred to in connection with each issue. Paragraph 1.4.17 set out the wide definition of the term “data”.

2.4 Issues raised – number of times raised, with and without data

- 2.4.1 Table 2-2 shows, for each issue, the proportion of times it was raised with data and the proportion of times it was raised without data. The overall figure is that in 52% of occasions issues were raised with some data and in 48% of occasions issues were raised without data.
- 2.4.2 The different proportion of times an issue is raised with data (or without) changes between individual issues varies. The issues which were raised and where in more than or close to three quarters of those occasions data was referred to were: energy related impact, employment (though this issue was only raised on six occasions and is essentially based on work by Dr Hillman on tourism¹³), road traffic accidents, public opinion and tourism.
- 2.4.3 The two issues which were mentioned most often were energy-related issues and road traffic accidents. Between them they were raised 107 times and account for 29% of the issues raised. 10 other issues were raised between 19 and 30 times each, or between 5% and 8% of the total.

¹³ For example, Hillman (2011)

- 2.4.4 It is hoped that looking at the issues raised in these studies provides a helpful understanding of those matters which might be impacted by a clock change. As a cautionary note it should be borne in mind that the references studied are not all those looking at the matter, neither are they a random sample of the totality of studies (should such a thing be possible). There is inevitably several instances of the repetition of the same issue raised by authors in one study which then appear in other studies, for example in review sections.

Table 2-2 Number of Times Issue Raised in References in Study, proportion with data referred to and without

Issue	Proportion of times raised – with data	Proportion of times raised – without data	Total number of times raised
Agriculture	5%	95%	19
Business	53%	47%	30
Children ¹⁴	43%	57%	23
Crime	38%	63%	24
Energy-related impacts	82%	18%	55
Employment	83%	17%	6
Health - general / well-being	29%	71%	28
Health - mental health	35%	65%	20
Health - physical health	37%	63%	19
Leisure and sports	25%	75%	20
Older People ¹⁵	42%	58%	12
Religious practices	0%	100%	2
Road Traffic Accidents	79%	21%	52
Public Opinion	85%	15%	13
Tourism	74%	26%	27
Trade, Transport & Communications	16%	84%	25
Total	52%	48%	375

Notes: If the percentage of time the issue is raised with data and the percentage of times the issue is raised without data do not add up to 100 this is because of rounding.

¹⁴ For the sake of clarity, being a child or an older person is not an issue in itself but a label which has been applied to issues which impact or could impact on those particular demographic groups

¹⁵ As above

2.5 Summary of Points Raised, By Issue

- 2.5.1 The next paragraphs look in a little more detail at what issues were raised within each of the category headings used.
- 2.5.2 **Agriculture** is mentioned 19 times, though only once with data quoted.
- 2.5.3 **Business** as an issue is mentioned in 30 references, with data quoted in around half. Business is quite a wide topic. The issues raised within it often made a distinction between businesses which operated “outside” or outdoors and where the impact might be greater, and those which operated in offices or buildings.
- 2.5.4 **Children** (raised 23 times, with data quoted in 43%), the issues which have or might impact on children include road traffic accidents (related to travelling to school) and time spent outdoors.
- 2.5.5 **Crime** (24 times, 38% with data). As might be expected, crime was mentioned in the context of some types of recorded crime which might be more likely to take place in darkness (e.g. burglary). The other issue which comes up in relation to crime is the fear of crime which is related to darkness.
- 2.5.6 **Energy related issues** (recorded 55 times, with 82% referring to data) were frequently around domestic consumption of electricity (e.g. mainly the impact on lighting, but in studies in some non UK countries this might also include power for air-conditioning). Some studies also referred to the impact of changes on the generation of energy as well as its consumption. Some studies calculated the impact also in terms of CO₂ and many gave an economic impact (e.g. cost to consumers of consumption changes).
- 2.5.7 **Employment issues** (raised 6 times, 5 with data). Employment was categorised as an issue as one aspect of the possible impact of a change on the economy. Estimates were modelled of the potential impact of a change on the tourism sector in parts of the United Kingdom.
- 2.5.8 **Health - general / well-being** (28 times and 29% with data). Impacts of clock change are often seen as having an influence on either general health or the quality of life (which may not be the same, but where there is no exact definition of either). There is some recognition that the impacts might affect different people differently.
- 2.5.9 **Health - mental health** (raised 20 times, 35% with data), mental health is often raised as an issue in connection with either depression, the impact of seasonal affective disorder or circadian rhythm¹⁶.
- 2.5.10 **Health - physical health** (19 times). Physical health was mentioned as being open to influence (on 37% of the occasions it was raised data was referred to). Physical health is related to the next category (leisure and sports), but to be classified as physical health the reference would have been broader. Frequently it was referred to simply as people “being outside”.

¹⁶ NHS Choices provides some more information on these: <http://www.nhs.uk/Conditions/Seasonal-affective-disorder/Pages/Causes.aspx>

- 2.5.11 **Leisure and sports**, occurring 20 times, one quarter with data. Leisure and sports can of course be closely related to physical health, the difference in this categorisation being a more specific activity is referred to for leisure and sports. Usually this is outdoor leisure and sport, though sometimes indoor sports and leisure are also referred to.
- 2.5.12 **Older people**. The “issue” was raised 20 times, one quarter of which included some data. Those mentioned which might impact on older people included fear of crime (especially going out after dark, but also just general “feelings” about darkness).
- 2.5.13 **Religious Practices**. Religious practices were mentioned in two references. These tended to look at the impact on practices based on daylight change (e.g. sunrise or sunset) of a change in the clock time in the context of no change in other matters such as employment start and finish times (see para 4.2.2 for some more exploration).
- 2.5.14 **Road Traffic Accidents** (recorded 52 times with 79% referring to data) was the other issue, alongside energy, which most frequently raised in the references. The impact was given in terms of casualties (and the seriousness of these) and this was often given a monetary value.
- 2.5.15 **Public Opinion**. Issues classified as public opinion were raised 13 times, 85% of which included data. As mentioned in para 1.4.20 some opinion was quantified from public opinion surveys and some has been aggregated up from consultation responses – some from businesses.
- 2.5.16 **Tourism** (27 times, 74% with data), tourism is the sector of the economy with the greatest number of relevant references. Studies or information have been commissioned or gathered by a number of Tourist Authorities in the UK.
- 2.5.17 **Trade, Transport & Communications** (25 times, 16% with data). This issue, as its description implies, is broad with a number of more specific matters arising within it. One of these relates to advantages or disadvantages for the UK of the alignment of times with other parts of the world.

2.6 Summary

- 2.6.1 This chapter has looked at the issues raised in the 118 references examined. The examination classified the issues raised into 16 types. Also recorded when the issue was raised was whether or not any data was referred to. A wide definition of the term “data” was used.
- 2.6.2 The two issues raised most frequently were energy consumption and road traffic accidents (29% of the total when combined). Eleven other issues each accounted for 5-10% of the total.
- 2.6.3 Looking at all issues, they were raised with a reference to data about half the time. The proportion of occasions they were raised with data varied issue by issue. For some issues the data was referred to more on than seventy per cent of occasions, while for some other issues this was lower than thirty per cent.

