Commuting in Great Britain in the 1990s

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Abstract

The paper studies commuting in Great Britain in the 1990s. The average one-way commute to work is now 38 minutes in London, 33 minutes in the south-east, and 21 minutes in the rest of the country. There are three other findings. First, commuting times are especially long among the highly educated, among home-owners, and among those who work in large plants and offices. In Britain, people with university degrees spend 50% more time travelling to work than those with low qualifications. Private renters do much less commuting than owner-occupiers. Second, there has recently been a rise in commuting times in the south-east and the capital. In our sample, full-time workers in London have lost 70 minutes per week of leisure time to commuting during the course of the 1990s. By contrast, outside the south-east of Britain, there has been no increase in commuting over this decade. In the south-east, 30% of workers now take at least 45 minutes to get to work. In the rest of the country, only 10% do. Third, after controlling for other factors and allowing for the endogeneity of the wage rate, there is a ceteris paribus inverse relationship between commuting hours and hourly pay.

1. Introduction

Commuting is a big part of working life in Britain. It is costly for individuals and for the economy. One-quarter of highly-educated men in the south-east spend at least two hours a day travelling to and from work[1]. The proportion is one-in-eight in the country as a whole. Despite the time and resource costs implied by such numbers, this topic has generated comparatively little research by British economists[2].

Commuting has good and bad sides. It is potentially a useful form of 'quasi' labour mobility – allowing people to access jobs far from where they live. In this way, it acts as a half-way house between immobility and migration. On the other hand, those travelling to work may impose externalities upon each other through congestion. As commuting times and congestion externalities rise through the years, this area of British economic life may further attract policy-makers' attention in the future.

We begin with some facts about commuting in Great Britain. Using data from the British Household Panel Survey (BHPS), we calculate over the period 1991/92-1997/98, a mean one-way commuting time of 26 minutes for men. This marginally exceeds that of 23 minutes for women. The median figure for men is 20 minutes. For women it is 15 minutes. Not surprisingly, commuting times are greater in the south east than elsewhere in Great Britain. In London, during the period, the mean one-way commuting time for men was 37 minutes.

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1 This figure is derived using the British Household Panel Survey waves 1 to 7, defining highly-educated on the basis of holding a Degree or Higher Degree qualification.

2 For example, the comprehensive text by Robert Elliott (1991) has no reference to commuting, despite much discussion of time use. A study by Thomas (1997) examines willingness to commute among the unemployed as a source of variation in unemployment durations, focusing upon ethnic differences.

Measures of central tendency are subject to a large variance and degree of skewness; the distribution of travel-to-work times is highly positively-skewed. The paper considers how the burden of commuting falls disproportionately on certain types of workers and the characteristics these individuals possess.

In addition to pure cross-sectional variation in commuting times of this kind, there are noticeable trends through the years. For British employees as a whole, commuting times have increased only marginally between 1991/92 and 1997/98. Certain types of workers have, however, experienced a steady upward trend in their average commuting times -- most noticeably those who are living in the south-east. Over the decade, in the south-east, we find a loss of 50 minutes of weekly leisure time to commuting for full-time workers. The figure is 70 minutes of lost time for those living in London.

The remainder of the paper is organised as follows. Section 2 provides a description of commuting behaviour of British employees. In order to provide a more formal framework for the discussion, Section 3 presents a simple model of rational commuting behaviour. This analysis motivates the empirical work undertaken in Section 4, which estimates ceteris paribus differentials in commuting behaviour by individual and employer characteristics. The theory and empirics largely focus on the effect of wages upon commuting times ie. should an increase in the wage lead employees to commute more, perhaps in order to live in a more attractive area, or less, as their time is more highly valued? The impacts of education and home ownership are also examined. Conclusions are provided in Section 5.

2. Commuting in the 1990s

The analysis uses the first seven waves of data from the British Household Panel Survey (BHPS). The data source is described in further detail in Section 4. The sample is selected on the basis of employees of working age, employed at least 20 hours per week. In this section, in order to consider how commuting times have varied over time, we restrict the sample to a balanced panel of 1622 workers who are present in each of the seven waves of the survey. This provides a total sample of 6454 male and 4900 female observations. The cross-sectional variation is not sensitive to this balanced panel sample restriction. Table A1 in the appendix sets out mean travel-to-work times in a larger cross-section of people in 1997/8.

We also focus on those individuals who experience particularly long journeys to work. At moderate travel-to-work times, commuting can be viewed as playing a positive role in the economy. It contributes to the flexibility and mobility that are necessary for a well-functioning labour market. Any net welfare cost associated with commuting is likely to stem principally from those individuals with high commuting times. This is partly because such individuals create disproportionate amounts of road, rail and air congestion. To our knowledge, little analysis has been done of commuting patterns among British employees in the decade.

Cross-sectional variation

Table 1 presents summary statistics on commuting times over the seven-year period within the 1990s that our data-set covers. The average one-way commuting time in 1997/98 is 25.9 minutes for men and 22.6 minutes for women. Those with higher levels of education tend to have longer commuting times – the travel-to-work times of university graduates and those with other higher qualifications, are about 50% longer than those people with the lowest educational qualifications. A pronounced regional difference is apparent when comparing those employees living in the south-east (including London) compared to those outside the south-east. Towards the end of the decade, Londoners are commuting almost twice as much as workers outside the southern corner of the country.

Males spend a little longer travelling to work than do females. The difference in means is statistically significant (t-value=4.47; p-value=0.00). There is no significant variation in the raw data on the basis of marital status or whether people work in a public-sector or private-sector workplace. Not surprisingly, full-time workers spend significantly more time commuting to work than do part-time employees; the average difference in one-way journey-to-work times is about 7 minutes. (t-value=8.87; p-value=0.00). There is also evidence of a significant raw differential in commuting times between owner-occupiers and non-homeowners. Owner-occupation is associated on average with about a 4-minute longer journey-to-work time.

