

**Studying disruptive events: innovations in behaviour, opportunities for lower carbon transport policy?**

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2 **carbon transport policy?**

3

4 **Abstract**

5 The continued failure to put transport on a robust low carbon transition pathway calls  
6 for new approaches in policy and research. In studies of transport systems and  
7 patterns of mobility, established approaches to data collection, analysis and  
8 subsequent policy design have focused on capturing ‘typical’ conditions rather than  
9 identifying the potential for substantive change. This focus on the apparent aggregate  
10 stability of the transport regime has reproduced a belief in policy circles that our  
11 current travel patterns are largely fixed and therefore very difficult to alter, which in  
12 turn has resulted in an over reliance on implausible assumptions about the carbon  
13 reductions that can be achieved through technological improvements such as low  
14 emission vehicles.

15

16 This paper argues that there is potentially much greater adaptive capacity in the  
17 mobility system than currently allowed for. It illustrates this potential through the  
18 investigation of actual adaptations made during a set of specific ‘disruptive’ events.  
19 The paper concludes by suggesting that we can go further in reducing the demand  
20 for travel if we broaden the scope of intervention to take a wider view of when and  
21 how mobility matters to participation in activities across the population. This could  
22 enable an acceleration of existing trends which suggest the potential for less mobility  
23 and therefore less carbon intensive lives.

24

## 25 1 Introduction

26 There is now growing consensus that rapid and radical change is required in the  
27 energy systems and patterns of mobility of developed countries if current targets for  
28 decarbonisation are to be achieved. In the UK, ambitious and ‘legally binding’ targets  
29 for the reduction of greenhouse gas emissions to 80% of their 1990 levels by 2050  
30 underline the scale of change required. However, as the *Stern Review on the*  
31 *Economics of Climate Change* (Stern *et al.*, 2006) set out, such a transformation will  
32 require almost total decarbonisation of the energy sector, major infrastructural  
33 adaptations in all sectors, and significant changes to systems of provision and  
34 patterns of consumption (Docherty and Mackie, 2010; HMG, 2011; Schwanen *et al.*,  
35 2011).

36  
37 Transport and the mobility of people and goods are central to any decarbonisation  
38 agenda, contributing 25.8% of EU-28 greenhouse gas emissions in 2015, 23% above  
39 1990 levels (European Environment Agency, 2018). Crucially, it is unlikely that  
40 technological innovations, such as the widespread electrification of the vehicle fleet,  
41 will be enough in themselves to meet decarbonisation targets within the timescales  
42 required (see Holtsmark and Skonhoft, 2014), and so further adjustments including  
43 substantial travel behaviour change will also be necessary (CCC, 2016; Oxley *et al.*,  
44 2012). Yet, transport has traditionally been conceptualised as “more difficult” to  
45 change (Stern, Peters *et al.*, 2006, xiii), at least in the short-medium term, than other  
46 energy- and carbon-intensive sectors. This is due to a variety of factors including: the  
47 scale and (perceived) stability of major transport flows; the fixed nature of transport  
48 infrastructure in space and the long planning horizons of major investments; complex

49 interdependencies with lifestyle choices and often entrenched public and political  
50 attitudes about the very notion of behaviour change and the extent to which it is  
51 legitimate for the state to intervene in individual decision making (Marsden et al.,  
52 2014; Docherty and Shaw, 2011; Banister *et al.*, 2007). If, as Brand et al. (2018)  
53 argue, it is necessary to couple technological change with substantial social or  
54 lifestyle change to achieve deep cuts in carbon, the reticence to shift behaviour must  
55 be addressed.

56

57 This paper seeks to challenge the pervading mindset that transport is ‘too difficult to  
58 change’ substantively, by exploring two key contentions. First, whilst the ‘transport  
59 system’ is perceived to be stable and durable, underlying patterns of *mobility* are in  
60 fact subject to considerable on-going change (Heinen and Chatterjee, 2015).

61 Although we measure (and even seek out) stability at the aggregate level (e.g. total  
62 vehicle kilometres travelled from one year to the next), as Cohen (2012: 380)  
63 suggests (drawing on the work of Phil Goodwin (2010)), “when seeking to identify  
64 nascent transport tendencies there is little value in focusing on global or national  
65 averages”. Indeed, at the same time that behaviour change has been labelled as  
66 difficult to achieve, over the past twenty five years in the UK there has been:

- 67 • A reduction in commute trips of 20% per person and despite longer trips, a net  
68 reduction in distance travelled per capita
- 69 • A move to 15% of goods being purchased on line and a 30% decline in  
70 shopping trips and 15% decline in distance travelled per capita

- 71       • A major shift in licence holding rates with delayed licence take up, ownership  
72           and use and 50% reduction in distance travelled by males aged 18-30  
73           (Marsden et al., 2018)

74 These trends are not unique to the UK although they vary in their strength in different  
75 contexts (Kuhnimhof, 2012; Polzin et al., 2014; McDonald, 2015; Maltha et al., 2017).  
76 The reasons for this extend well beyond transport to changes in the economy, in  
77 education and parenting (Chatterjee et al., 2018). However, the trends suggest that  
78 society can reconfigure to less car dependent lifestyles. We need to understand  
79 better how to cultivate and positively support such trends so that they can occur  
80 whilst simultaneously achieving welfare gains or at least avoiding welfare losses.

81  
82 Second, if we contend that some of the changes required to reduce the carbon  
83 intensity of mobility are already apparent, then learning from them might make it  
84 possible to steer the socio-technical system to a more sustainable state overall  
85 (Watson, 2012). However, the changes set out above have happened slowly over  
86 time and it is not always possible for people to be explicit about how the changes  
87 were brought about (Schwanan et al. 2012). It is therefore necessary to explore sites  
88 where change happens to allow more conscious exploration of what is necessary to  
89 achieve change. Graham and Thrift (2007: 5) suggest that some of the answers  
90 might be found through a focus on breakdown, maintenance and repair within  
91 systems: “when things break down, new solutions may be invented. Indeed, there is  
92 some evidence to suggest that this kind of piece-by-piece adaptation is a leading  
93 cause of innovation, acting as a continuous feedback loop of experimentation which,  
94 through many small increments in practical knowledge, can produce large changes”.

95 We therefore suggest that a key site of learning and innovation about change within  
96 the complex mobility system will be at sites of breakdown, repair and reconfiguration  
97 of mobility (Guell et al., 2012).

98

99 The overarching hypotheses which this paper explores are that, through the study of  
100 'disruptive events' we will find:

- 101 i) A greater range of behavioural adaptations than commonly assumed; and
- 102 ii) Insights into some of the mechanisms necessary to unlock more  
103 behavioural change

104

105 The paper proceeds as follows. First, we expand upon the research framework for  
106 our proposition that 'disruptions' represent critical episodes from which it is possible  
107 to learn more about what social adaptations occur and how. We then review the  
108 evidence from previous studies related to transport disruptions to underline the  
109 potential for such events to deliver insight. Our data is then introduced, comprising a  
110 large sample survey of residents in six sites to explore adaptive capacity at a  
111 personal scale and three distinct data collection exercises conducted during  
112 disruptive events. This is particularly novel as most of the literature reports on post-  
113 hoc recall of events and actions. Our argument is not that the responses observed  
114 during disruptions will take us on a more sustainable transition pathway *per se*, but  
115 rather that the learning from adaptation during disruption could be the basis for  
116 designing new interventions that reconfigure the mobility system in more sustainable  
117 and welfare enhancing ways. Our analysis focuses on these insights across a range  
118 of contexts which we use to reflect on our hypotheses. The paper concludes by

119 suggesting that we can go further in reducing the demand for travel if we broaden the  
120 scope of where to intervene to take a wider view of when and how mobility matters to  
121 participation in activities across the population.

122

## 123 **2 Conceptualising ‘Disruption’**

124 Graham (2010: 3) suggests that “studying moments when infrastructures cease to  
125 work as they normally do is perhaps the most powerful way of really penetrating and  
126 problematising those very normalities of flow and circulation to an extent where they  
127 can be subjected to critical scrutiny”. Drawing on Heidegger, Graham and Thrift  
128 (2007) contend that when things break or become inoperable then their relevance  
129 comes to the fore as, without this ability to adapt and reconfigure or repair, things  
130 cannot continue. They suggest both that “repair and maintenance is rather more  
131 significant than the practical models of the onflow of everyday life that have now  
132 become so significant in the social sciences and humanities” (p3) and that recovery  
133 is the means by which society “produces learning, adaptation and improvisation.”  
134 (p5). This thinking aligns strongly with our call to both accept change as a part of the  
135 everyday and to study change *in* the everyday. Whilst the study of ‘breakdown’ or  
136 what we refer to as ‘disruption’ holds appeal we need to be clear what sorts of  
137 ‘breakdowns’ and ‘disruptions’ are in focus. This section sets out our approach to  
138 understanding what disruption to the mobility system means.