3 DATA

3.1 Introduction

- 3.1.1 The purpose of this chapter is to look at data which has been used in the references found through the search strategy. The simplest way is examine key data sources issue by issue.
- 3.1.2 The data referred to in this chapter is firstly that sourced from the 118 references and, secondly, as suggested by the 36 bodies consulted in the production of this report (see Appendix 3 for a list).
- 3.1.3 The next chapter looks at matters which could be taken into account in carrying out a cost-benefit analysis.

3.2 Agriculture.

- 3.2.1 There is only one reference to data in relation to agriculture and this was from UK Government consultation with organisations. It measures opinion.

3.3 Business

- 3.3.1 A variety of studies have used data to measure the possible impact on business (tourism as a specific business is considered in section 3.16).
- 3.3.2 In 1989 the Secretary of State for the (UK) Home Department published “Summer Time: a consultation document”. This reports results from a survey of firms in which they were asked to estimate the impact. It is not made clear exactly how the data from the survey was then “grossed up” to estimate the impact nationally. Firms were asked to estimate the impact in terms of costs.
- 3.3.3 Dark day for firms (2010) reports on a survey of British Companies by GyroHSR. With survey data (of businesses or the public) these can either ask respondents to estimate the possible future impact of an event or they could be used to ask respondents to estimate the actual impact of an event – if it had occurred.
- 3.3.4 Miranda (2011) assesses the possible impact on the retail business by surveying shoppers.
- 3.3.5 A number of studies have looked at the impact on stock market trading of Daylight Saving Time shifts (for example Gregory-Allen et al, 2010). The data used in these is information from stock market exchanges (in the reference quoted it is daily stock returns of value-weighted indices for 22 of the countries that made up the MSCI World Index¹⁷).

¹⁷ The MSCI World is a stock market index of over 1,600 'world' stocks. It is maintained by MSCI Inc., formerly Morgan Stanley Capital International.

3.4 **Children**

- 3.4.1 Children are a demographic group who are seen to be potentially impacted by some aspects of any move to single/double summer time. The data which could be used to measure this is discussed under the other headings in this chapter. If it were thought desirable to be able to distinguish the impact on children then the data would need the age of the individuals concerned.
- 3.4.2 The Review of Standard Time (1970) looked at information supplied by some police forces on offences against children and which took place in the morning and afternoon.
- 3.4.3 Information collected on personal injury road accidents in Great Britain includes the age band of those involved, with a 0-15 years age band which can be used. Using this data Adams (2005) looked at year-round daylight saving and serious or fatal road traffic injuries involving children in the north-east of England.
- 3.4.4 Another study which particularly looked at children is that by Goodman et al (in press) which examines day length and weather effects on children's physical activity and participation in play, sports, and active travel. This study was with British children aged 8-11 and measured their activity through accelerometers they wore. Children also completed diaries in which they identified episodes of out-of-home play, structured sports and active travel.
- 3.4.5 Children would also be affected by broader impacts such as energy consumption.

3.5 **Crime**

- 3.5.1 Crime in the UK is essentially measured in two ways. Firstly, there is crime reported to and recorded by Police Forces¹⁸. The detailed way this is reported and recorded can be different in Devolved Administrations. No fundamental differences have been shown which would make the use of this data difficult in any Devolved Area, though it would need consideration for any UK wide comparisons. In Northern Ireland what is recorded on time is the details of the time that the crime or Anti-Social Behaviour incident was reported to the police as opposed to the time that it occurred, but generally they should be fairly similar for most incidents.
- 3.5.2 Secondly, crime is counted through regular Crime Surveys which can measure crime not reported to the Police and also measure fear of crime. Crime surveys have asked respondents how safe they have felt walking alone in their area after dark.
- 3.5.3 The British Crime Survey in the past has covered the whole of Great Britain¹⁹. It ceased to include Scotland in its sample in the late 1980s. From April 2012, the British Crime Survey (BCS) has been named the Crime Survey for England and Wales to better reflect its geographical coverage. Scotland is now covered by a

¹⁸ For further information see: <http://www.homeoffice.gov.uk/publications/science-research-statistics/research-statistics/crime-research/counting-rules/?view=Standard&pubID=867967>

¹⁹ For further information see: <http://www.homeoffice.gov.uk/science-research/research-statistics/crime/bcs-datasets/>

separate survey – the Scottish Crime and Justice Survey. A similar survey is run in Northern Ireland²⁰.

- 3.5.4 Many crimes can be recorded according to the time they occur, though there will be some instances when may not be possible (e.g. burglary of a vacant property).
- 3.5.5 Two references note a 1995 study by the Home Office which calculated a change in crime from an extra hour of evening daylight (but neither reference quotes the details of this source).
- 3.5.6 The Home Office publishes unit costs of crime and multipliers²¹. In September 2011, the latest publication gives revisions made to the multipliers and unit costs of crime used in the Integrated Offender Management Value for Money Toolkit.

3.6 Energy-related impacts

- 3.6.1 The issue of energy related impacts was found in the largest number of references.
- 3.6.2 Chong et al (2009) used daily profiles of GB demand for electricity, based on pooled data on half hourly demand for electricity over the course of the day for all working days over the years. This information was obtained from the National Grid Company. The study did not include analysis of gas use for domestic purposes. Most studies focus on energy used for lighting.
- 3.6.3 Studies from other countries (e.g. Momani et al, 2009, and Small, 2001) have used information either from national electric power companies or electricity supply utilities.
- 3.6.4 An alternative approach and data was used for the report based in Japan by Fong et al (2007). These measurements came from a number of data sources including:
 - a life schedule survey with 12,600 respondents which looked at the detailed breakdown of daily activities of different employment groups in 15-minute intervals, and
 - detailed on-site monitoring of 80 houses in various regions.
- 3.6.5 Within the United Kingdom, the Office for National Statistics has carried out Time-Use Surveys²² which aim to identify, classify and quantify the main types of activities that people engage in during a definitive time period. Surveys were carried out in 2000 and 2005. There is currently no commitment to a further time use survey.
- 3.6.6 Given that electricity has a price, the use of data to look at any change can be turned into a cost to consumers relatively simply. Some studies also note that the

²⁰ For further information see: <http://www.dojni.gov.uk/index/statistics-research/stats-research-publications/northern-ireland-crime-survey-s-r/perceptions-of-crime-findings-from-the-2010-11-northern-ireland-crime-survey.htm>

²¹ See: <http://www.homeoffice.gov.uk/publications/crime/reducing-reoffending/IOM-phase2-costs-multipliers>

²² See: <http://www.ons.gov.uk/ons/media-centre/statements/time-use-surveys-sep-2011/time-use-surveys.html>

costs associated with generation of a unit of electricity may differ from the price paid for its consumption (see also paragraph 4.4.3).

