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## Conference Paper

# The Travel-to-work. Which factors matter? An analysis on regional labor market in UK

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# Travel-to-work. Which factors matter?

## An analysis on regional labor markets in the UK

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### Abstract

The study focuses on the role of positive and negative monetary incentives in stimulating infra and inter-regional mobility (through commuting behaviors) in the UK, using data from the Quarterly Labour Force Survey 2004-2011. In particular, we estimate the predicted wage in the region of current residence through OLS and then we verify the increase in the probability of moving to other UK regions and Metropolitan Areas due to greater hourly wages w.r.t. that predicted for the region of current residence, through a Multinomial Logit model. We find that earnings play an important role in explaining commuting behavior, as well as length of the employment. We find that - on average - wages 20% greater than those in the region of residence lead to an increase of 2.2-3.2% (according to gender differences) in the probability of moving to other regions commuting more than 45 minutes. Moreover, we find support also for the “household responsibility hypothesis” and for the attractiveness of the Greater London Region.

**JEL Classification:** R23; R40;

**Keywords:** commuting, travel-to-work, gender, household responsibility, multinomial logit.

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# 1 Introduction

The aim of this study is to estimate which factors matter in the job searching, focusing mainly on commuting aspects and on the role of monetary incentives for stimulating geographical mobility among regional labor markets. This approach can be related to the idea of different local labor markets, which are in competition and are demarked by geographical and occupational criteria (Button, 1976) and, within this framework, earnings may play an important role in allowing workers to obtain a “better” job in other places and compensate losses due to the commuting time and moving costs.

According to the relevant literature and theoretical models, people should be able to respond to monetary incentives and opportunities moving freely from a place to another through migration. However, there are some rigidities which do not allow the labor market to be considered as a traditional one. One of these rigidities is related to the homeownership, intensively analysed from a micro and macro point of view with different results. While Rohe and Steward (1996), among the others, argue that residence stability is more likely to produce greater social capital, for Oswald (1997) homeownership produces inferior labor market outcomes due to greater transaction costs from moving among places in response to asymmetric shocks or opportunities.

A theoretical model developed by Oswald (1997) established, as a consequence of individual homeownership, an increase in the likelihood to be unemployed whereas it predicted full-employment for renters due to the absence of transaction costs (searching, buying and selling the house). In particular, according to the Oswald hypothesis, in presence of asymmetric shocks in the labor market, only the renters would be flexible enough to migrate to the region with greater opportunities and to produce adjustments, while homeowner would be more likely to be unemployed or to commute. However, there is not too much evidence on these results: while Coulson and Fisher (2009) analyse the relationship between unemployment and homeownership finding that homeowner have lower wages compared to renters, Van Leuvensteijn and Koning (2004) find that, in The Netherlands, higher wages are associated with homeownership and a smaller likelihood of being unemployed. Gardner et al. (2000), using UK data, show that homeowners are less mobile in the labor market. Thus, renters should be more likely to change their residence than homeowners when the workplace changes. For Munch et al (2006), homeowners set their reservation wage higher than renter, since they have moving costs, while renters do not experience these costs, or, if they do, not in the same amount. Munch et al. (2008) also argue that homeowners have greater probability to stay longer within their jobs and are subject to greater investments in human capital by their employers with the consequence that their wage are 5% greater

than renters. They estimate also that, for the job-to-job mobility in Denmark, homeowners are 14% less likely to move to another local labor market and 5% less likely to move to another job within the same local labor market.

However, migration is not always possible not only due to transaction costs but also because of the presence of psychological barriers related to changes in the environment, habits or familiar relationships. Therefore, commuting behaviors may represent a valid alternative to migration. In this regard, other authors have previously considered the travel-to-work behavior taking into account the commuting time and the commuting distance. Van Ommeren and Fosgerau (2009) focus on the marginal commuting costs, Vandyck and Proost (2012) define a theoretical model for analysing policies able to encourage/discourage commuting behaviors among different regions. Ma and Banister (2006) provide a critical review of the literature on excess commuting, as such commuting representing the difference between the actual travel time and the minimum possible time to be spent for the route workplace-residence. Van Ommeren and Van der Straaten (2008) investigates the differences between employed and self-employed, finding that the latter commute less distances and time than the first.

Particular attention has been devoted to testing the “household responsibility hypothesis” (HRH), that is a situation for which “employed women tend to have greater household and child-care responsibilities and, as a result, face greater time constraints and ultimately choose shorter commutes than employed men” (Turner and Niemeier, 1997 p. 398-399). This result is confirmed by Sandow (2008), Praskher et al. (2008) and McQuaid and Chen (2012).

Clark et al. (2003) investigate the relationships between residential changes and employment locations. In particular, they argue that individuals in a dual-earner household are more likely to have greater commuting before and after a moving than individuals in single earner households because of spatial constraints. Plaut (2006) finds that both for renters and homeowners jointly choose commute trips, meaning that commuting time for men is highly correlated with that of women. He also observes that salaries (log individual salaries) do not have impact on commuting time but only on the distance. So et al. (2001) observe that a change in the household location is associated with a wage offer greater than that for the case of commuting, as a consequence of the fixed costs of relocation. Cassel et al. (2013) find that highly educated workers have a greater probability to accept jobs travelling more than 40 minutes. Additionally, Sandow (2008) explores the Swedish case finding that longer commuting is associated with low populated residence areas. He also finds that workers in public sectors are less likely to commute compared to that of the private sector while male workers commute longer

distance than women. Also younger workers commute more than others because of the need to acquire experience and become more competitive.

Justifications for this study are found in the “2011 Census Analysis - Distance Travelled to Work”, which states that the average distance commuted to work in England and Wales increased by 12% in 10 years (from 13.4 km in 2001 to 15 km in 2011); full-time workers travelled more in 2011 than part-time workers and by 2011, the rates of commuting raised by 42% for men and 30% for women. These trends are also similar to those in other European and North American regions as reported by Lehmer and Ludsteck (2011).

Starting from the previous literature and data provided by the 2011 Census, this study wants to focus more on the regional labor markets, considering mainly the regional differences and the role of the monetary incentive for stimulating such commuting behavior and geographical mobility among regions, once having controlled for homeownership, regional heterogeneity and socio-economic conditions. Our purpose is to investigate which factor matters in the travel-to-work behavior and provide support for a non-linear response to monetary grants. In particular, workers who commute from one labor market to another should require earning grants able - at least - to compensate monetary and non-monetary moving costs and this may differ across gender as a consequence of differences in the evaluation of trade-off between higher wages and monetary and non-monetary moving costs.