139

140 First, we argue that the focus should be around disruption to the system of activities  
141 which the transport system supports (see Mattson and Jenelius, 2015). It is  
142 straightforward to conceptualise breakdown or disruption to a physical system such

143 as a bridge which might be closed for repairs or a railway washed away in flooding  
144 (Zhu and Levinson, 2010). A recent systematic review of transportation resilience  
145 concluded that “most of the definitions of transportation resilience are given either  
146 from a system perspective or a network perspective” (Wan et al., 2017) Operational  
147 resilience, and objectives to maximise the availability of infrastructure and put back  
148 infrastructure to the agreed level of service as quickly as possible in the event of any  
149 incident, for understandable reasons, dominate (e.g. Quarmby, 2010). However, the  
150 impacts of infrastructure or service provision failures are on people and businesses  
151 and so a wider mobility system perspective means focussing on what happens to the  
152 activities of everyday life when transport is disrupted.

153

154 Our research framework draws on Vollmer (2013: 2), who focuses his insights  
155 (although not specifically considering travel) around a key notion that what is  
156 ‘disrupted’ is the “coordination of activities and expectations” within a collective entity.  
157 It is not just the potential impact of disruption on an individual making a journey, but  
158 on the wider social systems of coordination that we need to explore and understand.  
159 This directly ties in with both Urry’s and Hägerstrand’s recognition of the importance  
160 of the complexity of the coordination task associated with mobility (Hägerstrand,  
161 1970; Urry, 2004), and strands of the resilience literature which foreground social  
162 adaptation (see Davoudi, 2012 and Nelson et al., 2007). Schwanen also calls for  
163 much greater attention to be paid to the intertwined social and environmental context  
164 within which change, and stability, occurs (Schwanen, 2016).

165



166 Vollmer's (2013) inclusion of expectations brings to the fore common assumptions  
167 around which the complex patterns of coordination are constructed. These include  
168 firms' decisions to hold limited inventories and rely on just-in-time delivery,  
169 organisational rules and norms that workers must be physically co-present in order to  
170 work with each other, the tolerance of lateness in society, or expectations about the  
171 time it should take to get between places. Social norms are understood to be an  
172 important influence on people's behavioural attentions (Anderson, 2000 and Wall et  
173 al., 2008) and Vollmer's work suggests paying greater attention to how these norms  
174 change and through disruption. Studying disruption to the mobility system means  
175 understanding the responses of individuals but recognising that these happen in a  
176 context.

177

178 There is an existing literature studying the impacts of disruptive events on travel  
179 patterns. The literature is limited in size, relative to the full body of literature on  
180 behavioural adaptations in transport, and scope (drawing predominantly from post-  
181 hoc reflections. This we suggest is the result of the often unanticipated nature of  
182 some of the events (timing, location or both) and the difficulties of mobilising  
183 resources to understand such events when the institutional focus is on response and  
184 repair. Van Exel and Rietveld (2001; 2009) have studied the impacts of industrial  
185 disputes on public transport use. Complete system shutdowns are sometimes  
186 observed, although more commonly only a part of the system closes or there is a  
187 limited service provided across a whole network. They provide a period of uncertainty  
188 in terms of the network that will operate and require a reaction, particularly from  
189 regular users of the network or those that had pre-planned to use the network in the

190 affected period. Their 2009 study of a pre-planned rail strike found that “Forty-four  
191 percent of the people who had anticipated to travel by train on the day of the strike  
192 abandoned their trip, 24% switched to car as driver, 14% switched to another mode  
193 (as passenger), 18% stayed with the train and rescheduled the planned activity to  
194 another day” (p526). Earlier work (Van Exel and Rietveld, 2001) identify a strong  
195 differential impact on participation in different types of activities during such strikes,  
196 with sizeable reductions in cultural and entertainment activities and smaller but still  
197 important reductions in shopping and church attendance. In the short run at least,  
198 there is capacity to change mode and to postpone travel. This is likely to vary with  
199 context, with a recent stated intention survey of reactions to a hypothetical one day  
200 complete transit system shutdown in Melbourne anticipating a more car based  
201 response (Nguyen-Phuoc et al., 2018).

202

203 A study of the London 2012 Olympics provides further insight into behavioural  
204 response preferences, albeit in an environment where there are a range of transport  
205 options for most journeys. Here, advice was given to travellers to avoid specific  
206 stations or routes and to avoid travelling on particular days where the combination of  
207 baseline and visitor traffic would have caused severe overcrowding. Interestingly the  
208 study found that 40% of people did not intend to make any changes when asked  
209 before the games but, of these, 40% did make changes. Of the 60% intending to  
210 change 76% went on to make a change (Parkes et al., 2016). The most common  
211 behavioural responses were retiming and reducing journeys (33% and 32% of  
212 respondents respectively) compared with 19% re-routing and 14% changing mode.

213 6% of people had sustained their change two to three months after the Games had  
214 finished (Parkes et al., 2016).

215

216 Cairns et al. (2002) and Zhu and Levinson (2010) review over 100 studies of the  
217 temporary or permanent loss of road capacity (e.g. bridge closures and roadspace  
218 reallocations to non car modes). Some of these interventions are planned, consulted  
219 on and communicated to the affected public (such as pedestrianising streets or  
220 closing a bridge for maintenance). Others are unplanned disruptions typically as a  
221 result of significant external factors (earthquakes, bridge collapse, flooding or  
222 damage to bridges). They all had significant durations and therefore required more  
223 than just an adaptation of actions from one day to the next. Cairns et al. (2002) found  
224 that in half of the cases they studied, 11% of vehicular traffic could not be found in  
225 the study areas after the reduction in capacity. In some cases this was attributed to  
226 traffic finding routes in other areas or people changing the mode of travel or  
227 destination. However, they also found adaptations that go well beyond those  
228 imagined purely from considerations of network availability and journey time costs.  
229 These included “consolidating trips for different purposes, altering the allocation of  
230 tasks within a household to enable more efficient trip-making, car-sharing, or no  
231 longer making journeys (e.g. by working from home occasionally). Longer-term  
232 responses included changes in job location, changes in household location and  
233 changes in developers’ choice of location for new development.” (p18). More  
234 recently, examination of the impacts of Hurricane Sandy, Kontou et al. (2017) found  
235 that wealthier commuters were more likely to continue teleworking for longer.  
236 Kaufman et al. (2012) reported the necessity of substantial workplace reorganisation

237 as a result of power outages as well as reduced transport options. This echoes  
238 Guiver's qualitative research of a bridge collapse which severed a town in a national  
239 park in England where substantial institutional and organisational reconfiguration  
240 happened to reduce the significant transport impacts (Guiver, 2011).

241  
242 The existing literature provides some support for the notion that both the scale and  
243 variety of behavioural adaptations during disruption is larger than that considered in  
244 traditional transport interventions. It also suggests that, after such events some of the  
245 adaptations persist, even where no intentional strategy to support that was present.  
246 These events are therefore interesting sites of learning about how bigger adaptations  
247 are made possible, the conditions necessary to extend those adaptations or the  
248 practical limits to doing so.

249  
250 However, much of the existing literature relies on recall to capture the behavioural  
251 adaptations and this has significant limitations in terms of forgetting, confounding or  
252 providing narrative reinterpretations of why certain changes were made (Behrens and  
253 Mistro, 2010). The next section introduces our novel data sets which enabled us to  
254 overcome some of those limitations and study behavioural adaptations during  
255 disruptions.

256

### 257 **3 Case Study Methodology**

258 Our empirical evidence is drawn from a set of surveys investigating changes in  
259 traveller behaviour in response to disruption in the UK, namely:

260

261 1 x baseline six-site household questionnaire survey:

- 262 • *Everyday survey*: A large sample online survey, N = 2,700, of six areas of the  
263 UK<sup>1</sup> seeking to understand adaptive capacity amongst travellers when faced  
264 with a variety of everyday disruptions.

265

266 3 x responsive mixed method surveys:

- 267 • *Winter*: a major snow and ice weather event in January 2013 affecting most of  
268 the country for over two weeks which led to the closure of motorways and  
269 airports as well as many minor roads and delays and cancellations to rail  
270 services. Online survey focusing on the heavily affected areas of Yorkshire,  
271 East Anglia, the southern Home Counties and South Wales, N = 2,417;

272

- 273 • *Flooding*: a major flooding event in 2014 across southern England which  
274 closed numerous roads and rail lines for several days, N = 520. This is  
275 augmented by in-depth qualitative research of flooding in the historic city of  
276 York (2012) in the north of England based on face-to-face interviews with  
277 households, N = 75;

278

- 279 • *Forth Road Bridge (FRB)*: The closure of a major estuarial road crossing on  
280 the main route north out of Edinburgh, Scotland to all traffic for 3 weeks in  
281 December 2015. A large sample questionnaire survey of travellers, N = 1,364,  
282 alongside data from traffic count sites and a smaller survey of affected  
283 businesses.

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<sup>1</sup> Aberdeen (n=436); Liverpool (n=410); London (n=632); Reading & Bracknell (n=410); Yeovil & Chard (n=405); York (n=407)

284

285 There are three important aspects to note about these data sets. First, for the  
286 *Everyday survey*, a questionnaire was administered in six different ‘Travel to Work  
287 Areas (TTWA)’ in the UK in September 2013. This survey was administered to  
288 enable benchmarking of experience of disruption (the frequency and type of adaptive  
289 response) in a variety of types of location across the UK (a capital city (London), a  
290 post-industrial city region (Liverpool), a historic city (York), a large regional  
291 employment centre with rural hinterland (Aberdeen), a commuter town (Reading) and  
292 a rural county (Yeovil and Chard). The design of the survey was preceded by a set of  
293 four focus groups, as well as an extensive literature review, to inform the types of  
294 disruption, adaptive response options and associated vocabulary used on the survey.  
295 A market research company (YouGov) was used to provide an online sample and  
296 age and gender quotas were applied to ensure a representative sample with  
297 additional corrective weights applied among the 2,700 final respondents. The sample  
298 under-represents those with limited computing skills or access.

