

Revisiting the Gender Gap in Commuting through Self-employment

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1. Introduction

Commuting is strongly gendered (Hanson, 2010), with the result that women tend to have shorter commutes than men, a finding that is remarkably persistent over time and consistent across countries (Black et al., 2014; Frändberg and Vilhelmson, 2011; Crane, 2007). The gender gap in commuting has attracted much attention in academic research and spatial planning because of its interconnectedness with, on the one hand, gendered labour market structures and, on the other hand, gender roles in households – and the essential related question of whether the short commutes of women are the result of choice or constraint (Rosenthal and Strange, 2012; MacDonald, 1999; Gordon et al., 1989a). This question has profound consequences for gender equality in access to job opportunities, individual wellbeing and the gendered spatial structure of jobs and workers.

The aim of this study is to advance knowledge of the gender commuting gap, specifically whether household responsibility, labour market constraints or an underlying gender preference explain the shorter commutes of women. It is difficult to disentangle cause and consequence of how these factors are linked with commuting. As a result, consensus in the literature on the relative importance of these competing explanations remains elusive. We take a different methodological approach to the gender commute gap than existing research in that we use individual-level panel models (with repeated measures for the same individual) and the self-employed (those who work for themselves as sole proprietor and do not have an employer as do wage and salary workers) as comparison group against employees and explore whether the well-known gender commuting gap also occurs among the self-employed. We do this on the basis that the self-employed enjoy a greater control over their

workplace choice than employees as argued by van Ommeren and van der Straaten (2008) who found that the self-employed have shorter commutes than employees. If spatial constraints related to where jobs (firms) suitable for given workers are located are less relevant for the self-employed than employees, then this allows us to better disentangle between household responsibility and labour market constraints linked with gender segmented labour markets. However, there remain labour market constraints on commutes that this approach cannot fully address, for example that some employees are compensated for longer commutes while the self-employed are less likely to be affected by efficiency wages (Carrington et al., 1996) and self-employment decisions are related to labour market opportunities (Georgellis and Wall, 2005).

We advance the existing literature in testing the influence of household responsibility on commutes of men and women through using more detailed information than in previous studies, namely on the hours spent on housework and in generating a sub-sample of parents for which we investigate who is the main carer for children, in addition to standard measures of the presence and age of children in the household, child/adult ratio and/or marriage used in existing studies (Fan, 2017; Sandow, 2008; Kwan, 1999). We test individual-level job-related reasons for the gender commute gap using the key factors stated in the existing literature: occupation, earnings and part-time employment (Madden, 1981).

Another methodological advance is the use of individual-level panel models, which go some way to controlling for unobserved heterogeneity and associated endogenous selection effects, for example underlying commute or residential preferences, personality traits, family history and upbringing, based on data from the UK Household Longitudinal Study 2009/10-2016/17.

The paper finds little evidence of a gender commuting gap among the self-employed. As well as being of considerable immediate importance in understanding the spatial nature of self-employment, findings point towards the importance of gendered labour market and employment structures rather than household responsibility or underlying gendered commuting preferences in accounting for the gender commuting gap among the workforce as a whole.

2. State-of-the-art literature review and rationale for current study

2.1 Gender and commuting

Patterns in commuting mobility, including the commuting gender gap, is of research and societal interest because low mobility can contribute to, and be caused by, disadvantage in the labour market, such as unemployment and low pay (Murray et al., 1998; Aronsson and Brannas, 1996; McGregor and McConnachie, 1995; Cooke and Shumway, 1991). Low proximity between residential areas and the locations of workplaces, for example due to the relocation of low-skilled jobs out of cities, can increase commute times and distances and/or cause unemployment or low pay, especially for less mobile groups such as low-skilled workers (Shen, 1998) and in some circumstances women (Cooke, 1997). Research has identified gender as a key factor linked with short/long commute distances and/or times (Madden, 1981; Hanson and Pratt, 1988; McLafferty and Preston, 1997), alongside other factors including earnings (McGregor and McConnachie, 1995); qualifications (Gordon et al., 1989b); age (Loewenstein, 1965); race and ethnicity (Ihlanfeldt and Sjoquist, 1990); rural and suburban locations (Molho, 1995); access to a car (Taylor and Ong, 1995) and household time budgets (Duffy, 1992).

Research has suggested different reasons for the gender commuting gap and given contrary responses as to whether short commutes of women are due to constraints or choices (MacDonald, 1999). The 'household responsibility hypothesis' assumes that women commute less than men because of domestic and parenting responsibilities (Clark et al., 2003; Lee and McDonald, 2003; Hjorthol, 2000; Turner and Niemeier, 1997; Johnston-Anumonwo, 1992) and the underlying gender divisions in households (Madden, 1981) and that therefore the gender commuting gap is largest in (married) couples with children (Fan, 2017). The household responsibility hypothesis has most commonly been empirically tested either through demographic characteristics, namely marital status, number and/or age of children or through activity patterns and the exploration of household- and children-related trips (see Turner and Niemeier, 1997 for an overview).

Some studies, however, found that gender differences in commuting persist after controlling for household type and presence of children, marital status, age and associated adaptations (mostly of women) in hours worked over the life-course (Neto et al., 2015; Hjorthol and Vågane, 2014; Crane, 2007; Gordon et al., 1989a). Such literature therefore suggests that the greater commuting sensitivity of women could partly be the result of gender differences in commute choices, albeit constrained choices (Gordon et al. 1989a). This could be referred to as the 'commuting preference hypothesis'.

Another set of explanations for gender differences in commutes relates to gendered labour market and employment structures, or a 'labour market structures hypothesis'. This view argues that women have shorter commutes because they are constrained by part-time employment and low pay so that long commutes do not pay off, women disproportionately work in service sector industries and occupations which also tend to be more spatially ubiquitous thus do not require long commutes and the practices of employers that maintain

gender segmented local labour markets (Sandow, 2008; Carter and Butler, 2008; Carlson and Persky, 1999; Johnston-Anumonwo 1997; Hanson and Pratt, 1995, 1992, 1988; Madden and Chiu, 1990; Rutherford and Wekerle, 1988; Hanson and Johnston, 1985; Madden, 1981). Others, however, contest the labour market structure hypothesis on the basis that gender differences in work trip length persist across most income and occupational categories (Gordon et al., 1989a).

Whether women have short commutes because of low pay or have low pay because of low propensity to commute remains uncertain. In addition, irrespective of whether due to labour market constraints or not, whether women's short commutes are the result of gendered divisions of household responsibilities or of personal preference not to have long commutes also remains unclear.

2.2 Self-employment and commuting

Our focus on the self-employed is informed by the method proposed by van Ommeren and van der Straaten (2008) who use the self-employed for estimating the amount of excess ('wasteful') commuting in the workforce. Following economic research that used the self-employed as a comparison group of workers who are less constrained in their labour market choices (e.g. Carrington et al., 1996), they treat the self-employed as a proxy of a theoretical minimum or 'preferred' commute assuming that they are less constrained in their workplace choices than employees and can therefore more readily realize a minimum commute. Van Ommeren and van der Straaten (2008) argue that whereas employees search for an employer offering a suitable job (e.g. suitable in terms of occupation, industry, skills and hours), the self-employed search solely for workplaces and therefore have a greater choice about where to work as requirements for workplace searches are much less diverse than for job searches.

Assuming that both men and women enjoy a greater freedom about their workplace in self-employment, then the commutes of the self-employed are logically a closer reflection of commuting preferences than the commutes of employees. While gender division of household responsibilities is still at play, gender division in the local labour market is much less pronounced than for employees.

Few studies on the commuting behaviour of the self-employed exist, but emerging evidence indicates that self-employed workers have substantially shorter commutes than employees (Shin, 2019; Gimenez-Nadal et al., 2018; Rosenthal and Strange, 2012; Giuliano, 1998). This pattern suggests that van Ommeren and van der Straaten's (2008) assumption of less spatial constraints in workplace selection among the self-employed is correct.