For this reason, we estimate the hourly wage for each worker for the region of residence and we compare it with that currently earned. In the second step, we use a Multinomial Logit Model for investigating the propensity to move out of the region of residence commuting more than 30 and 45 minutes. This represents the main novelty of this study since the previous literature does not provide any comparison among wages (even if unobserved) in different regions as we do with this study. In particular, McQuaid and Chen (2012) consider only the role of gross monthly wages on the propensity to commute more than a certain threshold (30 minutes, 45 minutes) whereas Sandow and Westin (2010) take into account the role of earnings introducing only different thresholds of annual gross income (High, Middle, Low) and change in income during the period of observation. They find that women with long-distance commute have a better income development compared to non-commuter. In general, long-distance commuting is a strong economic incentive.

In our model, we find that monetary incentives play an important role in determining the propensity to move across regions and territorial agglomerations, with wages greater than 20% than that of the region of residence increase the probability of commuting for more than 45 minutes by 2.6%, with a

gender gap estimated in 1%. Moreover, we find also that the region of London explains itself part of the commuting behavior, due to the greater attractiveness of the capital in terms of jobs, opportunities and also to the higher cost of living that pushes people to locate in the neighboring regions. We control also for gender differences, trying to explain the heterogeneity across women, finding that the presence of children or being married with lower absolute income affect negatively the women probability to commute whereas the effect is positive when the gross weekly wage is higher. Robustness checks confirm all findings.

The outline of the study is follows: Section 2 illustrates the simple theoretical model; Section 3 provides some descriptive statistics; Section 4 describes the econometric strategy; Section 5 presents comments to the empirical results; Section 6 involves some robustness checks; Section 7 presents the conclusion.

## 2 Theoretical Model

The worker's utility function is defined according to the following functional form  $V(Y, L, qh, R)$ , where  $Y$  represents the level of income,  $L$  the leisure time,  $q$  a dummy variable which is equal to 1 when there are household responsibilities  $h$  (otherwise the value is equal to 0) and  $R$  represents the region of residence. Assuming an utility-maximizing worker, each worker maximizes his utility function  $V(.)$  given two constraints *i*) the budget constraint  $Y = wH - c(d)$  where  $c(d)$  is the commuting cost, increasing in the distance  $d$ , and  $wH$  represents the hourly pay times the number of hours worked; *ii*) the lifetime constraint  $L = 24 - H - t$  where  $L$  is the leisure time as the day time net of the hours worked  $H$  and the commuting time  $t$ .

As aforementioned, in our model we are interested in verifying for which values of the hourly pay - given all other conditions - a worker is willing to work in a region different from that of his residence, incurring in greater transportation costs and commuting time as well as in additional costs due to household responsibilities. Therefore, given the worker  $i = 1 \dots I$ , the region of residence  $r$  and the region of workplace  $l$ , an utility-maximizing worker will choose to work in a different region  $l$  from that of residence  $r$  if and only if  $V_l(Y_l, L_l, qh_l, R_l) > V_r(Y_r, L_r, qh_r, R_r)$ . The situation of indifference has been ruled out, assuming that in case of equality between both utility functions, the worker would choose randomly. Substituting both constraints within the functional form we obtain

$$V_l(w_l H - c_l, 24 - H - t_l, qh_l, R_l) > V_r(w_r H - c_r, 24 - H - t_r, qh_r, R_r)$$

Assuming additive separability, hence the independence between Income and Leisure time, the expression may be re-stated as the following:

$$w_l H - c_l + (24 - H - t_l) + q h_l + R_l > w_r H - c_r + (24 - H - t_r) + q_r h_r + R_r$$

Simplifying, it is possible to say that

$$H(w_l - w_r) > (c_l - c_r) + (t_l - t_r) + q(h_l - h_r) + (R_r - R_l)$$

which means that a worker  $i$  - given the same amount of working hours - will choose in a different local labor market from that of residence if and only if the difference in the hourly wage will be such to compensate the greater transportation costs and the reduction in the leisure time as well as a change in household responsibilities (if any, that is for  $q = 1$ ). Indeed, we expect an increase in the wage as a consequence of an increase in the commuting cost and time.

### 3 Data and Descriptive Statistics

Our model is implemented using data from the Quarterly Labour Force Survey - 4th quarter (QLFS - UK) for the period 2004-2011 in order to have a greater number of observations and to consider such variables that are not significant in a single period. After dropping for missing values in our variables, the whole dataset has been manipulated keeping only those employed with age 23-65 and with an average gross hourly pay and a predicted hourly wage greater than 2 pounds and lower than 100 pounds so as to reduce the impact of outliers.

In order to have homogeneous representations of local labour markets and capture the differences between urban and rural areas, we consider both GORs (Government Office Regions) and former Metropolitan Counties, as properly reported by the LFS. Therefore, other than the UK regions, our data consider two territorial agglomerations for Scotland, which is divided in Strathclyde and Rest of Scotland; the region of Greater London as divided in Central/Inner London and Outer London; and six Metropolitan counties (Greater Manchester; Merseyside; South Yorkshire; Tyne and Wear; West Midlands Metropolitan County; West Yorkshire). This means that - instead of having eleven different regions - we have nineteen territorial areas, as presented in Table 1, implicitly allowing to control for differences in the urbanization, housing prices and job density.

Table 2 provides some descriptive statistics and indicates that - on average - men commute longer than women (30 minutes vs. 23 minutes), public transports are used more when workers move to other

Table 1
GORs (Government Office Regions)
Tyne & Wear
North England
South Yorkshire
West Yorkshire
Rest Yorkshire and Humberside
East Midlands
East Anglia
Central and Inner London
Outer London
South East
South West
West Midlands
Rest West Midlands
Greater Manchester
Merseyside
North West
Wales
Strathclyde
Rest Scotland

Table 1: UK Regions and Metropolitan Areas.

regions commuting more than 45 minutes reaching a percentage of usage of 50.84% against the 21.70% of workers using it commuting 30-45 minutes. Differently, for shorter commuting outside the region of residence, the most preferred modal choice is represented by the car (87.33% vs. 6.67% of workers using the public transport) while for commuting within the region of residence public transport is used by 10.36% of all workers. The average hourly wage rate is greater for workers who do longer commuting (18.53 £ and 15.34 £ respectively for the case of working at distance greater than 45 minutes and 30-45 minutes vs. 10.79 £ for the case of working within the same region).