Variation in Commuting over Time

For British workers as a whole, there is evidence of an increase in the average commute during the 1990s. It is not large. However, average commuting times have been increasing for those in the south-east – and in London in particular. The rise in travel-to-work time among those in the south-east is found evenly among male and female workers. The male subsample experiences an increase in its mean commute from 30.8 minutes to 36.1 minutes, whilst that for women increases from 23.2 minutes to 28.2 minutes. The increase in the mean commute between 1991/92 and 1997/98 for workers living in the south-east is statistically significant (t=3.01; p-value=0.00). The same null hypothesis of equality of mean commuting times in 1991/2 and 1997/8 can be rejected for workers living in London (t-value=2.83; p-value=0.00)[3].

Given that the travel-to-work time refers to the amount of time it 'usually takes to get to work, door to door (one-way journey only)', our estimates imply that full-time workers in London have lost 70 minutes per week of leisure time to commuting during the course of the 1990s. The equivalent figure for those living in the south-east as a whole is a loss of 50 minutes[4].

Whilst of interest in summarising the cross-sectional commuting patterns of British employees, the raw data fail to impose any <u>ceteris paribus</u> condition for

[3] 30% of the sample is located in the south-east with 10% living in London.

[4] Note that the increase in the mean commute for those in the south-east is not entirely accounted for by those living in London. Those in the south east, but outside London witness an increase in their mean commute from 25.5 to 30.0 minutes on average.

comparisons of commuting behaviour. This will be an aim of Section 4 of the paper.

Measurement error is possible. Inspection of the raw data reveals that rounding is likely to be present. Although reported times cover one-minute intervals up to 60 minutes, there are spikes at 5-minute intervals within this time-span. Above the 60-minute level, reported journey times tend to follow five-minute increments. These facts are suggestive of rounding. One may also question the reliability of the (rather small) number of individuals reporting journey times in excess of, for instance, 180 minutes[5]. Re-coding these values to, say, the 99th percentile would be one option (see eg, Hamermesh, 1999). This has not been adopted here. The variation in commuting highlighted in this section, both by individual characteristics and the upward trend for those living in the south-east, is not dependent on the inclusion of these extreme values. Moreover, there is no reason why rounding should give rise to an increase in the reported journey times over time.

We now focus on those individuals with especially long journey-to-work times. In Tables 2 to 5, we select time-thresholds for one-way commutes at 45, 60 and 90 minutes, and examine the proportion of employees commuting at, or in excess of, these three levels. We also consider how the numbers vary by individual characteristics.

Approximately 13% of British employees have a one-way journey-to-work time of 45 minutes or more; 6% of employees commute for one-hour or more; approximately 2% commute to work for 90 minutes or more. The distribution of travel-to-work time is highly skewed. Figures for the United States are, in fact, similar to those presented here. Evidence from the 1990 US Census of Population indicates a mean travel-to-work time of 22.4 minutes, with 12.5% of employees experiencing a one-way commute of 45 minutes or more, and 1.6% of employees exceeding the 90-minute threshold.

[5] 0.1% of employees reporting a commuting time provide a figure of 180 minutes or more.

We now consider patterns by gender, education, housing tenure and region. Table 4 classifies commuters by education. Almost twice as many of the most highly educated group (consisting of those with a degree, teaching qualification or 'other higher' qualification) experience journey times in excess of 45 minutes than among those without a degree[6]. There are also geographical differences: the difference between the south-east and elsewhere is large (see Table 5). In the 1990s, it has been the highly educated and those living in the south-east who have witnessed the largest increase in commuting times. Between 1991/92 and 1997/98, the proportion of those employed in Britain with a degree who have a one-way commute of at least 60 minutes increased from 9.4% to 12.4%. The equivalent figure among those living in the south-east is an increase from 11.5% to 18.7%.

Table 5 illustrates the extent of long-commutes in the south of the country relative to elsewhere. By 1997/8, approximately 30% of those in the south-east took 45 minutes to get to work. In the rest of the country, only about 10% of workers took this long. Table 6 provides average commuting times for home-owners and others.

To this point our analysis has been purely descriptive of the data, reflecting the fact that there has been little such description of commuting patterns of British employees, previously. We now go on to provide a more formal discussion of the decision to allocate time to commuting.

3. Analytical Framework

[6] It is, of course, possible to break these groups down further. For instance, in 1997/98 more than one-in-four men in the south-east had a one-way commuting time of at least 45 minutes, with almost one-in-five having a journey time of at least 60 minutes. Of those individuals who possess a degree and live in the south-east, 36% (25%) have a one-way commute of at least 45 (60) minutes.

A rational individual can be thought of as allocating scarce time among several various activities. The decision to spend non-negligible amounts of time commuting to work is presumably best viewed as an optimising choice by a worker. An economic model of travelling to work can then be constructed by expanding the standard model of the individual.

It is instructive to begin with a general framework and to move from this to special cases. Let ‘h’ be an individual’s chosen hours of work. This is assumed to be bounded above by some physical limit. Let ‘c’ be the amount of commuting time, that is, the number of hours devoted in a given time period to getting to and from the workplace. Leisure, ‘*l*’, is what remains after hours worked and time spent commuting. Define units so that : h + c + *l* = 1 , which is the time constraint.