Lee and McDonald (2003) and Rosenthal and Strange (2012) are the only studies we have been able to identify that have investigated commutes of the self-employed in relation to gender. Lee and McDonald's findings, based on a 2% sample of the South Korean Population Census, suggest that short commutes of the self-employed apply to both men and women, but do not systematically investigate a gender commute gap within the self-employed. Rosenthal and Strange (2012) more specifically investigate the gender commute gap amongst the self-employed using 2000 Census data for the USA and found that full-time self-employed women, especially when they have children, commute less than full-time self-employed men which the authors interpret as confirmation of the household responsibility hypothesis. Both studies, however, use cross-sectional (as opposed to longitudinal) data and OLS regressions that assume that there are not unobserved characteristics that are correlated with self-employment and commuting time.

Van Ommeren and van der Straaten's (2008) study is the only one of the above-mentioned studies that was able to control for selection effects into self-employment that are due to

time-constant factors (such as underlying commute preference, work motivation, etc.) because of the use of longitudinal data and fixed effects models. The self-employed may have certain preferences, attitudes and difficult-to-observe characteristics that may be linked with commuting behaviour. Interestingly though, the shorter commutes of the self-employed was a robust finding in their study across datasets and using different methods.

2.3 Self-employment characteristics and motivations

Self-employment in the UK is at a high (and rising) level compared with other advanced economies (see Hatfield, 2015). At the end of 2018, 14.8% of the UK labour force or 4.84M people of 32.6M people in work were self-employed (ONS, 2019). To compare, in 2001, 3.3M people or 12.0% of the labour force were self-employed. This rapid growth in self-employment has attracted much attention in research, policy and practice against the background that the self-employment growth may reflect a shortage of jobs following the 2008 Great Recession. However, the self-employment growth has been highest in areas with low unemployment and high wages (Henley, 2017). The growth is also driven by those with a degree, and highly qualified people have become more concentrated in self-employment (ONS, 2018, 26). Finally, although the rate of growth increased in the decade following the Great Recession, strong growth was evident in the decade prior to the Great Recession (recorded increases in self-employment in the UK were 13.3% over the period 1998-2008 and 21.8% over the period 2008-2018¹). Therefore, it has been suggested that the growth in self-employment is largely due to structural shifts in the economy and business organisation rather than a shortage of paid employment (D'Arcy and Gardiner, 2014).

Most significantly for this paper, the overall growth in self-employment in recent years is accompanied with an increased growth of self-employed women. Almost half of the growth

in self-employment between 2008 and 2014 was accounted for by women, although still 68% of all self-employed are men (Henley, 2017, 1314). Both full-time and part-time self-employment have strongly grown amongst women between 2001-2016 while growth in both full-time and in part-time paid employment amongst men have been relatively stable over the same period of time suggesting a notable change in women's employment in favour of self-employed work (ONS, 2018, 9). A steady increase in self-employment among women has been observed in other countries too (it is well-researched in the USA, for example) but the increase of the service sector alone cannot explain the increase in women self-employment (Parker, 2004, 124).

Overall, the desire to work independently has continuously found to be the primary factor that leads both men and women into self-employment (Shane et al., 1991). Being married and having children, however, has been linked with self-employment of women (Lim, 2019; Jeon and Ostrovsky, 2018; Andersson Joona, 2017; Patrick et al., 2016; Noseleit, 2014; Wellington, 2006; Hundley, 2000; Carr, 1996;) while family-related factors have little influence on men's self-employment (Boden, 1996). On this basis, some have argued that self-employment affords women the flexibility to combine work and family (Carr, 1996). Following this argument, women appear to commute less and become self-employed for the same family-related reasons. To contrast, Buding (2006) highlights the heterogeneity of self-employed women whereby women in non-professional occupations enter self-employment for family reasons while family-related factors seem to explain little why professional women enter self-employment who seem to follow careerist occupational models similar to their male peers. In similar vein, low wage returns in paid employment have been linked with women's transitions into self-employment (Boden, 1999). Some self-employed mothers spend more time with their child/ren than comparable mothers in paid employment, mostly

connected with working from home and working part-time, while other self-employed mothers, specifically self-employed mothers who have taken on employees of their own and are more likely to commute to business premises, both work more than mothers in paid employment and spend more time on childcare mainly through multitasking and flexible working time schedules (Craig et al., 2012).

Findings as to whether self-employed women work less hours in order to spend more time with their child/ren are rather ambiguous. While some find that self-employed mothers spend on average more time with their children and less time on income-generating work than mothers in paid employment (Lim, 2019 and Gurley-Calvez et al., 2009), others found the opposite, for example, Andersson Joona (2017). There may be significant national differences in regulatory structures such as high costs of childcare (UK and USA) pushing some women into self-employment as a means to gain temporal flexibility and to keep childcare costs low (Thébaud, 2015, Parker, 2004, 125).

2.4 Summary

The limited agreement in the literature over the relative contributions of household responsibilities, preferences and labour market structures in accounting for the gender commuting gap arises at least in part due to methodological challenges. First, there is ambiguity as to whether factors thought to be linked to commute mobility (specifically, domestic responsibilities and labour market status) are cause or effect of commute mobility. Second, unobserved traits (e.g. time budget, energy level, motivation, personality traits) may be endogenous to both commute mobility and the factors thought to be linked to commute mobility (domestic responsibility and labour market status). Third, controlling for income (wage) and occupation cannot capture entirely the spatial variation of jobs and job

accessibility or that certain locations are associated with shorter or longer commutes and that women and men behave differently to these spatial constraints (Osland, 2010; Shearmur, 2006).

Self-employed workers enjoy a greater choice and flexibility over the location and timing of their work so that self-employed women should be less affected by the constraints related to the spatial gender segmentation of jobs. If women still behave differently to men as Rosenthal and Strange's (2012) findings suggest, this can be then more directly related to household responsibility. There are still gender differences among the self-employed, as suggested in the literature, with respect to motivations for this type of work, which are much more linked with care responsibilities for women than men. Furthermore, self-employed women, similarly to women in paid employment, spend more time on domestic work and childcare than their partners (Craig et al., 2012). Therefore, the work location choices of the self-employed are significantly different to employees, as suggested by van Ommeren and van der Straaten (2008), while gendered household roles seem to be similar to other working households.

These findings provide a good basis on which to use the self-employed as a quasi-experimental group to compare against employees, in that the self-employed are less constrained by labour market factors in their choice of work location but face similar household responsibilities.

3. Methodology

3.1 Data

A sample was drawn for this study from the waves 1 to 8 of the UK Household Longitudinal Study, 'Understanding Society' 2009-2017.ⁱⁱ The Understanding Society dataset is based on a

probability sample of households in the United Kingdom in 2009. All household members 16 years and older are interviewed annually, and new household members added to the survey.

3.1.1 Commute time

Commuting time of those in work and who mainly work somewhere other than at their home is consistently captured every year using the question: “About how long does it usually take for you to get to work each day, door to door (in minutes)?”. Commuting distance is not captured for the self-employed and can therefore not be used for this study. Our dependent variable is therefore commuting time, similar to Gimenez-Nadal et al. (2018) and Giuliano (1998). The gender commuting gap is well-established with respect to both travel time and distance although the difference is usually more pronounced in terms of travel distance. Because women more often than men use slow transportation (less often the car and more often public transport and active transportation), their commuting times tend to be similar or even longer compared to men’s if the travel mode was not controlled for (Kwan and Kotsev, 2015). Thus, our findings underestimate gender differences in commuting by capturing only time and not distance or cost.

We restrict the study to those who reported that they mainly work at their employer or business premises and exclude those who work mainly from home, are driving or travelling as their job, or work in varying locations with no fixed workplaces such as at clients’ or customers’ premises. It is explained to respondents in the interviews that in case of travelling between different places of work they are asked to report ‘getting to work’ (e.g. the office or reporting depot for those who travel in the course of their job) and not trips between offices (customer premises). Differences between employees and self-employed workers stemming from reporting travelling as part of the work should therefore be minimal in the data. Even

though respondents were asked about their daily one-way commuting time, some people reported zero commutes (even though they reported to work elsewhere than at home). We do not include these cases in our sample. Some also reported very long commutes of more than 180 minutes. It is likely that people who partially work from home (which is not captured in the questionnaire that only asks for the main workplace) have very long commutes but their commuting frequency is low (Helminen and Ristimäki, 2007). Commuting frequency is unfortunately not given in the dataset. London in particular, however, attracts long commuting times including of those with daily commutes. In order to eliminate outliers (including those who may not commute on a daily/frequent basis), we select for our sample those with one-way commutes up to 180 minutes.