Quite interestingly is what happens for people who choose to move to other regions but with an average commuting time lower than 30 minutes, capturing situations in which workers move to closer city located in different GORs, near the administrative boundaries. In this case, they still earn a greater hourly wage but the commuting time is - on average - roughly the same (the average hourly wage is 12.24 £ vs. 10.79 £; the average commuting time is 21 minutes vs. 22 minutes). The average commuting time is also increasing in the distance when workers move outside their own region (42 minutes for distances between 30-45 minutes; 81 minutes for distances greater than 45 minutes).

## 4 The Econometric Strategy

The econometric strategy is based on two-steps. In the first step, since the choice of another regional labor market can be associated with higher wages and only the current wage is observed, a measure



**Table 2 - Descriptive Statistics**

	Overall	Female	Male	In Region	Out and <30	Out and 30-45	Out and > 45
Commuting time	26 mins	23 mins	30 mins	22 mins	21 mins	42 mins	81 mins
Commuting by car_motorbike	72.51%	70.21%	75.10%	73.34%	87.33%	76.31%	47.63%
Commuting by public transport	13.14%	13.67%	12.54%	10.36%	6.67%	21.69%	50.83%
Hourly wage	11.51	10.24	12.95	10.79	12.25	15.34	18.53
Predicted hourly wage (wage*)	11.51	10.25	12.95	11.06	12.05	14.2	15.66
wage/wage*	1.02	1.01	1.02	1	1.04	1.08	1.19
N. Observations	77029	40847	36182	65545	4090	2393	5000

Table 2: Descriptive Statistics.

of the latent wage ( $wage^*$ ) in the region of residence has been derived for all workers. This represents an innovation to previous analysis and - in this way - it is possible to analyse the differences between unobserved and observed wages and their role on the propensity to move. In the second step, the probability to work outside the region of residence is estimated using the Multinomial Logit model.

To estimate the potential wage in the region of usual residence, we first use the OLS for obtaining an estimate of the determinants of the wage and then we make a prediction of the region of the current residence ( $wage^*$ ). Indeed, we create an index ( $\frac{wage}{wage^*}$ ), which takes into account whether the current wage is lower/greater - and by what extent - than the predicted. This index is considered, according to different levels, as regressor in the second step. For estimating the predicted wage for the region of usual residence, we include several variables according to the literature. In particular, the model for the unobserved wage is defined as follows

$$wage = \alpha + \beta\mathbf{X} + \gamma\mathbf{Z} + \varepsilon$$

where  $\mathbf{X}$  is the vector of labor market characteristics, as the length of the contract within the same firm, the size of the firm, the type of contract (whether part-time), the sector, the role within the workplace and whether job-seeker;  $\mathbf{Z}$  includes all the unknown coefficients of individual socio-economic characteristics, as the age, the age of completed education, being a couple and the presence of children, health problems that limit the work activity, whether the worker owns his house or has a mortgage and the region of residence. Moreover, in order to control for the effect of the business cycle, annual dummies are additionally included.

In order to have a good prediction of the wage, which accounts for the gender differences, OLS is estimated separately for men and women and, as robustness check, results have been compared with the estimate of the all sample. Using the separate estimation, we make the prediction of the wage for the region of residence for each worker.

As shown in Table 3, results are coherent with the labor economic theory and the strong majority of the variables are highly significant (1%). Sex differences are evident, according to the main literature (Oaxaca, 1973). The unobserved wage increases with the age in a non-linear way but more for men while women benefit slightly more for the education level, considering the age of completed education as a proxy of the number of years spent in the education system.

The predicted wage is also greater in London, East Anglia, Southern East, East Midlands and Scotland, suggesting that regional characteristics matter (the coefficients are available upon request). Working for longer in the same place leads to increased wages for both genders but also an increase

in the gender pay gap. Manning and Swaffield (2008) found that this increasing gap w.r.t the early career wage may be explained by psychological differences. However, this is not the case of workers working for more than twenty years, for which women can have a greater predicted wage (1.856 for female vs. 1.667 for male). The gender pay gap is also confirmed for the type of occupation.

Table 3 indicates also that wages change according to the size of the firm and differences appear to be deeper as the company becomes bigger. Also in this case, male workers are likely to benefit more than their female counterparts in presence of bigger companies. Looking for another job during the current employment has also a strong impact on the wage determination, mainly for men. This negative relation can be associated to lower productivity and then lower wages.

According to the theory (Antonovics and Town, 2004), the household composition lead to asymmetries, with men paid 1.018 more when married or have children (0.828) while women experience a motherhood wage penalty of 0.167, which may be due to conflicts between family and job (Waldfogel, 1995). This means a reallocation of time and role between husband and wife (Lundberg and Rose, 2000). As expected, health problems that reduce the working activity significantly and negatively affect the hourly wage, with a greater reduction for men (-0.602).

Since data consider the period 2004-2011, the dependent variable has been previously deflated using the Consumer Price Index (CPI) provided by the ONS (Office for National Statistics) and the model has been controlled for the business cycle, confirming that wages suffered the economic crisis of 2008. Moreover, in order to have a homogeneous sample, all *wages\** less than 2 pounds per hour and greater than 100 pounds/hour have not been considered.

Quite interestingly, as shown by Table 2, on average, the current wage and the predicted wages are exactly the same for the case of male and female workers but they slightly differ when the region of the workplace is considered. This difference is also coherent with our hypothesis for which longer commuting time (and costs) is compensated by greater wages w.r.t to that of the region of residence.

The second step is to calculate the propensity to move to other regions. Since we use the discrete response model, we define as dependent variable:

$$\begin{aligned}
 y &= 0 \text{ if } region_{working} = region_{living} \\
 y &= 1 \text{ if } region_{working} \neq region_{living} \text{ and } ctime < 30 \\
 y &= 2 \text{ if } region_{working} \neq region_{living} \text{ and } 30 < ctime < 45 \\
 y &= 3 \text{ if } region_{working} \neq region_{living} \text{ and } ctime > 45
 \end{aligned}$$

Table 3. OLS - Wage regression (First Step)