3.7 Employment

- 3.7.1 The studies focused on the UK that calculate impact on jobs are those which estimated the impact on the tourist sector (see section 3.16).

3.8 Health - general / well-being

- 3.8.1 Some studies have looked at the impact on sleep patterns and activity of changes to and from Daylight Savings Time (e.g. Kantermann et al, 2007, Lahti et al 2006). These have generally used data from clinical trials or individuals who have agreed to be research subjects.
- 3.8.2 Hospital statistics could be used to look at general health. Slightly different statistics are available in England, Northern Ireland, Scotland and Wales. The data should record:
- admitted patients,
 - outpatients and
 - accident and emergency attendances.
- 3.8.3 The amount of information in these different data sets is not the exactly the same. Specifically, admitted patient data varies particularly around diagnosis / condition; as also does the information on Accident and Emergency and the time of day.

3.9 Health - mental health

- 3.9.1 Depression has been studied in relation to clock change. Olders (2003) looked at nine European cities and five US centres. For the European Cities this related sunrise and sunset times with depressive psychosis and for depression subcases from the EURODEP Programme²³.
- 3.9.2 A study by Shapiro et al (1990) examined daylight saving time in relation to psychiatric illness in Scotland. This was carried out using information on
- the parasuicide population, from the case register of the Regional Poisons Unit
 - psychiatric admissions, from the case register for a general psychiatric admitting hospital.
 - the daily number of suicides in Scotland over a 10-year period.
- 3.9.3 Hospital Episode Statistics data (or related information from devolved administrations) could be used as a source of information.

²³ For further information see: http://euglorehcd.euologos.it/IXT/_EXT-REP/_PIO.HTM#LB

3.10 Health - physical health

- 3.10.1 A number of studies have looked at the occurrence of accidents in connection with clock changes (road traffic accidents specifically are dealt with in section 3.14).
- 3.10.2 A study in Germany (Pfaff and Weber, 1982) looked at accident patients admitted to a hospital. Similar data would be available in the UK. Another study from Finland looked at hospital treatments for accidents or manic episodes following transition to Daylight Savings Time.
- 3.10.3 Consultation with organisations within the UK (see Appendix 3) has suggested that data collected through the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) might be used. The current RIDDOR data has the date and time of accident.
- 3.10.4 Some work has been carried out towards looking at the costs of workplace accidents²⁴. (For road traffic accidents, see section 3.14 below.)
- 3.10.5 A number of studies have been carried in Sweden looking at myocardial infarction (heart attacks) in connection with the effect of changing to and from daylight savings time (e.g. Janszky, 2012). The Swedish register data used probably could be replicated with Hospital Episode Statistics in England (see paragraph 3.8.2) or the equivalent from other parts of the UK.
- 3.10.6 Different types of hospital activity in the UK now have a cost tariff²⁵ so it would be possible to place a monetary value on changes in levels of healthcare activity. For example, as given in the National Health Service 2012-13 Payment by Results package²⁶. However the monetary valuation of lives saved / improved health is less often used in economic evaluation in health.

3.11 Leisure and sports

- 3.11.1 Surveys have been used to judge how people say they would spend their time under changed systems. Sproule, (2011) reports a poll by Ipsos MORI²⁷ in 2005 of Scottish residents in which they were asked whether they would take part in more sports or leisure activities in the evening if the clocks were changed.
- 3.11.2 This would be an example of data which reflects a potential impact. Another is Hillman (1993) reporting that in relation to typical weekday times when working adults and schoolchildren return home, there would be an average increase of 35 per cent in these hours for leisure activity in daylight.

²⁴ Pathak, M (2008) The costs to employers in Britain of workplace injuries and work-related ill health in 2005/06, Health and safety Executive, Discussion Paper Series No. 002 [Internet] Available at: <<http://www.hse.gov.uk/economics/research/injuryill0506.pdf>> [Accessed June 29th 2012]

²⁵ The “tariff” is the calculated price for a unit of healthcare activity. Tariffs are calculated by the Department of Health Payment by results team, and are based on Reference Costs data. They may be mandatory or non-mandatory.

²⁶

http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_132654

²⁷ <http://www.ipsos-mori.com/>

- 3.11.3 In these, and other cases, there are a number of assumptions. This example reports on an increase in daylight hours under certain circumstances. The first assumption here is unchanged working patterns and school opening hours. There is also the statement that the extra hours of daylight implied by these assumptions could be used for “leisure activity in daylight”. This is clearly the case, but records “potential”. How the hours would be used could be tested by public opinions surveys (which would still contain “speculative” or “promissory” information) and in many ways could only be confirmed through a backwards-looking study on changed behaviour following any clock change.
- 3.11.4 As reported in paragraph 1.4.25, the experience in a few countries has allowed the impact of change to be measured. In the State of Western Australia the introduction of daylight saving in 2006 provided a natural experiment to measure the effect additional “daylight” had on participation in physical activity. Daly (2007) examined this through data from the Western Australian Health and Wellbeing Surveillance System (HWSS). The HWSS is a continuous data collection system that, over the course of twelve months, surveys over 6,500 Western Australians of all ages. Information is collected on a wide range of health and wellbeing issues, health conditions, lifestyle risk factors, protective factors and demographics.

3.12 Older People

- 3.12.1 Information simply on the number of older people is available from the national population estimates available from the Office for National Statistics²⁸. Information on the impact, looking at several issues, has come from surveys which have been conducted of older people or the population in general but where the age of the person answering has been recorded, allowing an analysis of the views or experience of older people.

3.13 Religious Practices

- 3.13.1 A number of religions have practices which are related to sunrise and sunset. The interaction between these practices and “timetabled” activities might be affected as a result of any clock change. The numbers of people practicing some religions will become available following the publication of results from the 2011 Census of Population in 2012 or 2013.

3.14 Road Traffic Accidents

- 3.14.1 As an issue, road traffic accidents is the second commonest to be raised. Studies have been carried out in a number of countries. The data referred to here is that within the UK.
- 3.14.2 Adams et al (2005) examined year-round daylight saving and serious or fatal road traffic injuries affecting children in the north-east of England. STATS19 data was used which is described as “is the most comprehensive database on RTI [road traffic injuries] in Great Britain”. The information is recorded by the British police

²⁸ See: <http://www.ons.gov.uk/ons/publications/all-releases.html?definition=tcm:77-22371>

from each road traffic accident involving injuries that they become aware of. Following data checking and cleaning, they report this as STATS19.

3.14.3 This data is still reported through the STATS19 accident reporting form²⁹. Very few, if any, fatal accidents do not come to the attention of the police although it is known that a considerable proportion of non-fatal injury accidents are not reported to the police. Figures for deaths refer to persons killed immediately or who died within 30 days of the accident.

3.14.4 Further information is available which can be used to calculate the costs of road traffic accidents³⁰. The costs take into account:

- pain, grief and suffering
- lost economic output
- medical and healthcare costs
- material damage
- police costs
- insurance administration; and
- legal and court costs.