3.1.2 Household responsibility

The Understanding Society captures a number of variables that enable a comprehensive investigation of the household responsibility hypothesis. Most commonly, household responsibility is measured via the presence and age of children in the household and the related household composition (Fan, 2017; Sandow and Westin, 2010; Sandow, 2008; MacDonald, 1999; Turner and Niemeier, 1997) and the marital status (Gordon et al., 1989a). We identify those who are parents of a dependent child under 16 years of age (in the household) and generate a variable indicating the age of the youngest own dependent child in the householdⁱⁱⁱ to capture different levels of care needed for children according to whether the youngest child is a pre-primary school child 0-4 years of age, a young school child 5-9 years old or an older school child 10-15 years old. We also use being married as an indicator of household responsibility and identify in the data whether the partner/spouse of the respondent is working or not on the basis that couples are more constrained in their

workplace and residential choices when both partners are working (Clark et al., 2003; van Ommeren et al., 1999).

In addition to these household and partner characteristics, the dataset captures in selected survey years information on hours spent on housework per week and who in the household mainly looks after the child/ren with the following response items: mainly self, mainly partner, shared, someone else).^{iv} While certain housework activities such as shopping can now be done more flexibly (e.g. internet shopping), childcare imposes greater constraints on workers' schedules (e.g. the school run) so that following the household responsibility hypothesis the childcare arrangement of the partners should be more reflected in commuting time than hours of housework. The hours of housework variable cannot be transformed to approximate a normal distribution (many zeros but no negative values, some peaks within the distribution, strongly right skewed) so that we use dummy coding with cut-off points for those in employment at the 25th, 75th and 90th percentile.

3.1.3 Job characteristics

Job characteristics linked to shorter commutes of women in the existing literature include occupation, part-time employment and wage (Madden, 1981). As a measure of occupation, we include an occupational class variable that measures whether the job is skilled vs. unskilled and professional vs manual.^v The self-employed in our sample cluster in skilled manual jobs, and very few work in partly-skilled or unskilled occupations. We therefore derive a variable with three categories: professional/managerial; skilled non-manual; and manual or low/no skilled occupations. We further use Understanding Society's definition of part-time employment as working less than 30 hours a week.

The Understanding Society captures daily earnings only from employees but not the self-employed. In order to capture the gender wage gap in the measure of earnings, we derive a variable for hourly earnings from the monthly gross income and the usual hours worked in a week (Fan, 2017). For consistency, we derive this measure for both employees and the self-employed.

3.2 Samples

We include in this study only those of working age (18-64 years old) to reflect the workforce. We have in total 137,128 commute observations to business or employer premises (57,465 from men and 79,663 from women) from 39,936 people (17,743 men and 22,193 women). Of those, 132,193 observations (54,507 from men and 77,686 from women) are from when people were in paid employment and 4,935 (2,958 from men and 1,977 from women) from when people were self-employed. Note that the same person could be employed or self-employed over the study period. Further, the 39,936 people from whom we have commute times at least once over the study period, can have periods of non-employment. In the commuting time models, non-employed years are unavoidably dropped, although individuals with periods of non-employment are retained in the sample as long as they are employed in at least one year. A sample and variable description is reported in the Appendix.

Even though the Understanding Society is a large household panel with approximately 40,000 households interviewed in wave 1, it has to be noted that from participants who filled-out the adult questionnaire across the waves 1 to 8, only 19.6% provided information at each wave. For relatively large proportions, unfortunately, information is available for only 1-3 waves. Observations in our sample are further reduced as we investigate commutes to employer or business premises

We generate from our sample a sub-sample of those who are a parent of a child under 16 years in their household and who live as heterosexual couple to explore the influence of social gender roles in households on commuting time. The sub-sample of parents includes 4,888 men and 5,286 women. These give observations of the childcare arrangement in the household (and hours spent on housework) by employment status and gender as follows: 9,007 (9,609) men who are employees, 10,163 (10,867) women who are employees, 554 (597) self-employed men and 302 (325) self-employed women.

<Table 1>

Table 1 shows the distribution of commuting time by employment status and gender for all employees and the self-employed (at the top) and the sub-sample of parents (at the bottom).^{vi} Both men and women have shorter commutes in self-employment compared to paid employment. While this is true for the whole distribution when all employees and self-employed (parents and non-parents) are considered, amongst parents in heterosexual couple households, employee and self-employed men converge at the top of the distribution (at the 90th percentile).

Amongst employees and the self-employed, women have shorter commutes than men, although the commuting gender gap is smaller among the self-employed. While the difference in commuting time between men and women amongst all employees is prevalent for short commutes (25th percentile), equalises in the middle of the distribution and then goes apart again for longer commutes (from 75th percentile), the distribution is slightly different among all self-employed workers. Here, commuting times at the median and the top of the distribution (90th percentile) converge.

Gender differences in the distributions differ amongst parents to the total sample of employees and the self-employed (parents and non-parents). Here women, both amongst employees and the self-employed, have shorter commutes than men across the whole distribution although the difference is again smaller amongst the self-employed than employees.

3.3 Models

Understanding Society provides repeated measures of the same workers so that panel models can be employed. In order to test whether the gender commuting gap exists amongst the self-employed, we use linear random effects regression models (in Table 2) separately for employees and the self-employed with the log of commuting time as dependent variable:

$$\log TWT_{it} = \beta_1 GENDER_{1,it} \dots \beta_k X_{k,it} + a_i + u_{it} + e_{it} \quad (1)$$

where u_{it} is the between-individual error and e_{it} is the within-individual error. Predictor variables most relevant for this study are a gender dummy variable (GENDER) as well as household-related variables to capture household responsibility (as described in section 3.1.2) and job characteristics to capture job-related gender differences (as described in section 3.1.3). We add a dummy variable to indicate negative income (observed for some of the self-employed). Hours of housework, as a measure of household responsibility, is included in a separate model (in Table 2) to account for the fact that this information is not consistently captured in the panel data.

Because random effects models include comparison between different individuals, these models cannot control for unobserved heterogeneity including selection biases into self-

employment (Georgellis and Yusuf, 2016; Binder and Coad, 2016). In order to address this limitation, we include the Big Five Personality Traits^{vii} to control for traits such as an underlying attitude towards risk or fear of failure that are associated with the decision to become self-employed (Brachert et al., 2019). Caliendo et al. (2014) estimate that personality traits together explain 30% of the variation of an entry into self-employment. These variables also capture gender differences in becoming self-employed, for example that women are more risk averse and therefore are also less likely than men to become self-employed (Wagner, 2007).

As controls we further include age as both commuting and self-employment are influenced by age (for example, Minola et al. (2016) for self-employment and Sandow (2008) for commuting). A health variable (limiting long-lasting illness or disability) is included on the basis that those with health problems may be more likely to have short commutes. An urban/rural indicator of residential location is used to capture large-scale differences in the accessibility of workplaces, labour markets and related gender differences, with the gender commuting gap in rural areas being amplified (Moss et al., 2004; MacDonald and Peters, 1994). We further control for transport mode since transport mode choices that impact on commuting time are gendered (Hanson and Johnston, 1985). Lastly, we add ethnic group as control because of interactions between race/ethnic group and gender on commutes (McLafferty and Preston, 2019). We focus in the presentation of findings on the key predictor variables of relevance to our research focus and do not report control variables.