Let ‘z’ denote a vector of parameters that influence the individual’s optimal choice of working hours and time spent travelling. These will include the wage paid per unit of time, the cost of travel, the non-pecuniary advantage of different areas, and potentially many other factors. To fix ideas, the individual’s decision-making problem can be thought of as :

$$\max_{h,c} V(h,c,z) \qquad (1)$$

where ‘h’ represents hours of work, ‘c’ refers to hours of commuting, and leisure has been substituted out of the algebraic structure by using the time constraint. At an interior optimum, using subscripts to denote partial derivatives,

$$V_h = 0 \qquad (2)$$

$$V_c = 0 \qquad (3)$$

and, for a maximum,

$$V_{hh}V_{cc} - V_{ch}^2 \rangle 0 \qquad (4)$$

While this structure is too general to provide detailed intuition - an issue to which we turn next - it allows a comparative static result to be written down. Differentiating through (2) and (3) and combining the two equations to eliminate hours ‘h’, gives

$$\left(V_{ch} - \frac{V_{hh}V_{cc}}{V_{ch}} \right) dc \quad = \quad \left(\frac{V_{cz}V_{hh}}{V_{ch}} - V_{hz} \right) dz \qquad (5)$$

This tells us how small changes in the 'z' parameters affect the maximising choice of commuting time 'c'. Multiplying through equation 5 by V_{ch} , the left-hand-side becomes $V_{ch}^2 - V_{hh}V_{cc}$, which by the condition for a maximum must be negative. Hence, without having to impose further structure on the problem, it follows that commuting time reacts to the parameter z according to

$$sign\left(\frac{dc}{dz} \right) \quad = \quad sign \;\; V_{hz} \; V_{ch} - V_{cz} \; V_{hh} \qquad (6)$$

In order to derive the sign of the response of commuting time to a change in one of the parameters, it is therefore necessary to sign only the expression on the right-hand side of equation 6. This short-cut is used later. A central concern will be to understand what microeconomics would predict about the effect of wages upon commuting times.

Consider the following simple case. The individual's utility is additively separable; there is a cost of commuting; the return to commuting is non-pecuniary. By paying the financial and time costs of travelling, the worker is able to work in a nicer area. Define the utility function

$$V \quad = \quad y - k(c) + \mu(1 - h - c) + n(c) \qquad (7)$$

in which y is income (given by the product of the wage, 'w', and working hours, 'h'), *k(c)* is the cost of going to work , μ is a function capturing the utility from leisure and *n(c)* refers to the non-pecuniary utility from living in a nicer place. The cost-of-commuting function *k(c)* is assumed increasing and convex. The functions for value-of-leisure, μ , and niceness of area, *n*, are assumed increasing and concave. As earlier, only differentiable functions are considered. This formulation views the wage as independent of commuting distance, and we discuss later the implications of relaxing this assumption.[7]

[7] It might be natural to justify wage-independence by assuming that the marginal productivity of labour is independent of spatial location. Gabriel and Rosenthal (1996), however, assume that firms observe where their workers are living and wage-discriminate on

There are two first-order conditions. The worker sets to zero the net marginal utility from working and from commuting :

$$V_h \quad = \quad w - \mu'(1-h-c) \quad = \quad 0 \tag{8}$$

$$V_c \quad = \quad -k'(c) - \mu'(1-h-c) + n'(c) \quad = \quad 0 \tag{9}$$

First, as in standard theory, the wage in equation 8 is equated to the value of an hour of leisure. Second, in (9) the marginal niceness-of-area return to commuting, *n′(c)*, is equated to the sum of the marginal cost of travelling and the marginal value of the foregone leisure. The second-order condition is satisfied here provided the *n(c)* function is more concave than the *k(c)* function is convex, which is assumed.

It is of interest to examine the worker's optimal response to an increase in the wage rate. Using the method described above, it is easy to show that, as $V_{cw} \quad = \quad 0$ in this framework,

$$sign\left(\frac{dc}{dw}\right) \quad = \quad sign\, V_{hw}\, V_{ch} \tag{10}$$

$$= \quad sign\left\{\mu''\left(1-h-c\right)\right\} \quad < \quad 0 \tag{11}$$

In this simple setting, a small rise in the wage leads the worker to value his or her time more highly at the margin, which makes it more expensive to spend time on commuting. The rational individual therefore reduces commuting, c, after a marginal increase in the wage rate. In terms of equation 8, a rise in the wage means that at an optimum the value of $\mu'(.)$ must rise in proportion. By equation 9, $n'(c) - k'(c)$ must increase by the same amount. As $n(c) - k(c)$ is a concave function of commuting time, 'c' therefore has to fall.

The assumption that utility is linear in income is a special one. Going beyond it makes the comparative statics ambiguous, but in a systematic way. A central role is played by the responsiveness of marginal utility to income and, more precisely, by the degree of risk aversion. To show this, take a slightly

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this basis. This might be viewed as an extreme assumption. The Gabriel-Rosenthal model allows for no variability in hours of work.

more general case in which the individual's utility can be represented by the function

$$V \quad = \quad u(wh - k(c,\gamma)) + n(c) + \mu(1 - h - c) \qquad (12)$$

where *u(.)* is a concave and increasing function capturing the utility from money; *k(c,g)* is the cost of commuting, where γ refers to a shift parameter ; *n(c)* is again the direct utility from commuting, which is to be interpreted as capturing the niceness of areas further from the workplace ; and *m (.)* is the utility from leisure, which is again the number of hours available after work, 'h' and commuting, 'c'. If 'γ' is the number of other commuters, it is natural to assume $k_{c\,\gamma}$ and k_{γ} both positive.

Following the same technical short-cut as before, the response of commuting hours to the wage is determined by

$$sign\left(\frac{dc}{dw}\right) \quad = \quad sign\ V_{hw}\, V_{ch} - V_{cw}\, V_{hh} \qquad (13)$$

Writing out the separate components of (13) :

$$V_{hw} \quad = \quad \frac{\partial}{\partial h}\left[u'(.)h\right] \quad = \quad u'(.) + u''(.)hw \qquad (14)$$

$$V_{ch} \quad = \quad \frac{\partial}{\partial c}\left[u'(.)w - \mu'(.)\right] \quad = \quad u''(.)k_c\, w + \mu''(.) \qquad (15)$$

$$V_{cw} \quad = \quad \frac{\partial}{\partial c}\left[u'(.)h\right] \quad = \quad -u''(.)k_c\, h \qquad (16)$$

$$V_{hh} \quad = \quad \frac{\partial}{\partial h}\left[u'(.)w - \mu'(.)\right] \quad = \quad u''(.)\ w + \mu''(.) \qquad (17)$$

Hence, after simplification,

$$V_{hw}V_{ch} - V_{cw}\, V_{hh} \quad = \quad \mu''(.)\left[u'(.) + u''(.)hw\right]$$
$$- u'(.)u''(.)k_c w + u''(.)\mu''(.)hk_c \qquad (18)$$

Of the three terms on the right-hand side of equation 18, the second and third can be signed unambiguously as positive, because commuting costs rise with distance and *u(.)* and *m(.)* are both concave. Hence, in a manner not observed in the previous case, there are forces here leading to *more* commuting after a rise in the wage.