3.14.5 The Police Service of Northern Ireland has data on road traffic collisions.

3.15 Public Opinion

3.15.1 A number of studies have measured opinion in relation to a possible change to Single/Double Summer Time. There have been studies of public opinion and also the opinion of businesses (for example London Chambers of Commerce and Industry, 2010).

3.15.2 Opinion can be sought in a number of different ways. One is by a consultation exercise in which parties are asked to submit comments. This can be done by asking for the completion of on-line forms. The information obtained in these ways cannot be assumed to be representative of the whole population (e.g. people or businesses) as it has not been collected through a random sample or from structured research.

3.15.3 Another factor to consider in measuring public opinion is the amount of information that those being surveyed have when giving their view and also whether alternative clock change options are given to them.

3.16 Tourism

3.16.1 Tourism is a sector (or more precisely a set of activities involving a range of sectors) which has a significant relationship with the outside environment. The

²⁹ For further information see: <http://data.gov.uk/dataset/road-accidents-safety-data>

³⁰ See: <http://www.dft.gov.uk/webtag/documents/expert/pdf/unit3.4.1.pdf>

references found in this study do not record actual impact from occasions when clocks have been changed.

- 3.16.2 Estimates (such as Hillman, 2008) are therefore of potential impact, and have been produced using a range of data including: daylight hours (with the assumption of unchanged times for other activities), meteorological data on temperatures (morning and evening), and information on visits to some “attractions”.

3.17 Trade, Transport & Communications

- 3.17.1 A study in Belgium (Hecq, Borisov, and Totte, 1993) linked traffic hour data with such variables as the time of sunset, precipitation, temperature, and length of the daylight, etc. The study then went on to look at how the modification of evening mobility caused by daylight saving time impacted on fuel consumption. Following that there was an estimate of change in primary pollution.

3.18 Summary

- 3.18.1 This chapter has looked at the data used in the references or recommended following consultation. A number of data sources have been identified. Some have been used in previous evaluations, such as road traffic accidents, and some data sources are close to data used in studies in outside the UK.

4 INITIAL ISSUES FOR COST-BENEFIT ANALYSIS

4.1 Introduction

4.1.1 Any set of calculations which attempts to quantify the costs and benefits associated with a proposal – such as a possible move to Single/Double Summer Time (SDST) – can in a sense be regarded as “cost-benefit analysis”. To make use of cost-benefit analysis as it is more rigorously understood in economics, it will be necessary to consider

- which “actors” (persons, firms, government bodies, etc) are affected;
- what forms do those effects take?
- which of the effects stem directly from the proposed change, which of them are due to (or modified by) responses to that change (and possible further feedback effects, negative or positive);
- what monetary values (if any) should be put on those effects, and what issues arise in trying to compare the resulting valuations of effects across different groups of actors?

4.1.2 The linkages between different effects need to be taken into account. For example, it is possible to estimate the effect of SDST on road traffic accidents assuming that the daily pattern of traffic (including pedestrians and cyclists) is simply transposed forward by one hour relative to GMT – so that conditions in the morning rush hour are generally darker and colder, and in the evening rush hours generally lighter and warmer. However, one possible justification for the change is to allow people more daylight time for out-of-home activities after work or after school. If everybody took up that opportunity, and stayed out near their workplace or school one hour longer, the evening rush hours would take place at the same GMT time, and in the same conditions, as under the present regime, and there would be no reduction in evening accidents.

4.1.3 That however does not necessarily mean that people are undermining the benefits of ST/DST by staying out longer, because if they are freely choosing to do so then it is reasonable to assume that they get some benefit from doing so. There is then the question of how this should be measured and valued, possibilities including:

- counting only directly increases in GDP, eg additional expenditure by tourists (a very restrictive economic impact approach);
- including indirect gains to GDP, eg increased output plus savings in health expenditure if people take more exercise (a broader economic impact approach);

- including measures of how much people value the extra enjoyment, pleasure or (in economic jargon) utility they experience from whatever they choose to do during that “extra” hour of daylight (a “welfare” approach).
- 4.1.4 For completeness, of course, all of these must be matched by the equivalent estimates of what happens in the morning, including the displeasure, disutility of having to get up “one hour earlier”, and hence (for much of the year) in darker and slightly colder conditions than at present.
- 4.1.5 We believe that an important part of any study should be to consider the question “what kind of cost-benefit analysis?”. This needs to interact with the survey of policy impact areas developing from the list included in the brief. In this process, each part of the work will raise issues for the other:
- the review of existing evidence by impact areas will raise questions about “how does X fit into a cost-benefit analysis?”;
 - the consideration of “what kind of cost-benefit analysis?” will raise questions about “is there any usable evidence on Y?”.
- 4.1.6 We do not see this study as attempting to be prescriptive about the methodology for the possible cost-benefit study itself, but we do consider that some exchange between methodological and empirical aspects is necessary to a thorough review of the suitability of the available evidence for further analysis.

4.2 **Classifying effects**

- 4.2.1 The whole concept of “changing the clocks” hinges on the fact that so many activities are defined in terms of doing particular things at particular clock times that it is impractical to make widespread changes in the solar time at which things happen by changing timetables. [NB we use “timetable” and “timetabling” to mean “fixing when something is meant to happen in terms of the official clock time”.]
- 4.2.2 Any analysis of the costs and benefits of changing the clocks will therefore start from the assumptions that most timetabled activities – in particular, the majority of work and education timetables which are the main constraints for most of the population – will continue to take place at their current clock times, and the focus of the analysis will be on the consequences of this. Around those core work/education timetables (including a lot of public services, and support services such as a large part public transport, etc), other timetabled activities, especially those involving outdoor leisure activities – are more likely to change. Some of these are of course significant employment activities as well.
- 4.2.3 Given the expectation that a core of work and education activities will continue to operate to the same clock timetables, we can identify a sequence of issues working outwards from the individual or household to their interactions with others:
- will people (individually and as families) be happier or less happy as a result of timetabled activities giving them lighter evenings but requiring them to get up (and in many cases go out) when it is colder and darker? (suggested name for these: Inherent effects);

- will the pattern of colder/darker mornings but warmer/lighter evenings affect their use of resources (particularly lighting or heating) at home? (suggested name for these: Resource effects; this will also extend to similar questions for non-domestic buildings and other uses eg more trains running at hours which need use of carriage heating);
- will they choose to change the timetabling, the amount or the nature of the leisure activities they engage in, and to what extent will this contribute to greater happiness? (Choice effects);
- what involuntary consequences (particularly accidents and environmental impacts) will follow from the clock change combined with the above? (Externality effects). This category would also include the results of changes in the relationship between UK time and other time zones, notably the consequences of the UK having the same clock time as its continental neighbours.