Because random effects models cannot control for unobserved heterogeneity, we also run models (in Table 2) for employees and the self-employed as linear fixed effects regression models (which only examine changes to a given individual without comparing between individuals). Since gender does not change over time^{viii}, we cannot test gender effects directly

in a fixed effects modelling framework. However, interactions between time-constant variables (e.g. gender) and time-variant variables can be tested (Allison, 2009). Using gender interaction terms allows us to better understand how household responsibility and job characteristics interact with gender (Scheiner and Holz-Rau, 2017). We include all time-variant variables from Eq. 1 in the fixed effects model (Table 2):

$$\log TWT_{it} = \beta_1 X_{1,it} + \beta_2 (X_{1,it} \times GENDER_{it}) + \dots + \beta_k X_{k,it} + a_i + e_{it} \quad (2)$$

where a_i is the unobserved individual-specific component that is time-constant. We coded men as zero and women one so that β_1 shows the average effect of X for men and $\beta_1 + \beta_2$ shows the average effect of X for women relative to men. Equation 2 measures change and therefore those who have not experienced a change in commuting time over the study period are not included. Equally, time-constant predictor variables other than gender (ethnic group and the Big Five Personality Traits) are not included, as they are controlled for by a_i .

We also run linear fixed effects regression models separately for men and women (in Table 4) to test the hypothesis that the self-employed have shorter commutes (van Ommeren and van der Straaten, 2008). These models then provide more insights into the effects of household/partner characteristics (household responsibility) and job characteristics (gender differences in employment structures) on women's and men's commutes when self-employment (i.e. as a proxy for spatial workplace choice) is controlled for.

$$\log TWT_{it} = \beta_1 SELF_{1,it} + \dots + \beta_k X_{k,it} + a_i + e_{it} \quad (3)$$

In this model, the self-employment dummy variable (SELF) estimates whether on average people have shorter (longer) commutes when they are self-employed compared to when they are in paid employment – but only for those individuals who were also in paid employment at some point in the sample. We add to this a model (in Table 4) where we specifically test the effect of entering self-employment from paid employment:

$$\log TWT_{it} = \beta_1 \text{ENTRYSELF}_{1,it} + \dots \beta_k X_{k,it} + a_i + e_{it} \quad (4)$$

This latter model is restricted to those who were in paid employment the year before so that the reference category of the entry into self-employment dummy variable (ENTRYSELF) are those who remain in paid employment.

Equations 1 and 3 are run on the total sample of all employees and the self-employed (Tables 2 and 4) and subsequently on the sub-sample of parents in heterosexual couple households (in Tables 3 and 6) in order to better explore the household responsibility hypothesis according to which we expect stronger effects of domestic burdens on commuting time of mothers compared to fathers.

In the parent models, since people may report hours spent on childcare in the reported hours of housework^{ix}, we include childcare arrangement and hours of housework in separate models. Both variables have enough variation to be included as independent variables in the fixed effects models, with changes in hours of housework being more frequent than changes in childcare arrangements with the partner.

We first present findings from these models as presented here in relation to gender differences and differences in commute time between employees vs the self-employed (section 4.1). Subsequently, we discuss findings more specifically in relation to the household

responsibility hypothesis (section 4.2) and the labour market structures hypothesis (section 4.3).

4. Empirical results

4.1 The gender commuting time gap and self-employment

We first test the gender commuting gap amongst employees and the self-employed separately. Table 2 shows findings separately for employees and the self-employed. Models 2 and 5 (Table 2) add hours of housework per week to Models 1 and 4 for employees and the self-employed respectively. Table 3 displays estimates of commuting time for parents by employees and the self-employed including hours spent on housework and the childcare arrangement in the household as covariates.

<Table 2>

<Table 3>

Estimates confirm significantly shorter commuting times of women than men if they are employees – but not if they are self-employed (Table 2). Table 3 confirms the gender commute gap also for employees who are parents while again amongst self-employed parents, women do not show significantly shorter commutes than men. The lack of a gender difference in commutes among the self-employed, who are less constrained by the labour market in work location, after controlling for household responsibility suggests there is not an underlying preference for shorter commutes among women.

Fixed effects estimates for men and women in Table 4 confirm shorter commutes of the self-employed to employees for both men and women including when hours of housework per

week are controlled for – although the association between self-employment and commute time becomes weaker among men after controlling for hours of housework while the coefficient becomes larger for women. However, we find limited evidence for an association between self-employment and commuting time when an entry into self-employment is included rather than an average relationship between self-employment and commute time within individuals.^x Hence, on average, men and women commute less when they are self-employed to when they are in paid employment, but it is not that switching from paid employment to self-employment imminently reduces commute times after controlling for other factors. This could be related to other changes that moving into self-employment is accompanied with and which are related with commute time (e.g. an occupational change). The descriptive analysis of the commuting time before and after entering self-employment (between two consecutive waves) shows for both men and women on average shorter commutes after their entry into self-employment (Table 5).

<Table 4>

<Table 5>

When only parents are considered (Table 6), the association between self-employment and commuting time disappears for women altogether and for men if hours of housework per week are controlled for. We add to Table 6 for the same models estimates from linear random effects (RE) models to check whether unobserved heterogeneity due to time-constant factors explains why there is no relationship between self-employment and commute among women and only a weak relationship among men observed in the fixed effects (FE) models. The random effects models (Table 6) produce strikingly different results for the self-employment

dummy variable. Indeed, if not controlled for unobserved heterogeneity due to time-constant factors, self-employment has also a strong negative association with commuting time for both mothers and fathers. The fact that self-employed parents (mothers and fathers) have significantly shorter commutes than parents who are employees but that a given person (mother or father) does not tend to have a significantly shorter commute when they are self-employed than when they are an employee, suggests there are unobserved traits that are associated with selection into both parenthood and self-employment.

Parents are a select group with respect to a number of characteristics such as age, educational attainment, earnings and subjective well-being (Cetre et al., 2016; Schober, 2013). These selection factors are unlikely to explain our findings as we have controlled for them and we are only aware of existing study findings that point at reduced subjective well-being through commuting but not the opposite direction. A possible explanation may be gender role attitudes that are not captured in the actual childcare arrangement in the household reported by the respondents. Women (but not men) were found to select into parenthood according to their gender role attitudes (Kaufman, 2000). To contrast, traditional and egalitarian men were in this study not different in the probability to have children. Our finding that the association between self-employment and commute time fully disappears among mothers after controlling for unobserved heterogeneity (in a fixed effects model) could therefore be that traditional gender role attitudes that are likely to be reflected in residential choices impact on women's commute (rather than self-employment).

<Table 6>

4.2 Household responsibility

We find little support for the household responsibility hypothesis. Having a small child of pre-primary school age does not decrease the time women commute or increase commuting time for men (Tables 4 and 6). Quite the opposite, we rather find that women with a child 0-4 years of age tend to have significantly longer commutes compared to women with no dependent children in the household (Model 5 in Table 4). Amongst parents, the age of the youngest child has no effect on either women's or men's commuting time (FE models in Table 6). Neither being married nor having an employed partner are associated with shorter commutes for women and mothers or longer commutes for men and fathers.

Strikingly, hours of housework per week are significantly positively related with women's commute both for all employed women (Model 5 in Table 4) and mothers only (Model 5 in Table 6). We test interaction effects between hours spent on housework and sex for employees vs the self-employed (Models 3 and 6 in Table 2 respectively). Here the coefficients now show the average effects for men and the interaction terms show the average effects for women relative to men. There are significant gender differences amongst employees but contrary to the household responsibility hypothesis, more housework is positively associated with women's commuting times. Amongst the self-employed, in contrast, we find that women relative to men tend to have shorter commutes with increased hours of housework. However, women's longer commutes are still associated with more housework (Table 4). Thus, the greater spatial and temporal flexibility of self-employed work seems to reproduce traditional gender roles confirming existing study findings (Craig et al., 2012).

The practiced childcare arrangement in the household is not related with mothers' and fathers' commute times after controlling for selection effects into parenthood (FE models in Table 6 and Model 2 in Table 3 as comparison).