The first term on the right-hand side of equation 18 may be positive or negative. If it is positive, equation 18 takes positive values and *dc / dw* is thus unambiguously positive. A sufficient condition for

$$\left(u'(.) + u''(.) hw \right) \ \rangle \ 0 \qquad (19)$$

is that the degree of relative risk aversion exceed unity. Since $u''(.)\left(hw - k(c,\gamma) \right)$ must be strictly greater than $u''(.)hw$ at a given value of income, if $\left\{ u'(.) + u''(.)\left[hw - k(c,\gamma) \right] \right\}$ is positive, then the inequality in (19) is automatically satisfied. This establishes a sufficient condition for commuting to rise with wages. There seem no simple conditions that guarantee the opposite, namely, an inverse relationship between pay and commuting time.

In this model, the value of extra income declines as the wage increases. Then those individuals with higher rates of pay can often be expected to commute longer distances. This sounds paradoxical until it is recalled that the main purpose of commuting (in this model) is to obtain a better area in which to live. The intuition is straightforward:

(i) As the wage rises, those with sharply declining marginal utility from money wish to cut back their hours of work. They place more emphasis, at the margin, on niceness of area.

(ii) This increases the number of leisure hours, which drives down the marginal utility from leisure, and tends to raise the return from having a home in a pleasant area.

(iii) The leisure costs of commuting therefore fall, while, by assumption, the value of living in a pleasant area is relatively higher after the change in wage.

Rises in the wage, ‘w’, thereby tend to increase commuting, ‘c’.

Although the details are omitted, a further result can be proven. As might be expected, a rise in commuting costs, γ, leads unambiguously to lower commuting. After simplification it can be shown that

$$\begin{aligned} V_{h\gamma} V_{ch} - V_{c\gamma} V_{hh} \quad = \quad & - u''(.) w k_{\gamma} \mu''(.) - k_{\gamma} u''(.) k_c \mu''(.) \\ & + u'(.) k_{\gamma c} \left[u''(.) w^2 + \mu''(.) \right] \ \langle \ 0 \end{aligned} \qquad (20)$$

Hence, $\partial c / \partial \gamma$ is negative.

It might be thought that the framework is rather simple. First, no allowance has been made in the algebra for the possibility that the wage itself might be a function of distance commuted, ‘c’ (e.g. Zax, 1991). It is straightforward to re-do this. Maximand (7) can be re-written with a function, *w(c)*, replacing wage, w. However, it does not seem possible to generate unambiguous comparative statics in such a framework. We return to the possibility in the later empirical section. Second, the analysis has assumed that commuting time and work time enter the utility function in an identical (negative) way. It is possible to conceive of ‘h’ as entering with a larger cost than ‘c’. Our experiments suggested that allowing for this in a general way complicates the algebra without leading to much analytical advance. The simpler approach has therefore been adopted. Third, a weakness of the analysis is that its niceness-of-area function, *n(c)*, is independent of income. Separability here is not an entirely innocuous assumption, because one attraction of living in an area far from the workplace might be its low price level and perhaps especially its house prices. Generalising the utility function to allow for interactions between income and area-niceness allows few clear findings to be derived. Theory is then of little help and the matter becomes an empirical one.

By adopting neoclassical principles, this section has sought to lay out a model of rational commuting. As in the canonical model of hours worked, a role emerges for the wage rate. The following section turns to an empirical application of the analytical framework. It attempts, among other aims, to estimate the wage elasticity of commuting and to investigate how personal characteristics influence travel-to-work behaviour.

4. An Empirical Analysis of Commuting in Great Britain

4.1 *The Data*

The data provide a nationally representative survey that is conducted annually[8]. The BHPS data set consists of more than 5000 households and 10000 individuals. The first wave of interviews was conducted between September and December 1991. In this section of the paper we estimate the determinants of commuting times for a sample of British employees from the first seven waves of the BHPS. Our sample is restricted to those of working age, employed at least 20 hours per week, who provide relevant data on each of the variables employed in the analysis[9].

4.2 *Estimation Results*

We begin by conducting a least squares analysis of the travel-to-work time variable described above. Following the model of rational commuting presented earlier, much of our interest will focus upon variation in commuting times according to the wage-rate. But we are also able to provide evidence of other differences in commuting behaviour.

Table 7 presents the natural starting point in considering commuting times in Great Britain. We focus upon two specifications for both males and females. The second adds a set of individual and employer variables to a regressor set that consists of just the wage and housing tenure terms as well as a set of controls for industry, occupation, region, and wave of response.

[8] Interviews are scheduled during the period September to April, although in practice almost all tend to be completed by December.

[9] In this section, since our analysis is basically exploiting cross-sectional variation in the data, we do not employ the restriction that each individual should provide such data for each of the seven waves.

The results in Table 7 suggest a positive relation between commuting times and the wage rate. The elasticity of commuting times with respect to the wage is estimated at approximately 0.15-0.2 for men and 0.3 for women.

The results show that owner-occupiers have longer commutes to work, particularly when controlling for individual characteristics. The effect is large. Our estimates imply from Table 7 an approximately 37% longer journey-to-work time for male owner-occupiers relative to those renting from the private sector housing market. A number of additional differentials are estimated. Among male employees, older workers experience somewhat longer commutes, whilst, among females, those aged between 35 and 55 appear to devote less time to commuting. The highly-educated in Britain experience longer commuting times, ceteris paribus, with a differential between the degree-educated and those without academic qualifications estimated at 35% (30%) for men (women).