Dep. Variable: wage*	Overall	Only Female	Only Male
<b>Age bands (Ref: 20-29)</b>			
30 - 49	2.081*** (0.054)	1.757*** (0.067)	2.424*** (0.082)
50 - 59	2.210*** (0.066)	1.741*** (0.081)	2.636*** (0.114)
Over 60	1.761*** (0.093)	1.575*** (0.123)	1.897*** (0.143)
<b>Age Completed Education</b>	0.408*** (0.009)	0.447*** (0.012)	0.369*** (0.015)
<b>Couple</b>	0.578*** (0.042)	0.134** (0.050)	1.018*** (0.068)
<b>Child &lt; 15 y.o.</b>	0.379*** (0.060)	-0.167* (0.066)	0.829*** (0.100)
<b>Health Problems</b>	-0.420*** (0.054)	-0.295*** (0.060)	-0.602*** (0.095)
<b>Female</b>	-1.600*** (0.051)		
<b>Job type (Ref: Routine occupation)</b>			
Semi-routine occupation	0.271*** (0.050)	0.319*** (0.081)	0.017 (0.070)
Lower supervisory and technician	1.267*** (0.054)	0.956*** (0.100)	1.359*** (0.072)
Intermediate occupation	1.281*** (0.060)	1.262*** (0.080)	1.509*** (0.107)
Lower Managerial and professional	4.647*** (0.061)	4.457*** (0.084)	4.817*** (0.086)
Higher Managerial and professional	8.986*** (0.096)	8.631*** (0.144)	9.034*** (0.129)
<b>Tenure (Ref: &lt;2 y.)</b>			
2 - 5 years	0.282*** (0.056)	0.304*** (0.066)	0.269** (0.094)
5 - 10 years	0.618*** (0.061)	0.567*** (0.068)	0.761*** (0.091)
10 - 20 years	1.266*** (0.064)	1.181*** (0.078)	1.415*** (0.099)
> 20 years	1.767*** (0.075)	1.856*** (0.101)	1.667*** (0.117)
<b>Size of the firm (Ref: &lt; 25 )</b>			
25 - 49	0.394*** (0.059)	0.286*** (0.066)	0.573*** (0.098)
40 - 500	0.870*** (0.048)	0.613*** (0.056)	1.257*** (0.080)
> 500	1.611*** (0.065)	1.041*** (0.069)	2.370*** (0.111)
<b>Job-seeking</b>	-0.539*** (0.074)	-0.259** (0.095)	-0.778*** (0.107)
<b>Part-time</b>	-0.274*** (0.052)	-0.122* (0.054)	-0.325* (0.152)
<b>Homeowner/Mortgage</b>	1.379*** (0.045)	1.036*** (0.052)	1.738*** (0.073)
<b>Constant</b>	-4.952*** (0.300)	-4.753*** (0.646)	-5.821*** (0.392)
Industry sector dummies	Yes	Yes	Yes
Residence regions	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes
<b>R-squared</b>	0.437	0.424	0.425
<b>N</b>	77029	40847	36182

Bootstrapped Standard Errors are provided.

Table 3: First Step. OLS for the wage regression

We estimate the propensity to move to other regions, considering different thresholds of commuting time, through a Multinomial Logit. However, there are some drawbacks related to the use of this model, since it assumes IIA (Independence of Irrelevant Alternatives), meaning that the propensity of moving to another regions commuting more than 30 minutes is independent to the propensity to move to another region traveling more than 45 minutes or less than 30.

To produce estimates we use the Multinomial Logit Model and we consider the situation for which the worker lives and works in the same territorial area ( $Y = 0$ ) as the base outcome. Therefore, the probability of each alternative is defined as follows:

$$\Pr(Y = j) = \frac{\exp(\alpha_{ij} + \mathbf{X}_i \beta'_j)}{(1 + \sum_{k=1, k \neq 0}^y \exp(\alpha_{ik} + \mathbf{X}_i \beta'_k))} \text{ for } j \neq 0 \text{ and } j = 1, 2, 3;$$

$$\Pr(Y = 0) = \frac{1}{(1 + \sum_{k=1, k \neq 0}^y \exp(\alpha_{ik} + \mathbf{X}_i \beta'_k))}.$$

According to McQuaid & Chen (2012), we consider four factors, contained in X, that explain differences in the travel-to-work: 1) individual factors; 2) job characteristics; 3) household responsibilities; 4) external factors, as public transport and housing/mortgages availability. We also considers - as regressors - different levels ( $< 0.90$ ;  $0.90 - 1.10$ ;  $1.10 - 1.20$ ;  $> 1.20$ ) of the wage index ( $\frac{wage}{wage^*}$ ) obtained in the first stage and measuring the ratio between the current and the predicted wage<sup>1</sup>. Since it is a two stage model, standard errors are calculated through bootstrapping, allowing for 500 iterations.

## 5 Empirical Results

Table 4 shows results from the Multinomial Logit Model for the whole sample and by gender. Since the coefficients of the Multinomial Logit do not provide a direct interpretation, Table 5 presents a better understanding of results using the Average Marginal Effect (AME) for the variables of interest with respect to the baseline outcome. Tables 6-7-8 provide some robustness checks.

Some variables are not significant for the case of workers moving out of their region but at a distance lower than 30 minutes. This may be interpreted by the fact that the situation within the boundaries of the region/agglomeration area is quite the same as that in the neighborhood and, hence, there are no statistical differences from the baseline model. If we look at the descriptive statistics, we also note

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<sup>1</sup>In the Multinomial Logit, as baseline outcome for measuring the monetary incentive, we use the second level, that is  $0.90 - 1.10$ . In this way, we are able to take also into account potential estimation errors, which may affect the results. A further robustness check is also provided in Section 6.3 using different levels.

that the average commuting time is similar to that of workers living and working in the same region, meaning that for this case there is no role played by the monetary incentive.

Looking at the cases with commuting distance greater than 30 minutes (Out 30-45 and Out >45), age is represented using different age bands, in order to better capture the non-linearity. Results show how the willingness to move to other regions change according to the distance and to the gender. Women are more likely to commute longer distances when relatively young (up to 40 y.o) while male workers are always increasing in the probability of commuting, with high significance at any level.

The household composition is quite important in determining the commuting behavior: being married or living as a couple positively affect the probability of working in other regions; the presence of children affects gender differently, with a stronger impact on women, who are less likely to commute more than 30 minutes when they move to other local labour markets in presence of children with age less than 15 y.o. (-0.339 and -0.274 respectively for the case of commuting time of 30-45 minutes and more than 45 minutes). This result is coherent with that of McQuaid and Chen (2012), who found that women travel less in presence of dependent children. The economic explanation of these results is quite intuitive since women need more flexibility in order to solve conflicts between the family and the job and this may be also related to a household utility maximization problem that results in reduced commuting distances for women. At this regard, Sandow (2008) argue that shorter commuting may be a strategy to combine wage and deal with emergencies due to the presence of children and their possibility to be ill or to be picked up at school.