299

300 Second, for the three data sets collected on actual disruptions (*Winter, Flooding* and  
301 *Forth Road Bridge – the ‘Responsive’ surveys*), these were all collected during the  
302 period of the disruption itself. A core survey instrument was developed and passed  
303 through ethical approval which considered what should be asked in the event of a  
304 ‘generic’ disruption and this was quickly tailored for each circumstance. Data  
305 collection for the *Winter* and *Flooding* surveys took the form of online panel surveys  
306 (in this case Research Now). Specific geographical and socio-economic quotas were  
307 put in place to ensure that both surveys were statistically representative for the

308 regions being surveyed. Once again, the sample under-represents those with limited  
309 computing skills or access to ICT. The *Forth Road Bridge* closure survey used a  
310 mixed-method approach: (1) An online survey promoted via Twitter yielding few  
311 responses; (2) A postal survey mailed directly to 9,500 households in areas affected  
312 by the disruption; and (3) The distribution of self-completion paper surveys to  
313 passengers boarding train services operating across the River Forth and to  
314 passengers boarding direct coach services at a Park and Ride site travelling to  
315 Edinburgh via an alternative bridge (with a significant detour of 40 minutes (66%  
316 extra journey time)). Full details of the closure, data and analysis are provided by  
317 Shires et al. (2016).

318

319 Third, the responsive data covers a range of circumstances in a range of contexts  
320 within the UK. The *Forth Road Bridge* (FRB) closure was a clearly defined  
321 infrastructure failure where there was a government agency tasked with managing  
322 that failure and implementing a response plan. The *Flooding* research covered a  
323 large area of southern England where a large number of road and rail routes in the  
324 area were affected for, in some cases, several weeks. However, there were also  
325 parts of the network which were not affected and so re-routing options existed for  
326 many people. The *Winter* survey was conducted over several of the worst affected  
327 areas of England and Scotland during a period of snow ice and heavy rain. The  
328 impacts varied day to day with the weather but the freezing temperatures meant that  
329 large areas were impacted for one or two weeks with much less clarity over exactly  
330 where in the network impacts would occur. Taken together, these datasets provide a  
331 diverse set of behavioural responses from which it is possible to identify a range of

332 commonalities as well as distinctive reactions to each type of incident. There is no  
333 such thing as a representative disruption as each will be highly contextual in time and  
334 space. It is also, in circumstances like this, not possible to know what the target  
335 population is nor to be able to meaningfully interpret metrics such as response rates.  
336 For the online panel surveys, conducted by YouGov (Everyday survey) and  
337 Research Now (Winter and Flooding surveys) every effort was made to match the  
338 socio-economic characteristics of the population in the areas we requested the  
339 survey company to sample in. This was not the case with the FRB which distributed  
340 questionnaires in a random manner to rail users and through a household postal  
341 survey, the distribution of which was weighted to reflect population densities by  
342 postcodes (though still random within each post code).

343

344 The survey instruments which were used to gather data are all available to download  
345 from  
346 <http://www.its.leeds.ac.uk/fileadmin/documents/research/disruption/disruption.zip>.

347 The characteristics of the samples from the Everyday Survey and the FRB Survey  
348 are available as Annex 1.

349

350 From an employment perspective the FRB survey sample is replicative of the census  
351 statistics. This does not appear to be the case with regards driving licence and car  
352 availability, with the survey sample reporting much higher incidences of both (23%  
353 and 16% respectively). This suggests that those responding are more likely to have  
354 been directly affected by the FRB closure, namely car drivers or car passengers. It  
355 also reflects that our sample is skewed towards commuters (68%). Whilst care is



356 required in interpretation of the results, it is both likely and desirable, from a learning  
357 perspective, that those affected by these events are most likely to respond to surveys  
358 about the effects. Overall then, we do not claim that the scale of response is  
359 therefore transferable but we instead identify responses which could be expected to  
360 be evident in a range of places.

361

#### 362 **4 Case Study Findings**

363 The various data collection exercises described above differed with respect to their  
364 timings, precise methods and geographical contexts. Nevertheless, each was  
365 formulated and administered with the common objective of capturing perceptions and  
366 behavioural responses to disruption utilising, as far as was practicable, core survey  
367 questions relating to aspects such as adaptive behaviours. We structure the findings  
368 as follows. First, results from the *Everyday* survey are presented. This provides a  
369 complementary 'benchmarking exercise' to the Responsive survey results which  
370 follow by reflecting a 'base' level of potential flexibility upon which behavioural  
371 responses during disruptions are built across different types of disruption, place and  
372 socio-economic circumstance. Second, the adaptive behaviours are examined from  
373 the Responsive surveys, looking firstly at work and business travel and secondly at  
374 non-work related activities, reflecting Cass and Faulconbridge's (2016) call to look at  
375 travel in the context of particular purposes. Thirdly, these results are brought together  
376 through a categorisation of adaptive responses to disruption. Through this, we  
377 discuss what the implications could be for a reimagination of the broader 'travel  
378 behaviour change' policy agenda in response to our first hypothesis.

379

#### 380 4.1 Benchmarking adaptive responses using the Everyday survey

381 The six-city questionnaire survey investigated the capacity for people to adapt their  
382 travel patterns in the context of everyday journey making. To explore flexibility,  
383 standardised categories of adaptive behaviours were offered as response options on  
384 the survey. Such categories had been used previously (for example by Transport for  
385 London in their management of the London Olympics in 2012 (Parkes et al., 2016)).  
386 These comprised of *remoding* (using a different form of transport for at least a main  
387 leg of the trip, including working at home or shopping on the internet), *retiming*  
388 (modifying the time at which the trip starts) and *rescheduling/cancelling* (cancelling  
389 the activity on that day and potentially undertaking it on a different day).

390

391 In Figure 1 we see self-reported assessments of the relative ease or difficulty of  
392 *remoding*, *retiming* and *rescheduling/cancelling* for five different journey purposes.  
393 The question relates to everyday life, specifically asking people to recall the last time  
394 they undertook a journey for each of these purposes<sup>2</sup>, where relevant. This data  
395 provides a means of broadly capturing the degree and the type of flexibility (or  
396 inflexibility) for different types of trips in the absence of a disruptive event.

397

398 *Insert Figure 1 about here*

399

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<sup>2</sup>Specifically: “Think about the last time you undertook each of the activities listed below. How easy/difficult would it have been for you to have (i) travelled to these activities at a different time that day? (ii) used a different mode of transport (e.g. car, bus, walk, train or even the internet at home) from the one you used? (iii) cancelled/postponed this activity? This was asked on a 5-point scale: Very easy, somewhat easy, neither easy nor difficult, somewhat difficult, very difficult.

400 As may be expected, food shopping is perceived to be the most flexible, with many  
401 more people saying that it would be 'very easy' or 'somewhat easy' (combined into  
402 one category 'easy') to *retime* or *reschedule/cancel* these trips than said it would be  
403 'very difficult' or 'somewhat difficult' (= 'difficult'). Smaller but equal numbers of  
404 respondents claim it would be easy or difficult to *remode* despite the fact that  
405 remodeling could include using the internet in this case. By contrast, school trips are  
406 the least flexible with respect to *retiming* and *rescheduling/cancelling*, but almost  
407 twice as many suggested they would find it easy to *remode* as said it would be  
408 difficult. Therefore these two journey purposes directly contrast with each other in  
409 terms of the type of adaptation that is deemed possible.

410

411 Interestingly, *remoding* was found to be almost equally as easy or difficult as *retiming*  
412 for the journey to work, with just over 40% of employed respondents suggesting they  
413 would find it easy to have responded in each of these ways on their last journey. In  
414 this case, participants were asked to include working at home as a form of *remoding*.  
415 Voluntary work and caring for an adult outside the home appear to have a split profile  
416 across each of the three adaptation responses in that almost as many people  
417 recorded that it would be easy or difficult for each option. Voluntary work is slightly  
418 more flexible than caring with respect to both *remoding* and *rescheduling*, than caring  
419 duties.

420

421 In summary, looking across all journey purposes, *rescheduling/cancelling* is reported  
422 to be the most difficult adaptation, particularly with respect to the journey to school  
423 and work, as would be expected, but also for caring responsibilities outside the

424 home. *Retiming* is the most popular adaptation for shopping and caring, both  
425 *remoding* and *retiming* are equally popular for work but *remoding* is the only  
426 meaningful option for the school run.

427

428 The Everyday survey allowed us to examine how this perceived flexibility varied  
429 spatially. The availability of a range of transport services in an area (and the  
430 infrastructure they rely on) has long been associated with a lower propensity to travel  
431 by car (e.g. Santos et al., 2013). The findings from the Everyday survey corroborates  
432 this by showing a clear positive relationship between the level of public transport use  
433 in general (i.e. the average proportion of all trips per person per week undertaken by  
434 public transport) among commuters in each location and their stated ease of  
435 *remoding* for the journey to work (Figure 2). Yeovil & Chard, a predominantly rural  
436 location in the south west of the UK shows high car dependence and low reported  
437 *remoding* capability, with London the reverse on both counts. While the contrasting  
438 results for these two locations might be expected, this analysis reveals that there  
439 nevertheless exists some capacity to adapt in all locations.

