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Teleworking and housing demand

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ABSTRACT

The COVID-19 pandemic accelerated the trend towards teleworking. Many predicted that this would shift housing demand to the suburbs and homes with the potential for high quality office space. We examine these predictions using a survey of the working age population who live in the private housing sector. The majority in the sector are happy with their current home, but new teleworkers who plan to continue to do so – accounting for one fifth of the population – are characterised by a higher intention to move. Consistent with predictions, these teleworkers value a high quality home office more than others and are prepared to live further away from the centre to find it.

1. Introduction

Home working mandates are part of the measures that many governments implemented after March 2020 to slow transmission of the successive waves of the COVID-19 pandemic (OECD, 2021). In the UK, nearly 50% of the working population worked from home during the lockdowns in Spring 2020 and Winter 2021/22. Given that only 12% of the UK working population did so before the pandemic, many employees and employers learnt what teleworking entails. While working patterns after the pandemic are not yet clear, teleworking will be possible for many workers. A hybrid working pattern is likely with employees teleworking two to three days per week and spending the rest of the working time in their main workplace (Mizen et al., 2021).[1]

In this paper, we present evidence on teleworking experience and how this experience affects demand for home features. The data comes from a survey of respondents who are in employment and live in a home in the private housing sector in Scotland. The survey was administered in Autumn–Winter 2021.[2] Respondents provide not only detailed information on their teleworking experience, but also make a series of choices between their current and alternative homes. The alternative homes can have feature combinations that are not commonly seen in the housing stock, such as a home slightly larger than the current home, but closer to the city centre. The willingness to pay (WTP) for home features estimated with the choice data show that new teleworkers value high quality home offices more than others, but also that they value the amenities of cities just like others. This evidence complements the existing literature, which could not disentangle these effects. It is relevant to land use planners and policy makers, as it shows how to react to the new demand without increasing sprawl.

Teleworking allows people to unbundle where they work and where they live, although the effect is muted for hybrid working. This has motivated academic research and prompted commentary in the media about how teleworking could affect housing demand. First, teleworkers demand more spacious properties than non-teleworkers to accommodate a home office. Second, the use of public parks for recreation and exercise increased during the pandemic. This experience may have shown that living close to green space is beneficial.[3] Third, the demand of those who can telework should shift to the suburbs as effective travel cost are reduced for them, thereby flattening the price gradient and spreading the population over a larger area.[4] This effect would be similar to those trains, trams, and cars had in the past (Mieszkowski and Mills, 1993; Hayden, 2003). By increasing suburbanisation, teleworking

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[1] Web-Appendix A gives the data sources for the UK. In the US, the teleworking share in Spring 2020 was also close to 50% and hybrid working patterns are most likely in the future (Brynjolfsson et al., 2020; Barrero et al., 2021).

[2] Web-Appendix A provides context on COVID-19 exposure and measures to contain it in the UK, in particular during the survey period.

[3] ONS (2021) provides evidence of park use during the pandemic for the UK, Venter et al. (2021) provide evidence for Norway.

[4] There are other reasons to locate in urban areas than just work, such as opera houses and restaurants (Brueckner et al., 1999; Duranton and Puga, 2020). If important to teleworkers, such amenities will temper the wish to locate further away.

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could lead to more sprawl, reduce open space around cities, and may not even lead to more leisure (Rhee, 2008).

We find that teleworking experience and plans are positively associated with the Dingel and Neiman (2020) share of tasks that – for a given occupation – can be done from home. This validates the Dingel and Neiman (2020) measure for the UK labour market.[5] Of the respondents who experienced teleworking for the first time during the pandemic, 81.8% plan to continue afterwards, and the rest want to return to the office full time. The majority of those who plan to continue teleworking want to have hybrid working arrangements. Respondents who experienced teleworking for the first time during the pandemic and plan to continue are likely to have the most marked effect on housing demand. This type represents 31.6% of our sample and 18.9% of people in the private housing sector. We find that half of the respondents are happy with their current home, yet only 38% of homes have a high quality home office—a feature that should be important to teleworkers. The intention to move home is associated with respondents' age and household size, but also their teleworking experience. Respondents who plan to telework more in the future are more inclined to move.

In the experiments, 24% of respondents always choose their current home and we account for this with a hurdle model. We find that older age, home ownership, not living in a city area, and satisfaction with the current home all make this behaviour more likely. The estimated WTPs for home features are significantly positive for very good internet access and for a high quality home office. We find no significant evidence that a shorter walking time to greenspace is valued. The WTP for a home located closer to a town or city centre, however, is significantly positive. While we do not find that the price gradient for new teleworkers who want to continue teleworking is flatter, their higher WTP for a high quality home office translates into a willingness to travel around 21 min longer to a town or city centre to get a home with such an office. Therefore, our evidence supports the media commentary about the impact of teleworking on housing demand. Whether and how this will affect the housing stock and its spatial distribution depends not only on demand, but also on supply side factors and, not the least, how policy makers react.

There is a sizeable literature on teleworking. The first strand relates the teleworking potential of those working or living in an area before the pandemic to the growth of residential prices during the pandemic, see Althoff et al. (2022), Gupta et al. (2022), Liu and Su (2021), Ramani and Bloom (2021). All papers find a negative relationship between teleworking potential and rental growth. Papers that also examine teleworking potential and house price growth, find – with the exception of Ramani and Bloom (2021) – a negative relationship here too. As price growth in central urban areas is less than in suburban areas, the papers conclude that potential teleworkers became actual teleworkers during the pandemic and moved to the suburbs. The differential price growth during the pandemic implies a flattening of price gradients within cities, see Brueckner et al. (2023) and Gupta et al. (2022). Gupta et al. examine whether this will be permanent. As price-rent multipliers increased in central urban areas, but stayed fairly constant in suburban areas, they show that this implies – under plausible scenarios – that the market expects a revival of central urban areas. The second strand of the literature uses calibrated economic models to understand the possible long-run effects of teleworking, see Behrens et al. (2021), Davis et al. (2021), Delventhal et al. (2022), Delventhal and Parkhomenko (2022). The models consider interactions between labour, land use, and construction. Important modelling assumptions concern the degree to which teleworking can substitute for office work. Teleworking saves on travel, but face-to-face communication in the office seems more productive. Hybrid working for those who can telework seems a likely outcome. The impact on welfare is difficult to assess, but not everyone will benefit from a shift to more teleworking. The third strand of the literature uses surveys to understand the extend of teleworking during the pandemic and plans afterwards (Bick et al., 2021; Brynjolfsson et al., 2020). The comprehensive Survey of Working Arrangement and Attitudes (SWAA) has been fielded in 27 countries and also separately in the US and the UK, see Aksoy et al. (2022), Barrero et al. (2021), Mizen et al. (2021), respectively. On average, the surveys find that those who can telework, started to move to a hybrid working pattern in 2021 with two to three days in the office, a pattern that the average teleworker wants to continue with after the pandemic. Stanton and Tiwari (2021) is most closely related to our paper and examines how housing demand before the pandemic differed across teleworkers and non-teleworkers. Homes of teleworkers are on average larger and have higher prices per room. It is plausible that both the higher quantity and quality reflect the need for a good home office. Regarding the location of teleworkers' homes, Stanton and Tiwari (2021) do not find that these are further away from city centres.

The rest of the paper is structured as follows. In Section 2, we explain the design of the survey and the economic theory that underpins the experimental part. The technical implementation of the survey is described in Section 3. The results of the data analysis are presented in Section 4 and Section 5 concludes. The Web-Appendix contains additional information and we refer to it in the paper where appropriate.

2. Survey design

We use a survey to collect data for a representative sample of our target population: employed adults between the age of 18 to 67 years who live in a home in the private housing sector in Scotland. The upper bound on age ensures that we do not include people who are retired or at the end of their working lives. Only those in employment can be affected by teleworking and only those living in the private sector can readily change their housing demand. Accordingly, we do not consider people who rent in the public sector, which allocates housing based on administrative processes and not market principles. The effect of teleworking in the public sector would require a separate analysis.

2.1. Data for the target population

We collect data on respondents' socio-economic characteristics, teleworking experience and expectations, moving intentions, and features of respondents' current homes. The questions we use are similar to those from administrative surveys and the related survey literature.