Quite interestingly is also what happens considering the regions of the workplace (the coefficients are not reported), giving a map of the state of regional labor markets and their attractiveness, with places of migration and emigration. Keeping Tyne & Wear as the reference region, the North of England, Scotland and also Wales are regions with a quite local labor market or with high levels of out-commuting, since their coefficients are negative. Metropolitan Counties experience higher coefficients with respect to regions as a whole and this is explain by the fact that Metropolitan Counties are considered as large urban centers, while regions net of metropolitan counties have a greater share of rural zones. Moreover, people working in London are more likely to come from other regions. This is quite intuitive because of more opportunities, as well as the housing cost that can lead people to locate in other regions or in rural areas in order to have better trade-off between housing and commuting costs. This confirms Cameron and Muellbauer (1998), who found that lower unemployment rates and higher relative house prices encourage in-commuting.

Table 4 - Multinomial Logit

	Overall			Male Only			Female Only		
	<i>Out &lt; 30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>	<i>Out &lt; 30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>	<i>Out &lt; 30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>
<b>Age bands (Ref: 20-29)</b>									
30 - 49	0.043 (0.052)	0.080 (0.065)	0.237*** (0.059)	0.050 (0.078)	0.079 (0.102)	0.269** (0.093)	0.053 (0.082)	0.123 (0.095)	0.250** (0.079)
50 - 59	0.041 (0.061)	0.044 (0.084)	0.270*** (0.073)	0.048 (0.090)	0.033 (0.128)	0.142 (0.118)	0.056 (0.097)	0.083 (0.114)	0.359*** (0.094)
Over 60	0.061 (0.091)	-0.153 (0.135)	0.234* (0.098)	0.206 (0.129)	-0.284 (0.252)	0.056 (0.203)	0.003 (0.128)	-0.102 (0.155)	0.327** (0.117)
<b>Couple</b>	0.077 (0.039)	0.108* (0.049)	0.213*** (0.040)	0.110* (0.055)	0.152* (0.075)	0.198** (0.066)	0.042 (0.054)	0.057 (0.064)	0.186*** (0.054)
<b>Child&lt;15y.o</b>	-0.059 (0.046)	-0.082 (0.061)	0.061 (0.050)	-0.104 (0.069)	-0.339*** (0.103)	-0.273*** (0.083)	-0.018 (0.060)	0.078 (0.071)	0.216*** (0.059)
<b>Mortgage/Homeownership</b>	0.241*** (0.050)	0.507*** (0.063)	0.812*** (0.055)	0.161* (0.069)	0.496*** (0.106)	0.738*** (0.098)	0.291*** (0.067)	0.495*** (0.079)	0.832*** (0.076)
<b>Address Stability (Ref: &lt; 2 y.)</b>									
2- 10 years	-0.021 (0.051)	0.003 (0.066)	-0.060 (0.051)	-0.100 (0.074)	-0.092 (0.092)	-0.130 (0.083)	0.045 (0.070)	0.065 (0.077)	-0.026 (0.066)
>10 years	-0.062 (0.056)	-0.253*** (0.074)	-0.333*** (0.057)	-0.175* (0.082)	-0.610*** (0.113)	-0.538*** (0.095)	0.040 (0.077)	-0.029 (0.089)	-0.205** (0.073)
<b>Part-time</b>	-0.117* (0.047)	-0.607*** (0.077)	-0.551*** (0.059)	-0.085 (0.056)	-0.581*** (0.093)	-0.405*** (0.071)	-0.225* (0.110)	-0.456** (0.162)	-0.858*** (0.134)
<b>Job type (Ref:low-skilled)</b>									
Intermediate Occupation	0.090 (0.047)	0.538*** (0.084)	0.858*** (0.068)	0.076 (0.073)	0.733*** (0.148)	0.935*** (0.120)	0.097 (0.070)	0.469*** (0.099)	0.799*** (0.082)
Managerial Professions	0.214*** (0.044)	1.006*** (0.074)	1.405*** (0.063)	0.214** (0.066)	1.209*** (0.148)	1.416*** (0.114)	0.214*** (0.059)	0.938*** (0.086)	1.405*** (0.075)
<b>Tenure (Ref: &lt; 2 y.)</b>									
2 - 5 years	-0.115* (0.052)	-0.277*** (0.067)	-0.247*** (0.057)	-0.163* (0.068)	-0.272* (0.109)	-0.119 (0.091)	-0.070 (0.068)	-0.272*** (0.081)	-0.313*** (0.071)
5 - 10 years	-0.152** (0.052)	-0.316*** (0.066)	-0.260*** (0.054)	-0.150* (0.072)	-0.324** (0.105)	-0.148 (0.087)	-0.158* (0.071)	-0.301*** (0.081)	-0.315*** (0.068)
10 - 20 years	-0.151** (0.054)	-0.333*** (0.070)	-0.413*** (0.058)	-0.230** (0.077)	-0.265* (0.110)	-0.308** (0.099)	-0.089 (0.072)	-0.362*** (0.085)	-0.474*** (0.073)
> 20 years	-0.137* (0.062)	-0.448*** (0.087)	-0.325*** (0.063)	-0.286** (0.101)	-0.118 (0.140)	-0.035 (0.115)	-0.060 (0.087)	-0.618*** (0.099)	-0.489*** (0.079)
<b>Public firm</b>	-0.308*** (0.037)	-0.253*** (0.050)	-0.413*** (0.041)	-0.256*** (0.051)	-0.243** (0.075)	-0.407*** (0.064)	-0.346*** (0.058)	-0.230*** (0.068)	-0.353*** (0.052)
<b>Female</b>	-0.248*** (0.037)	-0.581*** (0.048)	-0.755*** (0.038)						
<b>Mon. Incentive (Ref: 90-110)</b>									
<90	-0.143** (0.045)	-0.331*** (0.061)	-0.412*** (0.051)	-0.087 (0.063)	-0.423*** (0.097)	-0.340*** (0.083)	-0.184** (0.064)	-0.268*** (0.077)	-0.447*** (0.067)
110-120	0.018 (0.072)	0.140 (0.091)	0.271*** (0.074)	-0.119 (0.106)	-0.043 (0.158)	0.446*** (0.117)	0.131 (0.111)	0.263* (0.122)	0.186 (0.102)
>119	0.105* (0.048)	0.252*** (0.063)	0.550*** (0.047)	0.095 (0.072)	0.209* (0.095)	0.652*** (0.081)	0.114 (0.071)	0.285*** (0.079)	0.497*** (0.069)
<b>Car_Motorbike</b>	1.288*** (0.070)	2.283*** (0.158)	2.148*** (0.123)	1.388*** (0.106)	2.456*** (0.294)	2.393*** (0.259)	1.195*** (0.096)	2.164*** (0.191)	2.028*** (0.157)
<b>Public Transport</b>	-0.018 (0.096)	1.965*** (0.168)	2.977*** (0.121)	0.100 (0.140)	2.310*** (0.298)	3.501*** (0.252)	-0.154 (0.140)	1.693*** (0.198)	2.651*** (0.152)
<b>Constant</b>	-3.157*** (0.135)	-5.592*** (0.226)	-6.364*** (0.198)	-3.408*** (0.192)	-6.139*** (0.408)	-7.086*** (0.336)	-3.173*** (0.179)	-5.738*** (0.276)	-6.520*** (0.267)
Annual Dummies		Yes			Yes			Yes	
Regional Workplace Dummies		Yes			Yes			Yes	
Pseudo R-squared		21.00%			19,3%			21,7%	
N		77029			36182			40847	

Bootstrapped Standard Errors are provided.

