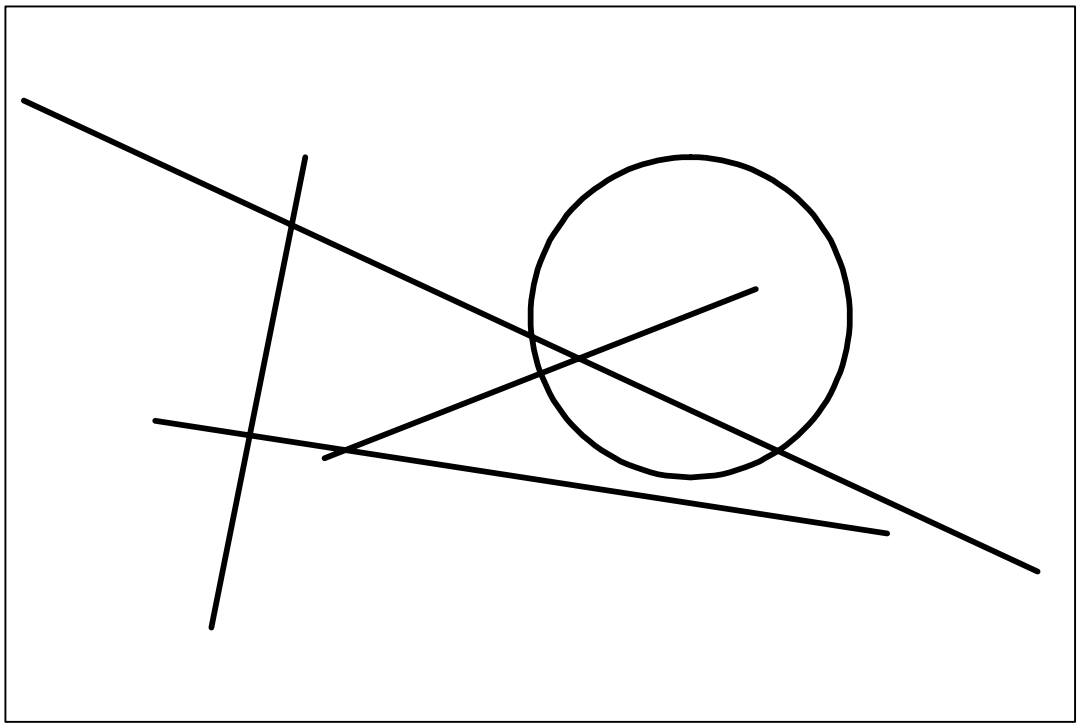

Introducing Consideration of Varied-Spatiotemporal Workers to the Study of Teleworking

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Abstract

The act of undertaking work elsewhere than the 'normal workplace' has been variously termed teleworking, telcommuting, homeworking and remote working in a research literature that now spans a number of years. Of greatest evident interest to transport research and policy has been the removal of the commute brought about by working from home. Attention in turn has been given to the present and future extent of teleworking, taking this primary travel demand benefit as a given. There has also been examination of secondary or indirect travel impacts of working from home with concern that these may offset the primary benefit of reducing travel. With a fast changing communications culture in the workplace driven by email and the Web, coupled with wider Internet access from home, this paper seeks to draw attention to whether the primary benefit or impact of homeworking is any longer as straightforward. It does so by broadening the interpretation of homeworking to encompass the notion that an individual on a given day may both work at home *and* in the 'normal workplace' such that the commute is not removed but *may be* temporally displaced. An Internet-based survey has been used to secure insights regarding the pattern of working in time and space of a sample of 1014 individuals drawn from the British labour force. The research finds that for this sample, more than twice as many individuals practiced part-day homeworking at least once in the chosen reference week compared to those who practiced whole-day homeworking at least once during the week. The paper examines this finding further to establish to what extent and why such homeworking may result in commute displacement.

Keywords

Homeworking, Teleworking, Telecommuting, Commuting, Working patterns, ICTs, Internet survey

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1. Introduction

For those individuals for whom communication and working with information forms all or part of their role, it would seem that the information age is presenting, increasingly, the scope for no longer associating working with a fixed location. The result of affordable information and communications technologies (ICTs) including desktop computing with (broadband) Internet access, laptop computers, mobile phones, mobile email devices and wireless Internet connections (Wi-Fi), is the prospect of a truly 'flexible' worker. Such a worker is no longer as constrained to the confines of their workplace but is able to work from home or nomadically (in both fixed and moving locations). This lack of constraint led Davenport and Pearlson (1998) to state that "work is what you do, not a place where you go".

1.1. Matters of definition

Telework, belonging to a 'family' of flexible working practices including job-sharing, a compressed working week and part-time working, reflects a working regime enabling the worker to work remotely from their workplace. Although not a new concept there is no universally accepted definition or term referring to this working practice (Baruch, 2000; Moon and Stanworth, 1997). This reflects the fact that the working practice is far from generic or homogenous – it embodies a multiplicity of variants characterised by, amongst other things, where, when and how often people work remotely. Telecommuting (common in North American literature, with strong transport connotations especially in relation to commuting), teleworking (common in European literature), working at home, homeworking, flexible working and remote work are all overlapping terms referring to the process of decentralised working. Two factors commonly identified across a range of definitions are that telework involves: (i) work conducted remotely from wherever might be seen as the 'traditional' workplace and (ii) the use of ICTs (Huws et al, 1996; Kerrin and Hone, 1996; and Sullivan, 2003). Lyons (2002) notes that working from home does not necessarily involve the use of ICTs, but points out that such technology is so integral to the modern office that in some instances it is perhaps a prerequisite for telework.

Huws et al (1990) suggest that telework should not be perceived as a single, fixed form of employment as it encompasses working from home some or all of the time, working from a remote centre or working while on the move. Handy and Mokhtarian (1996) define *telecommuting* as "the substitution of working at home for commuting to a usual work site, or the substitution of commuting to a telecentre, for commuting to the more distant usual work site". This excludes home-based workers and workers who work at home for *part of* the day

and then commute to their usual work site. The removal or reduction in length of the commute trip is an important aspect of telecommuting definitions. Stanek and Mokhtarian (1998) suggest that telecommuting is "the practice of working from home, or a location close to home, instead of traveling to work during the normal work day", (p. 53).