The results in Table 7 also indicate that workers at larger establishments commute further. The effect is large – a differential of 17% among men and 28% for women, comparing establishments with 500 or more employees to those with under 25 employees. Studies of the employer-size wage differential may therefore wish to control for a compensating wage differential associated with the journey to work. Those who have changed job within the last year experience longer commutes, whilst part-time employment is associated with a shorter commuting time. Estimating a single equation across both male and female sectors, with a dummy variable for gender, reveals a small gender differential at the margin of significance with a differential estimated at 0.026 log points, with a standard error of 0.012. Finally, although we are able to provide evidence of a number of characteristics that are significantly related to commuting times, it is clear that there is a large amount of unexplained variation present.

The model presented in Section 3 acknowledged that it is possible that the wage, ‘w’, is a function of commuting time, ‘c’. Empirically, we allow for this endogeneity of the wage-rate by employing union-membership and public-sector variables as instruments for the wage[10]. There seems no reason a priori why union members or individuals employed in the public sector should be likely to spend any more or less time commuting, independent of any effect via the influence of these factors upon the wage. Given evidence of wage differentials by union membership (eg. Andrews et al., 1999) and by public sector affiliation—at least in the case of women employees (see eg. Benito, 1997; Disney and Gosling (1998))—these indicators should act as useful instruments for the wage. In the corresponding first-stage wage equations for our IV estimates, an F-Test of the public sector and union membership terms shows that these are highly significant; in the case of the male sample, $F(2,12685)=119.58$ whilst in the female wage equation a test of the significance of the same terms reveals $F(2,10517)=254.95$. In Table 8, we also report a test of the validity of the over-identifying restriction from Newey (1985) and a standard test of the exogeneity of the wage term.

The significant feature to emerge from the IV estimates of Table 8 is a change in the sign of the estimated wage elasticity of commuting times. As expected, allowing for the tendency that employees may be compensated for a longer commuting time with a positive wage differential, leads to a reduction in the estimated wage elasticity of commuting times. The wage term in the commuting time equation becomes significantly negative for both men and women. The wage elasticity of commuting is estimated as –0.44 for men and –0.36 for women. Paying an individual more appears to imply that s/he will wish to enjoy more leisure time and/or supply more hours of work but reduce his/her commuting time, with this tendency being stronger for men than

[10] In waves 2 to 4, the union presence questions were not asked of the respondent if they were in the same job as in the previous year. In these circumstances the union status of the respondent has been classified as the same as the previous year in which such information was provided.

women, although the difference is not statistically significant[11]. The OLS estimates of a positive elasticity therefore appear to be subject to the simultaneity bias associated with a compensating wage differential for commuting. This suggestion is supported by the outcome of the test of the exogeneity of the wage term that rejects the null hypothesis in both male and female travel time equations. The instrument validity test does not reject the null hypothesis that the IV errors are unrelated to the instruments. This supports the choice of instruments (union and public sector status). We also experimented with these instruments alternatively. Employing just the union membership term as an instrument in the male travel-to-work-time equation results in a wage elasticity of –0.36 (with a standard error of 0.15). Using the same instrument in the analysis for females, we derive an estimate (with standard error) of –0.27 (0.13). With the public-sector indicator alone as an instrument for the wage, there is again a negative wage-elasticity estimate. For males, the estimated coefficient (standard error) is –0.47 (0.34) and for females, -0.43 (0.13). Benito (1997) shows that although women tend to experience a significant pay premium for employment in the public sector, the differential for men is generally insignificant and quantitatively small. This weak instruments problem is likely to account for the less well-determined wage elasticity estimate when employing solely the public sector dummy as the instrument for the male subsample.

The IV estimates therefore suggest a negative wage elasticity of commuting time. In terms of the additional set of differentials in commuting times previously discussed, these remain largely unaffected when moving to the IV estimates[12]. The notable differences relative to the OLS results are, first, an increase in the degree-related differential in commuting and, second, an increase in the differential associated with workplace size.

[11] This result is reminiscent of the finding of Biddle and Hamermesh (1990) that the allocation of time to sleeping is inversely related to the wage rate (at least for men) in the US.

[12] A comparison of OLS estimates with and without the wage term also reveals that the differentials by these other characteristics are stable.

Fixed effects

We now consider an extension of the empirical model by adopting a fixed effects estimation approach. In particular, we are interested in the robustness of the results suggesting that private renters spend less time commuting and those working at larger workplaces spend longer commuting to and from work. The suggestion that those who have recently switched job possess longer commutes is of further interest as this is in the spirit of the 'quasi-labour mobility' interpretation of commuting.

Adopting a fixed effects approach is not without its problems, however. In particular, there are significant concerns that our previous instrument set, in the form of the union membership and public sector dummies are not, in a fixed effects framework which is essentially estimating time-series effects, sufficiently strongly correlated with the wage to act as useful instruments. The use of these two binary variables as instruments for the wage results in the wage being insignificant, but this is likely to reflect insufficient time-series movement in these indicator variables to allow the isolation of a well-determined commuting/wage relationship, in a fixed effects framework[13]. In the light of this, and in order to focus on the robustness of the other individual characteristics, Table 9 reports the fixed effects results with the endogenous wage term omitted. The influence of several of the variables, such as age and race, is now subsumed into the fixed effects. The educational variables are included purely for consistency, as there is some (minor) time variation in them. The equations are estimated separately for males and females. The sole additional selection criterion we employ relative to the previous analysis

[13] The significance of the two instruments falls noticeably in the fixed effects wage equations. In the male wage equation the coefficients (standard error) on the public and union member dummies are 0.0003 (0.017) and 0.094 (0.010) respectively; in the case of females the corresponding coefficients (standard error) are 0.087 (0.016) and 0.062 (0.011). Nevertheless as dummy variables they are still likely to act as weak instruments.

in this section, is the requirement that there is a minimum of three observations per individual in the unbalanced panel.