440

441 *Insert Figure 2 about here*

442

443 On an individual level, our data supports this positive relationship, finding that many  
444 people are multi-modal and therefore are already skilled in remoding and these skills  
445 could be applied to other circumstances. The Everyday survey enables an  
446 examination of a broad set of socio-demographic characteristics associated with  
447 perceived flexibility across different journey purposes including its association with a

448 number of attitudinal constructs. There are too many variables to include here (see  
449 Anable and Budd, 2014 for further details), but Table 1 provides an overview of the  
450 relationship between self-perceptions of ease/ difficulty of remodeling for the journey to  
451 work and a selection of typical socio-demographic characteristics. Where the socio-  
452 demographic characteristic is a categorical variable, the relationship with the  
453 categorical 'perceived ease of remodeling for the journey to work' variable was  
454 examined with chi-square analysis. Where the socio-demographic variable is a  
455 continuous variable, a one-way Anova was performed. The sample has been  
456 restricted to those who claim to use the car for their main mode to work and do not  
457 have any disability that could impair choice of alternative travel mode (N=792).

458

459 *Insert Table 1 about here*

460

461 This analysis reveals that individual perceived ability to adapt varies according to a  
462 range of characteristics, some of which can be assumed to clearly constrain flexibility  
463 in more or less predictable ways. For instance, shorter distance to work, greater  
464 multi-modality, ability to work flexibly, ability to work at home and fewer fixed  
465 commitments outside of work are all associated with a lower perceived difficulty to  
466 remode away from the car for the commute journey. On the other hand, this analysis  
467 did not reveal income, tendency to undertake business trips, possession of a bicycle  
468 for own use, the length of time living at the same address or having children at home/  
469 dropping them off on the way to work (unless a lone parent where this is more  
470 difficult) as being related to this perceived capacity to change.

471

## 472 4.2 Findings from the responsive surveys: work and business travel

473 Commuting and business trips represent 20% and 9% of all person miles travelled in  
474 England respectively, and are therefore an important source of carbon emissions  
475 (DfT, 2016). The journey to work is traditionally identified by transport planners as *the*  
476 critical trip in economic and infrastructure investment terms, so our surveys  
477 undertaken during the disruption events focused first on these journeys.

478

479 The response options given in the responsive surveys differed due to the ability of  
480 participants to be more specific about whether activities had really been rescheduled  
481 or cancelled and because remodeling for the winter and flood results would be difficult  
482 to interpret given the lack of data on alternative service provision and quality.  
483 Retiming has the same meaning across Sections 4.1 and 4.2, rescheduling is the  
484 same but we have separated out cancelling from rescheduling and classed them as  
485 activities not conducted at any point. Relocating includes activities done elsewhere or  
486 from home. The Forth Road Bridge survey allowed re-routing and remodeling to be  
487 captured.

488

489 During the *Forth Road Bridge* disruption there was a headline reduction in the  
490 number of days people travelled to work of 0.4 days per person per week, with 14%  
491 of respondents reported reducing the frequency of work trips. The largest reduction  
492 was in people travelling to work five days a week which decreased from 63% to 51%  
493 of commuters with three-quarters of this reduction in mobility achieved instead by  
494 working from home instead of commuting to an office or other regular place of work  
495 (relocation). The remainder may be explained by *cancellation* or by greater use of

496 flexible working arrangements such as formal flexi-time arrangements (rescheduling)  
497 to work more intensively on days when travel (which often had significantly longer  
498 journey times due to the diversion) was made.

499

500 Similar adaptations were revealed during the *Winter* and *Flooding* disruptions  
501 studied. Table 2 shows the range of temporal and spatial adaptive responses for the  
502 commute and in-work business travel during the *Winter* survey period and on the first  
503 day following flooding from the *Flooding* survey. The winter weather event had the  
504 greater impact on work and business travel due to its impact on many routes on a  
505 regional scale. Both events led to a large amount of *retiming*, especially during the  
506 winter events and for commuting journeys, but *rescheduling* was also a key response  
507 for business trips. Rescheduling was a comparatively small response with  
508 respondents more likely to work from home or somewhere other than their usual  
509 place of work than to reorganise on which days they would work.

510

511 *Insert Table 2 about here*

512

513 As part of the Flooding survey respondents were asked how many times they had  
514 experienced flooding. Those that had been affected 7 or more times by flooding were  
515 more than twice as likely to work from home as a response than those never  
516 previously affected (12% to 5%) and more likely to reallocate tasks to other people  
517 (4% to 1%) reinforcing the importance of learning over time and within social groups.

518

519 During the FRB closure additional rail services were put on and, because of the  
520 length of the diversionary routes for cars (although 31% of respondents indicated  
521 they did travel on a different route), *remoding* was a major response with 42% of car  
522 users and 46% of bus/coach users shifting to rail which is consistent with the  
523 estimated ease of remoding from the Everyday survey. In addition, in the Everyday  
524 survey the *remoding* category included working from home whereas this was  
525 measured separately in the FRB study. There was a 46%<sup>3</sup> increase in the number of  
526 days working from home. This was largest for car users (58%) and lowest for  
527 bus/coach (8%) with rail and 'other' similar at 28% and 27% respectively.

528

529 Working from home is not an option for everyone, although 84% of respondents in  
530 our sample reported it being possible. Of these 84%, 38% of employers were  
531 supportive of home working (a great deal or quite a bit) but 42% were not supportive.  
532 90% of respondents reported flexible working being possible (e.g. longer hours on  
533 some days). 57% of employers were supportive of flexible working (a great deal or  
534 quite a bit) and 18% were not supportive of flexible working. It is worth noting that in  
535 the Everyday survey, only just under half of all working respondents agreed that their  
536 working hours were flexible. 22% of respondents currently in work agreed that 'the  
537 attitudes of my work colleagues about start/finish times make coping with disruption  
538 more difficult' and 26% believed 'employers could be more sympathetic when travel  
539 disruptions happen'. Nevertheless, in the FRB survey, even for those with no ability  
540 to work from home, different shift arrangements were sometimes implemented during  
541 the disruption to increase the intensity (hours worked) of each work trip and therefore

---

<sup>3</sup> Albeit it from a small base of 0.5 days before the disruption.



542 reduce the total trip volume. This is reflective of a more general shift to fewer  
543 commutes and longer working days across the UK (Le Vine et al., 2017).

544

545 Taken together, the Everyday and Responsive surveys suggest significant  
546 proportions of the population capable of remodeling, retiming and relocating their work  
547 activities at least some of the time. Some sectors of the population find this more  
548 challenging due to non-transport factors (nature of employment, parenting  
549 responsibilities limiting flexibility) although factors such as long distances and more  
550 limited options also reduce the scope for remodeling.

551

#### 552 **4.2 Findings from the responsive surveys: non work trips**

553 Although given less attention in transport policy, non-work trips comprise 71% of all  
554 distance travelled domestically in England (19% visiting friends, 13% personal  
555 business and other escort, 11% shopping, 5% educational escort and 22% other  
556 leisure (DfT, 2016)). It is not unusual to classify leisure and personal business trips  
557 as discretionary within transport and to presume that this is where most flexibility may  
558 lie (e.g. Chu, 2010). However, as hinted at in the Everyday survey with respect to the  
559 differential perceived abilities to reschedule shopping, caring and voluntary work  
560 trips, we observe that this assumption belies important differences between different  
561 'discretionary' activities.

562

563 Figure 3 shows the % of respondents from each of the Responsive surveys reporting  
564 retiming, rescheduling, cancelling and relocating each of the activity types which  
565 gives an indication of how likely different activity types were to be affected. Table 3

566 shows the median % of respondents recording a response by disruption (flood, winter  
567 and FRB) and organised first by joining all responses across each activity type and  
568 then by type of adaptation. This allows some more generic but important summary  
569 findings to be made. First, each disruption had quite a different scale of response  
570 showing the importance of context such as the scale of network impacted and the  
571 anticipated duration of impact. Second, whilst noting differences in magnitude and  
572 sometimes order of responses across disruptions, some activity types (shopping,  
573 leisure and visiting friends and family) seem much more amenable to change than  
574 others (health and sport). Third, rescheduling to another time period and cancelling  
575 seem more likely to be undertaken more limited retiming and relocating of activities,  
576 although context again matters here with relocation being the most important  
577 adaption during flooding.

578

579 *Insert Figure 3 about here*

580 *Insert Table 3 about here*

581

582 The qualitative work during the York flooding case study enriched the understanding  
583 of which adaptation behaviours are likely to be applied to discretionary activities.  
584 Household interviews revealed that many people shopped more locally, were able to  
585 make do with food stocks for a little longer or did small top-up shops en-route to  
586 activities when they did manage to travel during this period. Some replaced a  
587 physical shopping trip with a home-shopping activity which they sometimes did  
588 anyway. In the flooding surveys, where only some areas were affected, relocation of

589 activities was a more important response and this was true across all activity types  
590 other than health where there is limited scope to relocate where this occurs.