It is important to distinguish between whether definitions refer to the work or the worker. Being a teleworker does not necessarily imply that every working day is spent teleworking. In turn, the number of people defined as teleworkers may not provide a clear indication of the extent to which, on any given day, teleworking is being practiced across the workforce. To date, interpreting the type of working practice an individual engages in on a given working day, especially where homeworking of full-time employees is being considered in relation to commuting, has tended to adopt a rather black and white approach. On a given day an individual may be deemed either to be teleworking or to be working at the workplace (notwithstanding days where working at an alternative site may apply, as in the case of a business trip from home).

Quite appropriately it has been stated that if a worker commutes at any point during their normal working day to their usual work site, they are no longer a telecommuter because their commute journey has no longer been substituted by the practice of working at home (Handy and Mokhtarian, 1996). This observation is especially important when teleworking is being considered from a transport perspective. The British Labour Force Survey (LFS)[1] has defined occasional teleworkers as workers who do not usually work from home but have done so for at least one day in the survey reference week. This definition of 'occasional' telework carries the implicit assumption that telework on a given day indicates the same location of work for the whole day - and thus that no commute takes place.

1.2. Varied-spatiotemporal working

It has perhaps been taken as given that homeworking is something measured in whole day units and that when practiced, commuting does not take place. Yet this rather constrains the spatio-temporal context of homeworking and its commute consequences. Given the rapid penetration of ICTs into many people's lives and homes, it seems appropriate to relax the interpretation of homeworking, thereby changing its unit of measurement and, potentially, the commute implications. Suppose homeworking is now defined as "working at home on a given

[1] "The Labour Force Survey (LFS) is the principle source of statistics on teleworking in the UK" (Ruiz and Walling, 2005). The LFS in fact covers Great Britain (GB) (England, Scotland and Wales) as opposed to the whole of the UK (England, Scotland, Wales and Northern Ireland)

day for a continuous period of at least 30 minutes". It seems likely that with such a definition, a far greater number of people on any given day may be homeworking than measurements such as those made by the LFS would suggest. This new definition caters for a set of types of working day as follows:

W all work takes places at the workplace;
H all work takes place at the home;
H-W at least 30 minutes of work takes place at the home followed by the remainder of work taking place at the workplace;
W-H work first takes place at the workplace followed by at least 30 minutes taking place at the home;
H-W-H at least 30 minutes work takes place at the home followed by work at the workplace and concluding with at least 30 minutes work at the home; and
O other spatio-temporal patterns of work which may involve work at other locations.

What is meant by 'workplace' is perhaps increasingly ambiguous as pointed to by Davenport and Pearlson (1998). For some individuals their home is their workplace (or main place of work) while for nomadic workers their workplace may be variously a car, train, hotel or an airport departure lounge. In the context of our expanded definition of homeworking offered above, we define 'workplace' as 'the specific spatial location that is the destination when an individual makes a commute trip from home'. We choose to define collectively the working days 'H-W', 'W-H' and 'H-W-H' as *varied-spatiotemporal working* or *VST working*.

1.3. Commute displacement

Working day 'H' reflects a removal of the day's commute trips. Teleworking in this context has been viewed as a potential remedy to congestion (Balepur et al, 1998; Dodgson et al, 2000; and Freeman, 1996). It has also been noted, however, that removal of commute trips (or their reduction in length) can be offset by the generation of new (car) trips arising from teleworking (Mokhtarian, 1996; 1998; 2003). Mokhtarian has pointed to the possibilities of complementary travel arising from teleworking: teleworkers may make additional trips that would previously have been combined with their commute; another household member may switch transport mode because a free vehicle is available at the house; or the teleworker may live further away from the daily workplace thus making longer if fewer commute trips (Lund and Mokhtarian, 1994).

In contrast to 'H' working days, VST working days reflect a possible *displacement* (as opposed to replacement or removal) of one or both of the commute trips. Displacement is not

certain to occur because such working days may reflect an individual extending their working day by working at home whilst preserving the pattern of work at the workplace in terms of its duration and the temporal position of the commute trips. De Graaff and Rietveld (2004) suggest that even though teleworkers do not need to travel at peak times there appears to be an intrinsic need to continue doing so. However, if displacement does occur it could have important implications for understanding present and future patterns of traffic, especially in urban areas. It could be argued that the benefits of substituting the commute journey by working at home have largely been lost on a VST day - the number of vehicle miles travelled (VMT) and vehicle emissions may remain largely unchanged. However, some significant benefits could remain. Displacement of commutes on VST working days could contribute to peak spreading whereby more effective use of the transport system's temporal carrying capacity is made in terms of reduced traffic in a given period of time and thus reduced congestion. Alternative routes may be used, including perhaps shorter distance routes which would otherwise be avoided if travelling on a normal 'W' day because of traffic levels. Consequently a positive impact on vehicle emissions could result. It may also be that VST working is less prone to the complementary travel effects associated with whole day homeworking ('H'). That the commute journey still takes place provides potentially an opportunity for chaining the commute with other trips (such as grocery shopping or escort journeys) rather than such trips occurring alone. Where VMT is not reduced, residential relocation may be less likely. This said, an individual may practice both VST working and whole day homeworking on different days painting a yet further complex picture. Allied to travel consequences, prolonged periods of working at home may have negative social and organisational effects (e.g. Bailey and Kurland, 2002; Baruch and Nicholson, 1997; Standen, 2000) - VST working may overcome some of these issues.

1.4. Measurement of teleworking trends in Britain

Estimating the prevalence of individuals who work at home has been made difficult because of the lack of consensus on definitions. The LFS considers individuals who are employed, individuals who are self-employed, unpaid family workers and individuals in full and part-time employment. It chooses to define homeworkers as those individuals who work *mainly* from home (or have home as their main working base). Those homeworkers who use a telephone and computer are termed teleworkers and those individuals who *need* to have a telephone and computer to work at home are termed TC teleworkers. It also acknowledges individuals who worked at least one day from home in the reference week using a telephone and computer as 'occasional teleworkers' – these numbered some one million in the Spring 2005 survey (Ruiz and Walling, 2005). Ignoring these, there were some 3.1 million homeworkers in GB in 2005 compared to 2.3 million in 1997 (a 35 per cent increase) (ibid). 8

per cent of the GB workforce were classed as teleworkers in 2005 of which 62 per cent were self-employed. Only 4 per cent of employees were teleworkers in 2005 (though this excludes occasional teleworkers) (ibid). Earlier reporting based on the LFS (Hotopp, 2002) found that alongside a 29 per cent increase in teleworkers between 1999 and 2001, the increase in occasional teleworkers was most dramatic, having gone up by nearly half (with 82 per cent of occasional teleworkers being employees, rather than self-employed).