The fixed effects results reinforce our earlier conclusions regarding the relationship between housing tenure and commuting. Private renters (the reference group) have significantly shorter journey to work times than owner-occupiers or those renting public housing. The differential is estimated at a 20% (17%) longer journey to work time for male (female) owner-occupiers and at 24% (18%) for male (female) employees who rent public sector housing in all cases relative to renting private sector housing[14]. For the male subsample, a job change in the last year is also significantly associated with the journey to work time, whilst the fixed effects results continue to indicate that individuals working at larger establishments commute further distances. In the male sample, a part-time job is associated with a significantly shorter journey time. In the female sample, the estimated coefficient is not statistically significant, but may reflect the limited degree of switching in this characteristic that we observe among the sample of women. Overall, our fixed effects results suggest our earlier conclusions are robust to an allowance for individual-specific heterogeneity.

[14] The results of Henley (1998) are also relevant here. Henley (1998), using the first four waves of the BHPS, finds evidence suggesting that home-owners are less mobile than non-owner occupiers. He also includes a travel-to-work time variable in his duration models of mobility. A quantitatively small effect among owner-occupiers, is interpreted as indicating that transaction costs associated with owner-occupation inhibit the locational matching of house and job.

5. Conclusions

The typical British worker now spends many hours each week travelling to and from work. Although commuting imposes costs on people and society, it has not often been studied by economists. Commuting is interesting because it acts as a form of quasi-mobility of labour with employees being prepared to substitute journey times for a residential move. It also leads to congestion externalities. Moreover, commuting patterns influence the demand for, and nature of, transport in Great Britain.

Using information from the British Household Panel Study, we reach a number of conclusions. At an initial level, our data analysis provides some interesting summary statistics on the commuting behaviour of British employees. The average one-way commute to work is now 38 minutes in London, 33 minutes in the south-east as a whole, and 21 minutes in the rest of the country. There are three other new findings. First, commuting times are especially long among those who are highly educated, among home-owners, and among those who work in large plants and offices. In Britain, people with university degrees spend 50% more time travelling to work than those with low qualifications. Private renters do significantly less commuting than owner-occupiers. Second, there has been a noticeable rise in travel-to-work times in the south-east and the capital. In our sample, full-time workers in London have lost 70 minutes per week of leisure time to commuting during the course of the 1990s. Outside the south-east of Britain, there has been no increase in commuting over the decade. Third, after allowing for the endogeneity of the wage-rate, there is a negative relation between commuting times and hourly pay. Paying an individual more implies that s/he will wish to increase his/her working and/or leisure time and reduce time spent commuting to and from work.

Table 1: Average one-way commuting times in the 1990s (minutes)

	N	Gender		Education			Location		
		Male	Female	No qualifications	Non-degree qualification	Degree / Other Higher	London	South-east	Non-south-east
'91/2	1622	23.5	21.3	19.0	21.1	26.8	31.4	27.7	20.2
1992	1622	23.3	21.6	18.1	20.9	27.1	32.9	28.6	19.7
1993	1622	23.7	22.3	18.4	21.5	27.2	34.4	29.6	20.2
1994	1622	23.6	22.8	19.2	21.4	27.2	33.7	29.7	20.3
1995	1622	24.1	22.3	18.3	20.9	28.1	34.4	29.8	20.3
1996	1622	24.3	22.4	17.2	21.4	27.6	36.1	31.4	20.0
'97/8	1622	25.9	22.6	17.9	21.9	29.2	38.4	32.8	20.9
Test of equality of means		t-value=4.47 [p-value=0.00]		t-value=19.52 [p-value=0.00]			t-value=25.60 [p-value=0.00]		

Note: The sample is selected on the basis of being working-age employees, employed at least 20 hours per week, not at home, and providing commuting time data at each wave of the BHPS, waves 1 to 7. The test of the equality of means for the education subsamples considers those with a degree qualification against those without. The test for the location subsamples considers those in the south-east compared to those outside the south-east.

Table 1 (cont.): Mean travel-to-work time (minutes)

	Public / Private sectors		Part-time/Full-time		Married	
	Public	Private	Part-time	Full-time	Married / living as a couple	Not married
1991/2	22.2	22.8	15.5	23.1	22.2	23.5
1992/3	22.4	22.7	16.2	23.0	22.2	23.6
1993/4	23.9	22.7	17.9	23.4	22.9	23.7
1994/5	23.7	23.1	17.3	23.6	23.0	24.1
1995/6	23.6	23.2	16.9	23.7	23.4	23.1
1996/7	23.2	23.6	18.1	23.8	23.7	22.6
1997/8	24.4	24.6	17.5	25.0	24.5	24.7
Test of equality of means	t-value=0.14 [p-value=0.88]		t-value=8.87 [p-value=0.00]		t-value=0.74 [p-value=0.46]	

Table 1 (cont.): Mean travel-to-work time (minutes)

	Housing tenure		Age	
	Owner-occupier	Not owner-occupier	Under 35	35 or older
1991/2	23.1	19.8	22.9	22.2
1992/3	23.2	19.6	22.9	22.3
1993/4	23.4	21.2	23.7	22.6
1994/5	23.8	19.7	24.5	22.4
1995/6	24.0	18.1	24.4	22.7
1996/7	24.1	18.7	24.4	23.0
1997/8	25.0	20.7	25.5	24.1
Test of equality of means	t-value=7.18 [p-value=0.00]		t-value=4.04 [p-value=0.00]	

Table 2: Proportion of sample of British males with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	13.9	14.3	14.5	13.0	13.7	15.1	15.9
60 mins	6.5	7.0	7.6	7.4	7.6	8.7	9.1
90 mins	2.2	1.5	1.7	1.1	1.6	2.0	2.6

Table 3: Proportion of sample of British females with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	11.6	10.9	11.7	12.6	14.0	12.6	13.4
60 mins	5.4	5.4	7.1	7.1	7.4	7.1	7.3
90 mins	0.9	1.3	1.1	1.7	0.1	1.6	1.4

Table 4a: Proportion of employees with Degree or similar qualification with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	17.2	17.9	19.1	17.4	18.6	19.1	20.0
60 mins	9.4	9.3	10.6	10.0	11.1	11.3	12.4
90 mins	3.1	2.3	2.2	2.1	2.0	2.7	3.6

Note: Subsample refers to those whose highest academic qualification is a Degree, Higher Degree, Teaching Qualification or Other Higher Qualification.