<Table 7>

To corroborate these modelling findings, we analysed descriptively the commutes before and after respondents became a parent (Table 7). We exploit information from four waves of the panel (i.e., we create a sub-sample of the parent sample presented in section 3.2). We identify those who became parents and live in a heterosexual couple household between consecutive waves (t and $t-1$). We use their commuting time before they became parents (at wave $t-1$) and one year (at wave $t+1$) and two years (at wave $t+2$) after they became parents (and still live with their own dependent child). We do not report figures by employment status because numbers in the sample of self-employed people becoming parents and staying over four waves in the panel by gender are small. The difference in commuting time before and after becoming a parent is small for both men and women. Women who became mothers had on average rather slightly longer commutes than men who became fathers the year before becoming a parent. Men slightly increase their commute in parenthood while women on average experience little change. Notably, these women have not had career breaks beyond maternity (or adoption) leave and thus findings appear to be strikingly different to cross-sectional analysis that investigates commutes of a heterogeneous group of mothers at one point in time (cf. Tables 1 and 7).

4.3 Job-related constraints

We do not find occupation, earnings and part-time work to be related with commuting time of the self-employed whereas these job-related factors show the expected relationships among employees (Madden, 1981). Specifically, those in professional and managerial occupations have longer commutes, higher earnings are associated with longer commute

time while part-time employment is associated with shorter commuting times (Table 2). We further test gender differences in job characteristics for employees vs the self-employed using gender interaction terms in fixed effects models (Table 2). In Models 3 and 6, the coefficients of occupation, earnings and part-time work are now the average effects of men and the respective gender interaction terms are the average effects of women relative to men. These models confirm strong job-related gender differences amongst employees while no gender differences are suggested in the self-employment model confirming our underlying hypothesis that the self-employed are less spatially constrained by labour market and employment structures which is reflected in their commutes (van Ommeren and van der Straaten, 2008). As employees, manual work shortens the commutes of both men and women but significantly more so for women than men while men accept long commutes with increased earnings but women significantly less so. This is likely to be related to women appreciating more than men non-monetary values of work such as flexibility (which is inherent in self-employed work) (Trzcinski and Holst, 2012). While these findings correspond with the existing literature (Madden, 1981), we find that amongst employees, men's commuting behaviour is much more sensitive to part-time work which is in stark contrast with previous findings (McQuaid and Chen, 2012). Men accept significantly shorter commutes in part-time work relative to women. Notably, many more women than men are part-time employees.

4.4 Robustness checks

We presented findings based on longitudinal data of people's commutes not including observations when people mainly worked from home, i.e. had zero commutes. Amongst the

self-employed, the gender commute gap may appear smaller (or in fact not significant as shown in our evidence) because women are more likely to select into self-employment in order to work from home and avoid commutes altogether. Van Ommeren and van der Straaten (2008) also exclude those who mainly work from home in their commuting study of employees and the self-employed. Rosenthal and Strange (2012) present findings on the gender commute gap of workers with a commute and all workers including homeworkers (with zero commutes). The estimated gender commute time gap is larger in their OLS regression models when homeworkers are included but the direction and significance level of the gender effect are the same.

We follow Rosenthal and Strange (2012) and re-run all models that estimated the association between gender and commuting time (Tables 2 and 3) for all workers including homeworkers with zero commutes. Similar to Rosenthal and Strange's study, this does not change our findings. Even after including homeworkers, we still do not find a gender commute time gap amongst the self-employed and the significant gender difference in commute time amongst employees remains including for the sample restricted to parents.

We further test in fixed effects logit models whether mainly working from home as compared to mainly working somewhere else than the own home (as dependent variable) is associated with self-employment and women who are self-employed via an interaction term between a dummy indicating whether a person is self-employed or an employee and a gender dummy variable, alongside the same controls that we use in this study to estimate commuting time. The findings show a large association between self-employment and homeworking but no unique gender effect. Further reassuring is that existing studies on home-based businesses show that the main reasons for working from home are cost-minimisation and the nature of

the business which does not require commercial premises – and not primarily because of commuting (Vorley and Rodgers, 2012; Mason et al., 2011).

The selection into self-employment that is due to time-constant factors is controlled for in the linear fixed effects models (Eq. 2-4) although we are limited in addressing this selection bias in Eq. 1. There may be, however, unobserved factors that change over time and that affect people's decision to become self-employed. The effect of young children that may lead women to choose self-employment should be controlled for through the age of the own youngest child in the household, but it is likely that people change their attitude towards work and/or residential preferences when they have a child.

We conducted checks whether household responsibility may be a reason for becoming self-employed. Findings in the existing literature are ambiguous as to whether women become self-employed in order to spend more time with their children and less time on income-generating work (see section 2.3). We used a fixed effects logit model with an entry into self-employment as dependent variable and lagged covariates (i.e. the year before the entry into self-employment) including the childcare arrangement, hours of housework and the age of the youngest child in the household. We use gender interaction terms with these three variables capturing domestic and care responsibilities. Neither of these three variables nor the gender interaction terms are significantly related with an entry into self-employment so that we cannot find evidence in our data that household responsibilities may be affecting the selection into self-employment. Findings of these robustness checks are reported in the supplementary documentation.

5 Summary and conclusions

Overall, our findings indicate strong labour market constraints shortening women's commutes rather than household responsibilities or underlying gender commuting preferences. However, some of our detailed findings (in particular differences in results between random effects models that compare differences between people and fixed effects models that analyse changes in the same people) hint at complex interdependencies and underlying selection effects in relation to labour market status, household gender roles and commuting.

We have used the self-employed as a quasi-experimental comparison group to employees to provide new insights into the gender commuting gap that has attracted the attention of geographers, transportation planners and urban researchers internationally for decades. The self-employed are freer in their workplace choice and are thus less spatially constrained in the labour market than employees (van Ommeren and van der Straaten, 2008). They can therefore help control for (some) labour market and employment constraints that geographical and feminist research has highlighted as reasons for the short commutes of women. We used a longitudinal design with repeated measures for the same individuals to systematically explore differences between employees and the self-employed and gender differences among employees and the self-employed in order to test the effects of labour market and employment constraints, household responsibility and remaining unaccounted effects which could be assumed to reflect underlying gendered commute preferences on commuting time. Importantly, our fixed effects panel estimates control for the self-selection into self-employment by preferences for residence and workplace locations and characteristics of workers which are difficult to observe, and help disentangle pathways between changes to employment, commuting and household responsibilities. Our analysis represents a number of methodological advances: use of individual-level panel models to

control for unobserved heterogeneity (due to time-constant factors such as energy level; employment, household and commuting preferences/predispositions); detailed measures of household responsibility; comparison of parents and non-parents in separate models; and the use of a quasi-experimental group in the self-employed.

We find little evidence for a gender commuting time gap amongst the self-employed, in contrast to Rosenthal and Strange's (2012) cross-sectional study, while our findings confirm existing evidence of a gender commuting gap for employees. Occupational social status, earnings/wage and part-time employment are all associated with commuting time amongst employees and with significant gender differences amongst employees, but we cannot find significant relationships of these job-related factors with commute time and with gender amongst the self-employed. Our first key finding therefore is that one reason why there is no gender commuting gap amongst the self-employed, and the self-employed have shorter commutes than employees, is because the self-employed are less labour market constrained. Therefore among employees, women are more constrained than men by labour market opportunities in where they can work. In particular, the self-employed in professional and managerial positions can avoid the long commutes observed by some in paid employment, even excluding the higher proportion of self-employed workers who work mainly from home (i.e. have zero commute time). This suggests that labour market constraints and opportunities play key roles in producing the gender commuting gap among employees, and that underlying gender differences in commute preference play a little role – otherwise we would expect to see a gender commuting gap among the self-employed. This finding is highly important for current debates about gender (in)equality in the labour market and policies for sustainable and inclusive growth (such as the EU's Europe 2020 strategy).