Table 1 lists the socio-economic characteristics that we collect. The questions and response options for tenure mode, gender, and household size follow the UK census and the most recent Scottish Household Survey 2019 (SHS Project Team, 2020). The response options for age and location collect coarser information: respondents report their birth year and in which of the 32 local council areas they live in. This reduces the sensitivity of the questions to respondents and avoids collecting data that can be used to identify respondents.[6] Household income is measured in broad ranges to reduce the sensitivity of the question (Dillman et al., 2009). Respondents can refuse to report their income.[7]

The survey collects respondents' occupations using a drop-down menu, which provides titles for industry, sector, and occupation based

[5] For the US labour market, several studies have validated the Dingel and Neiman (2020) measure, see for instance Bick et al. (2021), Brynjolfsson et al. (2020).

[6] Using birth year rather than date of birth for the age calculation introduces only a slight upward bias as the survey was conducted at the year's end. The census uses the very finely grained UK postcodes, a level of locational detail not required in our analysis.

[7] Income is not collected in the census. In the SHS, people are asked to report precise income amounts, but data are missing for approximately 30% of respondents.

Table 1
Summary statistics for respondents' socio-economic characteristics.

	Survey		Experimental	
Owns home	0.81		0.79	
City	0.33		0.31	
Female	0.52		0.53	
Age	41.40	(12.61)	41.52	(12.39)
Number of adults	1.97	(0.81)	1.96	(0.80)
Number of children	0.66	(0.95)	0.66	(0.95)
Monthly income	–	–	3793.97	(1975.06)
N	1,068		964	

Reports for binary characteristics the mean and for continuous characteristics the mean and the standard deviation (in brackets). If respondents do not own the home, then it is rented privately. City means that the respondent lives in one of the four city council areas: Aberdeen, Dundee, Edinburgh, Glasgow. Otherwise, respondent lives in one of the remaining 28 local council areas. Age is in years and income in GBP. N is the number of respondents. The analysis of the experimental data requires respondents' income. 54 respondents do not report income and are not considered in the analysis of the experimental part. We also exclude 50 respondents from the analysis who report prices for the home they own that are implausibly small.

on the Tijdens (2019) database. For instance, a respondent would select the industry *finance, banking and insurance*, then the sector *finance, economics* and eventually the occupation *financial advisor*. Tijdens (2019) provides the two-digit ISCO-08 codes of the International Labour Office (2012), so that the occupation titles can be linked to the teleworkable jobs shares of Dingel and Neiman (2020). Following Barrero et al. (2021) and WFH Research (2022), the survey asks respondents about their teleworking experience during the pandemic (the number of paid work days per week they teleworked) and the number of days they would like to telework in the future. Respondents also assess whether their employer would support this.

The variables gathered about respondents' current home ask about their moving intentions and features of their current home. Both play a prominent role in the debate on teleworking and housing demand.

Table 2 lists the home features in its first column. The quality of the home office is of utmost importance for those who telework. The office should be permanent and in a quiet room with good natural light. Effective teleworking requires video conferencing, software and document downloads, and the use of cloud computing services. This makes high-quality internet access from home essential. Respondents are asked to rate the quality of the office space and internet access in their current home.[8] We measure the size of homes with the home type (flat or house) and the number of rooms, which is the conventional measure of size in the UK housing market.

Teleworking could affect demand for the home location. As fewer trips to centrally located company offices are required, homes away from noisy and polluted city centres might become more attractive. Respondents are asked to report the travel time to the closest town or city centre from their current home. It is also possible that locations close to green space become more attractive. Panduro and Veie (2013) find that out of eight types of green space, only parks have a significant effect on housing prices, and that the effect is positive. Therefore, we focus on this type of green space. Respondents are asked how long it takes them to walk to such a park from their current home. We describe a park using Panduro and Veie's definition with a photo to minimise perception differences across respondents.

The final feature owners are asked for is the market value of their current home, i.e., the price they expect to get if they were to sell the home. For renters, the feature is the monthly rent they pay for their current home.

[8] Shortened descriptions of the levels of home office quality and internet quality are given in the caption of Table 2.

2.2. Experimental part

In the experimental part, respondents are asked to make hypothetical choices between their own home and alternative homes that differ in a set of features. The resulting data, combined with econometric theory, will allow the estimation of WTP for the home features in Table 2. Choice experiments have been used widely in economics.[9] For private goods, hypothetical and actual choices are usually close and estimated WTPs converge, see Ferreira and Wong (2020), Kesternich et al. (2013), Kling et al. (2012), Mas and Pallais (2017), Wiswall and Zafar (2018).[10]

In each experimental task, respondents have to choose between their current home and two alternative homes. The respondent's current home is always included in each task to keep the choice situation realistic. The alternative homes in each task are generated on the spot based on a pivoted design, which is centred around the respondent's current home, see Table 3. This ensures that the alternative homes are affordable to respondents, not strongly dominated by the current home or too different from the types of homes the respondent would consider. As a result of the careful study design, respondents are asked to choose between their own home and alternative homes that are variations of their own home with prices varying in a reasonable range.

Before respondents approach the experimental tasks, they are instructed to imagine that the pandemic is contained and the uncertainty associated with it is over. The respondents are then informed that they should choose between their current home or one of two alternative homes. As homes have many different features, respondents are instructed that the alternative homes differ only in the features presented to them and are otherwise identical to the current home. Respondents are also informed that they have to make 10 such choices. Figs. 1 and 2 show how the tasks are presented to a respondent who is an owner or a renter, respectively.

We model respondents' choices – which home is chosen and which are not – in the econometric analysis using a random utility function with the general form

$$u = u(\mathbf{b}, \mathbf{c}, y - p, \mathbf{r}, \epsilon) \tag{1}$$

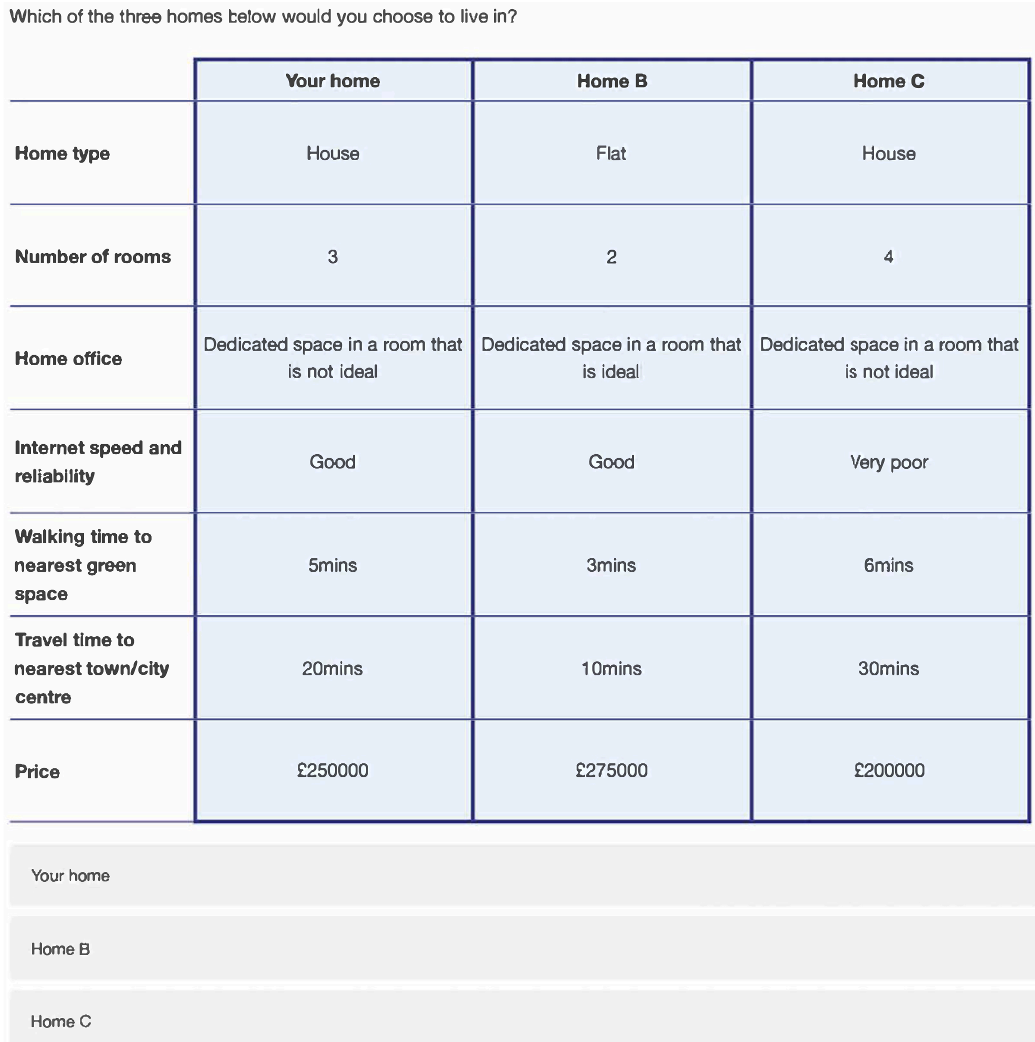
The row vector $\mathbf{b}$ collects binary indicators for categorical home features, the row vector $\mathbf{c}$ collects continuous home features, and $y - p$ is monthly disposable income after housing cost.[11] The row vector $\mathbf{r}$ collects characteristics of the respondent. ϵ stands for taste variation and features of respondent's current home which are not observed by the econometrician. Therefore, we treat ϵ as random variable, see Ben-Akiva and Lerman (1985, pp. 55). Once the function in Eq. (1) is specified and estimated, we can compute the WTP for home features that depends on respondent characteristics.