Table 4b: Proportion of employees without a Degree qualification with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	10.8	10.1	10.0	10.0	10.7	10.2	10.5
60 mins	4.4	4.8	5.6	5.6	5.1	5.5	5.0
90 mins	0.8	1.0	1.1	1.0	0.7	1.1	0.9

Table 5a: Proportion of sample of employees in south-east with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	21.5	24.7	25.4	24.3	27.8	28.0	29.3
60 mins	11.5	13.7	15.4	14.5	16.0	18.4	18.7
90 mins	3.9	3.0	3.7	2.8	3.5	4.6	5.6

Table 5b: Proportion of sample of employees outside the south-east with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	9.5	8.1	8.5	8.3	8.3	8.5	9.3
60 mins	3.9	3.4	4.2	4.4	4.2	3.9	4.4
90 mins	0.7	0.8	0.6	0.8	0.3	0.7	0.8

Table 6a: Proportion of owner-occupiers with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	13.3	12.8	13.4	13.4	14.6	14.6	15.1
60 mins	6.1	6.3	7.4	7.8	8.0	8.5	8.6
90 mins	1.8	1.4	1.6	1.5	1.1	1.9	2.1

Table 6b: Proportion of non-owner-occupiers with commuting times in excess of certain thresholds

	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
45 mins	10.7	12.9	12.6	8.8	7.9	9.3	12.7
60 mins	5.5	6.5	7.4	3.9	3.7	4.4	6.1
90 mins	0.7	1.6	0.9	0.5	1.6	1.1	2.2

Table 7 : Least-Squares Analysis of Commuting Times
Dependent Variable : log (travel-to-work time)
(standard errors in parentheses)

	Male	Female	Male	Female
log (hourly wage)	0.199 (0.017)	0.313 (0.019)	0.152 (0.019)	0.286 (0.021)
Education				
Other qualification			-0.121 (0.077)	0.152 (0.095)
Apprenticeship			-0.058 (0.048)	0.175 (0.145)
CSE grades 2-5			-0.023 (0.036)	-0.013 (0.044)
Commercial			-0.328 (0.153)	0.014 (0.037)
O-level s			0.112 (0.025)	0.016 (0.026)
A-levels			0.133 (0.028)	0.066 (0.031)
Nursing			-0.464 (0.115)	0.051 (0.048)
Other Higher			0.138 (0.025)	0.090 (0.029)
Teaching			0.138 (0.061)	0.156 (0.046)
Degree or Higher			0.301 (0.032)	0.265 (0.036)
owner-occupier	0.311 (0.026)	0.061 (0.027)	0.318 (0.026)	0.164 (0.027)
rent (public)	0.265 (0.032)	0.067 (0.034)	0.290 (0.032)	0.154 (0.033)
age: 26 to 35			0.019 (0.024)	-0.005(0.023)
age: 36 to 45			0.074 (0.026)	-0.121 (0.025)
age: 46 to 55			0.148 (0.028)	-0.140 (0.026)
age: 56 to 65			0.201 (0.035)	-0.044 (0.041)
white			0.054 (0.038)	0.106 (0.039)
married			-0.031 (0.018)	-0.064 (0.017)
part-time			-0.131 (0.053)	-0.138 (0.020)
changed job in last year			0.132 (0.016)	0.078 (0.016)
Workplace size:				
25 to 99 employees			0.049 (0.019)	0.006 (0.019)
100 to 499 employees			0.065 (0.020)	0.091 (0.020)
500 or more employees			0.155 (0.022)	0.244 (0.023)
Constant	1.850 (0.056)	2.094 (0.069)	1.674 (0.069)	1.926 (0.081)
region dummies	Yes (17)	Yes (17)	Yes (17)	Yes (17)
industry dummies	Yes (8)	Yes (8)	Yes (8)	Yes (8)
occupation dummies	Yes (8)	Yes (8)	Yes (8)	Yes (8)
wave dummies	Yes (6)	Yes (6)	Yes (6)	Yes (6)
F-tests :				
Education dummies	n.a.	n.a.	F(10,13364)=16.14	F(10,11424)=7.78
Region dummies	F(17, 13533)=39.74	F(17,11567)=24.51	F(17, 13364)=37.35	F(17,11424)=24.30
Industry dummies	F(8, 13533)=20.12	F(8, 11567)=21.55	F(8,13364)=21.04	F(8,11424)=17.46
Occupation dummies	F(8, 13533)=31.77	F(8, 11567)=10.93	F(8,13364)=18.21	F(8,11424)=9.45
Wave Dummies	F(6, 13533)=1.99	F(6, 11567)=1.45	F(6,13364)=2.90	F(6,11424)=1.48
Model F-test	F(42, 13533)=55.16	F(42, 11567)=40.69	F(63,13364)=42.60	F(63,11424)=36.88
R-squared	0.146	0.129	0.167	0.169
Adjusted R-squared	0.144	0.126	0.163	0.164
sample size	13,576	11,610	13,428	11,488

Note: 1. ttwt denotes one-way travel-to-work time.