We find little support for the household responsibility hypothesis, which we tested using panel models for parents and all workers (parents and non-parents) that include the age of the youngest child in the household, hours of housework per week, childcare arrangement in the household, being married and having an employed partner as influencing factors on commuting time. A large number of cross-sectional studies have found household responsibility to influence the commutes of women, whereas in our study none of these factors significantly reduce commuting times of women and/or increase commuting times of men when panel models are used. Our second key finding is therefore that women and men do not seem to change their commuting behaviour because they have children, are married or spend more time doing housework (i.e. have a greater household responsibility). Rather, and almost paradoxically, fixed effects panel models indicate that women in particular tend to have longer commutes when they do more (rather than less) housework. This said, our study focussed on commute time and therefore did not embed issues of gender disadvantage related to non-employment and career breaks. Specifically, we investigated whether women and men have on average significantly different commutes when they have children compared to when they had no dependent children in the household. Our rather surprising findings do not capture (or contradict) results of previous work in labour economics that have highlighted the 'child penalty' on women through decreasing labour market participation after the first child (Sandler and Szembrot, 2019). They rather point at the heterogeneity of women's employment decisions.

Socially ascribed gender identities and roles may be important undercurrents shaping all these observed outcomes. Random effects models show that among parents, the self-employed have shorter commutes than employees, but fixed effects models show that a given parent does not on average have shorter commutes when they are self-employed. In

contrast to parents, all workers (parents and non-parents) do have shorter commutes when they are self-employed. Thus, there appear to be unobserved traits and/or circumstances associated with selection into self-employment, parenthood and having a shorter commute. Specifically, we find that self-employment is linked with traditional divisions of labour in terms of hours of housework, which may plausibly result from greater flexibility in when and where to work. Thus, it may appear from our findings that more traditional women select into self-employment, possibly motivated in part to have greater flexibility in how to use time (Craig et al., 2012).

In many mature economies the self-employed represent a rising and sizeable portion of the workforce (Hatfield, 2015) and therefore their commuting patterns are of interest in their own right in addition to being a means to shed light on the reasons behind the gender commuting gap in the workforce as a whole. Self-employment produces distinct spatial structures that will become more important for understanding gendered commutes, space and place in the future, including the question of whether the short commutes of self-employed workers represent empowerment with associated environmental benefits of less travel (Shin, 2019), or if the localism of self-employment may in the longer term come to limit opportunities, networks and well-being (Reuschke, 2019; Rosenthal and Strange, 2012) – and how those relationships may turn out to be more gendered than emerging findings of no gender gap in the commutes of self-employed workers suggest.

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Table 1. Distribution of one-way commuting time by employees vs self-employed workers and gender

Employment status and gender	Mean	Percentiles				Std. Dev.	n
		25 th	50 th	75 th	90 th		
All (parents and non-parents)							
Employees							
Men	28.56	12	20	40	60	22.37	54,507
Women	24.17	10	20	30	50	19.52	77,686
<i>t-test</i>	<i>t= 37.9627, p=0.000</i>						
Self-employed							
Men	22.25	10	15	30	45	20.93	2,958
Women	18.97	7	15	25	45	18.23	1,977
<i>t-test</i>	<i>t= 5.8273, p=0.000</i>						
Parents in heterosexual couple households¹							
Employees							
Men	29.72	15	25	40	60	23.05	9,007
Women	22.99	10	20	30	45	18.69	10,163
<i>t-test</i>	<i>t= 22.2818, p=0.000</i>						
Self-employed							
Men	23.90	10	20	30	60	21.17	554
Women	17.13	5	15	20	30	15.24	302
<i>t-test</i>	<i>t=4.9032, p=0.000</i>						

Note: Understanding Society 2009-17; 18-64-year-olds with a commute >0 and <180 minutes to a fixed workplace; unweighted data.

¹With information on childcare arrangement in household.

Source: authors' compilation

Table 2. One-way commuting time (log) by employees and self-employed workers, random effects generalized least squares estimates (RE) and fixed effects (FE), standard errors in brackets

Covariates	Employees			Self-employed		
	M1 RE	M2 RE	M3 ¹ FE	M4 RE	M5 RE	M6 ¹ FE
Sex (women)	-0.117*** (0.009)	-0.112*** (0.010)	-	0.029 (0.052)	-0.033 (0.062)	-
Age of youngest child in hh (ref. no dep. child)						
0-4 yrs. old	0.016 (0.009)	0.026* (0.011)	-0.006 (0.020)	-0.001 (0.046)	0.057 (0.059)	0.017 (0.079)
5-9 yrs. old	-0.010 (0.009)	-0.014 (0.012)	-0.010 (0.023)	0.039 (0.047)	0.042 (0.060)	0.002 (0.084)
10-15 yrs. old	-0.019* (0.008)	-0.015 (0.011)	0.010 (0.021)	-0.092* (0.040)	-0.085 (0.050)	-0.087 (0.067)
Housework (hrs/week) (ref. 0-2)						
3-11 hrs.	-	0.031*** (0.008)	0.012 (0.011)	-	0.073 (0.041)	0.122** (0.045)
12-19 hrs.	-	0.010 (0.011)	0.001 (0.020)	-	0.101 (0.057)	0.173* (0.086)
20+	-	0.002 (0.013)	-0.041 (0.029)	-	0.062 (0.067)	0.076 (0.166)
3-11 hrs. × women	-	-	0.041* (0.019)	-	-	-0.241* (0.106)
12-19 hrs. × women	-	-	0.068* (0.026)	-	-	-0.212 (0.136)
20+ × women	-	-	0.123*** (0.035)	-	-	-0.130 (0.199)
Married (yes)	-0.005 (0.008)	-0.018 (0.010)	0.005 (0.014)	-0.030 (0.044)	-0.020 (0.054)	-0.069 (0.080)
Has an employed partner (yes)	0.003 (0.006)	-0.001 (0.008)	-0.011 (0.009)	0.034 (0.031)	-0.011 (0.042)	0.072 (0.047)

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Covariates	Employees			Self-employed		
	M1 RE	M2 RE	M3 ¹ FE	M4 RE	M5 RE	M6 ¹ FE
Occupation (ref. prof./managerial)						
Skilled, non-manual	-0.111*** (0.008)	-0.127*** (0.010)	-0.012 (0.023)	0.341 (0.254)	0.285 (0.349)	-1.079 (0.555)
Manual, low/no skilled	-0.258*** (0.008)	-0.286*** (0.010)	-0.089*** (0.024)	-0.023 (0.034)	0.017 (0.045)	0.062 (0.073)
Skilled, non-manual × women	-	-	-0.073* (0.029)	-	-	-
Manual, low/no skilled × women	-	-	-0.088** (0.032)	-	-	-0.105 (0.113)
Daily earnings/100 (£)	0.013** (0.004)	0.033*** (0.008)	0.210** (0.066)	0.029 (0.042)	0.080 (0.066)	0.067 (0.080)
Daily earnings/100 (£) × women	-	-	-0.207** (0.066)	-	-	-0.152 (0.162)
Part-time (yes)	-0.108*** (0.006)	-0.123*** (0.008)	-0.176*** (0.023)	0.028 (0.036)	0.008 (0.051)	-0.059 (0.095)
Part-time × women	-	-	0.110*** (0.026)	-	-	0.060 (0.119)
Constant	2.816*** (0.056)	2.858*** (0.065)	2.335*** (0.100)	2.387*** (0.370)	2.396*** (0.447)	3.204*** (0.708)
n observations	88,195	48,236	67,424	3,201	1,742	2,483
n individuals	21,517	19,876	31,160	1,209	973	1,489
Wald Chi2/F	10696.75***	8437.72***	56.72***	390.95***	302.14***	2.81***
R2	0.229	0.234	0.184	0.211	0.231	0.105

Note: Understanding Society 2009-17; 18-64-year-olds with a commute >0 and <180 minutes to a fixed workplace. Control variables not shown: age (in years), limiting health, mode of transport and negative labour income dummy in all models plus the big five personality traits and ethnicity in the Random Effects Models.

Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

¹These models also include interaction effects between the age of the youngest child (not significant) and the mode of transport (as controls) with sex.