The experimental design ensures that the alternative homes are different from each other and from the current home in any given task. Between tasks, the design ensures that the alternative homes differ in an efficient way. Given the features $(\mathbf{b}, \mathbf{c}, p)$ of a respondent's current home, a very large number of alternative homes – and thus experimental tasks – can be generated with the levels and pivots in Table 3. No respondent

[9] Examples are: Delavande and Zafar (2019), Eriksson and Kristensen (2014), Johnston et al. (2017) and in regional and urban economics Bullock et al. (2011), Caplan et al. (2021), Earnhart (2002), Rouwendal and Meijer (2001).

[10] For public goods—in particular those which are unique and cannot be experienced directly, such as pristine wilderness, there is a debate whether stated choices are reliable. As actual choices are, by definition, not available, it is difficult to assess this.

[11] If a categorical home feature has more than two categories, it is modelled with a set of binary indicators. The reference category is always omitted. p for the current home is *Monthly rent* for a renter and $(0.03/12) \times Home\ price$ for an owner, which uses an initial yield commonly reported for the UK housing market.


Which of the three homes below would you choose to live in?

	Your home	Home B	Home C
Home type	House	Flat	House
Number of rooms	3	2	4
Home office	Dedicated space in a room that is not ideal	Dedicated space in a room that is ideal	Dedicated space in a room that is not ideal
Internet speed and reliability	Good	Good	Very poor
Walking time to nearest green space	5mins	3mins	6mins
Travel time to nearest town/city centre	20mins	10mins	30mins
Price	£250000	£275000	£200000

Your home

Home B

Home C

Fig. 1. Task in the experimental part for a respondent who is owner. Screenshot for a task example. Home A (Your home) has the features of respondent's current home. The features of Home B and Home C are pivots of those of Home A, see Table 3. For instance, Home B has one room less than the current home, whereas Home C has one room more. The respondent has to click one of the fields at the bottom of the screen to complete the task.

would be willing to complete so many tasks. We must therefore reduce the number of alternative homes in a way that allows us to learn as much as possible about the random utility in Eq. (1). To do this, we use the D_p-error as a criterion under the assumption of a multinomial logit model, a linear specification for Eq. (1) and priors on the coefficients to select a set of alternative homes (Rose and Bliemer, 2007; Rose et al., 2008).[12]

The design is segmented based on the number of rooms in respondents' current home. For smaller current homes with two or fewer rooms, the pivoted number of rooms either remains the same or increases by one room. For larger current homes with three or more rooms, the pivoted number of rooms either remains the same, increases by one room or decreases by one room. The alternative homes in the experimental tasks are generated based on 60 pairs of level and pivot combinations: 30 for smaller and 30 for larger current homes. Each of the 30 pairs is split further into three sets of 10 pairs. During the experiment, these sets are allocated randomly to respondents and used to generate the alternative homes based on the respondent's current home. This balances the amount of information we obtain from each respondent with the burden to respondents of answering too many choice tasks (Bech et al., 2011).

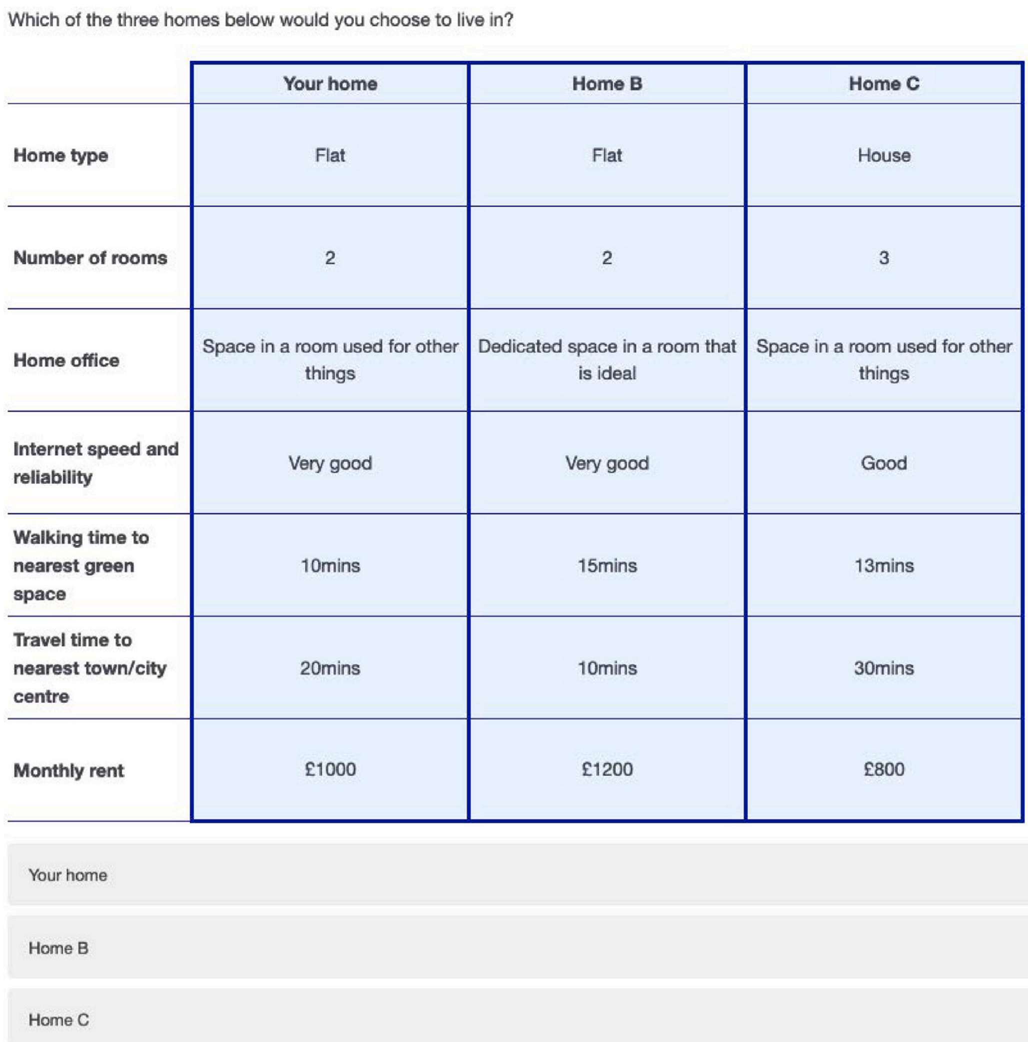
In summary, we implement the experiment in a way that ensures the choice tasks are realistic and relevant to respondents, which promotes respondent engagement with the survey. The online survey is programmed to compute and render the features of alternative homes instantly based on the features of a respondent's current home. The price for the home, either the market value or the rent, is presented given respondent's tenure mode. The segmented design prevents that respondents who live in smaller homes are presented with homes with one or zero rooms. The current home is always an option in the choice tasks and respondents can always choose it.