4.2.4 The effects within any one sector of the economy will typically reflect a combination of the latter three effects. Changes in the road transport sector, for example, will include

- some resource effects arising from the need to operate vehicles in colder, darker mornings in order to meet timetables for deliveries and for getting to work/education;
- choice effects from people changing their patterns of activities (whether throughout the year or just at certain seasons) in order to optimise the effects of the clock change – for example, lighter evenings might lead to some smoothing out of the evening peak period at those times of the year when at present the time of leaving work makes the difference between getting home in the light (or twilight) or in the dark;
- externality effects, resulting partly from the effect of light and temperature on factors such as accident rates and pollution effects, but modified by changes in choices.

4.2.5 The following sections consider each of these types of effect in a little more detail.

4.3 Inherent effects

4.3.1 The classic example of this effect is the argument that ST/DST would allow people to enjoy lighter evenings (in many cases, after work) even if they don't actively engage with other people or with the economy in the course of that enjoyment; it could be (in the most passive example) simply the extra happiness from having their evening meal with the curtains open and daylight outside during parts of the year when it would otherwise be twilight or dark. That of course would be offset by the obligation to have breakfast in the dark at times of year when it would otherwise be at least dawn.

4.3.2 Other purely domestic effects would include the questions of getting children up and to school in darker mornings.

- 4.3.3 It should be possible to devise survey/analysis methods which would allow estimation of the values people would put on these effects, and probably to carry out that survey work around the present summertime/wintertime changes so that people would be aware of the issues as they currently arise (eg getting children up/putting them to bed). Some of this are discussed later in this chapter.
- 4.3.4 A number of studies record the amount of daylight experienced by parts of the United Kingdom (for example Secretary of State for the Home Department, 1989).
- 4.3.5 There is then the Roenneberg research³¹ into the consequences of differences between natural and social time. That seems to be suggesting that people can suffer some impairment in their mental functioning if they are trying to work, study etc. at hours that are significantly at odds with their chronotype (ie their natural daily pattern of activity in relation to the sun – conventionally classified as “larks” and “owls”). It is not clear whether people are aware of this; in so far as it affects productivity, the effect should be counted as a resource effect, if it contributes to accidents the effect should be counted as an external effect; any other parts of it that just leave people feeling less happy count as inherent effects.

4.4 Resource effects

- 4.4.1 This includes all the things like more/less use of heating, lighting etc at home and elsewhere.
- 4.4.2 Any cost-benefit analysis would need to keep in mind that any reduction in the requirement for heating at home might well result in people keeping their houses warmer rather than in using less energy to keep them at the same temperature. This would still be a benefit (in greater comfort) to the individuals affected, but would have different implications for environmental impacts.
- 4.4.3 A cost-benefit analysis would need to consider which prices to use in considering the money value of any changes in resources used:
- part of the price paid by consumers (domestic or commercial) is tax, reducing consumption and paying less tax will be a benefit to the consumer but an equal disbenefit to government (at least assuming that taxes on fuel are cheap and efficient to collect, which seems likely);
 - any changes will vary by time of day, which is important for electricity: the prices paid by consumers don't exactly reflect the different resource costs at different times of day. Reducing peak demand would be more valuable than an equal reduction off-peak. Carbon pricing would need to be taken into account if the effect was to change the use of fossil fuels.
- 4.4.4 Some of these effects are liable to be changed by choice effects – as noted in the proposal, if people respond to lighter evenings in spring/autumn by staying out an hour later, then the savings in energy used for domestic lighting may be reduced – it will be just as dark when people get home, though they will presumably not stay up so late (or they may stay up later and get up later, if less constrained by other timetables).

³¹ For example see: <http://nymag.com/arts/books/reviews/till-roenneberg-internal-time-2012-5/>

- 4.4.5 This category would also include losses/gains of productivity due to Roenneberg-type effects.

4.5 Choice effects

- 4.5.1 These are potentially very important to the overall effect on the population. There are two categories
- choices that people make in order to mitigate undesired consequences of the change in clock times (for example, going for a run in the evening because it is now too dark to run in the morning)
 - choices that people make in taking advantage of the change in clock times (for example, going for a run on spring/autumn evenings when without the clock change it would have been too dark, and they wouldn't have run at all).
- 4.5.2 These will all tend to increase the net benefits of a change: the former category will tend to reduce negative effects (eg the person who now runs in the evening is not as unhappy as if he/she gave up running altogether) or to create new positive effects. However it would only be correct to include the former category as benefits (assuming we could quantify and monetise them) if we first included the initial disbenefit that is being reduced (in the example, the disbenefit of it being too dark for running in the morning).
- 4.5.3 The evidence for these effects is likely to be limited to deductions based on the changes which occur around the shifts to/from summertime or based on the differences between neighbouring time zones (within a narrow range of latitude where the difference in solar time is minimal). The latter are difficult in the European case, because of cultural differences between the British Isles and continental Europe. Putting values on these benefits would be difficult, especially in cases where a collective rather than an individual choice is involved (eg the decision to play (amateur) football during the lighter evenings requires other people to make the same decision).
- 4.5.4 The choices that people make will influence both the resource and externality impacts.

4.6 Externality effects

- 4.6.1 This category includes everything which is neither a direct consequence of the change in clock time nor a conscious choice made in response to that change. This would range from severe, even fatal effects for individuals (road traffic accidents) to impacts on the natural environment³². Crime would also come into this category, in that we would need to measure and value the impacts on victims, not

³² Natural effects would range from the emission of greenhouse gases to very local impacts on particular species. It has been suggested in discussion that one benefit of a change in clock time would be the toad population. The times when toads are most mobile currently tend to coincide with peak traffic flows, with fatal results for the toads. A change in clock times would reduce the coincidence between peak car traffic and peak toad traffic – though as noted earlier, if choice effects result in peak car traffic occurring at different clock times, this benefit might be less than expected.

on the people who choose to commit crimes. (Fear of crime, on the other hand, should be probably be counted as part of the inherent effects, as it is related to going out in the dark and not necessarily well correlated with the actual probability of becoming a victim of crime.)