Source: authors' compilation

Table 3. One-way commuting time (log) of parents, by employees and self-employed workers, random effects generalized least squares estimates

Covariates	Employees				Self-employed			
	M1		M2		M3		M4	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Sex (women)	-0.140***	0.020	-0.121***	0.021	-0.129	0.111	-0.096	0.115
Age of youngest child in hh (ref. 0-4 yrs. old)								
5-9 yrs. old	-0.061***	0.014	-0.061***	0.014	-0.078	0.071	-0.077	0.070
10-15 yrs. old	-0.073***	0.020	-0.076***	0.020	-0.264**	0.099	-0.248*	0.098
Housework (hrs/week) (ref. 0-2)								
3-11 hrs.	0.018	0.014	-		0.042	0.073	-	
12-19 hrs.	-0.014	0.021	-		0.159	0.100	-	
20+	-0.029	0.023	-		0.065	0.117	-	
Who cares for child/ren in hh? (ref. mainly respondent)								
Mainly partner	-		0.064**	0.020	-		0.003	0.100
Shared equally	-		0.031*	0.015	-		-0.045	0.077
Someone else	-		0.147	0.092	-		0.233	0.345
Married (yes)	0.005	0.020	0.008	0.020	0.031	0.118	0.030	0.116
Has an employed partner (yes)	0.012	0.018	0.019	0.018	0.029	0.091	0.035	0.091
Skilled, non-manual	-0.132***	0.018	-0.132***	0.018	-		-	
Manual, low/no skilled	-0.306***	0.018	-0.307***	0.017	-		-	
Daily earnings/100 (£) ²	0.011	0.008	0.012	0.008	0.127	0.128	0.128	0.129
Part-time (yes)	-0.085***	0.016	-0.085***	0.016	0.013	0.081	0.037	0.083
Constant	3.051***	0.174	3.037***	0.175	2.011*	1.040	2.845***	0.807
n observations	15,229		15,204		638		640	
n individuals	7,043		7,026		395		398	
Wald Chi2	2752.08***		2770.51***		177.97***		179.99***	
R2	0.245		0.247		0.272		0.275	

Note: Understanding Society 2009-17; 18-64-year-olds with an own child under 16 years old in the household, who live in heterosexual couple households and have a commute >0 and <180 minutes to a fixed workplace.

Control variables not shown: age (in years), limiting health, rural/urban location, mode of transport, ethnicity, negative labour income dummy and the big five personality traits.

*Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Source: authors' compilation

Table 4. One-way commuting time (log) by gender, fixed effects estimates, standard error in brackets

Covariates	Men			Women		
	M1	M2	M3 ¹	M4	M5	M6 ¹
Self-employed (ref. employee)	-0.135*** (0.028)	-0.096* (0.045)	-	-0.121*** (0.029)	-0.145*** (0.045)	-
Entered self-employment in last year (ref. remained an employee)	-	-	-0.211† (0.117)	-	-	-0.167 (0.110)
Age of youngest child in hh (ref. no dep. child)						
0-4 yrs. old	0.005 (0.013)	-0.008 (0.021)	0.010 (0.026)	0.016 (0.012)	0.037* (0.018)	0.035 (0.023)
5-9 yrs. old	0.009 (0.014)	-0.012 (0.023)	-0.013 (0.029)	0.001 (0.012)	0.027 (0.019)	0.036 (0.023)
10-15 yrs. old	0.001 (0.015)	-0.001 (0.021)	-0.003 (0.029)	-0.009 (0.010)	0.013 (0.015)	0.026 (0.019)
Housework (hrs./week) (ref. 0-2)						
3-11 hrs.	-	0.015 (0.011)	0.034* (0.014)	-	0.052*** (0.015)	0.075*** (0.018)
12-19 hrs.	-	0.006 (0.020)	0.019 (0.024)	-	0.068*** (0.017)	0.080*** (0.021)
20+	-	-0.042 (0.029)	-0.035 (0.036)	-	0.080*** (0.018)	0.094*** (0.019)
Married (yes)	0.002 (0.015)	0.013 (0.023)	0.026 (0.029)	0.016 (0.012)	0.006 (0.018)	0.013 (0.021)
Has an employed partner (yes)	-0.003 (0.009)	-0.010 (0.015)	-0.004 (0.019)	0.006 (0.007)	-0.008 (0.012)	-0.008 (0.015)
Occupation (ref. prof./managerial)						
Skilled, non-manual	-0.016 (0.015)	-0.005 (0.024)	-0.003 (0.030)	-0.056*** (0.011)	-0.090*** (0.016)	-0.057** (0.021)
Manual, low/no skilled	-0.076*** (0.015)	-0.066** (0.023)	-0.019 (0.031)	-0.144*** (0.012)	-0.180*** (0.019)	-0.122*** (0.026)
Daily earnings/100 (£)	0.074* (0.029)	0.172** (0.055)	0.290** (0.087)	0.003 (0.004)	0.003 (0.008)	0.002 (0.008)

Covariates	Men			Women		
	M1	M2	M3 ¹	M4	M5	M6 ¹
Part-time (yes)	-0.117*** (0.014)	-0.161*** (0.023)	-0.165*** (0.032)	-0.052*** (0.007)	-0.063*** (0.011)	-0.041** (0.014)
Constant	2.123*** (0.108)	2.291*** (0.159)	2.032 (0.219)	2.417*** (0.086)	2.397*** (0.124)	2.431*** (0.168)
n observations	56,640	29,255	18,400	78,640	40,652	29,544
n individuals	17,501	13,968	9,371	21,997	18,298	13,655
F	97.74***	35.70***	19.67***	156.17***	60.41***	33.03***
R2	0.169	0.181	0.155	0.200	0.196	0.175

Note: Understanding Society 2009-17; 18-64-year-olds with a commute >0 and <180 minutes to a fixed workplace.

Control variables not shown: age (in years), limiting health, mode of transport and negative labour income dummy.

*Significance level: †p<0.1, *p<0.05, **p<0.01, ***p<0.001*

¹*These models are restricted to those who were employed the year before, are 18-64-year-olds and have a one-way commute >0 and <180 minutes to a fixed workplace at two consecutive waves.*

Source: authors' compilation

Table 5. One-way commuting time (minutes) before and after becoming self-employed by gender

	Commute time one year before becoming self-employed			Commute time after becoming self-employed		
	Mean	Mode	n	Mean	Mode	n
Men	26.47	22.5	130	22.92	20	130
Women	24.35	18.5	114	21.93	15	114

Note: Understanding Society 2009-17, unweighted data.

Commuting time change is measured between two consecutive waves. Included are only those who were employed the year before, are 18-64-year-olds and have a commute >0 and <180 minutes to a fixed workplace before and after they became self-employed.

Source: authors' compilation

Table 6. One-way commuting time (log) of parents, by gender, fixed effects estimates (FE) and random effects estimates (RE), standard errors in brackets

Covariates	Men (with dep. child in hh)				Women (with dep. child in hh)			
	FE		RE		FE		RE	
	M1	M2	M3	M4	M5	M6	M7	M8
Self-employed (ref. employee)	-0.049 (0.074)	-0.157* (0.077)	-0.300*** (0.045)	-0.299*** (0.045)	-0.037 (0.082)	-0.034 (0.084)	-0.237*** (0.052)	-0.239*** (0.052)
Age of youngest child in hh (0-4 yrs. old)								
5-9 yrs. old	-0.004 (0.023)	-0.004 (0.024)	-0.035 (0.020)	-0.033 (0.020)	0.034 (0.022)	-0.024 (0.023)	-0.084*** (0.019)	-0.084*** (0.019)
10-15 yrs. old	0.001 (0.040)	0.013 (0.042)	-0.046 (0.029)	-0.045 (0.029)	0.068 (0.036)	-0.064 (0.038)	-0.110*** (0.027)	-0.112*** (0.027)
Housework (hrs./week) (ref. 0-2)								
3-11 hrs.	0.027 (0.019)	-	0.023 (0.018)	-	0.080 (0.045)	-	0.032 (0.045)	-
12-19 hrs.	0.013 (0.032)	-	-0.029 (0.030)	-	0.091* (0.046)	-	0.020 (0.046)	-
20+	-0.074 (0.046)	-	-0.056 (0.045)	-	0.105* (0.048)	-	0.001 (0.047)	-
Who cares for child/ren in hh? (ref. mainly respondent)								
Mainly partner	-	-0.005 (0.061)	-	0.092 (0.056)	-	0.083 (0.044)	-	0.118** (0.039)
Shared equally	-	-0.007 (0.061)	-	0.062 (0.056)	-	0.024 (0.018)	-	0.025 (0.015)
Someone else	-	0.064 (0.168)	-	0.241 (0.143)	-	0.038 (0.139)	-	0.113 (0.121)
Married (yes)	-0.024 (0.049)	-0.007 (0.055)	0.004 (0.030)	0.015 (0.030)	-0.047 (0.044)	-0.055 (0.048)	0.010 (0.026)	0.009 (0.026)
Has an employed partner (yes)	0.017 (0.027)	0.020 (0.029)	-0.001 (0.022)	0.004 (0.022)	0.010 (0.037)	0.012 (0.040)	-0.003 (0.033)	0.010 (0.033)