3. Survey implementation

3.1. Data collection

The survey is programmed in Qualtrics and hosted on their platform. Potential respondents were recruited by Survey Engine from managed access online panels between 12 October and 5 December 2021. Respondents had to fall within the target population's age band of 18 to 67 years. Once recruited, further screening ensures that respondents are in employment and live in a home in the private sector.

[12] The error is based on the inverse of the determinant of the Fisher information matrix and exploits its relationship with the asymptotic covariance matrix of the coefficient estimator.



Which of the three homes below would you choose to live in?

	Your home	Home B	Home C
Home type	Flat	Flat	House
Number of rooms	2	2	3
Home office	Space in a room used for other things	Dedicated space in a room that is ideal	Space in a room used for other things
Internet speed and reliability	Very good	Very good	Good
Walking time to nearest green space	10mins	15mins	13mins
Travel time to nearest town/city centre	20mins	10mins	30mins
Monthly rent	£1000	£1200	£800

Your home

Home B

Home C

Fig. 2. Task in the experimental part for a respondent who is renter. Screenshot for a task example. Home A (Your home) has the features of respondent's current home. The features of Home B and Home C are pivots of those of Home A, see Table 3. For instance, Home B has the same number of rooms as the current home, whereas Home C has one room more. The respondent has to click one of the fields at the bottom of the screen to complete the task.

Table 1 shows summary statistics of the socio-economic characteristics for the 1,068 survey respondents who fulfilled all criteria of the target population. The summary statistics for our survey and the SHS for the same targeted population are close, although those living in one of the four densely populated cities are slightly over-represented in our survey.[13] The media commentary about teleworking and housing demand speculated that the effect would be strongest for new teleworkers living in urban areas. In this case, any introduced bias would overestimate the effects of teleworking on housing demand. Table 1 also shows summary statistics for the observations that will be used in the analysis of the experimental part. Respondents who do not report income or owners who report implausibly small prices for their current home will not be used. The closeness of the summary statistics in the two columns of Table 1 shows that this should have little effect, as the omissions leave the composition based on the observed characteristics unaltered.

The target population could have a sizeable effect on the housing market. The SHS shows that it accounts for 59.8% of those who have their home in the private housing sector and for 47.8% of the housing sector overall. However, if only a few of those in the target population alter their housing demand following the experience of teleworking, the effect on the private sector housing market would be muted.

3.2. Data quality

There is a risk that respondents do not engage fully with an online survey. To reduce this risk, we pre-tested the survey with a convenience sample of seven respondents. We used their detailed feedback on the survey to improve the wording and order of some questions. Once in the field, we paused data collection at 200 respondents to take stock. We looked, in particular, at an open-ended question that asks respondents for comments on the survey. There was no indication of problems with survey engagement.

Respondents could take as long as they wished to complete the survey and could leave and return at a later point in time. This gives respondents ample opportunity to engage with the survey. It is nonetheless possible that a respondent does not engage and tries to speed through the survey as fast as possible. "Speedster" respondents who complete a survey in less than one third of the median time (9.54 min in our survey) should be excluded from further analysis, which is similar to Barrero et al. (2021). In our sample, there are none.

We also ask three debriefing questions to gauge how difficult respondents found engaging with the survey. The majority of respondents agree or strongly agree that it was easy to describe their current

[13] Web-Appendix B provides details on the analysis of the SHS.

Table 2
Summary statistics of features of respondents' current homes (experimental sample).

	All		Owner		Renter	
Home office quality						
low	0.43		0.42		0.46	
moderate	0.19		0.19		0.22	
high	0.38		0.39		0.33	
Internet quality						
very poor	0.01		0.01		0.01	
poor	0.05		0.05		0.05	
good	0.49		0.49		0.46	
very good	0.46		0.45		0.48	
House	0.72		0.80		0.38	
Number of rooms	4.53	(1.94)	4.77	(1.96)	3.60	(1.53)
Travel time to town/city centre	18.30	(14.05)	18.48	(14.24)	17.63	(13.32)
Walking time to green space	11.45	(14.40)	11.26	(13.60)	12.20	(17.15)
Home price	–	–	204.58	(158.89)	–	–
Monthly rent	–	–	–	–	561.29	(189.10)
N	964		765		199	

Reports for binary features the mean and for continuous features the mean and the standard deviation (in brackets). Home office quality is: *low* (space in a room used for other things, equipment has to be tidied away after work, others might use room at the same time), *moderate* (dedicated space in a room, equipment does not have to be tidied away after work, but others might use the room occasionally at the same time and the room could be dark or noisy.), *high* (dedicated space in a room, equipment does not have to be tidied away after work, undisturbed work is possible and room has good natural light and is quiet). Internet quality is: *very poor* (video calls have only sound and quality is poor, download of large documents and streaming is not possible), *poor* (video calls have good sound, but video is unstable, download of large documents is slow and streaming is not possible), *good* (video calls have good quality, download of large documents is unproblematic, streaming is possible, but occasional outages are possible), *very good* (video calls have excellent quality, download of large documents and streaming are unproblematic and all of this can be done at the same time). Travel and walking time are in minutes. Home price is in thousands of GBP and is owner's estimate of market value. Monthly rent is in GBP. *N* is the number of respondents.

Table 3
Home features' levels and pivots for the experimental tasks.

Features	Levels and pivots
Home type	Flat
	House
Home office quality	Low
	Moderate
	High
Internet quality	Very poor
	Poor
	Good
	Very good
Number of rooms	−1, no change, +1
Walking time to greenspace	−50%, −25%, no change, +25% +50%
Travel time to town/city centre	−50%, −25%, no change, +25%, +50%
Home price or monthly rent	−20%, −10%, no change, +10%, +20%

For the first three home features, each of the two alternative homes take one of the levels in the second column. For the remaining four features, each of the two alternative homes has feature levels that are pivots and defined relative to the current home's feature levels. If the respondent's home has two or fewer rooms, then the pivots for the number of rooms are only no change and +1.

home (86.7%). The majority also found it easy to choose between the alternative homes presented in the experimental tasks (84.4%). We also ask whether respondents believe that their participation and choices in the experiments will have an impact on housing policies in the future. Vossler et al. (2012) show that the incentive to reveal preferences in a choice experiment is stronger if respondents believe that there will be an impact on policy or practice. While few respondents disagree that there is such an impact and 43.6% believe there is, the remaining 42.2% are unsure. Web-Appendix B gives further details.

4. Results

4.1. Teleworking experience and plans

Table 4 gives summary statistics for respondents' teleworking experience and plans for the three periods before, during, and after the pandemic. Eight possible types of teleworking patterns are also indicated.

Of those respondents who teleworked during the pandemic, only Types 1 and 5 plan to telework after the pandemic.[14] Table 4 also presents averages of Dingel and Neiman (2020) teleshares, which measures the degree to which an occupation is suitable for teleworking. The average teleshares correlate well with the actual teleworking patterns. For instance, the median for Type 5 respondents is very high, whereas the median for Types 7 and 8, who did not telework during the pandemic, is small. Type 5 is the group of people for whom a change in their housing demand has been predicted: they experienced teleworking during the pandemic for the first time, liked it, and plan to continue afterwards. This type accounts for 31.6% of the target population and 18.9% of those who live in the private housing sector.[15] The majority of respondents of Type 5 (61.5%) plan to telework in a hybrid working style with no more than three days per week at home.

In the following, we analyse the association between respondents' teleworking plans, employer support, moving intentions and home office quality and other variables collected in the observational part of the survey. We fit the regressions with a full set of relevant explanatory variables, then we select those which are jointly statistically significant, and report the results for the regression that has only the selected variables included.[16]

Table 5 shows that the actual teleworking experience of a respondent before and during the pandemic has a reasonable positive statistically significant relationship with the planned teleworking days. In addition to respondents' experience, the Dingel and Neiman (2020) teleshare has a positive impact.