591  
592 Leisure activities were cancelled most often and for a range of reasons. For example,  
593 in the FRB study, extended journey times for work reduced the amount of leisure  
594 time available. In the winter and flooding studies some leisure activities were unsafe  
595 or difficult to access and so cancelled. Across all activity types, rescheduling  
596 activities within a week was still commonplace. The responses for sporting activities  
597 are dictated by the nature of the facilities affected and the degree of formalisation of  
598 participation. Team or individual league related sports have to be rescheduled  
599 whereas hobby related sport can be cancelled.

600  
601 We contrast the findings in Figure 3 and Table 3 to those from the Everyday survey  
602 on Friends and Family (Figure 1), which suggested that *rescheduling* and *cancelling*  
603 are reported to be the most difficult adaptations overall, but in particular for caring  
604 responsibilities outside the home when compared to other discretionary activities  
605 measured. Here, rescheduling and cancelling are most prevalent except in the flood  
606 survey where relocation features strongly. This is potentially important  
607 methodologically as it may be that rescheduling and cancelling are less desirable  
608 responses to remodeling or retiming on paper but not in practice when the realities of  
609 the trade-offs are faced. We are unable to test this further as the respondents to the  
610 Everyday survey were different to those in the disruptions.

611

612 The household interviews during the York study revealed great efforts being made to  
613 reach certain events such as birthdays and christenings which had a high degree of  
614 synchronisation between many participants and sometimes no temporal flexibility.  
615 Therefore, such events came across as very rigid. Caring trips for elder relatives  
616 (often classified as a discretionary activity) were also described as a high priority as  
617 routines for care recipients were seen to be very important although they could  
618 sometimes be reallocated to other people who were less affected. Within household  
619 and within workplace task reallocation was commonly discussed.

620

621 Overall, the results therefore suggest greater attention needs to be paid to where  
622 flexibility may lie and what sort of flexibility might be possible at a more disaggregate  
623 level than a simple typology of work versus discretionary travel. More attention also  
624 needs to be paid to the nature of the activity beneath such aggregate headings as  
625 'friends and family' if we are to understand where flexibility may lie and where it does  
626 not. There is however evidence of some flexibility for some people in all of the  
627 different activities. The flexibility does not just lie with the individual but depends on  
628 colleagues, family members, wider social networks and the norms which  
629 predominate during the disruptions.

630

### 631 **4.3 A categorisation of adaptive behaviours**

632 The *Everyday* survey adopted a tried and tested limited categorisation of potential  
633 adaptive behaviours (*remoding, retiming, rescheduling/ cancelling*) which was  
634 expanded and tested further in the responsive surveys. Indeed the mixed method  
635 opportunities offered by the responsive surveys found these initial three categories to

636 squash quite different types of response together which oversimplifies or, potentially,  
637 overlooks, how best to understand how people behave. Consequently, in response to  
638 our first hypothesis we expand this list to seven behavioural adaptations that could  
639 be a goal of policy as set out in Table 4.<sup>4</sup> Each category in the table relates to a  
640 unique combination of spatial, temporal and material reconfigurations involved in the  
641 adaptation. If what we are seeking to do is reconfigure the patterns of societal co-  
642 ordination as Vollmer suggests, then we need to be broader in our inclusion of  
643 temporal, technological and locational adaptation (see also Lyons and Davidson  
644 (2016) for discussion of the Triple Access System) as well as thinking about modes  
645 and routes.

646

647 *Insert Table 4 about here*

648 In setting out these behavioural responses, we also note that the second order  
649 effects of such responses need to be considered. For example, reallocation of tasks  
650 does not save carbon unless the person or group to whom the task is reallocated is  
651 closer or will use a less carbon intensive mode to conduct the task. Similarly, shifting  
652 an trip to a bank to an on-line transaction is different in carbon benefits to replacing a  
653 trip to a store with a home delivery.

654

655 We also suggest that the nature of an individual set of capacities needs to be framed  
656 even more broadly than the seven categories included here to include, as discussed  
657 above, what Vollmer (2013) refers to as 'expectations'. As such, we also identify  
658 '*renorming*' as a new category of adaptive strategy and response. The *renorming*

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<sup>4</sup> Cancellation is removed from the list as this is not a policy strategy but an emergency response and we acknowledge that not changing is also a possible response, but it is not classed as an adaptive behavior.

659 concept emerged in particular from the qualitative components of our studies. The  
660 interview data suggested in a variety of ways that the boundaries of norms are  
661 renegotiated or reinterpreted during moments of disruption (see also Parkes et al.,  
662 2016 during the London 2012 Olympics). There was clearly an intensification of  
663 flexible working and home working for example and whilst there is still some way to  
664 go to match the potential degree of flexibility to attitudes and expectations of  
665 employers and colleagues these boundaries shift during disruptions. This is more an  
666 acceleration of existing trends than the creation of a new norm. Recent research has  
667 shown that for the past twenty years the UK labour market has had an increase in  
668 working from home, working from multiple sites and reduced commute frequencies  
669 per capita (LeVine et al., 2017). Similarly, the degree of comfort in home delivery of  
670 goods has increased and intensifying home shopping is now a more normal part of  
671 everyday life for many people (77% of adults in Great Britain shopped on-line in  
672 2016, up from 53% in 2008, DfT 2017) and therefore a more normal response to it  
673 being more difficult to physically reach a store for many people.

## 674 **5 Discussion and Conclusions**

675 This paper opened with two important contentions about the shape of the current  
676 debate on the potential to reduce transport emissions. First, we described why one of  
677 the reasons for a cautious policy approach to intervening in travel demand is a wide  
678 ranging perception that mobility patterns are stable, durable and difficult to change.  
679 This mindset emerges from the longstanding framing of transport policy around  
680 analyses that focus on travel patterns at the aggregate level which do indeed change  
681 slowly, rather than alternative sites of analysis that might reveal considerable churn  
682 and/or adaptation that is already apparent. Using novel data sets, we have been able

683 to provide a range of evidence to demonstrate that there is a greater range of  
684 behavioural adaptations than commonly assumed and that these adaptations are  
685 applicable across a wide range of places, people and journey purposes. In our  
686 analysis of what may support (or prevent) adaptive capacity, the importance of  
687 disaggregation across detailed journey purposes, locations and prior experience of  
688 disruption were revealed. Assumptions typically made relating to the flexibility of  
689 discretionary journeys as contrasted to the inflexibility of work-related journeys were  
690 exposed as somewhat misguided. Certain classes of activity generally permit a range  
691 of destinations and timings (e.g. shopping), others such as healthcare facilities are  
692 more fixed. Significant flexibility in accessing work was seen for many. However,  
693 caring responsibilities and family special occasions were found to be especially  
694 'rigid', exposing the complexity of coordinating activities and expectations as vital  
695 components of the mobility system.

696

697 In reflecting on the findings of the discovered set of behavioural adaptations, we see  
698 what Graham and Thrift (2007) suggest, which is innovation at sites of breakdown  
699 and recovery. The behaviours observed in some senses represent those which  
700 would in any case be deployed in the normal run of daily life (remodelling, retiming,  
701 rescheduling, reallocating) but the disruptive events generated greater need to  
702 deploy alternative strategies and revealed more about what flexibilities could be  
703 available. Although these flexibilities are not entirely new, they are less considered,  
704 understood and visible in the normal framing of travel behaviour.<sup>5</sup>

---

<sup>5</sup> We acknowledge that activity-based modelling attempts to take account of role allocation within households and of activity chaining across periods longer than a day. These approaches have yet to see widespread application however and the policy implications remain muted.

705

706 Our second contention was that by developing insights from research on cities as  
707 systems (Graham and Thrift, 2007) and combining it with Vollmer's work on the  
708 sociologies of disruption (Vollmer, 2013), it might be possible to demonstrate how  
709 mobility (and thus emissions) might be reduced in future by applying the lessons  
710 implied by our evidence. Evidence now suggests that, in England, per capita trip  
711 making and trip distances have declined over the past ten to twenty years in almost  
712 every activity class (DfT, 2017) even in the absence of a policy to support this. To  
713 enable this change, many of the adaptations found in this research seem likely to be  
714 at play. It is surely, therefore, legitimate to consider using the insights from this  
715 research to accelerate these trends such that active participation in society is less  
716 mobilitydependent.

717

718 Recent research has shown that many people are in fact multi-modal when their total  
719 mobility choices are considered across even a week (Heinen and Chatterjee, 2015).  
720 The Everyday survey was able to test this at the individual level and spatially,  
721 showing that the places and people with the greatest multi-modal capacity and  
722 experience are most likely to self-report as being adaptable. Whilst our work  
723 reinforces the potential to see existing multi-modality as an important marker of  
724 capacity for change (see also Cass and Faulconbridge (2016) on the importance of  
725 competencies to use modes), it also demonstrates that experiences of doing things  
726 differently builds a set of adaptive capacities which goes well beyond remodeling to  
727 relocating, reducing and reallocating, all of which could potentially contribute to less  
728 travel and lower emissions. Whilst it may not be possible for most people to reduce



729 car use all of the time, it is clearly possible for the majority of drivers to do so some of  
730 the time. This requires a change in the planning mindset however from the current  
731 approach of seeing people as 'modal users' (e.g. car drivers or bus users)  
732 undertaking a regular set of journeys. The incentives we have in place reinforce this  
733 with many season ticket offers on public transport making sense only for very regular  
734 users and workplace parking fees often being monthly or yearly tariffs. The advent of  
735 more integrated ticketing and payment across modes through Mobility as a Service  
736 could offer the potential to change the system of incentives to reinforce more flexible  
737 and less mobility intensive lifestyles and thus reinforce what appear to be changing  
738 underlying societal norms.