Latest LFS reporting (Ruiz and Walling, 2005) chooses to exclude occasional teleworkers because it is argued that "is not entirely accurate to classify these individuals as occasional teleworkers, because some people may have teleworked during the reference week but do not often do so, while others may occasionally telework but did not do so during the reference week". From the perspective of gauging potential impacts on commuting this is somewhat unhelpful. A substantial number of individuals occasionally teleworking can be as significant as a smaller number of individuals teleworking more often. Indeed, the most important segment of the labour force in terms of teleworking trends over time could be those individuals who are employees and who, on average, work from home one or two days each week. At present the LFS is not designed to distinguish between VST working days and 'H' days. It may be the case that in some instances VST days are being reported by LFS respondents as working from home days thus registering the individuals as occasional teleworkers.

1.5. Paper outline

Having articulated a broader definition of homeworking, a number of potentially important research questions present themselves:

1. How extensive is the practice of VST working (when compared to that of 'H' working)?
2. To what extent do VST working days result in commute displacement?
3. If displacement occurs is it caused by workplace, domestic or traffic/commute factors?
4. Is VST working increasing over time?

This paper reports on research that is being undertaken to address these questions and seeks to provide insights if not comprehensive answers concerning the first three of them. The research takes the form of a longitudinal survey which is examining the working patterns in a given reference week of c1000 members of the GB labour force. The research methodology is presented in the following section. Subsequent sections present and discuss the findings from the first wave of the survey.

2. Research methodology

2.1. Sample

The LFS reveals that most teleworkers are self-employed. However, the primary interest of this study is the impact of homeworking on the commute to the workplace. The survey methodology as explained below makes use of a panel of 120,000 weekly Internet users. Accordingly, the population of interest was defined as the GB adult (18-64) population of weekly Internet users in full-time paid employment. The intention in sample selection, given the sample size achievable with the available resources, was to secure a range of respondents from across the population of interest, as distinct from pursing a truly representative cross-section[2]. Sample quotas were set relating to gender, age, occupation (blue/white collar workers) and GB region. The resulting sample of 1014 individuals is outlined in Table 1[3].

Table 1 Sample composition (n=1014)

Gender		Age (years)		Occupation*	
Male	584	18-24	137	Blue collar	320
Female	430	25-34	222	White collar	694
		35-44	212		
		45-54	234		
		55-64	209		

'Blue collar' is categorised as: skill trades occupations, personal service occupations, process, plant and machine operatives, and semi-skilled occupations

'White collar' is categorised as: managers and senior officials, professional occupations, associate professional and technical occupations, administrative and secretarial occupations, and sales and customer service occupations

[2] By comparison, the LFS quarterly survey samples 60,000 households (http://www.statistics.gov.uk/StatBase/Source.asp?vlnk=358&More=Y)

[3] The results from the LFS conducted at the same time as the study survey can be found online at http://www.statistics.gov.uk/onlineproducts/lms_hqs.asp#employment. These show the survey sample profile to be over representative of females (females represent 35 per cent of those in full-time employment, while representing 77 per cent of those in part-time employment), to closely represent the proportion of 18-24 and 25-34 year olds while somewhat less well representing those aged 35-64 (although comparable figures are not directly available) and to closely represent the overall split between white and blue collar workers (as classified by this study).

Teleworking studies have tended to demonstrate less interest in ‘blue collar’ workers (though there are exceptions, e.g. Orr (1996) and Zuboff (1988)). Although it might be assumed that ‘white collar’ workers will constitute the majority of homeworkers and ‘blue collar’ workers the minority, the extent of ‘blue collar’ homeworking is not known, especially when part-day homeworking is taken into account.

2.2. Survey design

A questionnaire survey was designed which centred upon capturing feedback from respondents on their pattern of work during the previous ‘reference’ week. For each day of the week (Monday to Friday) a set of nine questions was used. The suitability of requiring retrospective recall of activity was tested in focus group sessions and subsequent survey piloting.

Questions (and response options) were based both on the previous literature and on earlier qualitative research. For each day within the reference week respondents were provided with options that *best* described their working day. Prior to selecting a work pattern, respondents were reminded that they should have spent a minimum of 30 minutes working in a given place, and were provided with the following definition of workplace: ‘workplace is defined as the destination after your commute from home’. Respondents were able to choose from the following seven options: worked at my workplace only (W); worked at home only (H); worked at home and then at my workplace (H-W); worked at my workplace and then at home (W-H); worked at home then my workplace then at home (H-W-H); did not work today; and other working pattern (O).

Working at the workplace, then at home, then at the workplace was excluded from the list of options as this was not highlighted as a working pattern during qualitative research. Further, it is unlikely that a respondent would travel the workplace, then home, and then back to the workplace during the day as this would involve four commute journeys.

Respondents were then asked to indicate the time at which they left home to commute to the workplace, and the time that they left the workplace to commute home by selecting from predefined 30 minute time-bands. They were subsequently asked for the *main* reason that they left the home when they did (to commute to the workplace) and the main reason for leaving the workplace when they did. Respondents were able to choose from the following options: usual/expected working day; specific work commitment that day; responsibility towards a child or other dependent; personal/household obligation; joint travel arrangement with

someone else; avoiding traffic; public transport availability; no particular reason; and other. Categories were again based upon the preceding qualitative research.

Respondents were also asked to rate, for the time spent working at home, how important the lack of disruptions were to how they worked at home - previous research suggests that individuals may choose to work at home because of the lack of interruptions leading to a (perceived) increase in productivity (Apgar, 1998; Baruch and Nicholson, 1997). Additionally, they were asked to rate how important access to a computer, internet and phone were to how they worked at home - this was intended to gauge the role of ICT as a facilitator or enabler of homeworking (noting that the entire sample is comprised of weekly Internet users).

2.3. Survey methodology

The survey was administered as an online questionnaire. NOP (now GfK-NOP[4]) is a market research organization in the UK that has assembled a panel of weekly Internet users which, at the time of survey implementation, comprised some 120,000 individuals. Quota sampling was used to secure completed responses from the panel. Members of the panel were sent an email invitation which contained a Web link which if followed took them to the screen-by-screen Web questionnaire. Respondents were invited to participate in the survey between 18th March and 25th March 2005. A longer period was not permitted due to issues of recall accuracy concerning the reference week beginning Monday 14th March 2005. The reference week coincided with the time of year used for the Spring LFS and avoided the Easter public holiday period.

To minimise respondent burden, a 5-day week (Monday to Friday) was selected over a 7-day week. In using this approach it was acknowledged that some respondents would have a working week that involved weekend working instead of or as well as time working between Monday and Friday. However, a particular concern of the study is to establish to what extent VST working might impact upon peak-period commute congestion and thus weekday as opposed to weekend homeworking was of primary interest.