Older respondents plan to telework fewer days than younger respondents, as do respondents who live in one of the four cities, all else equal. Having a home with a high quality home office is associated with

[14] Types 2 and 6 have the same teleworking patterns before and during the pandemic as Types 1 and 5, respectively, but do not plan to telework after the pandemic. This shows that not everyone who can telework wants to.

[15] Using the SHS share of 59.8% for the target population.

[16] The initial specification always includes age and female and some of the following sets where relevant: *home features* (house, no. of rooms, home office quality), *household* (no. of adults, no. of children, owner, city), *teleworking* (either days or types, teleshare).

Table 4
Teleworking days per week before, during, and plans after the pandemic.

		Teleworking days per week									Teleshare	
		Before			During			Plans after				
Type	Total	Min	Med	Max	Min	Med	Max	Min	Med	Max	Med	Mean
1	245	1	2	5	1	5	5	1	4	5	0.803	0.655
2	26	1	3	5	1	2.5	5	0	0	0	0.721	0.540
3	12	2	5	5	0	0	0	1	3.5	5	0.396	0.455
4	8	1	4.5	5	0	0	0	0	0	0	0.096	0.259
5	338	0	0	0	1	5	5	1	3	5	0.854	0.709
6	75	0	0	0	1	4	5	0	0	0	0.630	0.550
7	89	0	0	0	0	0	0	1	2	5	0.076	0.348
8	275	0	0	0	0	0	0	0	0	0	0.076	0.250

Summary statistics for the numbers of days per week reported by respondents when asked about teleworking days per week before and during the pandemic and planned days after the pandemic. Type classifies the eight possible teleworking patterns, where the grey background indicates a type was teleworking or plans to telework. For instance, type 5 respondents did not telework before the pandemic, teleworked during the pandemic, and plan to telework after the pandemic is over. Total gives the number of respondents that belong to each of the different types. Teleshare is the Dingel and Neiman (2020) share of jobs that can be done from home given a respondent's occupation. The range is from zero to one and the higher the share, the more an occupation is suited for teleworking. Number of respondents is 1,068.

Table 5
Teleworking days planned.

Age	−0.006**	(0.002)
Days before	0.083***	(0.011)
Days during	0.233***	(0.018)
Teleshare	0.425***	(0.079)
Home office quality high	0.143**	(0.045)
City	−0.099*	(0.048)
Constant	−0.159	(0.110)
AIC	3613.70	
Pseudo R^2	0.188	

Reports ML estimates of Poisson regression with respondent's planned teleworking days as dependent variable. Respondent's age is in years and days refer to teleworking before and during the pandemic, respectively. Teleshare is the Dingel and Neiman (2020) share of jobs that can be done from home given a respondent's occupation. The range is from zero to one and the higher the share, the more an occupation is suited for teleworking. The caption of Table 2 contains short descriptions of the levels of home office quality. City means that the respondent lives in one of the four city council areas: Aberdeen, Dundee, Edinburgh, Glasgow. Initial specification includes the variable sets: home features, household, teleworking. Number of observations is 1,068. Standard errors in parentheses are robust to heteroscedasticity. *0.05 level, **0.01 level, ***0.001 level.

Table 6
Teleworking support by employer.

Coefficients of hurdle function β		
Days before	−0.184*	(0.077)
Days after	0.150**	(0.049)
Constant	−2.186***	(0.195)
Coefficients of support function γ		
Age	−0.015**	(0.006)
Days before	0.219***	(0.066)
Days during	0.398***	(0.050)
Days after	−0.199***	(0.058)
Constant	0.163	(0.285)
AIC	1858.51	
Pseudo R^2	0.075	

Reports ML estimates of hurdle model, see Eqs. (2) and (3). Both $H(x)$ and $F(x)$ are specified as logistic distribution functions. Support is based on each respondent's assessment of whether their respective employer will support teleworking after the pandemic. Days are the number of teleworking days per week before, during, and planned after the pandemic. Initial specification includes the variable set: teleworking. Number of observations is 1,068. Standard errors in parentheses are robust to heteroscedasticity. *0.05 level, **0.01 level, ***0.001 level.

more planned teleworking days. The regression results imply that, on average, those with teleworking experience, teleworkable occupations (teleshare) and suitable homes plan to do so intensely.

4.2. Employer support

Whether a respondent can achieve their teleworking plans after the pandemic depends on support from the employer. The survey asks respondents their opinion on such support. Respondents who are not confident enough to form an opinion can say so. We analyse the data on support for planned teleworking with a hurdle model. The contribution of a respondent to the likelihood function is

$$\mathcal{L}_i = 1_i^h H(\mathbf{z}_{hi}\boldsymbol{\beta}) + (1 - 1_i^h)(1 - H(\mathbf{z}_{hi}\boldsymbol{\beta}))L_i \tag{2}$$

$H(x)$ is a distribution function and gives the probability of the respondent not being able to form an opinion. Accordingly, $1 - H(x)$ measures the respondent's confidence in being able to answer the question. The row vector $\mathbf{z}_{hi}$ collects explanatory variables. We specify $H(x)$ as logit. 1_i^h is an indicator function that becomes one if the respondent cannot say whether the employer would support their plans or not, in this case the respondent enters the likelihood function through the first term in Eq. (2). If the respondent can answer the question, 1_i^h becomes zero and the second term in Eq. (2) with

$$\begin{aligned} L_i &= F(\mathbf{z}_{si}\boldsymbol{\gamma})^{1_i^s}(1 - F(\mathbf{z}_{si}\boldsymbol{\gamma}))^{1-1_i^s} \\ &= \frac{\exp\{\mathbf{z}_{si}\boldsymbol{\gamma}\}^{1_i^s}}{1 + \exp\{\mathbf{z}_{si}\boldsymbol{\gamma}\}} \end{aligned} \tag{3}$$

becomes relevant. F is a distribution function and gives the probability that the respondent thinks that the employer will support the teleworking plans. We specify $F(x)$ as logit, see the second line of Eq. (3). The row vector $\mathbf{z}_{si}$ collects explanatory variables. 1_i^s becomes one if the respondent thinks that the employer is supportive of their teleworking plans. It becomes zero if the respondent thinks that the employer will not support the plans.

Table 6 presents the estimation results for Eq. (2) and Eq. (3). The first panel shows that the confidence required to answer the question increases with the number of days a respondent teleworked before the pandemic: respondents with teleworking experience in normal times are more confident in forming an opinion about employer support. However, the confidence is smaller the more teleworking days a respondent plans in the future.

The second panel shows that the likelihood of a respondent thinking that the employer will be supportive increases with teleworking days before and during the pandemic, but falls with the planned number of days. This shows that those with more experience of teleworking expect more employer support for their plans, and suggests that respondents

Table 7
Moving intentions.

	(1)		(2)	
Age	−0.049***	(0.005)	−0.047***	(0.005)
Number of adults	−0.202**	(0.069)	−0.203**	(0.069)
Type 1			0.575***	(0.168)
Type 2			0.597	(0.479)
Type 3			0.554	(0.747)
Type 4			−0.576	(0.943)
Type 5			0.343*	(0.159)
Type 6			0.029	(0.271)
Type 7			0.435	(0.234)
AIC	2520.07		2518.65	
Pseudo R^2	0.044		0.050	

Reports ML estimates of ordered logit model. Values of dependent variable are 1 (happy with current home), 2 (thought about moving, but have not looked for a new home), 3 (looking for a new home), and 4 (recently moved to a new home). Outcome specific constants are not reported. Initial specifications include the variable set: household. Number of observations is 1,068. Standard errors in parentheses are robust to heteroscedasticity. *0.05 level, **0.01 level, ***0.001 level.

Table 8
High quality home office.

Teleshare	0.445**	(0.180)
Planned teleworking days	0.121***	(0.038)
Number of children	−0.311***	(0.077)
House	0.543***	(0.165)
Number of rooms	0.150***	(0.037)
Constant	−1.913***	(0.204)
AIC	1344.12	
Pseudo R^2	0.054	

Reports ML estimates of logistic regression. Dependent variable is one if home office quality is high and zero else. Teleshare is the Dingel and Neiman (2020) share of jobs that can be done from home given a respondent's occupation. The range is from zero to one and the higher the share, the more an occupation is suited for teleworking. Initial specification includes the variable sets: home features, household, teleworking. Number of observations is 1,068. Standard errors in parentheses are robust to heteroscedasticity. *0.05 level, **0.01 level, ***0.001 level.

expect employers to support hybrid rather than full teleworking work patterns in future. Older respondents also think that employers will be less supportive of their plans.