Table 4: Multinomial Logit

**Table 5 - Marginal Effects under different treatments**

<b>Margins for Multinomial Logit</b>									
	<i>Overall</i>			<i>Male</i>			<i>Female</i>		
Mon. incentive (Ref: 90-110)	<i>Out &lt;30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>	<i>Out &lt;30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>	<i>Out &lt;30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>
<90	-0.004** (0.002)	-0.007*** (0.002)	-0.014*** (0.002)	-0.006** (0.003)	-0.006** (0.003)	-0.022*** (0.003)	-0.022 (0.003)	-0.007*** (0.002)	-0.007** (0.002)
110-120	-0.001 (0.003)	0.003 (0.003)	0.012*** (0.003)	0.005 (0.005)	0.009** (0.005)	0.009 (0.006)	-0.006 (0.004)	-0.002 (0.003)	0.015*** (0.004)
>119	0.002 (0.002)	0.004** (0.002)	0.026*** (0.002)	0.002 (0.004)	0.007** (0.003)	0.032*** (0.004)	0.002 (0.003)	0.002 (0.002)	0.022*** (0.003)
<b>Margins No London</b>									
<90	-0.005** (0.002)	-0.003*** (0.001)	-0.007*** (0.002)	-0.007** (0.003)	-0.005*** (0.002)	-0.013*** (0.003)	-0.002 (0.002)	-0.006*** (0.001)	-0.001 (0.001)
110-120	0.001 (0.003)	0.003 (0.002)	0.008** (0.003)	0.006 (0.005)	0.008** (0.004)	0.005 (0.005)	-0.004 (0.004)	-0.001 (0.002)	0.009** (0.003)
>119	0.002 (0.002)	0.004** (0.002)	0.021*** (0.002)	0.024 (0.004)	0.008** (0.003)	0.029*** (0.004)	0.002 (0.003)	0.002 (0.002)	0.013*** (0.002)
<b>Margins HRS</b>									
<90	-0.003 (0.002)	-0.004** (0.002)	-0.007*** (0.002)	-0.005 (0.003)	-0.003*** (0.003)	-0.011*** (0.003)	-0.009 (0.003)	-0.005** (0.002)	-0.004* (0.002)
110-120	-0.001 (0.003)	0.002 (0.002)	0.009*** (0.003)	0.005 (0.005)	0.008 (0.004)	0.005 (0.005)	-0.006* (0.004)	-0.003 (0.003)	0.013*** (0.004)
>119	0.001 (0.002)	0.001 (0.002)	0.018*** (0.002)	0.001 (0.004)	0.004 (0.003)	0.022*** (0.004)	0.002 (0.003)	-0.009 (0.002)	0.017*** (0.003)
<b>Margins with different thresholds</b>									
Mon. incentive (Ref: 95-105)									
<95	-0.003 (0.003)	-0.007*** (0.002)	-0.02*** (0.002)	-0.004 (0.003)	-0.006* (0.003)	-0.018*** (0.004)	-0.019 (0.003)	-0.007*** (0.002)	-0.012*** (0.003)
105-120	-0.001 (0.003)	0.001 (0.003)	0.007** (0.003)	0.008 (0.005)	0.005 (0.004)	0.011* (0.005)	-0.006 (0.004)	-0.002 (0.003)	0.004 (0.003)
>119	0.002 (0.003)	0.003 (0.002)	0.024*** (0.003)	0.003 (0.004)	0.006 (0.004)	0.034*** (0.005)	0.001 (0.004)	0.001 (0.003)	0.016*** (0.003)

Table 5: Analysis of Marginal Effects under different settings.

Moreover, the model defines low-skilled positions as reference, which have a particularly local labor market and also greater wages. Table 4 indicates that managerial workers are more likely to travel-to-work more than 30 minutes and this can be also explained by the fact that white-collars tend to be more informed about alternative jobs (Button, 1976). Therefore, if we consider the type of job as related to the level of education, then more educated workers are more likely to commute (Romani et al. 2003, Cassel et al., 2013; Parenti and Tealdi, 2015) and there is heterogeneity in the women's behaviors according to their position and their ambitions.

Results from housing ownerships and the presence of mortgages, which represent forms of rigidities in the worker's behavior, are consistent with the theory and, hence, workers are more likely to commute because of the high costs of changing location or re-negotiating the mortgage. However, this could not be the case of the long run when, according to the theory, these costs can be relaxed. To strengthen this hypothesis, Clark and Burt (1980) found that workers are likely to minimize the commuting distance



when the residence changes. In this regard, Deding et al. (2009), looking at a two-earner household, find that residential mobility is more likely to occur when the commuting distance of both spouses are larger.

This interpretation may be also confirmed in our study by looking at the presence of stability in the employment (length of the contract within the same firm) for which the probability of working in other regions falls as the time within the same workplace increases. Hence, it is possible to suppose that workers, in the long run, - facing stability in their job position - reduce their commuting and relocate their residence, solving in this way the problem of market imperfections due to housing costs (Levinson 1998; Van Ommeren et al. 1997). However, our data do not allow to assess which form of stability comes first and, hence, to answer the question: “Does the workplace follow the residence or does the residence follow the workplace?”. In any case, looking at the residence stability variable, which measures the stability of the household within the same address, we might conclude that - in the long-run (at least 10 years) - living at the same address for longer negatively affects the propensity to move to other regions commuting more than a certain threshold (45 minutes for men; 30 minutes for women). In contrast, living in the same address for less than 10 years, and interpreting this as the short-run result, does not significantly change the probability outcome w.r.t. living less than 24 months. Our data on the employment stability are significant only for male workers, suggesting that, if there are forms of relocation, these are driven by men.