Although the number of surveys conducted over the Internet are dramatically increasing (Witt, 1998), it is acknowledged that using such a method is subject to sampling bias. In the last quarter of 2004 prior to the survey, 52 per cent of households in the UK had Internet access at home (ONS, 2004). Although more households have access to a telephone, reaching potential respondents may remain problematic as respondents are either unreachable (unlisted

[4] http://www.gfknop.co.uk/

telephone numbers) or decline to participate (Dillman, 1999; Satmetrix, 2001). Online surveys are less subject to interviewer bias (Green et al , 2001) and less prone to socially desirable answers (Burke 2000). They have, however, previously been criticised for their poor response rates (Dillman & Bowker, 2002). At the time of the survey, NOP were using an online loyalty scheme 'ipoints', enabling respondents to collect points that can later be exchanged for products - a system designed to guard against low response rates.

The survey has been designed as a longitudinal instrument to be used on a total of four occasions at 1-year intervals. This paper reports only on the responses received for wave 1.

3. Survey findings

Survey findings are presented and examined in relation to the research questions identified earlier.

3.1. How extensive is the practice of VST working?

Table 2 provides an overview of the incidence of different combinations of working during the reference week[5]. This reveals that 143 respondents (14 per cent of the sample) undertook at least one day of VST working ('H-W', 'W-H' or 'H-W-H'). This compares with 63 respondents (6 per cent of the sample) who undertook at least one full day of homeworking ('H'). Only 21 individuals had a combination of VST and 'H' working in the reference week – 85 per cent of those who undertook VST work did not have a full day of homeworking and 67 per cent of those who worked a full day at home did not undertake a VST day. 327 days of VST work were recorded for the reference week. This compares to 142 days of 'H' work.

These results reveal two things for this sample. Firstly, the number of *workers* who did some homeworking during the week (when defined as a minimum of 30 minutes) is three times as high as the number of workers who did at least one whole day of homeworking (185 compared to 63). Secondly, the number of *worker days* being influenced by homeworking is over three times as high as 'whole day' definition and monitoring would suggest (469 compared to 142). That so many more individuals are practicing *some* homeworking may point to a potential for the incidence of homeworking per individual to increase if they

[5] It should be noted that Table 2 includes individuals who did not report working a full five days in the reference week (for reasons such as holiday, sickness or weekend working) – 666 individuals reported a full five days of work. The equivalent to Table 2 was prepared for this sub-set, revealing that the overall proportions of individuals undertaking VST and or 'H' days were similar.

practice this more often over time, with possibly more substantial consequences for commuting. The cross-sectional single wave data cannot of course provide an indication of whether VST (and 'H') working days are on the increase or whether they will continue to increase.

Table 2 Frequency of working patterns during the reference week

		Number of VST days worked						
		0	1	2	3	4	5	Total
No. of 'H' days worked	0	829	57	20	12	13	20	951
	1	15	6	4	0	4		29
	2	4	1	3	1			9
	3	10	2	0				12
	4	6	0					6
	5	7						7
	Total	871	66	27	13	17	20	1014

Table 3 Incidence of types of working day during the reference week

Day type	Day of reference week					
	Mon	Tue	Wed	Thu	Fri	Mean
W	717	767	745	729	720	736
H	29	26	27	26	34	28
H-W	14	12	12	14	18	14
W-H	71	35	37	32	23	40
H-W-H	11	13	12	14	9	12
Other	39	36	37	39	33	37
Not working	133	125	144	160	177	148
Total	1014	1014	1014	1014	1014	1014

Table 3 considers the incidence of working day types during the reference week. It shows that by far the most common form of VST working is 'W-H'. This may start to point to any temporal consequences for the commute of VST working being centred upon the commute home from the workplace rather than applying in equal measure to the am and pm commutes. Whole day homeworking ('H') is evenly practiced across the working week with a slightly higher incidence on Friday. Meanwhile, 'W-H' working is much more common on Monday than any other day and practiced rather less on Friday. Other forms of VST working seem evenly spread across the week though again for 'H-W-H' this is less common on a Friday.

Of those who did at least one ‘H’ day and no VST days, 67 per cent were male, the average age was 43 and 7 per cent were blue collar workers . Of those who did at least one VST day and no ‘H’ days, 46 per cent were male, the average age was 42 and 22 per cent were blue collar workers. However, note that 58 per cent of the overall sample were male and 32 per cent were blue collar workers – accordingly, Table 4 presents results for gender and occupation type sub-samples. Thus if account is taken of workers who did some homeworking during the week (when defined as a minimum of 30 minutes) this reveals the following. Albeit that females are over-represented in the sample, the practice of homeworking is not as dominated by male, white collar workers as had previously been thought. Indeed, females appear much more likely to VST work than males and accordingly are more likely to homework than males. (Previous teleworking literature suggests that working at home is more common amongst males (LMT, 2002; Luukinen, 1996; Olszewski and Mokhtarian, 1994)). When considering only whole day homeworking, white collar workers are more than five times more likely to homework than blue collar workers. Once part-day (30 minutes or more) homeworking is considered, this reduced to twice as likely to. It seems that male, white collar workers remain the primary source of commute removal because of homeworking, while female and blue collar workers make a more substantial contribution to the *potential* for commute displacement.

Table 4 Proportion of sub-sample with pattern of work involving homeworking (%)

Pattern of work in the reference week	Gender		Occupation	
	Male	Female	White	Blue
At least one ‘H’ but no VST	4.8	3.3	5.6	1.0
At least one VST but no ‘H’	9.6	15.3	13.7	8.5
At least one ‘H’ or VST day	16.8	20.2	21.8	10.6

Table 5 indicates the breakdown of individuals practicing each form of homeworking according to job category. The job categories remain too coarse to fully appreciate the types of roles and of work involved under these headings for specific individuals. Nevertheless, the figures do point to the commonly recognised feature of homeworking in all its forms – it is substantially the preserve of managers, senior officials and professionals.

The implications of VST working for transport would depend upon the modes of travel being affected. Considering all ‘W’ days worked in the reference week, the commute mode split was as follows: car (driver) – 63 per cent; car (passenger) – 8 per cent; bus – 7 per cent; train – 7 per cent; walk – 9 per cent; and other – 6 per cent. For all VST days, the commute mode split

was: car (driver) – 71 per cent; car (passenger) – 3 per cent; bus – 8 per cent; train – 6 per cent; walk – 6 per cent; and other – 6 per cent. Thus the mode split on 'W' days compares very closely with that on VST days suggesting that VST working does not noticeably affect mode choice or conversely that commute mode is not shown to be a particular determinant of people VST working. As expected, these results also confirm that the main potential impacts of VST working concern car traffic. Nevertheless, over 1 in 10 VST days are associated with public transport commuting. It could be inferred that VST working in such instances allows individuals to better accommodate the fixed timetabling (and possibly low frequency) of public transport.