739

740 As well as designing systems which encourage a broader set of travel behaviours,  
741 our research also suggests that there is greater potential for people to adapt than  
742 they may indicate if asked in surveys. An approach of adopting temporary or  
743 seasonal closures or adaptations to infrastructure offers the potential to experiment  
744 (as with the New York City experiments in Sadik-Khan and Solomonow, 2016). Some  
745 of this is inevitable in any case given the scale of urban maintenance programmes,  
746 but more thought should be given as to whether things need to be put back the way  
747 they were or can be part of changing pathway. Our work suggests that there is  
748 greater potential for societal adaptation if we can explain why it is necessary and  
749 what the benefits might be.

750

751 It is important to note that individual capacity to adapt varies across individuals for a  
752 range of reasons (Murray and Doughty, 2016). Some of this relates to the availability

753 of different transport options, physical or mental capacity or financial ability to access  
754 alternatives as studied in the literature on uneven distributions of transport access  
755 (Lucas, 2012). Some relates to broader social conditions such as the presence of  
756 children in the household, single parenthood and the nature of employment (Cass  
757 and Falconbridge, 2016). It is also clear from our results that very coarse activity  
758 headings also mask important differences in the degree to which different activities  
759 are flexible and in what ways they might be flexible to different groups.

760

761 In conclusion then, our findings suggest the dominant framing of stability in transport  
762 policy seems incorrect and likely to miss opportunities that exist to learn from and  
763 capitalise on innovation and change in the everyday. This matters because if current  
764 targets for decarbonisation are to be achieved, then radical change is required in the  
765 energy systems and patterns of mobility of developed countries at a wholly different  
766 scale and pace to that currently achieved. The focus on change and reconfiguration  
767 during disruption could help to reveal more about the nature of societal adaptations,  
768 many of which are happening in everyday life, and which could be stimulated further  
769 to accelerate progress on a lower carbon transition pathway.

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988 **Acknowledgements**

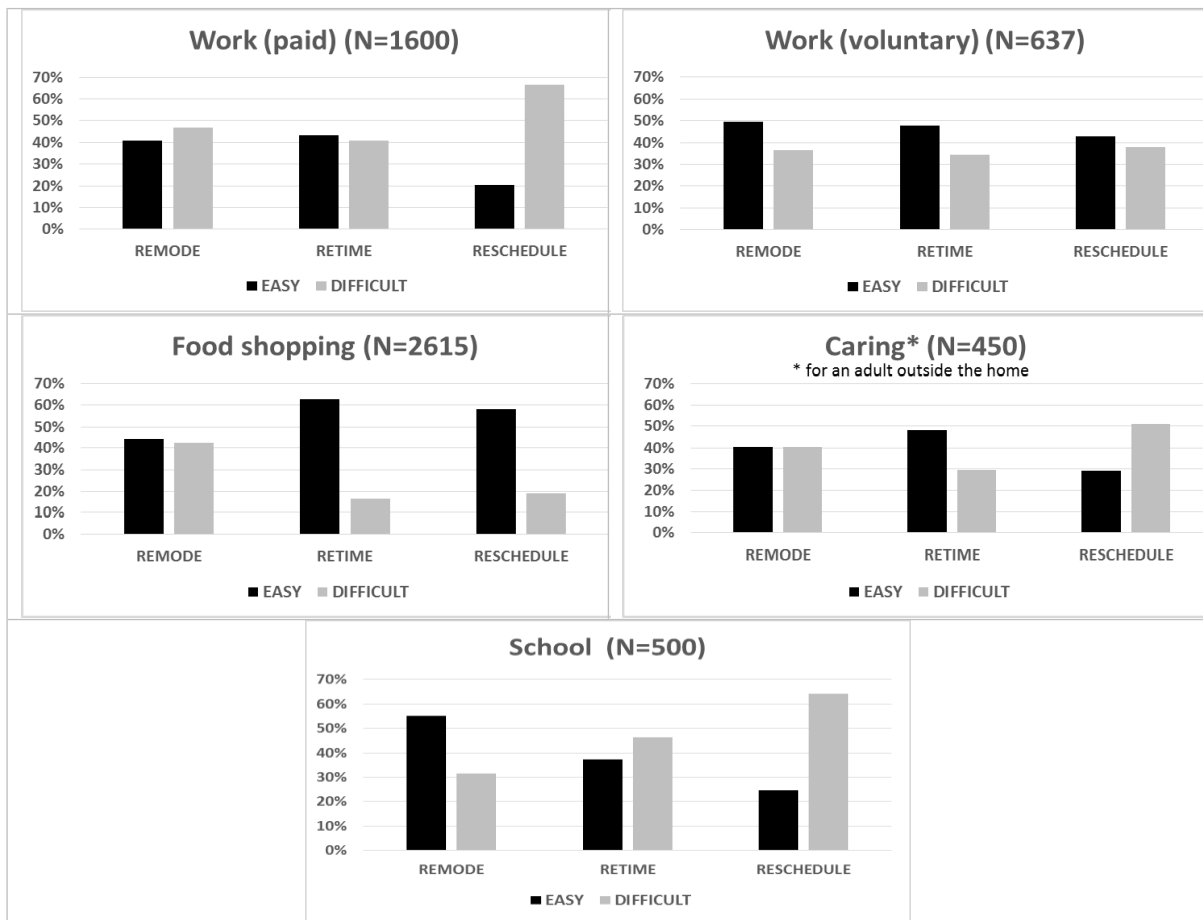
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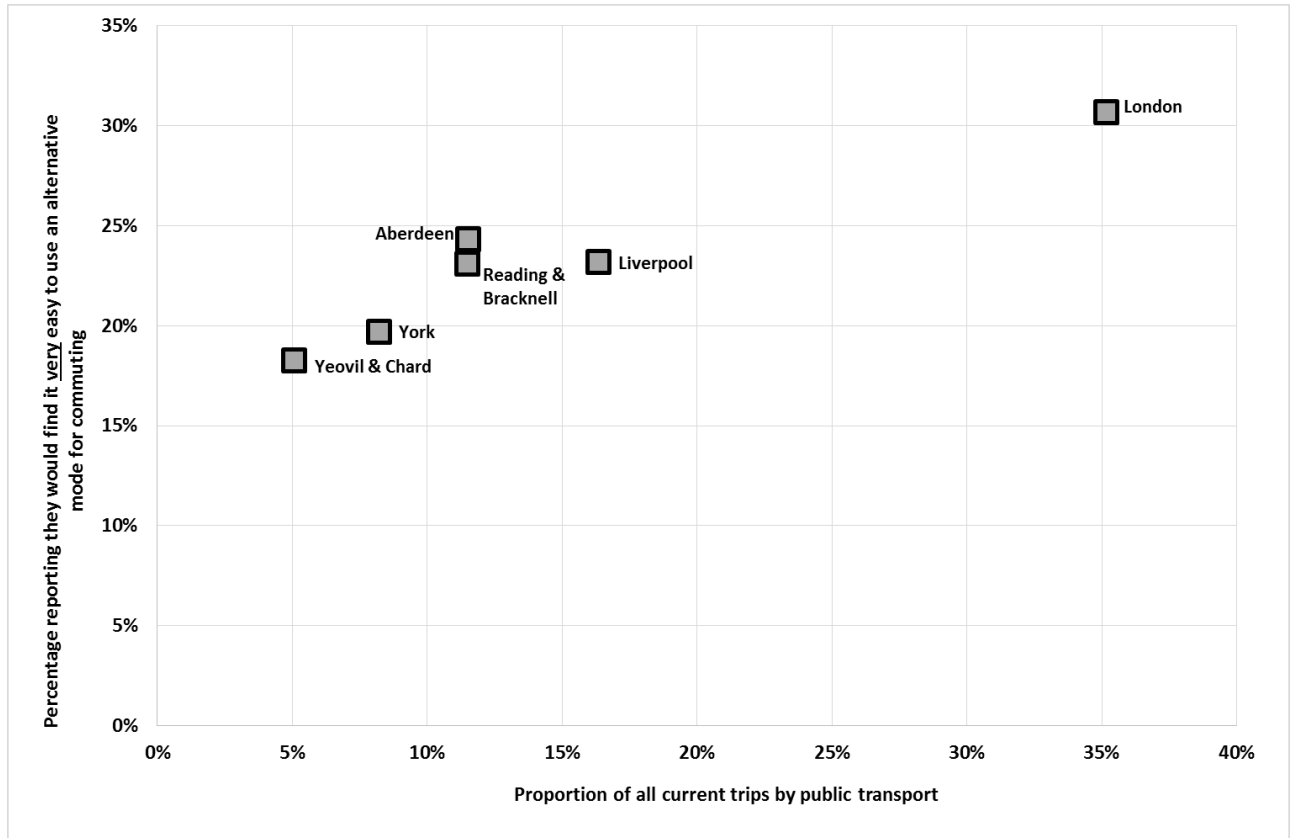
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**Figure 1: Percentage of respondents indicating whether an adaptive response would be easy/difficult for each journey purpose (based on their last experience)**