Table 8 : IV (2SLS) Estimates of Commuting Times
Dependent Variable : log (travel-to-work time)
(standard errors in parentheses)

	Male	Female
log (hourly wage)	-0.440 (0.148)	-0.363 (0.106)
Education		
Other qualification	-0.103 (0.082)	0.228 (0.102)
Apprenticeship	0.024 (0.051)	0.162 (0.159)
CSE grades 2-5	0.064 (0.041)	0.026 (0.048)
Commercial	-0.210 (0.159)	0.115 (0.040)
O-levels	0.207 (0.032)	0.120 (0.030)
A-levels	0.263 (0.040)	0.200 (0.037)
Nursing	-0.465 (0.126)	0.193 (0.055)
Other Higher	0.289 (0.042)	0.209 (0.036)
Teaching	0.237 (0.069)	0.377 (0.057)
Degree or Higher	0.521 (0.063)	0.468 (0.051)
owner-occupier	0.375 (0.032)	0.225 (0.031)
rent (public)	0.277 (0.035)	0.157 (0.037)
age: 26 to 35	0.185 (0.047)	0.119 (0.033)
age: 36 to 45	0.286 (0.059)	0.023 (0.035)
age: 46 to 55	0.373 (0.059)	-0.035 (0.034)
age: 56 to 65	0.388 (0.061)	0.075 (0.049)
white	0.090 (0.040)	0.124 (0.043)
married	0.034 (0.026)	-0.016 (0.019)
part-time	-0.110 (0.059)	-0.168 (0.022)
changed job in last year	0.068 (0.023)	0.019 (0.020)
Workplace size:		
25 to 99 employees	0.121 (0.025)	0.061 (0.023)
100 to 499 employees	0.164 (0.032)	0.193 (0.028)
500 or more employees	0.288 (0.039)	0.361 (0.032)
Constant	2.171 (0.153)	2.381 (0.113)
Region dummies	yes (17)	yes (17)
industry dummies	yes (8)	yes (8)
occupation dummies	yes (8)	yes (8)
wave dummies	yes (6)	yes (6)
F-tests :		
Region dummies	F(17,11134)=29.41 [p=0.00]	F(17,10518)=21.14 [p=0.00]
Industry dummies	F(8,11134)=20.80 [p=0.00]	F(8,10518)=19.99 [p=0.00]
occupation dummies	F(8,11134)=16.21 [p=0.00]	F(8,10518)=12.29 [p=0.00]
wave dummies	F(6,11134)=0.96 [p=0.45]	F(6,10518)=0.99 [p=0.43]
Model F-test	F(63,12686)=38.94 [p=0.00]	F(63,10518)=29.08 [p=0.00]
Newey test of over-identifying restriction	$\chi^2(1)=0.008$ [p=0.93]	$\chi^2(1)=1.04$ [p=0.31]
Test of Exogeneity (p-value)	0.00	0.00
sample size	12,750	10,582

Notes to Table 8 :

1. Instruments for the wage-rate are union member and public sector dummies.
2. Newey Test refers to test of over-identifying restrictions (Newey, 1985).

Table 9: Fixed effects estimates of commuting times
Dependent Variable : log (travel-to-work time)
(standard errors in parentheses)

	Male	Female
Owner occupier	0.186 (0.030)	0.157 (0.030)
Rent (public)	0.214 (0.043)	0.165 (0.045)
Job change last year	0.069 (0.013)	0.006 (0.012)
Part-time	-0.134 (0.057)	-0.022 (0.022)
Workplace size:		
25 to 99 employees	0.042 (0.019)	0.032 (0.019)
100 to 499 employees	0.039 (0.021)	0.076 (0.022)
500 or more employees	0.118 (0.025)	0.148 (0.026)
Married	-0.013(0.025)	0.004 (0.023)
Qualification dummies	Yes (10)	Yes (10)
Region dummies	Yes (17)	Yes (17)
Industry dummies	Yes (8)	Yes (8)
Occupation dummies	Yes (8)	Yes (8)
Wave dummies	Yes (6)	Yes (6)
F-tests		
Fixed effects	F(2429, 10203)=9.12 [p=0.00]	F(2020,8376)=9.38 [p=0.00]
Qualifications dummies	F(10, 10203)=3.08 [p=0.00]	F(10, 8376)=2.66 [p=0.00]
Region dummies	F(17,10203)=5.02 [p=0.00]	F(17, 8376)=3.39 [p=0.00]
Industry dummies	F(8, 10203)=5.42 [p=0.00]	F(8, 8376)=2.18 [p=0.03]
Occupation dummies	F(8, 10203)=2.38 [p=0.01]	F(8, 8376)=2.66 [p=0.01]
Wave dummies	F(6, 10203)=1.61 [p=0.14]	F(6, 8376)=0.87 [p=0.51]
R-squared within	0.028	0.024
R-squared between	0.048	0.019
R-squared overall	0.044	0.019
Individuals	2,430	2,021
Observations	12,690	10,454

Appendix: Cross-section patterns in 1997/8

The following table records the mean one-way commuting time, in minutes, for employees working at least 20 hours per work, based on the seventh wave (1997/98) of the BHPS.

Table A1: Travel-to-work times 1997/98 (mins)

	Mean	N
Male	25.8	2186
Female	22.7	1831
London	36.5	416
South-east	30.4	1229
Outside south-east	21.5	2786
Aged 35 or less	24.4	1988
Aged over 35	24.5	2029
Public sector employee	23.6	986
Private sector employee	24.7	2886
Part-time	17.9	378
Full-time	25.1	3639
Married / co-habiting	24.4	2803
Not married	24.5	1214
Owner-occupier	24.9	3185
Not owner occupier	22.5	828
Degree or other Higher qualification	28.7	1664
Non-degree qualification	22.1	1851
No qualifications	19.3	461
Male and south-east	32.7	637
Female and south-east	27.7	592
Male and London	36.6	207
Female and London	36.3	209
Degree / Other Higher and south-east	35.3	585
Degree / Other Higher and London	42.0	214

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