Table 5 Incidence of types of working day during the reference week – % of day type category (number of respondents in brackets)

	Job category	Type of homeworking practised				
		H	H-W	W-H	H-W-H	Mixed VST*
White collar	Managers and Senior Officials (144)	37 (23)	-	17 (13)	30 (3)	17 (6)
	Professional occupations (197)	27 (17)	35 (7)	35 (27)	30 (3)	46 (16)
	Associate professional and technical occupation (118)	11 (7)	10 (2)	10 (8)	10 (1)	14 (5)
	Administrative and secretarial occupations (182)	13 (8)	15 (3)	10 (8)	20 (1)	3 (1)
	Sales and customer service occupations (53)	2 (1)	5 (1)	4 (3)	10 (1)	9 (3)
Blue collar	Skilled trades occupations (155)	6 (4)	5 (1)	13 (10)	-	6 (2)
	Personal service occupations (51)	3 (2)	15 (3)	8 (6)	-	3 (1)
	Process, plant and machine operative (57)	-	10 (2)	4 (3)	-	3 (1)
	Semi skilled occupations (57)	2 (1)	5 (1)	-	-	-
	Total (1014)	100 (63)	100 (20)	100 (78)	100 (10)	100 (35)

* Individuals who practiced two or three different forms of VST working during the reference week

Table 6 corresponds to Table 2 and is intended to highlight whether the relative home-workplace locations in distance and time appear to relate to the working patterns involving homeworking. There is some indication of a consequence of relative location although the number of respondents reflected in some cells is very small thereby restricting the ability to draw any robust conclusions. Nevertheless it seems that those who engage in VST work but not whole day homeworking tend to live in close proximity to their workplace and (on average) 'enjoy' what appears to be only a modest commute duration. Although the picture is mixed, those who live further from their workplace appear more likely to include *whole day* homeworking as part of any pattern of homeworking during the week. The

association of VST-only homeworkers with short commutes and the higher incidence of VST working compared to whole day ('H') homeworking suggests the following. VST working could, potentially (if commute displacement occurs), more substantially affect traffic levels and thus congestion in urban areas by virtue of the *number* of commute trips affected (assuming the home and/or workplace to be located in many instances in the urban area[6]) rather than affecting VMT by virtue of the *lengths* of commute trips affected.

Table 6 Mean commute distance (miles) and time (in minutes and shown in brackets) according to working patterns during the reference week

Number of 'H' days worked	Number of VST days worked: 0	1	2	3	4	5
0	5-10 (<=15)	5-10 (<=15)	5-10 (<=15)	5-10 (16-30)	5-10 (<=15)	5-10 (<=15)
1	10-25 (46-60)	5-10 (16-30)	5-10 (<=15)	-	10-25 (46-60)	
2	5-10 (<=15)	10-25 (16-30)	2-5 (46-60)	10-25 (46-60)		
3	10-25 (46-60)	25-50 (61-90)	-			
4	<1 (<=15)	-				
5	2-5 (16-30)*					

Distance and time bands are those identified by respondents outside of reporting on the reference week (i.e. they implicitly refer to the norm or typical values)

*In all cells except this one the am and pm average bands are the same – for this cell the am commute time is 16-30 mins; the pm commute time is 31-45 mins

Table 7 summarises the importance or not of having a phone, computer, Internet access and no interruptions on VST and 'H' working days. This underlines the impact ICTs appear to have had on working practice. For the study sample, having a computer is a prerequisite of 'H' working. The results suggest that email may now be more important (or certainly more extensively used) than phone calls for communications. The *relative* importance of these

[6] 76 per cent of those who undertook one or more days of VST working live in a town or city; 87 per cent work in a town or city.

different working aids is the same for VST days as for 'H' working days but the *actual* importance of each aid is lower on VST days. This lower importance on VST working days is likely to underline the fact that the duration of the homeworking period(s) on VST days will have been (considerably) shorter than on 'H' working days – thus avoidance of interruptions would be much less critical in many instances. The lower reliance on ICTs suggests a different mix of work tasks is undertaken during VST working than on 'H' working days.

Table 7 Importance of different working aids to homeworking (% of respondents answering 'Important', 'Very important', or 'Not important')

	VST working days		'H' working days	
	Important / Very Important	Not important	Important / Very important	Not important
Phone	63	37	85	15
Computer	83	17	99	1
Internet	76	24	94	6
No interruptions	59	41	77	23

3.2. To what extent do VST working days result in commute displacement?

Further to having established that VST working is occurring at levels considerably higher than 'H' working, we now move to the important question of whether or not such a working practice impacts upon commute trips. Within the reference week, Monday is the day with the highest incidence of VST working and the highest incidence of 'W-H' working. Figure 1 shows, for all respondents who made a commute trip on Monday, the distribution of departure times from home to the workplace for working day types 'W', 'H-W' and 'H-W-H' (Figure 1a) and from the workplace to home for working day types 'W', 'W-H' and 'H-W-H' (Figure 1b). Attention should first be drawn to the number of respondents in each category of working day type before commenting on the distributions.

For the morning commute, it seems that the practice of 'H-W' may overall be displacing commuting forwards in time (i.e. later departure). The interpretation for 'H-W-H' is less clear. For the evening commute it seems that the practice of 'W-H' may be displacing commuting backwards in time (i.e. earlier departure), albeit to a modest extent. Again the interpretation for 'H-W-H' is less clear. Figure 2 corresponds to Figure 1b displaying the departure time distributions on Friday. This is provided to highlight that, for this sample, the depature time profile for each working day type does change across the week. 'Normal' commuting home from the workplace (corresponding to 'W') overall tends to take place earlier on Friday than

Monday. ‘W-H’ working seems to result in a more pronounced displacement of commuting backwards in time (i.e. earlier departure) on Friday.