Furthermore, workers of public firms/administrations are less likely to commute confirming previous findings (Sandow 2008) while part-time jobs are less likely to be found in other job-markets because of the higher disutility of commuting. According to Cameron and Muellbauer (1998), who found a strong response of relative wages and relative job prospects, earnings are important in explaining the propensity to move. From Table 4, we can easily see that both male and female workers increase their probability to do longer commuting out of their own region in presence of greater monetary incentives. This happens for all cases with distance greater than 30 minutes (Table 4) whereas for shorter distances there are no significant variations. However, if we look at the disaggregate effect, we can see that this is mainly the case for female workers whose coefficients are greater than that of male (0.654 vs. 0.497 in case of commuting more than 45 minutes ad wages greater than 20%). It is also quite interestingly to see what happens in case of negative incentives, which means the *wratio* lower than 0.90. In this case both genders are significantly less likely to commute for any commuting time. Moreover, the greater significance of the threshold indexes for the case of moving to other regions at

a distance greater than 45 minutes suggests that the monetary incentive - as a compensation of the time spent commuting, transportation costs and changing in habits - works only for greater distances whereas for shorter distances the situation is similar to that in the region of residence.

However, looking only at the magnitude of the coefficients does not allow to better explain the result. Table 5 provides an analysis of the marginal effects for different levels of the wage index *wratio* and under all cases considered for robustness check. In particular, a salary greater than 20% raises the probability to move to other regions commuting more than 45 minutes by 2.6% on average whereas only by 1.2% for salaries 10-19% higher. However, when the monetary incentive is negative - as expected - the probability of moving decreases by 0.7% (for 30-45 minutes) and by 1.4% (for more than 45 minutes). Looking at the gender differences, wages 20% higher than the predicted increases by 3.2% the probability of commuting more than 45 minutes for male workers and by 2.2% for female workers, on average. Hence, on average, the gender gap is around 1% for the case of longer commuting. A moderate increase in the wage is significant only for women commuting more than 45 minutes with a marginal increase in probability of 1.5%. Indeed, looking at the difference between thresholds, female workers seem to be more sensitive to increase in their monetary incentives while male workers are not significantly affected by moderate increase in their wages.

Quite interestingly is to see also what happens when we control for the transportation mode. Both cars and public transports are increasing in the probability of moving to other regions but public transports are declining for commuters traveling shorter distances. This confirms the idea that public transport becomes more convenient as long as the distance increases.

## 6 Robustness check

### 6.1 Controlling for the Region of Greater London

In order to check for the validity of our analysis, we consider the same model without the inclusion of the region of the Greater London, indicated in our sample by two territorial areas: Inner/Central London and Outer London. This is done modifying the original sample and running first a new OLS (not reported here) for obtaining the prediction of the expected wage in the region of residence to be used as regressor in the Multinomial Logit.

In this way we check for peculiar characteristics of the capital, as the role of attractions for many job-seekers, the greater costs of living and transports as well as the greater wages offered to Londoners. In

Table 6 - Multinomial Logit without the Greater London Region

	Overall			Male Only			Female Only		
	Out < 30	Out 30-45	Out > 45	Out < 30	Out 30-45	Out > 45	Out < 30	Out 30-45	Out > 45
<b>Age bands (Ref: 20-29)</b>									
30 - 49	0.077 (0.068)	0.113 (0.092)	0.290*** (0.083)	0.198* (0.089)	0.234* (0.119)	0.336*** (0.100)	-0.020 (0.093)	-0.007 (0.148)	0.265* (0.133)
50 - 59	0.078 (0.076)	0.083 (0.110)	0.403*** (0.096)	0.220* (0.107)	0.252 (0.143)	0.488*** (0.114)	-0.044 (0.104)	-0.173 (0.184)	0.290 (0.165)
Over 60	0.123 (0.103)	-0.091 (0.167)	0.263 (0.143)	0.213 (0.137)	-0.005 (0.208)	0.315 (0.174)	0.108 (0.155)	-0.304 (0.376)	0.263 (0.311)
<b>Child&lt;15 y.o</b>	0.094* (0.044)	0.160* (0.065)	0.088 (0.054)	0.014 (0.058)	0.159 (0.083)	0.083 (0.069)	0.166** (0.063)	0.117 (0.096)	0.029 (0.090)
<b>Couple</b>	-0.115* (0.054)	0.035 (0.073)	0.009 (0.062)	-0.050 (0.074)	0.183* (0.092)	0.146 (0.077)	-0.185* (0.080)	-0.244 (0.144)	-0.380** (0.135)
<b>Mortgage/Homeownership</b>	0.301*** (0.061)	0.480*** (0.098)	0.557*** (0.083)	0.386*** (0.087)	0.459*** (0.117)	0.634*** (0.099)	0.176* (0.087)	0.486** (0.158)	0.369* (0.144)
<b>Address Stability (Ref: &lt; 2 y.)</b>									
2- 10 years	-0.055 (0.062)	0.068 (0.081)	0.009 (0.070)	0.028 (0.086)	0.100 (0.102)	0.029 (0.083)	-0.150 (0.083)	0.034 (0.130)	-0.046 (0.123)
>10 years	-0.100 (0.067)	-0.236* (0.092)	-0.274*** (0.079)	0.017 (0.091)	-0.083 (0.117)	-0.176 (0.096)	-0.228* (0.093)	-0.492** (0.152)	-0.485** (0.150)
<b>Part-time</b>	-0.170** (0.057)	-0.706*** (0.102)	-0.819*** (0.100)	-0.248 (0.133)	-0.367* (0.186)	-1.204*** (0.265)	-0.142* (0.065)	-0.726*** (0.130)	-0.594*** (0.122)
<b>Job type (Ref:low-skilled)</b>									
Intermediate Occupation	0.091 (0.055)	0.535*** (0.107)	0.970*** (0.106)	0.095 (0.072)	0.464*** (0.118)	0.906*** (0.116)	0.094 (0.083)	0.772*** (0.201)	1.249*** (0.248)
Managerial Professions	0.205*** (0.053)	1.062*** (0.090)	1.921*** (0.094)	0.210** (0.067)	0.983*** (0.096)	1.779*** (0.111)	0.205* (0.082)	1.290*** (0.197)	2.384*** (0.240)
<b>Tenure (Ref: &lt; 2 y.)</b>									
2 - 5 years	-0.113 (0.059)	-0.258** (0.084)	-0.340*** (0.069)	-0.019 (0.089)	-0.236* (0.110)	-0.365*** (0.086)	-0.216** (0.084)	-0.269* (0.136)	-0.276* (0.134)
5 - 10 years	-0.175** (0.058)	-0.356*** (0.079)	-0.502*** (0.070)	-0.127 (0.088)	-0.283** (0.104)	-0.522*** (0.089)	-0.227** (0.086)	-0.445** (0.148)	-0.445*** (0.128)
10 - 20 years	-0.156* (0.062)	-0.472*** (0.090)	-0.714*** (0.076)	-0.089 (0.088)	-0.498*** (0.108)	-0.733*** (0.094)	-0.240* (0.094)	-0.370* (0.153)	-0.676*** (0.145)
> 20 years	-0.177* (0.073)	-0.618*** (0.103)	-0.856*** (0.091)	-0.098 (0.097)	-0.750*** (0.135)	-0.918*** (0.109)	-0.304** (0.116)	-0.282 (0.191)	-0.750*** (0.190)
<b>Public firm</b>	-0.343*** (0.045)	-0.234*** (0.068)	-0.373*** (0.055)	-0.498*** (0.074)	-0.256** (0.091)	-0.439*** (0.074)	-0.203*** (0.059)	-0.199* (0.097)	-0.247* (0.096)
<b>Female</b>	-0.236*** (0.042)	-0.603*** (0.063)	-0.852*** (0.051)						
<b>Mon. Incentive (Ref: 90-110)</b>									
<90	-0.163** (0.050)	-0.340*** (0.078)	-0.374*** (0.070)	-0.211** (0.073)	-0.292** (0.103)	-0.425*** (0.083)	-0.095 (0.079)	-0.423*** (0.127)	-0.257 (0.132)
110-120	-0.035 (0.083)	0.195 (0.113)	0.237* (0.104)	0.123 (0.116)	0.308* (0.151)	0.227 (0.131)	-0.239 (0.129)	0.015 (0.190)	0.302 (0.179)
>119	0.098 (0.057)	0.258** (0.079)	0.624*** (0.066)	0.109 (0.074)	0.297** (0.107)	0.580*** (0.079)	0.089 (0.082)	0.216 (0.125)	0.718*** (0.119)
<b>Car_Motorbike</b>	1.354*** (0.096)	2.460*** (0.270)	1.523*** (0.162)	1.337*** (0.141)	2.400*** (0.410)	1.320*** (0.177)	1.362*** (0.120)	2,499 (1.359)	2.141* (1.034)
<b>Public Transport</b>	-0.127 (0.153)	1.579*** (0.296)	2.255*** (0.177)	-0.253 (0.260)	1.454** (0.452)	1.941*** (0.193)	-0.035 (0.199)	1,695 (1.369)	3.074** (1.033)
<b>Constant</b>	-3.198*** (0.155)	-5.854*** (0.321)	-5.758*** (0.240)	-3.390*** (0.212)	-6.125*** (0.465)	-5.887*** (0.309)	-3.269*** (0.228)	-6.219*** (1.348)	-7.004*** (1.079)
Annual Dummies		Yes			Yes			Yes	
Regional Workplace Dummies		Yes			Yes			Yes	
Pseudo R-squared		12,3%			11.10%			12.20%	
N		67536			31201			36335	