4.7 How the available evidence relates to this classification

- 4.7.1 We have reviewed some of the key references to check how their findings relate to this classification of effects.
- 4.7.2 Chong et al (2009) estimate changes in electricity consumption use which would result from changes in clock time. Their method was an aggregate statistical one, starting with data on national electricity usage during each half-hour period of each day for a series of years in the 2000s (2001-2006 according to their Appendix, p22, but 2001-8 according to their description of the analysis on p10). The independent variables are not listed (but may be detailed in the supporting methodological paper). The paper seems in places to assume that differences in electricity consumption are due to differences in the use of electric lighting, but the analysis seems to be of total consumption. We would suggest that the differences include other effects, eg if it is too dark for children to play outside, they will not just be inside under artificial light but quite probably watching television or playing computer games as well.
- 4.7.3 The analysis looks exclusively at the use of one resource, electricity; the changes in demand which the authors estimate for possible changes in clock time represent estimates of the changes in resource consumption after allowing for some unmeasured and unidentified choice effects (such as children playing outdoors rather than inside in late afternoon/early evening). They make the point that the resource costs (including greenhouse gas emissions) are determined not only by the total consumption of electricity but also by the peak consumption. A change in clock time could therefore produce resource benefits if it reduced the ratio of peak demand to base demand, even if total consumption remained the same.
- 4.7.4 Broughton et al (1999) conclude in respect of road accidents that both of the models they used "...are logically vulnerable to possibilities associated with the unavoidable confounding of any direct light effect with its indirect effect on traffic level. For example, the sharp reductions in pedestrian casualties for times of day that become lighter after an hour change may (somewhat improbably) be due to an immediate transfer of traffic to other periods of the day, which our models do not countenance." In other words, the accident effects which Broughton et al estimate (the increase in accidents which would have occurred had the British Standard Time experiment not taken place) are based on estimating the changes in occurrence/severity of the accidents that would have resulting from better/worse levels of natural lighting at the time of each accident. There is no allowance in the estimates for the possibility that there would have been more or fewer road users at risk at any particular time.
- 4.7.5 That particular paper does not put money values on the estimated accident savings, but that could be done using standard DfT values; if it were done, the results would be estimates of the values of the externality effects arising in road accidents,

excluding any choice effects that might modify the distribution of traffic (vehicle, cycle and pedestrian) in time and/or space.

- 4.7.6 The report by Hillman (2008) for the Tourism Alliance is primarily about choice effects. It implicitly assumes that people will continue to get up at the same clock time (and that hotels will continue to serve breakfast at the same clock time), and hence that people will experience lighter and slightly warmer evenings, at least in spring, summer and autumn; it then considers what people will choose to do in response to these improved conditions. This of course is not just about individual or family choices in isolation; the report mentions for example that the horse-racing and professional football industries could respond to the change (and to the increased willingness of customers to stay out in the evenings for more of the year) by offering more or more conveniently times events. These changes (both of individuals and of firms) would of course have further resource (and externality) implications. (There are of course numerous cost-benefit issues (many of them mentioned in the reference) such as increases in overseas visitors coming to the UK, or reductions in foreign trips by UK residents, representing a net gain to the UK economy, whilst other changes may represent gains to the tourist-serving sectors and areas at the expenses of other parts of the UK economy.)
- 4.7.7 Daly et al (2007) consider physical exercise in Western Australia in the same way (though different methods): their estimates of how much more exercise people took (if any) as a result of daylight saving time are entirely to do with choices. Nothing is said about the form or location of the exercise, so there may well be resource implications such as more spending on gym fees (and on driving to the gym), or less spending on transport if for example the additional physical exercise consists of walking or cycling to work or college.
- 4.7.8 Olders (2003) estimates relationships between average sunrise time and depression; his conclusions include for example an estimate that switching to SDST would reduce the prevalence of depressive neurosis among the geriatric population of London from 14.4 per hundred to 8.3 per hundred. This in itself is purely an inherent or internal effect – the effect of the change in clocks would impact directly on the well-being of individual members of the population (and indirectly on their families). There would of course be a range of further effects, eg
- among the economically active population, improvements in psychological well-being are likely to lead to improved chances of getting/keeping work and to increased productivity in work (and possibly other effects – see references to the (disputed) hypothesis of a link between Seasonal Affective Disorder and stock market returns in Gregory-Allen et al, 2010, p404 footnote)
 - reductions in the incidence of depression will reduce the costs of care and treatment for those affected.
- 4.7.9 These are likely to represent additional benefits over and above the value of reducing the incidence of depression.

4.8 Time to adjust to change

- 4.8.1 In addition to classifying the effects of costs and benefits some consideration should be given to timing with regard to both costs and benefits.
- 4.8.2 With regard to the implications of timing with regard to costs, an important one would be the length of time between any announcement that a change would happen on a certain date and that date itself. This period would influence the costs to organisations and individuals in making any necessary changes. In particular a move to Double Summer Time would require airlines reconfiguring their global airline schedules (which are fixed globally based on GMT). More time between the announcement of a change and the change itself would reduce the costs.
- 4.8.3 In the time after a change the costs and any benefits would need to be calculated or estimated in relation to a period of time. For example what would the costs or benefits look like each year. The annual costs and benefits can be compared, but some consideration would need to be given on whether the impact of any costs or benefits would change over longer periods.

4.9 Summary

- 4.9.1 The resource and externality effects are probably better covered by existing research than the other categories. It is somewhat debatable whether that is because they are more important or just because the relevant variables (eg electricity consumption, road traffic accidents) are somewhat easier to identify and measure. Some of the inherent effects have also been quantified, but only it seems in so far as they impact on recognized problems such as depression, not on the population in general.
- 4.9.2 The more general inherent effects and the possible choice effects probably account for a large proportion of how individuals would feel about a change in clock time, but are more difficult to assess. One of the problems in asking people about their reactions to a possible change in clock times is the unfamiliarity of the consequences except at the spring and autumn changes to and from summertime.
- 4.9.3 One possible, although admittedly resource intensive, approach would be to ask individuals to keep a diary of their household activities in a typical week once a month over a period of a year. ("Typical" would mean, for example, weeks in school term for families with school-age children.) Once these activities had been recorded it would be possible to remind the individuals of the activities that they had recorded in the previous month and ask them to identify which of the changes that had occurred had been a result of the changes in available daylight at the beginning and end of the day (eg "would you have done X [something the respondent did this month but not last month] last month if the evening had been lighter?"). This would assist in identifying the choice decisions that are already influenced by changes in available daylight and would give insight into the likely impacts of a change in clock time.
- 4.9.4 The survey could be further enhanced by asking the participating individuals to consider the changes in their activity patterns over the year and then reflect on how much "value" they would place on being able to continue undertaking the evening activities that cease with the onset of winter for an additional month, or commence

the activities that are commenced with the onset of summer a month earlier. The survey would similarly also focus on the reverse impact of the mornings generally being darker and the (often negative) value placed on the changes in activity patterns that would result from this.

- 4.9.5 The challenge in developing a survey to elicit the “value” is how to construct a framework in which respondents could monetise the benefits and disbenefits of changes in their activity patterns in a meaningful way. This is necessary to place a value on the inherent elements, and those that are subsequently influenced by choice. Ideally a hypothetical market would be offered to individuals in which they could indicate a willingness to pay for preferred activity patterns or a willingness to accept (i.e. the compensation required) for less desirable activity patterns³³. This is an approach that has been used widely in the literature to place a monetary value on travel time.
- 4.9.6 It would be possible to explore an extension to this approach by asking survey respondents to consider different profiles of daily activities alongside the daylight conditions in which they would occur. Each profile of activities could have a monetary value associated with it, framed as a change that the individual may face in their council tax (or an alternative payment vehicle) in order to pay towards or compensate for the change in daylight by clock hour to allow the activities to be scheduled with varying amounts of daylight. By exploring a range of different trade-offs across a range of scenarios it would be possible to infer the monetary value placed on undertaking different activities in different daylight conditions.