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Covariates	Men (with dep. child in hh)				Women (with dep. child in hh)			
	FE		RE		FE		RE	
	M1	M2	M3	M4	M5	M6	M7	M8
Occupation (ref. prof./managerial)								
Skilled, non-manual	0.031 (0.045)	0.044 (0.046)	-0.022 (0.031)	-0.020 (0.031)	-0.031 (0.035)	-0.015 (0.037)	-0.168*** (0.022)	-0.169*** (0.022)
Manual, low/no skilled	-0.008 (0.041)	0.010 (0.043)	-0.177*** (0.025)	-0.181*** (0.025)	-0.086* (0.041)	-0.071 (0.043)	-0.339*** (0.024)	-0.337*** (0.024)
Daily earnings/100 (£) ²	-0.014 (0.093)	-0.064 (0.098)	0.396*** (0.071)	0.390*** (0.071)	0.001 (0.008)	0.002 (0.008)	0.007 (0.008)	0.008 (0.008)
Part-time (yes)	0.038 (0.050)	0.032 (0.052)	-0.029 (0.042)	-0.025 (0.042)	-0.039* (0.020)	-0.036 (0.021)	-0.092*** (0.017)	-0.090*** (0.017)
Constant	2.923*** (0.112)	2.369*** (0.412)	2.875*** (.259)	2.792*** (0.267)	4.060*** (0.356)	4.227*** (0.377)	3.262*** (0.254)	3.279*** (0.251)
n observations	10,101	9,459	7,299	7,291	11,059	10,343	8,663	8,646
n individuals	5,034	4,838	3,338	3,334	5,435	5,225	4,045	4,033
F/Wald Chi2	7.12***	6.48***	1140.65***	1155.68***	10.91***	9.72***	1513.38***	1533.66***
R2	0.147	0.140	0.230	0.232	0.100	0.106	0.235	0.238

Note: Understanding Society 2009-17; 18-64-year-olds with an own child under 16 years old in the household, who live in heterosexual couple households and have a commute >0 and <180 minutes to a fixed workplace.

Control variables not shown: age (in years), limiting health, mode of transport and negative labour income dummy in all models plus the big five personality traits and ethnicity in the Random Effects Models.

*Significance level: *p<0.05, **p<0.01, ***p<0.001*

Source: authors' compilation

Table 7. One-way commuting time (minutes) before and after becoming a parent by gender

	Commute time one year before becoming a parent			Commute time one year after becoming a parent			Commute time two years after becoming a parent		
	Mean	Mode	n	Mean	Mode	n	Mean	Mode	n
Men	27.61	20	351	28.83	25	340	29.38	25	337
Women	28.19	25	402	27.51	25	395	28.18	25	397

Note: Understanding Society 2009-17, unweighted data.

18-64-year-olds who are parents of dependent child <16 years old in the household, live in a heterosexual couple household and have a commute >0 and <180 minutes to a fixed workplace at each measuring point.

Source: authors' compilation

Appendix Table. Sample and variable description

Variables	mean	minimum	maximum	n
Commute time	25.79	1	180	137,128
Women	0.58	0	1	137,128
Self-employed	0.04	0	1	137,128
Parent with own dep. child in household and in heterosexual couple household	0.30	0	1	137,128
Age of youngest child in household				
No dep. child	0.62	0	1	137,128
0-4 yrs. old	0.16	0	1	137,128
5-9 yrs. old	0.11	0	1	137,128
10-15 yrs. old	0.11	0	1	137,128
Married	0.53	0	1	136,893
Has an employed partner	0.51	0	1	137,101
Housework (hrs./week)				
0-2 hrs.	0.19	0	1	70,824
3-11 hrs.	0.53	0	1	70,824
12-19 hrs.	0.16	0	1	70,824
20+	0.12	0	1	70,824
Who cares for child/ren in household?				
Mainly respondent	0.27	0	1	20,026
Mainly partner	0.25	0	1	20,026
Shared equally	0.48	0	1	20,026
Someone else	0.02	0	1	20,026
Occupation				
Professional/managerial	0.44	0	1	136,031
Skilled, non-manual	0.26	0	1	136,031
Manual, low/no skilled	0.30	0	1	136,031
Daily earnings (£)	15.05	-89.44	8298.92	136,636
Negative self-employment flag ¹	0.03	0	1	4,935
Part-time (<30 hrs./week)	0.26	0	1	136,636
Age (in years)	40.52	18	64	137,128
Has limiting health	0.11	0	1	137,116
Lives in rural area	0.21	0	1	137,128
Mode of transport				
Driver of car	0.61	0	1	137,112
Passenger	0.06	0	1	137,112
Train	0.05	0	1	137,112
Other public transport	0.11	0	1	137,112
Cycle	0.03	0	1	137,112
Walk	0.13	0	1	137,112
Other	0.04	0	1	137,112
Ethnic group				
British white	0.77	0	1	135,791
Other white	0.05	0	1	135,791
Mixed	0.02	0	1	135,791
Asian or Asian British	0.10	0	1	135,791
Black or black British	0.05	0	1	135,791
Arab	0.03	0	1	135,791
Any other ethnic group	0.04	0	1	135,791

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Variables	mean	minimum	maximum	n
Big Five Personality Traits				
Agreeableness	5.62	1	7	93,520
Conscientiousness	5.55	1	7	93,520
Extraversion	4.63	1	7	93,520
Neuroticism	3.63	1	7	93,520
Openness	4.62	1	7	93,520

Note: *Understanding Society 2009-17; 18-64-year-olds with a commute >0 and <180 minutes one way to a fixed workplace; unweighted data.*

¹Of those who are self-employed.

Source: authors' compilation

ⁱ Own calculations of the Office for National Statistics' Labour Market Series 'Self-employment jobs' (DYZN).

ⁱⁱ University of Essex, Institute for Social and Economic Research. (2018). *Understanding Society: Waves 1-8, 2009-2017 and Harmonised BHPS: Waves 1-18, 1991-2009*. [data collection]. 11th Edition. UK Data Service. SN: 6614, <http://doi.org/10.5255/UKDA-SN-6614-12>

ⁱⁱⁱ This measure of 'own' children in the household includes biological, adopted, step and foster children.

^{iv} Hours spent on housework per week is captured in waves 1, 2, 4, 6 and 8 of half of the annual survey sample (with interviews between January to June). Who in the household cares most for the child/ren is asked in waves 2, 4, 6 and 8.

^v We use the Registrar General's Social Class variable.

^{vi} Figures are presented for parents with information on the childcare arrangement in the household. The values are only marginally different when for the sub-sample of parents observations with information on hours spent on housework are used.

^{vii} The Big Five Personality Traits are as follows: agreeableness, conscientiousness, extraversion, neuroticism, openness.

^{viii} We exclude those from the study who changed gender between survey years.

^{ix} The question followed on from the question on "who is mainly responsible for looking after the children, is it ..." and is worded as follows: "About how many hours do you spend on housework in an average week, such as time spent cooking, cleaning and doing the laundry?"

x Random effects models produce similar estimates.