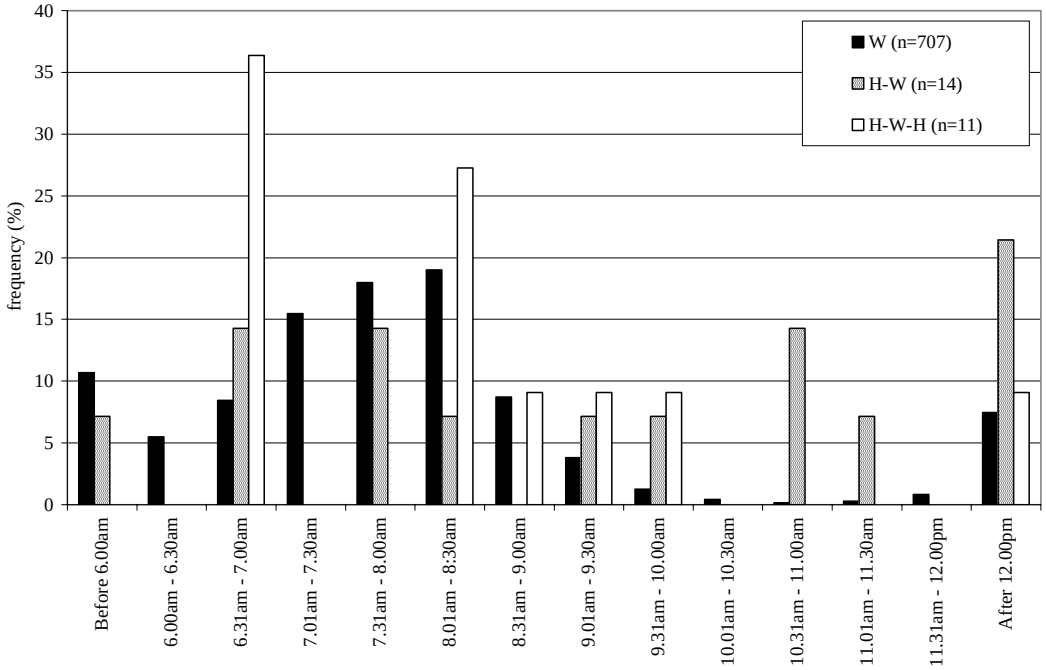

Figure 1a Distribution of departure times from home to the workplace on Monday[7]

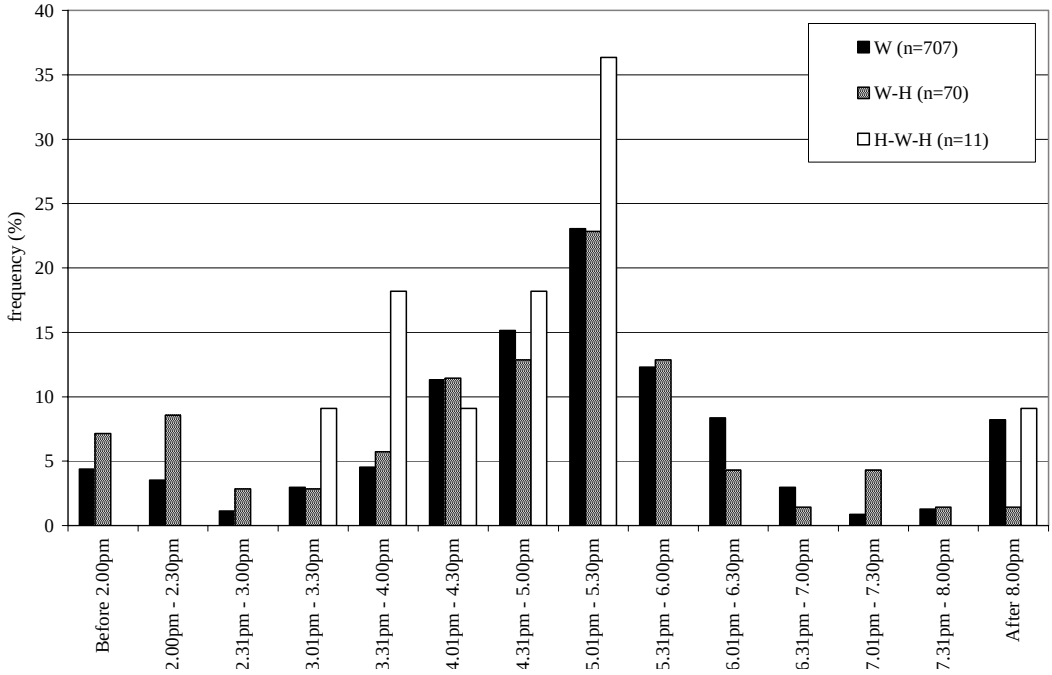

Figure 1b Distribution of departure times from the workplace to the home on Monday

[7] For ‘W’, n=707 in Figure 1a whereas in Table 3 the figure is 717. The difference of ten respondents is attributable to a ‘N/A’ response being entered for departure time question. Any discrepancies in Figures 1b and 2 are similarly explained.

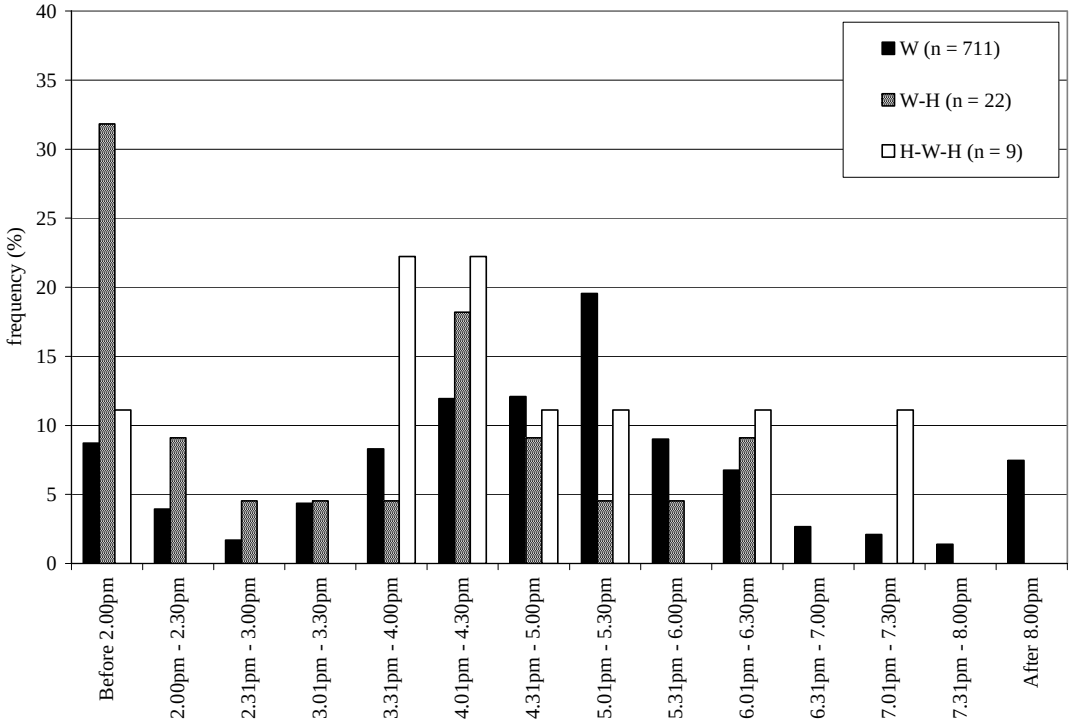

Figure 2 Distribution of departure times from the workplace to the home on Friday