4.3. Moving intentions

The existing literature suggests that teleworking experience during the pandemic has and will lead to more home moves as people can unbundle where they live and where they work. When asked about moving intentions, the respondents selected amongst the four intensity-ordered options as follows: 50% are happy with their current home, 22% have thought about moving, 14.5% are looking for a new home, and 13.5% have moved to a new home during the pandemic. We can compare these numbers with those of the SHS for the same target population. In 2019, before the pandemic, 13.3% planned to move within the next two years and 17.8% within the next three years. This indicates that the pandemic did not alter moving intentions by much on average.

Given that not all respondent types experienced teleworking in the same way, the intention to move could be related to this experience. We examine this with an ordered logit model. Table 7 reports the results, Web-Appendix C discusses the average partial effects.

The explanatory power of both regressions measured with the pseudo R^2 is small. This shows that moving intentions are difficult to model. Age and the number of adults in the household reduce the moving intention in both specifications. Older households should be fairly settled in their life and we expect that this reduces moving intentions.[17] Following (Kan, 1999), a household with more adults finds decision making more difficult, which lends extra power to the status quo, and this reduces the moving intention. The second specification includes dummies for all possible types with Type 8 as base category. Only the coefficients for Type 1 and Type 5 are statistically significant and both are positive. Both types are more likely to plan to or have moved. Type 1 has teleworked before and during the pandemic and plans to continue to do so. Type 5 learnt during the pandemic what teleworking entails and plans to continue teleworking.[18] Types 1 and 5 are also very confident that employers would support their teleworking plans, with averages $\bar{F}(\mathbf{z}_{si}\hat{\gamma})$ over all members of 79.5% (Type 1) and 71.8% (Type 5). As teleworking can be done from nearly anywhere, both types are less restricted in where they live, will have lower future commuting cost and should be more inclined to consider a move. The average partial effects are small, however. This can be explained by the fact that only a few people want to telework fully and most prefer a hybrid working pattern.

4.4. Home choices

4.4.1. Respondents' current homes

Table 2 gives summary statistics for the current homes of respondents in the experimental sample.[19] The differences between owner-occupied and rented homes are small. As expected, homes that are houses have, on average, more rooms than flats. About 94% of homes have good or very good internet quality, which matches the numbers reported for Scotland by Ofcom (2021).[20] The homes of owners and renters are similar in terms of walking time to green space and travel time to the nearest town or city centre. In the survey, the average price of a home is about £205,000 and the average rent is around £560, both are of comparable magnitude to the average price (£194,100) and ask rent for three room flats (£689) reported by the Scottish Government for 2020 (RoS, 2021; CAD, 2021).

While 38% of homes have a high quality home office, about the same share of homes has only a low quality office. If those who want and can telework have a home that is not fit for purpose, then this should affect their housing demand.

Table 8 shows what other home features, household, and teleworking characteristics make it likely that a home has a high quality home office. All else equal, the probability of a high quality home office falls with the number of children in a household, and increases with the number of rooms and when the home is a house. Both the Dingel and Neiman (2020) teleworking share and planned teleworking days make it more likely that a home has a high quality home office. With an average predicted probability of 42%, people of Type 5 already have a high quality home office. This leaves 58% of this type who may potentially move to improve the suitability of their home for their new working patterns.[21] We examine next whether respondents are willing to pay for a high-quality home office.

[17] We expect the same effect for home owners, but while the estimated coefficients have the correct sign, they are not statistically significant. The set of house features are not considered in the regressions, as this makes no sense for recent movers.

[18] A referee suggested to compare the coefficients for Type 5 and Type 6, as both share the same teleworking experience before and during the pandemic, but only the Type 5 plans to continue teleworking. The difference between the coefficients is positive, but not statistically significant.

[19] The summary statistics for the full sample are not different.

[20] According to Ofcom (2021), the remaining homes with lower internet quality are almost entirely in rural areas. Including internet quality as a home feature controls for the spatial distribution of internet quality when we estimate the effect of distance to town or city centre on home utility in Eq. (5).

[21] For the remaining types, there is an inverse relationship between the predicted probability and their teleworking experience and plans: 0.41 (1), 0.32 (2), 0.37 (3), 0.34 (4), 0.31 (6), 0.36 (7), 0.29 (8).

Table 9
Home choices.

	(1)		(2)	
Coefficients of hurdle function β				
Age	0.037***	(0.008)	0.037***	(0.008)
Owner	0.923**	(0.316)	0.889**	(0.317)
City	−0.539*	(0.225)	−0.543*	(0.226)
Moving intention 2	−2.137***	(0.386)	−2.185***	(0.388)
Moving intention 3	−2.176***	(0.587)	−2.231***	(0.613)
Moving intention 4	−0.585*	(0.283)	−0.576*	(0.284)
Constant	−2.983***	(0.470)	−2.981***	(0.419)
Coefficients of utility function θ				
House	1.085***	(0.060)	1.087***	(0.060)
2 rooms	0.651	(0.353)	0.666	(0.357)
3 rooms	1.222***	(0.362)	1.232***	(0.365)
4 rooms	1.848***	(0.364)	1.866***	(0.368)
5 rooms	2.298***	(0.368)	2.316***	(0.372)
6 rooms	2.711***	(0.374)	2.739***	(0.379)
7+ rooms	0.413***	(0.053)	0.416***	(0.054)
Home office quality moderate	−0.110	(0.063)	−0.110	(0.078)
Home office quality moderate × Type 5			0.006	(0.127)
Home office quality high	0.325***	(0.049)	0.220***	(0.060)
Home office quality high × Type 5			0.300**	(0.095)
Internet quality very poor	−1.811***	(0.098)	−1.816***	(0.098)
Internet quality poor	−1.423***	(0.114)	−1.419***	(0.114)
Internet quality good	−0.351***	(0.052)	−0.353***	(0.052)
Current home	0.880***	(0.052)	0.883***	(0.052)
AIC	11732.24		11747.36	
Pseudo R^2	0.451		0.452	

Reports penalised ML estimates of the hurdle model Eqs. (2) and (4). Semiparametric specification of utility function is in Eq. (5), coefficients for the spline basis functions are not reported. The caption of Table 7 contains descriptions of the moving intention levels. The number of rooms are dummies and a linear function for the few homes which have more than six rooms. The caption of Table 2 contains short descriptions of the levels of home office and internet quality. Initial hurdle specification includes variable set household. Number of observations is 9,640. Standard errors in parentheses are robust to heteroscedasticity and clustered by respondent. *0.05 level **0.01 level, ***0.001 level.

4.4.2. *Home choice in experimental tasks*

In the 9,640 experimental tasks that respondents complete, the current home is chosen in 69.4% of the tasks and one of the two alternative homes in roughly equal proportions in the rest. While this indicates reasonable variation over the 964 respondents, 230 choose their current home in all 10 tasks they complete. This might be because a respondent is not interested in other homes or because the alternative homes presented in the choice tasks are not attractive enough.[22] We use a hurdle model to account for the possibility of such behaviour and for additional flexibility use a semiparametric specification for the random utility (Abe, 1999; von Haefen et al., 2005).

The contribution of a respondent to the likelihood function has the same form as Eq. (2), where the hurdle now models the probability that a respondent chooses the current home in all 10 tasks. In such a case the indicator function 1_i^h becomes one, otherwise zero. Correspondingly, $1 - H(x)$ is the probability that the respondent chooses an alternative home at least once in the 10 tasks. The second part in Eq. (2) now considers the choices a respondent makes. In each task, the home that provides the respondent with the highest utility is chosen. With an additive random utility function $u_{itj} = v_{itj} + \epsilon_{itj}$ and random terms that are i.i.d. Gumbel, this leads to the multinomial logit distribution

$$L_i = \prod_{t=1}^{10}\prod_{j=1}^{3}\left(\frac{\exp\left\{v_{itj}\right\}}{\sum_{k=1}^{3}\exp\left\{v_{itk}\right\}}\right)^{1_{itj}^c} \tag{4}$$

The indicator 1_{itj}^c becomes one when respondent i chooses home j in task t and zero else.