³³ There is of course the well-known effect whereby people generally put a higher valuation on something if asked about the possibility of losing it than on the possibility of gaining the same thing when they haven't got it. The implications of this would need to be explored in any cost-benefit analysis of SDST.

5 FACTORS INFLUENCING THE USE OF DATA

5.1 Introduction

- 5.1.1 The earlier Chapters of this report have looked at the issues which have been raised as being or potentially being impacted by moves in daylight savings time. The report has then gone on to look at data which has or might be used to measure the impact of changes in relation to these issues. The report then looks at initial issues which would need to be considered in a costs benefit analysis. This chapter is a further look at the use of data and some other matters which would need to be taken into account in analysing impact.
- 5.1.2 The chapter starts by examining ways in which the quality of the data might be judged, looking at the potential for using citation indices and National Statistics. It then goes on to look at some studies which have used similar data sets but have applied different statistics techniques in the analysis. It then looks at some studies which have used with similar data sets but over different lengths of time (and so the amount of data has varied).

5.2 Assessing the quality of references

- 5.2.1 In determining which data might be used to look at the impact of a clock change, one important aspect must be the quality of previous work or references on the subject. As one means of looking at the potential value of individual references, the number of times they were cited was checked using the citations recorded in the Microsoft Academic Search³⁴. Other citation indices are available, such as the Google Scholar citation index³⁵, Scopus³⁶ and the Web of Science³⁷.
- 5.2.2 Of the 118 references found for the study, 37 appeared in the Microsoft Academic Search.
- 5.2.3 Checking which these references were showed some limitations of this citation index (and which might apply to others). All the references which appeared in this index were from academic articles. There was no citation of any found references which were from media sources, or were from interested parties (i.e. letters or websites): this is understandable. However it is also the case that none of the found references from studies published or commissioned by Governments appeared in this citation index. Neither do any found references which have been described as “commissioned” appear. The term “commissioned” here has been

³⁴ <http://academic.research.microsoft.com/>

³⁵ <http://scholar.google.co.uk/>

³⁶ <https://www.scopus.com/home.url>

³⁷ http://thomsonreuters.com/products_services/science/science_products/a-z/web_of_science/

used to describe those which have been produced by organisations or people related to organisations, such as Think Tanks and Research Institutions. In both cases there are a number of publications which have been given these descriptions and which deal with the issues of clock change directly and are frequently referenced in other publications. This referencing though is not (yet) picked up in this citation index.

5.2.4 Examples of the references which are cited in other studies but which do not appear in the Microsoft Academic Search (at time of access) are:

- Broughton and Sedman, (1989) *The potential effects on road casualties of Double British Summer Time*. Transport and Road Research Laboratory, Department of Transport, Research Report No. 228, Crowthorne;
- Hillman, (1993) *Time for Change: Setting Clocks Forward by One Hour Throughout the Year - a New Review of the Evidence*, London, Policy Studies Institute;
- Indiana Fiscal Policy Institute (2001), *The Energy Impact of Daylight Saving Time Implementation in Indiana* (Interim Report).

5.2.5 Checking the above three references in the Google Scholar citation index shows that while Broughton and Sedman (1989) and Hillman, (1993) do appear, Indiana Fiscal Policy Institute (2001) does not.

5.2.6 Further consideration of the citation of references indicates that solely relying on the number of citations would not necessarily indicate suitable data which might be used in further work. One reason is that if authors disagree with the findings by others then they will naturally need to cite the reference with which they disagree – so citation does not by itself imply an agreement on quality. Though the disagreement might be about the method used to analyse a data set rather than the data set itself.

5.2.7 A second reason why only relying on a citation index would not be sufficient is that some references deal with more than one data source. While many references deal mainly with single issues some deal with a number of issues (e.g. Hillman 1993). If a reference which refers to many data sources is cited it cannot be assumed that there would be equal agreement on each of the data sources referred to.

5.2.8 This route this study took to quality assure findings on data was to circulate findings to the bodies listed in Appendix 3 seeking their comments.

5.3 Relationship with National Statistics

5.3.1 Another way of examining the quality of data that could be used in a study is to look at relationships with (UK) National Statistics.

5.3.2 Many statistics from the UK Government and other agencies have been produced for a number of years (the first Census of Population was carried out in 1801). The accreditation of statistics as “National Statistics” though is more recent.

- 5.3.3 To become a “National Statistic” the statistics must be considered compliant with the Code of Practice for Official Statistics³⁸, published by the UK Statistics Authority in January 2009. This is not a one off exercise as the Statistics Authority is required to assess National Statistics to determine whether their designation should continue.
- 5.3.4 The Code of Practice for Official Statistics sets out the principles and protocols which are intended to ensure that the range of official statistics meets the needs of users; that the statistics are produced, managed and disseminated to high standards; and that the statistics are well explained.
- 5.3.5 There is an extensive range of National Statistics. The list of National Statistics from the Government Statistical Service for 2011-2012 contains 483 “products”, produced by 37 producers³⁹. These are available for different areas within the United Kingdom: Great Britain, England, Northern Ireland, Scotland and Wales. As well as showing the geographical area for which the statistics are published, the inventory gives information on the frequency of publication as well as the National Statistics theme covered.
- 5.3.6 The data identified in the references was examined to see if they came from National Statistics. However complete identification was difficult as the sources for the data used were not always given. Additionally an exact identification of data as being a National Statistic would depend on knowing not only the source of the data but also when the data which was used was produced and when that data product became a National Statistic.
- 5.3.7 Rather than looking back over the past it would be useful to consider the value of using National Statistics as far as possible in any future exercises.
- 5.3.8 In examining the possible roles for National Statistics it should also be remembered that many reliable data sources which are not National Statistics have been used in studies. The most obvious ones are information from some opinion polls and the use of data from power companies.

5.4 The application of different statistical techniques

- 5.4.1 In examining the references which have looked at aspects of clock change it became apparent that different statistical techniques could be applied to the same or similar data sets.
- 5.4.2 Kamstra et al (2000) looked at the issue of daylight-saving-time changes impacting financial markets. A discussion then followed with Pinegar, (2002) on the statistical techniques used. A large element of this was in terms of looking at how data varied over time and the statistical techniques which could be used to assess whether differences shown by the data were significant i.e. in this case dependent on clock changes, or simply random.

³⁸ This code is available at <http://www.statisticsauthority.gov.uk/assessment/code-of-practice/>

³⁹ For a full list see: <http://www.statisticsauthority.gov.uk/national-statistician/types-of-official-statistics/list-of-national-statistics/index.html>

- 5.4.3 In a similar way, Gregory-Allen et al (2010) examine dates and periods with and without error correction in Kamstra, Kramer, and Levi (2000). Before correction, they find the same results as Kamstra, Kramer, and Levi. After employing “White standard errors”, they report that the significant effects nearly all disappear.