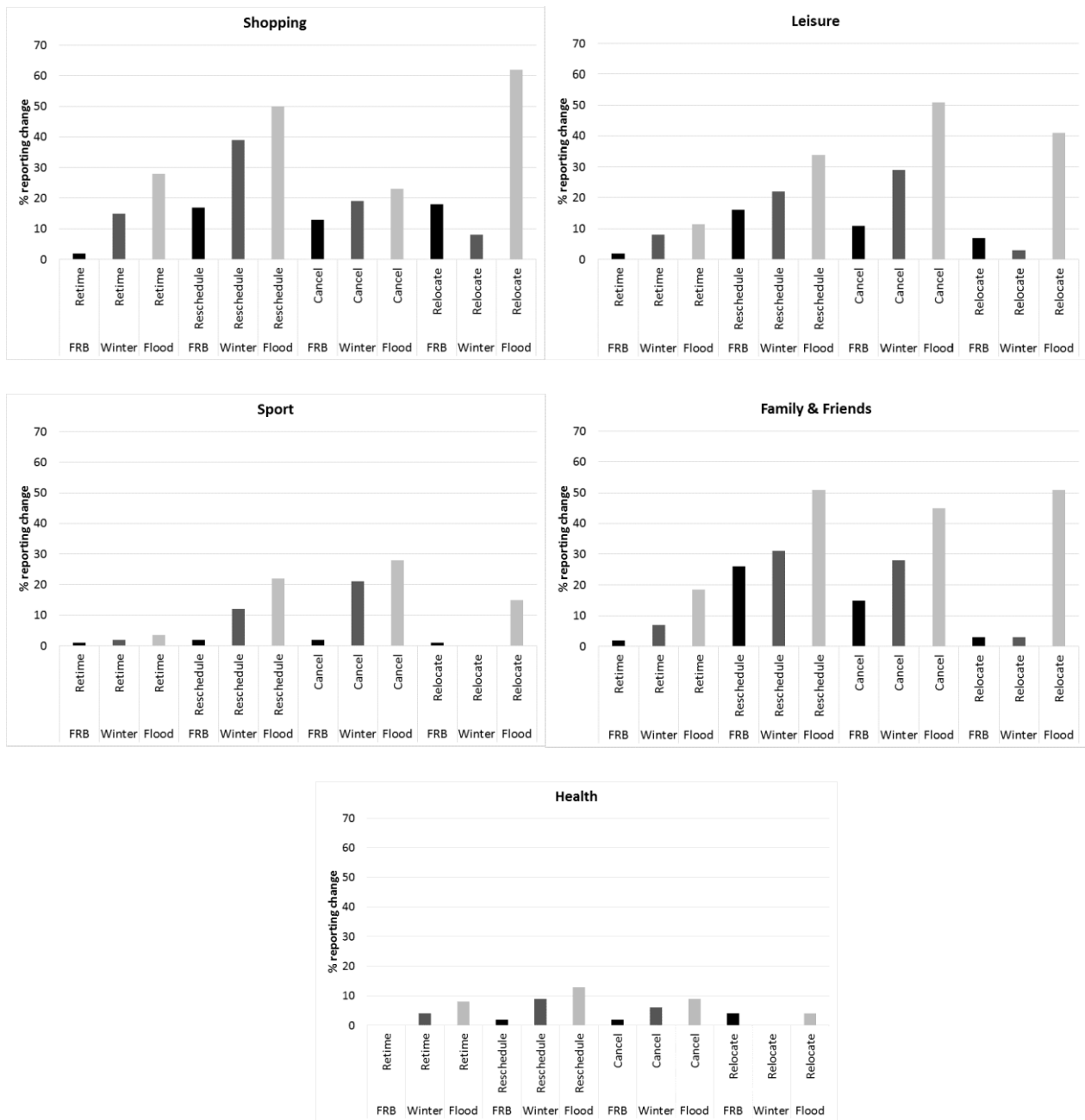
Source: Everyday survey (N=2700); Note (i) that response rates for individual questions varied as respondents only answered if they undertook such a journey (i.e. if they have a voluntary job, drop children off at school) (ii) 'Easy' is the combined proportion of 'very easy' + 'somewhat easy' and 'difficult' = 'very difficult' + 'somewhat difficult'.

**Figure 2: Relationship between stated ease of remodeling for commuting and average proportion of all trips per capital per annum undertaken by public transport**



Source: Everyday survey (N=1611 - those in full-time or part-time work only)

**Figure 3. Non-work trip responses (by trip purpose) to winter weather, flooding and FRB disruptions (Sample N FRB=1,364, Winter=2,417 and Flooding=520)**





**Table 1: Key socio-demographic characteristics and their relationship with the 'perceived ease of use of remodelling for journey to work' variable**

Characteristic	Relationship with perceived ease of remodelling for journey to work (5 pt scale)	
<b>SIGNIFICANT RELATIONSHIP</b>		
		<b>Pearson Chi Square (X<sup>2</sup> (df) p-value)</b>
<b>Age (6 bands)</b>	Youngest and oldest perceive less difficulty	37.406 (20), p<0.01
<b>Education (5 bands)</b>	Higher educated perceive greater difficulty	53.684 (16), p<0.001
<b>Household structure (6 bands)</b>	Lone parents, single adults, childless couples perceive most difficulty; Single seniors, adult house sharers and couples with children perceive less difficulty	61.861 (24), p<0.001
<b>Presence of children in the household (Y/N)</b>	Those with children perceive less difficulty	45.748 (4), p<0.001
<b>Number of cars in the household (4 bands)</b>	The fewer the number of cars, the less difficulty perceived	75.363 (16), p<0.001
<b>Agree/disagree working hours are flexible (5 bands)</b>	Flexible working hours is associated with lower perceived difficulty	48.895 (16), p<0.001
<b>Agree/disagree can work from home (5 bands)</b>	The ability to work at home is associated with lower perceived difficulty	55.476, (16), p<0.001
<b>Additional travel responsibilities (3 bands)</b>	Fewer fixed commitments outside work is associated with lower perceived difficulty	23.130, (8), p<0.01
<b>ANOVA (F (df) p-value)</b>		
<b>Proportion of all journeys undertaken by car per week</b>	Lower car dependency is associated with lower perceived difficulty	F=5.028 (4), p<0.001
<b>Proportion of all journeys undertaken by public transport per week</b>	Greater public transport use is associated with lower perceived difficulty	F=9.854 (4), p<0.001
<b>Distance to work (derived from mid-point of 8 distance bands)</b>	Shorter commute distance is associated with lower perceived difficulty	F=21.553 (4), p<0.001
<b>NO EFFECT (NOT SIGNIFICANT (NS))</b>		
<b>Gender (M/F)</b>	NS	--
<b>Annual household income (4 bands)</b>	NS	--
<b>Time at current address (4 bands)</b>	NS	--
<b>Bicycle available for personal use (Y/N)</b>	NS	--
<b>Commute involves dropping child at school</b>	NS	--
<b>Job involves travelling on business (Y/N)</b>	NS	--

Source: Everyday survey (N=792 - those using car as main mode to work and without disability)

**Table 2: Temporal and spatial adaptations on work and business journeys.**

Activity	Response				N <sup>a</sup>
	1 Retimed	2 Rescheduled	3 Cancelled	4 Relocated	
<i>Commute Trips</i>					
Winter	49%	8%	41%	14%	974
Flood Day 1	29%	5%	9%	6%	627
<i>Business Trips</i>					
Winter	21%	41%	41%	7%	126
Flood Day 1	10%	8%	6%	4%	567

<sup>a</sup>Note respondents could indicate more than one response, for example they might have retimed one work trip and cancelled another. As a result % do not sum to 100% in rows.

Source: Winter Weather and Flooding (Responsive) Surveys

**Table 3: Response Differences across disruption, activity type and response type**

	Flood	Winter	Forth Road Bridge	Median across disruption
Family and Friends	48	17.5	9	17.5
Sport	18.5	7	1.5	7
Leisure	37.5	15	9	15
Health	8.5	5	2	5
Shopping	39	17	15	17
Median across activities	37.5	15	9	
Retime	11.5	7	2	7
Reschedule	34	22	16	22
Cancel	28	21	11	21
Relocate	41	3	4	4
Median across response types	31	14	7.5	

**Table 4: Expanded Categorization of Adaptive Behaviours**

<b>Adaptation</b>	<b>Description</b>
Remoding	Using a different form of transport for at least the main leg of the trip
Rerouting	Taking a different route from that which was planned or would typically be taken
Retiming	Modifying the time at which a trip starts by either bringing it forward or pushing it back without altering where in the sequence of activities it occurs
Rescheduling	Changing when in the week a trip is made. This is distinct from retiming as the trip is seen to be moved in a sequence of activities
Relocating	Changing the destination of a journey such as shopping somewhere else.
Reallocating	Passing over the responsibility for a journey to someone else (e.g. childcare pick up or caring trip)
Reducing	Not conducting a trip at all but conducting the activity through ICT

## Annex 1

### Representativeness of the FRB Survey Sample

Table A.1 outlines some key descriptors which indicate how representative the data is and whether there are any inbuilt biases that should be considered when interpreting results. Where possible, comparative measures, as taken from the Scottish Census (Scottish Census, 2011) for the Fife region, have been reported (inside brackets) alongside the survey data.