The deterministic part of the utility function is

$$v_{itj} = \mathbf{b}_{itj}\boldsymbol{\theta}_1 + (\mathbf{b}_{itj} \otimes \mathbf{r}_i)\boldsymbol{\theta}_2 + f_1(c_{1itj}) + f_2(c_{2itj}) + f_3(y_i - p_{itj}) \tag{5}$$

where $f_m(\cdot)$ are smooth, but otherwise unspecified functions.[23] The subscript *itj* refers to element j of the set $\mathcal{H}_{it} = \{A_i, B_{it}, C_{it}\}$. The elements of the set are the homes (and implicitly their features) presented to respondent i in task t. Observe that the first element in $\mathcal{H}_{it}$ is always respondent's current home, irrespective of the task. The arguments of the continuous functions are the walking time to the nearest greenspace, travel time to the nearest town centre, and a respondent's disposable income after housing cost. By not specifying the functional form of $f_m(\cdot)$ a priori, we allow for possible non-linear effects of disposable income and the continuous home features on utility.[24] We model the continuous functions in Eq. (5) with cubic regression splines $f_m(x) = \mathbf{s}_m(x)\boldsymbol{\delta}_m$, where $\mathbf{s}_l(x)$ is a k_m-dimensional row vector of spline basis functions evaluated at x and $\boldsymbol{\delta}_m$ is a column vector of coefficients. We estimate the hurdle model with the penalised ML estimator

$$(\hat{\boldsymbol{\beta}}, \hat{\boldsymbol{\theta}}, \hat{\boldsymbol{\delta}}) = \arg\max\left[\sum_{i=1}^{N}\ell_i - \sum_{m=1}^{3}\lambda_m\boldsymbol{\delta}_m^{\top}\mathbf{S}_m\boldsymbol{\delta}_m\right] \tag{6}$$

where ℓ_i is the log of a likelihood function similar to Eq. (2), but with Eq. (4) as last term. The coefficients in $\boldsymbol{\beta}$ are for the hurdle function $H(x)$, the coefficients in $\boldsymbol{\theta}$ are for the parametric part of Eq. (5), and the coefficients in $\boldsymbol{\delta}$ are for the spline functions. The term $\boldsymbol{\delta}_m^{\top}\mathbf{S}_m\boldsymbol{\delta}_m$ in Eq. (6) is a penalty for overfitting. It evaluates $\int f_m''(x)^2 dx$ and becomes large if f_m is very wiggly and small if the function is fairly straight. The smoothing parameter λ_m determines the degree to which the wiggliness of the function f_m is penalised. We select $\lambda = (\lambda_1, \lambda_2, \lambda_3)$ by k-fold

[22] The former can happen if the current home is well-suited or adapted to respondents' specific needs.

[23] We consider type-specific and also linear functions for some features in the estimation, but do not express this explicitly to avoid cluttered notation.

[24] A standard linear specification can lead to biased WTP estimates, especially when preferences over cost are misspecified (Torres et al., 2011). While a range of possible parametric forms have been suggested in the literature, e.g., Holte et al. (2016), our approach has the advantage of being fully flexible and letting the data determine the functional form.

cross-validation. For further details on the estimator, see Web-Appendix D.

Table 9 presents the estimation results. The first panel shows that the likelihood of a respondent always choosing their current home in the choice tasks increases with age and home ownership. Both characteristics are indicators for settled respondents.[25] Respondents who live in a city are less likely to always choose their own home. The omitted base category for the moving intention are those who are happy with their current home. As one would expect, this group is more likely to choose their current home than the three other groups of respondents.

The second panel of Table 9 reports the coefficients for the utility function in Eq. (5). Both specifications include all the home features from Table 3, but specification (2) allows the utility of the home office, walking time to green space and travel time town or city centre to differ depending on whether respondents are new teleworkers (Type 5) or not. Stanton and Tiwari (2021) find that before the pandemic teleworkers consumed more housing than non-teleworkers. They hypothesise that this was due to teleworkers needing space for a home office. We test if new teleworkers value a high quality home office more than other respondents. Gupta et al. (2022) find that the price gradient flattened in urban areas during the pandemic. They suggest this is due to teleworkers moving further away from business districts as travel cost are less relevant to them. We examine whether the price gradient is flatter for new teleworkers than for others. We do the same for walking time to green space.

Table 9 shows that a house brings more utility than a flat, as one would expect. The utility of a home increases nearly monotonically in the number of rooms. The omitted base category for internet quality is very good. In each case, a move to lower internet quality decreases utility. The omitted base category for home office quality is low quality home office. There is no statistically significant effect on utility of a moderate quality compared to low quality home office. However, a high quality home office increases utility. In specification (2), we see that for Type 5 respondents there is a statistically significant increase in utility of a high quality home office compared to all other respondents. This shows that while a high quality home office is important to respondents overall, it is even more important to those respondents who are new teleworkers.

The left panel of Fig. 3 shows the estimated smooth functions for the two distance measures and the disposable income for specification (1) and the right panel for specification (2). The utility is decreasing in walking time to green space and travel time to town or city centre. We find that respondents prefer homes that are closer to green space (parks). We also find that respondents prefer homes that are closer to town or city centres. Thus, the pre-pandemic finding of negative price or rent gradients still holds. From the right panel of Fig. 3, we see that relationships are broadly similar for Type 5 respondents and all other respondents. The lines for the Type 5 respondents are more wiggly, because the sample size is smaller. Overall, this suggests that those who experienced teleworking for the first time during the pandemic do not have different location preferences from others, either for travel time to town or city centres or walking time to green space. Fig. 3 also shows that utility is increasing in disposable income with diminishing marginal utility, as expected.

[25] The coefficient for the number of adults is positive, as one would expect if decision making becomes more difficult with the number of adults, leading to a tendency for the status quo. The coefficient is, however, not statistically significant.

4.4.3. Willingness to pay for home features

Given the deterministic part of Eq. (5), the WTP of respondent i for feature k is

$$\frac{\Delta p_i}{\Delta b_k}\Big|_{\bar{u}} = \frac{\theta_{1k} + (\mathbf{e}_k \otimes \mathbf{r}_i)\theta_2}{f_3'(y_i - p_i)} \tag{7a}$$

if k is binary, and

$$\frac{d p_i}{d c_{ki}}\Big|_{\bar{u}} = \frac{f_m'(c_{ki})}{f_3'(y_i - p_i)} \tag{7b}$$

if k is continuous. $\mathbf{e}_k$ has the dimensions of $\mathbf{b}$, a one in column k and zeros else. To conduct inference, we compute cluster bootstrap standard errors for the WTP estimates averaged over respondents. Resampling with replacement from the sample of respondents with all of their choice tasks ensures that standard errors are robust to heteroscedasticity and within-respondent correlation of errors.

Table 10 reports average monthly WTP estimates for marginal changes in home features from specifications (1) and (2) in Table 9. We see that respondents are willing to pay around £377 more per month for a house compared to a flat, holding all else equal. As in Table 9, the WTP increases monotonically in the number of rooms and decreases monotonically in internet quality. The average WTP of all respondents for a high quality home office is £113.04 per month. Type 5 respondents are willing to pay £192.91 per month to have a high quality home office. Table 10 also reports average WTP for having one minute more walking time to a park and one minute more travel time to a town or city centre. We find that marginal WTP for walking time to a park is not statistically significantly different from zero either for all respondents or Type 5 respondents. The WTP per minute of travel time to a town or city centre is £9.01 for Type 5 respondents, not different from the WTP for all other respondents. This shows that new experience of teleworking has not affected respondents' value of a home's location per se. However, as the current housing stock might not provide homes with high-quality home offices close to town or city centres, new teleworkers might be tempted to move to suburban areas, where homes are larger. Based on our results, we can equate Type 5 respondents' WTP for travel time to a town or city centre and their WTP for a high quality home office. We find that these respondents would be willing to travel around 21 min (192.91/9.01) longer to a town or city centre to get a home with a high quality home office.