It should be noted that the distributions by type of working day on different days of the week do not relate to the same sets of individuals (particularly for VST working). The distributions also reflect individuals living and working in different parts of the UK and local traffic conditions (and therefore potentially the mean departure times for commuting) may vary from one area to another. The 'working hours' norm for each individual's employing organisation may also be different. Nevertheless, it appears that some displacement in the aggregate departure time distributions can be attributed to VST working. With the sample sizes available it is not possible to determine easily with more confidence the nature and extent of that displacement.

3.3. If displacement occurs is it caused by workplace, domestic or traffic/commute factors?

Respondents were asked: 'What was the MAIN reason for leaving the workplace [or home] when you did?'. The potential importance behind this question is as follows. If, from a transport policy perspective, commute displacement is a desirable form of demand management, then there is a need to understand not only the propensity for or extent of VST working but the causal factors of any displacement, or lack of it. If, for example, the main determinant of when people leave the workplace on VST days is related to the *workplace* then any initiative to influence the nature of commute displacement might need to be channelled

through employers and their guidelines or constraints about in-office working hours and flexibility. If, on the other hand, the main determinant of when people leave the workplace on VST days is *commute* related then it may be that external intervention is not warranted or as important because individuals will themselves respond to traffic conditions such that peak-spreading becomes a 'natural' was of responding to congestion. A third category of determinants of displacement could be labelled '*domestic* related'. Thus it may be the opening/closing times of schools that are dictating (a proportion of) the commute departure time profiles of VST working days.

Table 8 Reason for departure time from workplace to home on Monday in reference week (percent of all respondents per type of working day who gave a reason)

Reason	Type of working day				
	W (n=712)	H-W (n=14)	W-H (n=71)	H-W-H (n=11)	O (n=37)
Usual/expected working day[1, potentially]	75	64	68	82	44
Specific work commitment that day[1]	7	21	11	9	28
Responsibility towards a child or other dependent[3]	2	7	6	0	3
Personal/ Household obligation[3]	2	0	0	0	0
Joint travel arrangement with someone else[2]	2	0	0	9	0
Avoiding traffic[2]	2	0	4	0	0
Public transport availability[2]	2	0	0	0	3
No particular reason	5	7	6	0	13
Other	3	0	6	0	9

[1]workplace-related reason
[2]commute-related reason
[3]domestic-related reason

As an example, Table 8 shows the different reasons given for the different types of working day for departure time from the workplace to home on Monday (corresponding to Figure 1b). Regardless of the type of working day, the most common reason for the departure time is 'usual/expected working day'. This is not surprising given the routine and habitual nature of commuting behaviour for many people. It is, however, perhaps more unexpected for VST days, particularly if an impact on the commute is assumed on VST days. For individuals giving this reason for VST days, two associated explanatory points arise. The first is that no discernable effect on the person's commute time occurs on the VST day. Accordingly, homeworking on that day is extending the hours they work for the day rather than changing the time(s) of the commute(s) within the working day. The second is that the individual's

commute *is* displaced on a VST day relative to that on a 'W' day but that their practice of VST working has become ritualised such that they now consider the 'MAIN' reason for their commute behaviour as being associated with 'usual/expected'. Where this second point applies it would have been desirable, in hindsight and given more space in the questionnaire, to have probed further to determined whether the underlying reason for their habitual behaviour on a VST day was workplace, commute or domestic-related.

Nevertheless, there remains a sizeable proportion of respondents for each type of working day that gave other reasons for their commute departure time home on Monday. For those practising VST working, the main other reason concerned a specific work commitment. This was more common for VST working than for 'W' working.

It had been anticipated that at the level of the individual, VST days and 'W' days could be compared to establish whether VST commutes were earlier, similar or later. However, by looking at specific individuals' reference weeks, a reminder is provided of the complexity of real life which makes both its capture by a survey instrument and the interpretation of aggregated data challenging. Table 9 shows the reference week commuting pattern for six selected individual respondents who undertook at least one day of W-H working.

Respondent 12488 had two 'identical' days in the workplace on Wednesday and Friday, did not work on Thursday, homeworked all day on Tuesday and W-H worked on Monday when the am commute was as usual but the pm commute was earlier than 'normal'.
Respondent 13077 had an 'other' type of working day on Monday, Wednesday and Friday, each with different am commute times – one of which was considered 'usual' and corresponds to the days at the workplace on Tuesday and Thursday. The pm commute was similar on all days of the week including Tuesday which was a W-H day (suggesting no commute displacement).
Respondent 303173 had four days in the workplace only and one W-H day (Wednesday). On all five days the am commute took place at the same time for reasons of avoiding traffic. The usual departure time for the pm commute was 5.01-5.30pm. On three days for different reasons this departure time changed, including the W-H day when a responsibility towards a child or other dependent had to be met.
Respondent 21787 did not work on Thursday. For the other four days the am commute was connected with responsibility towards a child or other dependent and was the same each day. Monday was a W-H day but the pm commute was 'the same' as that for Tuesday which was spent working only in the workplace. A specific work commitment resulted in a late pm commute on Wednesday. Friday was a slightly earlier pm commute than other days but

considered ‘usual’.

Respondent 172784 had three different types of working days. ‘Usual’ am commutes were similar but not the same across the week. Leaving the workplace at 5.31-6.00pm was ‘usual’ (Thursday). On other days the pm commute varied and with different reasons e.g. having a personal/household obligation, or a work commitment.

Respondent 187429 had four days of working only in the workplace and one day of W-H working (Monday). The pm commute appears to occur routinely at 4.31-5.00pm even for the W-H day (no commute displacement) except for Friday when it seems ‘usual’ to leave the workplace earlier. The am commute is the same on all days except on Friday when a specific work commitment displaces the commute making it earlier.