5.5 Amount of Data Used (or time period)

- 5.5.1 A number of studies have used similar data sets but looked at these data over different lengths of time, and have sometimes come to different conclusions.
- 5.5.2 Coren (1996) looks at daylight savings time and traffic accidents. The analysis is of all traffic accidents in Canada as they were reported to the Canadian Ministry of Transport for the years 1991 and 1992. With a similar study, though considering the USA, Ferguson et al (1995) look at data from 1987 to 1991, so a five year period. The conclusions they reach are different.
- 5.5.3 Kamstra et al (2000) look at the impact of daylight savings changes on different stock markets in different countries over different time periods:
- NYSE, AMEX, and NASDAQ indices, 1967 to 1997,
 - S&P 500 index 1928 to 1997,
 - TSE 300 index, 1969 to 1998,
 - U.K. total market return index, 1969 to 1998,
 - AX 100 index, 1973 to 1998.
- 5.5.4 Gregory-Allen, Jacobsen, and Marquering, (2010) look at this issue but in more countries. Also, more related to this topic, they look at similar data but for longer time periods.

5.6 Conclusions

- 5.6.1 In order to take a further step and look at how data might be judged as appropriate for use and how it might be used, this chapter has examined some of the factors which can arise to influence conclusions drawn from data. The use of a citation index does not provide a suitable means of assessing the quality of references or data. National Statistics could provide an element of quality assurance, though some relevant issues do not have National Statistics data measuring them. Different conclusions can be drawn from similar data sets applying different statistical techniques. Similarly, different conclusions can be drawn from similar data but analysed for different time periods.

6 DISCUSSION AND CONCLUSIONS

6.1 Discussion

- 6.1.1 This review has applied a search strategy and produced a significant number of references relevant identifying robust data which could be used to assess or monitor the potential effects of a policy to move the clock forward the year round in the United Kingdom.
- 6.1.2 118 studies and reviews were found through the search and subsequent consultation.
- 6.1.3 Issues that were raised in the reviews were classified to help understanding and a record was kept of where data was quoted.
- 6.1.4 In order to maximise the value from the work a wide definition was given to both data and daylight savings time. Studies were examined which looked at data from different parts of the world. One third of the issues raised were from studies which looked at the United Kingdom.
- 6.1.5 The data in the studies was examined and this was followed by consultation with UK Government Departments, Devolved Administrations and some parties who had carried out or used research in the area.
- 6.1.6 Evidence is used from studies which have been able to look back at different systems, these include some that have looked at the changes in Great Britain in 1968-1971, but also from the USA and Australia where different states adopt or have had different time systems.
- 6.1.7 Energy consumption and road traffic accidents accounted for approaching one third of the issues raised. A number of other issues each accounted for between 5% and 10% of the total raised. These are: agriculture, business, issues impacting on children, crime, health or general well-being, mental health, physical health, leisure and sports, tourism, and trade, transport and communications.
- 6.1.8 A significant amount of issues had data associated with them which came from opinion measures of various types – some from consultation exercises, some from more formal studies based on random samples. The opinion sought was often about what people or organisations thought would be the impact if a new system were introduced. This is naturally not the same as measuring an impact which has happened – for example measures of road traffic accidents following the three year experiment that was introduced from 1968-1971 when summer time (GMT+1) applied throughout the year in the UK.
- 6.1.9 One of the factors to consider when asking people about their reactions to a possible change in clock times is the unfamiliarity of the consequences except at the spring and autumn changes to and from summertime.

- 6.1.10 The measurement of Road Traffic Accidents is probably the clearest issue in terms of data and method.
- 6.1.11 Different approaches have been used to measure the impact of energy consumption, but there are a reasonable number of studies which to examine for lessons.
- 6.1.12 A number of studies have looked at health issues and, where these have been in other countries, closely comparable data available within Great Britain has been suggest (hospital episode statistics and RIDDOR accident data).
- 6.1.13 Data could be used to measure the impact of crime, though only a few studies have so far looked at this in this context.
- 6.1.14 Other impacts have been modelled from a range of data – particularly that on the tourism sector. The modelling of an impact contains more assumptions than measuring the impact of a change after it has occurred.
- 6.1.15 One issue where new data would have to be collected would be any impact on leisure including physical activity. Although this is measured in the UK (for example through the Active People Survey in England⁴⁰, some modifications would be required to bring the data more into line with that which has been used the limited studies in other countries.
- 6.1.16 Within the UK some of the data would contain slightly different definitions in different Devolved Administrative areas. But no fundamental obstacles have been found to their use in any Devolved Administrative Area.
- 6.1.17 The study has also looked at matters which would need to be considered when using the data in a cost-benefit analysis. This includes considering looking at the extent to which costs and benefits might be measure: whether only direct increases to GDP would be counted or whether some measures of the value of enjoyment / dissatisfaction or well-being could be included. The study then looked at a sequence of issues working outwards from the individual or household to their interactions with others which would help in any cost-benefit analysis.
- 6.1.18 Finally the study considered some other factors which would need to be taken into account when considering how data might be used. These included looking at data quality, the amount of data needed and the need to use appropriate statistical techniques.

6.2 Conclusions

- 6.2.1 Our overall conclusions are that we believe a formal ex ante cost-benefit analysis of the single/double summer time proposal would be possible, but that more research is needed to inform it, particularly in relation to how people would respond to the change in terms of carrying out different activities at different times.

⁴⁰ See: http://www.sportengland.org/research/active_people_survey/active_people_survey_4.aspx

7 APPENDIX 1 – REFERENCES USED IN STUDY

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8 APPENDIX 2 – PUBLICATIONS CONSULTED FOR SEARCH TERMS

This is a list of publications which were consulted to derive a list of terms used to describe the subject and so produce an initial list of terms to be used in searching for further references.

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9 APPENDIX 3 – ORGANISATIONS, INDIVIDUALS AND NETWORKS ASKED FOR COMMENTS ON DATA

Action with Communities in Rural England
Association of British Bookmakers
Department for Business Innovation & Skills
Cabinet Office
Department for Environment, Food and Rural Affairs, Rural Communities Policy Unit
Department for Communities & Local Government
Department for Culture, Media and Sport
Department for Education
Department for Energy and Climate Change
Department for Environment, Food and Rural Affairs
Department for Health
Department for Transport
Dr Garnsey, Cambridge University
Dr. Mayer Hillman
Government of Scotland
Government of Wales
Health and Safety Executive
Her Majesty's Treasury
Home Office
House of Commons Library
Lighter Later Organisation
Local Government, through the Local Government Association (Research and Information), and Local Area Research and Intelligence networks in Scotland and Wales
Ministry of Defence
Ministry of Justice
Northern Ireland Office
Office of the First Minister and the Deputy First Minister (Northern Ireland)
Office for National Statistics

Public Health Observatories, through the through the Association of Public Health
Observatories Technical Group

Religious Organisations, through the Department of Communities & Local Government
Scotland Office

Transport Research Laboratory

Wales Office

The following were kept informed of the study and sent copies of drafts for information:

Government of Isle of Man

Government of the Irish Republic

Government of the States of Guernsey

Government of the States of Jersey.