From a gender perspective the survey sample contains slightly more males than females (2% more) and is not quite reflective of the Fife population as a whole (4% more females). This may reflect a bias towards commuters within the survey which are likely to have higher numbers of males.

The age profile of the survey sample is over representative towards the older age categories (40+ years) and underweighted towards the youngest age categories, especially 16-19. This pattern is a familiar one and highlights higher response rates amongst older segments of society vs lower response rates amongst younger segments. The contrast is particularly marked for the youngest cohort (16-19 years) and reflects the likelihood that this age group was not reached particularly well by the train/coach surveys or household survey. In the case of the latter it is likely that a parent will have completed the survey, whilst for the former the flows will have been dominated by older groups making commuting/business/leisure trips as opposed to educational trips.

From an employment perspective the survey sample is replicative of the census statistics. This does not appear to be the case with regards driving license and car availability, with the survey sample reporting much higher incidences of both (23% and 16% respectively). This suggests that those responding are more likely to have been directly affected by the FRB closure, namely car drivers or car passengers. It also reflects that our sample is skewed towards commuters (68%). Care is therefore required in the conclusions to ensure that the views of non-car users are also represented

Table A.1: Descriptive Data Statistics by Survey & Census Forth Road Bridge Survey

<i>Descriptor</i>	<i>Male</i>	<i>Female</i>					<i>Obs</i>
<b>Gender</b> <sup>1</sup>	51% (48%)	49% (52%)					1,309
	<i>16-29 yrs</i> <sup>2</sup>	<i>30-39 yrs</i>	<i>40-49 yrs</i>	<i>50-59 yrs</i>	<i>60-69 yrs</i>	<i>70+ yrs</i>	
<b>Age Group</b> <sup>3</sup>	7% (21%)	14% (15%)	20% (18%)	23% (16%)	24% (15%)	12% (15%)	1,316
	<i>Employed</i>	<i>Not Employed</i>					

<sup>1</sup> <http://www.scotlandscensus.gov.uk/ods-analyser/jsf/tableView/tableView.xhtml>

<sup>2</sup> Note that the response for 16-19 was 1% and 20-29 was 7%. The comparative census figures for these two groups is 6% and 15%

<sup>3</sup> <http://www.scotlandscensus.gov.uk/ods-analyser/jsf/tableView/tableView.xhtml>

<b>Employment<sup>4</sup></b>	70% (72%)	30% (28%)					1,313
	Yes	No					
<b>Driving license<sup>5</sup></b>	91% (68%)	9% (32%)					1,317
	Yes	No					
<b>Car Availability<sup>6</sup></b>	86% (70%)	14% (30%)					1,221
	<i>Children &lt;6 yrs - Yes</i>	<i>Children &lt;6 yrs - No</i>	<i>Children 6-16yrs- Yes</i>	<i>Children 6-16 yrs - No</i>			
<b>Household Composition</b>	14%	86%	22%	78%			1,157 1,220
	<i>Edinburgh</i>	<i>Non-Edinburgh</i>					
<b>Home Location</b>	12%	88%					1,364

<sup>4</sup> <http://www.scotlandscensus.gov.uk/ods-analyser/jsf/tableView/tableView.xhtml>

<sup>5</sup> <http://www.gov.scot/Publications/2015/08/3720/7>

<sup>6</sup> <http://www.gov.scot/Publications/2015/08/3720/7>

### ***Representativeness of the Everyday Survey Sample***

The questionnaire was administered by a market research company (YouGov) in six 'Travel to Work Areas (TTWA) in the UK using an on-line market research panel provider (YouGov) in September 2013. TTWA are statistically derived geographical regions based on UK Census data that describe self-contained labour markets where at least 75% of the area's resident workforce also work in the area and at least 75% of the people who work in the area also live in the area. They were chosen to represent statistically defined boundaries based on revealed choices for travel related research, rather than using traditional electoral or other administrative boundaries. The questionnaire underwent pre cognitive testing (n=27) and a pilot (n=100). It took an average of 20 minutes to complete.

Age and gender quotas were applied to ensure a representative sample. In addition, before undertaking the analysis, survey data samples were weighted to correct for non-response bias in the achieved sample as far as possible. This bias occurs because some subsets of the population may be more willing or able to respond to surveys than others. The corrective weights were derived by comparing the age and gender of the achieved samples with population figures (from ONS mid-year population estimates) for each of the six travel to work areas. Weighting by age/gender combination is a commonly used approach in many national surveys.

Table A.2 shows key demographic characteristics of the sample in each area, contrasting the weighted with the unweighted results. Looking at the gender and age profiles of the different locations, we can see the largest corrections were applied to the Aberdeen and Reading and Bracknell samples where males had been overrepresented, and Liverpool where they had been underrepresented. The greatest age corrections were necessary for the very youngest age group (17-29 years) which had been underrepresented in all locations. The tendency for younger age groups to be less well represented is a typical finding in social surveys. Overall, London required the greatest amount of corrective weighting across all the parameters and especially with regards to the lowest age groups, middle income and households with children, all of which had been underrepresented in the sample.

In conclusion, the age and gender corrections proved to be useful, despite attempts to apply quota sampling. However, correcting a sample based on these two parameters does not account for additional biases which related to characteristics which are entirely unrelated to age and gender. These may include attitudinal biases and personality traits which may determine how or whether a person will fill out a questionnaire survey in the first place.

Table A.2 Unweighted and Weighted Descriptive Statistics for the Everyday Survey

		UNWEIGHTED (WEIGHTED)						
		Aberdeen	Liverpool	London	Reading & Bracknell	Yeovil & Chard	York	<i>Total</i>
N=		436	410	632	410	405	407	<b>2700</b>
Gender	Male	55.5 (49.1)	45.6 (49.0)	45.1 (47.6)	54.1 (49.5)	51.1 (48.1)	49.9 (48.2)	<b>49.9 (48.5)</b>
Age Group	17-29 yrs	18.3 (27.3)	12.2 (25.6)	12.5 (24.2)	17.1 (21.9)	6.2 (16.0)	14.3 (24.8)	<b>13.4 (23.4)</b>
	30-39 yrs	17.2 (18.1)	19.0 (19.5)	19.0 (23.4)	24.6 (23.8)	7.2 (10.8)	17.7 (16.5)	<b>17.6 (19.1)</b>
	40-49 yrs	14.2 (15.1)	21.0 (15.1)	19.1 (17.7)	20.7 (17.3)	12.6 (13.8)	18.4 (14.7)	<b>17.8 (15.8)</b>
	50-59 yrs	17.4 (16.1)	22.2 (17.3)	17.4 (12.3)	17.8 (16.8)	22.5 (21.9)	21.4 (18.9)	<b>19.6 (16.8)</b>
	60-69 yrs	25.7 (18.6)	19.0 (17.1)	23.9 (17.7)	13.7 (13.9)	36.0 (26.8)	18.9 (17.2)	<b>23.0 (18.5)</b>
	70+ yrs	7.1 (4.8)	6.6 (5.4)	8.1 (4.6)	6.1 (6.3)	15.6 (10.6)	9.3 (7.9)	<b>8.7 (6.4)</b>
Income	< £20,000	20.0 (22.3)	32.4 (32.4)	22.1 (20.9)	16.4 (22.2)	28.4 (28.9)	22.7 (30.4)	<b>23.5 (25.8)</b>
	£20-49,999	47.1 (47.8)	48.1 (48.6)	43.1 (52.6)	51.3 (49.8)	51.0 (49.3)	55.5 (50.9)	<b>48.9 (50.0)</b>
	£50-74,999	18.0 (16.1)	14.2 (14.0)	17.4 (12.4)	17.0 (15.1)	12.7 (14.1)	13.7 (12.0)	<b>15.7 (13.9)</b>
	£75,000 +	14.9 (13.8)	5.2 (5.1)	17.4 (14.1)	15.2 (12.9)	7.8 (7.6)	8.1 (6.6)	<b>11.9 (10.3)</b>
Employment (FT or PT)	Yes	62.6 (63.4)	60.2 (59.6)	59.5 (60.8)	69.8 (64.1)	47.7 (50.9)	61.9 (57.5)	<b>60.3 (59.6)</b>
Driving Licence	Yes	79.1 (73.5)	82.0 (78.8)	76.4 (74.9)	87.8 (83)	93.8 (89.4)	82.8 (74)	<b>83.0 (78.5)</b>
Car Availability	Yes	82.6 (80.8)	79.8 (79.3)	73.1 (75.9)	80.5 (77.4)	95.3 (94.3)	86.2 (81.9)	<b>82.1 (81.1)</b>
Household with Children	Yes	20.6 (22.9)	25.1 (23.7)	21.8 (32.1)	32.0 (29.7)	16.0 (20.0)	23.3 (22.3)	<b>23.0 (25.7)</b>
Disability	Yes	13.5 (12.8)	15.4 (12.4)	15.5 (16.0)	10.2 (10.9)	17.3 (17.0)	10.6 (9.8)	<b>13.9 (13.4)</b>



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