4.4.4. Robustness

We conduct several robustness exercises. First, we address the reliability of the WTP estimates. In Section 2.2, we discussed literature that provides evidence that WTP estimates from stated choices are reliable for features of private goods that are traded in markets. We provide such evidence for a segment of the Scottish private housing market for which we have detailed transaction data, see Web-Appendix E. As the WTP estimates converge, we believe that the WTPs for features that are observed only for the stated choices are reliable too. Second, the semiparametric estimator allows for a utility function much more flexible than what is usually used in stated choice applications. The flexible utility function allows that preferences for home features differ across teleworking types, but otherwise assumes preference homogeneity. To examine the effect of this assumption, we estimate a parametric version of the flexible utility function using a mixed logit model, thereby allowing for preference heterogeneity. The WTP estimates are very similar to those in Table 10 and are not reported.[26] Third, in addition to the analysis of the data with a focus on the eight different types and Type 5 in particular, we also examine whether the intensity of planned teleworking plays a role for moving intentions and the WTPs

[26] The parametric utility function assumes linearity for $f_1(\cdot)$ and $f_2(\cdot)$ and an isoelastic form for $f_3(\cdot)$. We are grateful to both referees who encouraged us to conduct both types of robustness exercises.

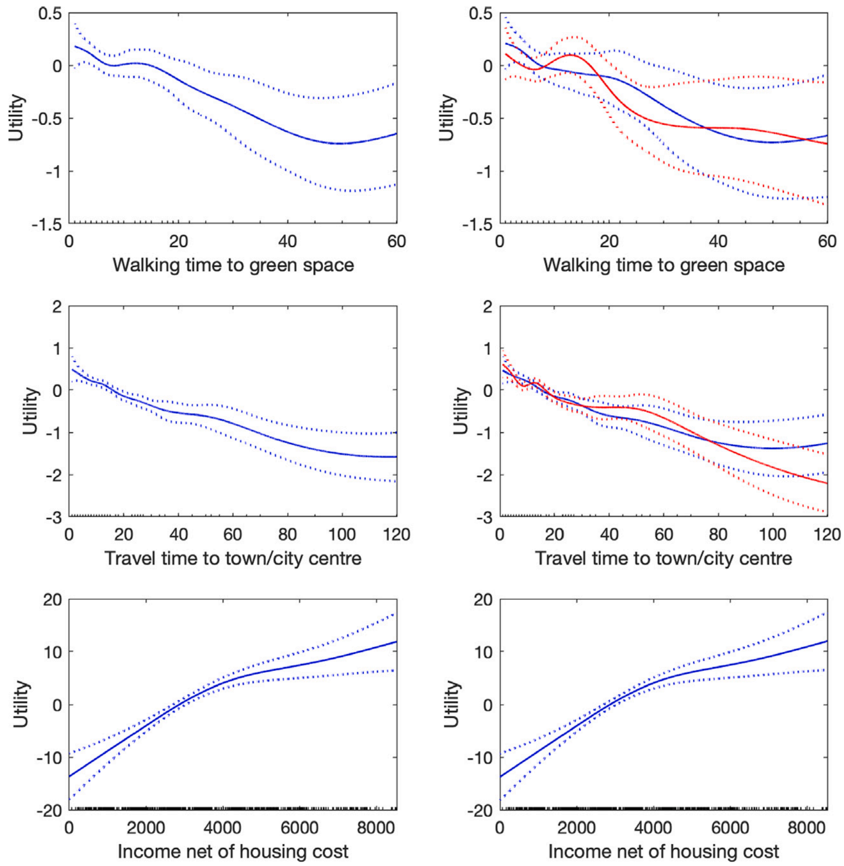


Fig. 3. Smooth components of utility function. Left panel shows estimates of $f_1(c_1)$, $f_2(c_2)$, and $f_3(y-p)$ from Eq. (5). Right panel shows estimates of same functions, but allows $f_1(c_1)$ and $f_2(c_2)$ to be type-specific. Red (blue) lines are functions for Type 5 (except Type 5). Functions are normalised to have zero mean. Functions of walking time to green space (travel time to town/city centre) are truncated at 60 (120) minutes and exclude 8 (1) outliers. Dotted lines are 0.95 pointwise confidence intervals. Rugs show distribution of respondents. Number of observations is 964.

Table 10
Willingness to pay.

	(1)		(2)	
House	377.23**	(125.19)	379.27*	(179.80)
2 rooms	226.42	(155.77)	232.60	(164.35)
3 rooms	425.05*	(174.13)	429.95	(224.79)
4 rooms	642.82**	(214.54)	651.01*	(307.08)
5 rooms	799.28**	(247.21)	808.27*	(367.32)
6 rooms	946.17***	(284.44)	955.67*	(448.74)
7+rooms	143.54***	(42.81)	145.29*	(69.27)
Home office quality moderate				
All Types	−38.25	(26.55)		
Except Type 5			−37.14	(34.25)
Only Type 5			−38.66	(45.75)
Home office quality high				
All Types	113.04**	(37.89)		
Except Type 5			74.46	(39.99)
Only Type 5			192.91*	(81.39)
Internet quality very poor	−629.97**	(210.35)	−633.57*	(284.45)
Internet quality poor	−494.98**	(161.72)	−495.04*	(212.73)
Internet quality good	−122.05**	(46.25)	−123.14*	(60.12)
Travel time to town/city centre				
All Types	−9.27**	(3.25)		
Except Type 5			−9.40*	(4.46)
Only Type 5			−9.01*	(3.77)
Walking time to green space				
All Types	−5.16	(3.11)		
Except Type 5			−5.95	(5.09)
Only Type 5			−3.43	(3.89)

Reports average monthly WTP (in GBP) for home features. WTP for discrete (continuous) features are computed from Eq. (7a) (Eq. (7b)). Type specific WTP are averaged over respondents who are of the respective type. The caption of Table 2 contains short descriptions of the levels of home office and internet quality. Walking time to green space and travel time to town/city centre are in minutes. Number of observations is 964. Standard errors in parentheses are computed using the paired bootstrap clustered by respondent. Number of bootstrap replications is 200. *0.05 level **0.01 level, ***0.001 level.

for home features. There are a few further and plausible insights. The intensity of planned teleworking helps to predict moving intentions, just as we found for the teleworking types. We also find that the WTP for a high quality home office increases with the teleworking intensity. This is plausible and is not obvious from the results reported so far, see Web-Appendix F for details.

5. Conclusion

The measures introduced to slow the spread of the COVID-19 pandemic caused an unprecedented increase in teleworking. Many of those who did not telework before could experience what this entails for the first time. This experience was mostly positive, as we find that 81.8% of new teleworkers plan to continue teleworking after the pandemic, most likely in a hybrid pattern with no more than three days teleworking per week. As has been suggested, new teleworkers value homes that can accommodate high quality home offices. We find that this value corresponds to nearly £200 per month. Green space accessible by foot does not seem to matter more to new teleworkers than to others and it is inconclusive whether it matters at all, as the WTP estimates are not statistically significant. We find no support for the hypothesis that new teleworkers place a lower value on proximity to town or city centre than others. However, combining new teleworkers' value for proximity and their value for a high quality home office shows that they are willing to commute 21 min longer for a home with a high-quality office.

We also find that houses are more likely to accommodate high quality home offices than flats. As residential buildings in urban centres are mainly blocks of flats, whereas houses are mostly located in the suburbs, it is likely that housing demand of new teleworkers, who have a higher intention to move than most others, will shift to these areas. The shift will be muted, however, as we predict that 42% of new teleworkers already have a home with a high quality office. In the long run, once construction has taken place, this demand shift could lead to further sprawl. Planners face the challenge of how to manage this, for instance by encouraging redevelopment of multifamily housing in urban areas that is spacious and functional for teleworking.

CRediT authorship contribution statement

Rainer Schulz: Conceptualisation, Methodology, Software, Validation, Writing. **Verity Watson:** Conceptualisation, Methodology, Software, Validation, Writing. **Martin Wersing:** Methodology, Software, Validation, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Declaration

The research was approved by the Committee for Research Ethics and Governance in Arts, Social Sciences, and Business at the University of Aberdeen.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.regsciurbeco.2023.103915.

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