Consideration of these six individuals serves to illustrate that some individuals appear to have more of a pattern and repeatability or consistency to their working week than others. Across individuals there is a multiplicity of different types of weekly patterns of commute and associated determinants which is masked in the process of aggregation. This said, across all respondents, 68 per cent stated that the reference week was typical, 17 per cent that the week was atypical and 15 per cent stated that they did not have ‘typical’ weeks. A slightly higher proportion of individuals who had undertaken VST work indicated not having ‘typical’ weeks. For those individuals for whom the reference week consisted of five ‘W’ working days (n=489), 63 per cent departed from home for the workplace in the same time band every day and 53 per cent departed from the workplace for home in the same time band every day (and 86 per cent considered the reference week to be typical[8]). This may suggest that traditional ‘W’ working in relation to transport issues is more predictable than for what may be an emerging trend in VST working. However, this said, of those who VST worked at least once (and who worked for the full five days of the reference week) 82 per cent said it was a typical week.

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Table 9 Reference week commuting pattern for selected individual respondents who undertook at least one day of W-H working

	Respondent ID	12488	13077	303173	21787	172784	187429
Monday	day type	W-H	Other	W	W-H	W-H	W-H
	time left am	8-8.30	7-7.30	7-7.30	7.30-8	7.30-8	8-8.30
	am reason	usual	specific	avoid	child	usual	usual
	time left pm	3.30-4	6.30-7	4.30-5	5-5.30	5.30-6	4.30-5
	pm reason	specific	usual	personal	usual	other	usual
Tuesday	day type	H	W-H	W	W	W-H	W
	time left am	-	8-8.30	7-7.30	7.30-8	7.30-8	8-8.30
	am reason	-	usual	avoid	child	specific	usual
	time left pm	-	6-6.30	5-5.30	5-5.30	6-6.30	4.30-5
	pm reason	-	usual	usual	usual	other	usual
Wednesday	day type	W	O	W-H	W	H-W	W
	time left am	8-8.30	9.30-10	7-7.30	7.30-8	8-8.30	8-8.30
	am reason	usual	specific	avoid	child	usual	usual
	time left pm	5-5.30	6-6.30	4.30-5	7.30-8	7-7.30	4.30-5
	pm reason	usual	usual	child	specific	no reason	usual
Thursday	day type	not work	W	W	not work	W	W
	time left am	-	8-8.30	7-7.30	-	8-8.30	8-8.30
	am reason	-	usual	avoid	-	usual	usual
	time left pm	-	6-6.30	5-5.30	-	5.30-6	4.30-5
	pm reason	-	usual	usual	-	usual	usual
Friday	day type	W	O	W	W	W	W
	time left am	8-8.30	8-8.30	7-7.30	7.30-8	7.30-8	7-7.30
	am reason	usual	usual	avoid	child	usual	specific
	time left pm	5-5.30	6-6.30	6.30-7	4.30-5	4.30-5	3-3.30
	pm reason	usual	usual	specific	usual	personal	usual

'usual' = usual/expected working day; 'specific' = specific work commitment that day; 'avoid' = avoiding traffic; 'child' = responsibility towards a child or other dependent; 'personal' = personal/household obligation

4. Concluding discussion

Key findings from the first wave of this national survey of the GB workforce are as follows:

- the number of full-time employees who practice VST working and the practice of VST working itself is much higher than for conventional homeworking ('H') – almost double;
- the incidence of VST working is much higher than conventional homeworking for blue-collar workers;
- women are more likely to VST work compared to men while the reverse is true for conventional homeworking;
- commute mode is not shown to be a particular determinant of people VST working though most VST working is associated with car use;
- ICTs are an important feature of most VST working days though less so than for conventional homeworking days;
- 'W-H' seems by far the most common form of VST working with Monday being the most popular day of the week for VST working;
- VST working is associated with shorter commutes than conventional homeworking;
- there is evidence of some displacement of the commute brought about by VST working; and
- habit (perhaps largely concerning the workplace routine) mainly governs when commutes take place on VST days though commute and domestic-related reasons govern a minority of VST commute trip departure times.

Perhaps the most striking finding is the high incidence of VST working when compared to conventional homeworking. The study has not, however, revealed a substantial impact of VST working overall in terms of commute displacement. This may reflect a constraint of the 'conventional' work ethic where expectations of the employer and social norms of time dictate when an individual should work and travel (Steward, 2000).Two issues may be related to the limited extent of commute displacement. The first is that in this study we have defined VST working in terms of a minimum 30-minute working period in the home. This time period was chosen to avoid counting those individuals who undertook short 'top-up' work tasks at home as VST workers. Thus for example, spending ten minutes checking phone messages upon returning home or spending 5 minutes checking the daily diary before leaving home would not count as VST working in terms of its potential relevance to transport. What is not known from the survey is for how long an individual did in fact work at home on a VST day. It may be that most VST working sits closely to this 30-minutes minimum (with little consequent commute displacement) or it could reflect a range of working durations of up to

several hours.

The second issue is that of whether VST working constitutes a change to how the working hours of the day are arranged or whether it constitutes an *extension* to the working hours of the day. The former points towards commute displacement whereas the latter may suggest the conventional working day (and its associated commutes) are not impacted upon by VST working. It is certainly conceivable that a 'catch-up culture' could be developing whereby people are 'dipping into' their email messages in the evenings or early mornings with a sense of being able to do this to keep on top of workload and abreast of work-related activities. While not the focus of this research or paper this is an area which could have economic and social consequences as email (and the work tasks tied into it) seeps into home life thereby extending working hours but compromising work-life balance.

Nevertheless, the high incidence of VST working does point to the important *potential* for commute displacement. A much higher proportion of people are able to do some of their paid work in the home than previously thought. This may indicate a potential to do longer and more periods of paid work in the home if circumstances called for this. Such circumstances could be worsening congestion during peak commuting periods or (in future) congestion charging that provides a pricing signal for VST working to be used to displace the commute.

The results do point to a broadening of opportunity to homework across the workforce, moving away from the middle/senior management white collar male stereotype of homeworking (though the stereotype is still very well represented across those who homework). Such results return us to a wish to address the fourth of our research questions raised in the introduction to the paper. We do not know how VST working has evolved over time to date. It may be that VST working has been a feature of the labour force for some years. Alternatively, it may be a very recent phenomenon or certainly one whose incidence has rapidly increased in the face of ICTs and their penetration into the home. It remains important therefore to now attempt to follow how the incidence and makeup of VST working changes over time in future. The current study includes a further three waves of the survey which provides the opportunity to do so.

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