Bootstrapped Standard Errors are provided.

Table 6: Multinomial Logit without the Greater London Region

general, all coefficients are slightly lower in the Multinomial Logit without the Greater London Region (Tab. 6). Quite interestingly is the comparison of marginal effects between the two models (with and without London). In the latter case (Tab. 5), a 20% greater wage increases the probability to commute by 0.4% for the case of 30-45 minutes and by 2.1% for distances longer than 45 minutes. However, this result is mainly driven by the gender differences, which are greater than before. In particular, male workers increase their probability to move to other regions and territorial agglomerations commuting more than 45 minutes by 2.9% (while it was 3.2% in the previous case) while women only by 1.3%, that is 0.7% less than the marginal effect considering the full sample.

Additionally, excluding the region of Greater London from the sample leads to a raise from 1% to 1.6% in the gender gap in the probability of commuting more than 45 minutes, with the consequence that female workers working in London are more willing to commute than their national counterpart. This result may be explained by the greater attractiveness of the capital, especially for women. Finally, these further evidences confirm also the peculiarity of the Region of Greater London (and also the higher hourly pay in that regions) and its influence on the infra and inter-regional geographical mobility in the UK.

## 6.2 Controlling for the Household Responsibility Hypothesis

In this section, we provide further controls for the “household responsibility hypothesis” considering also heterogeneity in the household composition in terms of wealth, that is whether couples with a relatively higher wage are more willing to commute longer and what is the pure effect of the monetary incentive once the control for the gross (weekly) wage is provided. It should be noted that weekly wage bands are now used, in order to control for the economic stability, and these are additional to the threshold index which captures the hourly monetary incentive. The new variable *wageband* assumes values equal to 0 for weekly wages lower than 200 £; 1 for 200-500 £; 2 for 500-1000 £ while the interaction term *couple\*wageband* is used to consider the joint effect of being a couple and gross weekly earnings.

As shown in Table 7, the direct effect of being in a couple on the probability of moving to other regions commuting more than 45 minutes is positive but, once we control for the weekly wage bands through the interaction term, it decreases substantially such that non-married workers have a greater probability to commute outside their regions when the earning is lower than 200 £ and this happens mainly for women with high significance. However, for weekly wage 500-1000 £, the variable is

Table 7 - Multinomial Logit for the Household Responsibility Hypothesis

	Overall			Male Only			Female Only		
	Out < 30	Out 30-45	Out > 45	Out < 30	Out 30-45	Out > 45	Out < 30	Out 30-45	Out > 45
<b>Age bands (Ref: 20-29)</b>									
30 - 49	0.016 (0.053)	0.022 (0.067)	0.173** (0.06)	0.01 (0.083)	0.072 (0.096)	0.159 (0.081)	0.043 (0.079)	0.012 (0.105)	0.252** (0.095)
50 - 59	0.023 (0.062)	0.007 (0.086)	0.233** (0.074)	0.022 (0.098)	0.052 (0.116)	0.296** (0.095)	0.047 (0.091)	-0.003 (0.013)	0.151 (0.012)
Over 60	0.054 (0.092)	-0.16 (0.135)	0.235* (0.099)	-0.022 (0.129)	-0.111 (0.155)	0.308** (0.116)	0.223 (0.13)	-0.28 (0.253)	0.112 (0.204)
<b>Female</b>	-0.213*** (0.038)	-0.488*** (0.05)	-0.636*** (0.041)						
<b>Couple</b>	0.09 (0.164)	0.417* (0.179)	0.816*** (0.148)	-0.129 (0.195)	0.194 (0.187)	0.484** (0.169)	0.443 (0.372)	0.916** (0.324)	1.592*** (0.299)
<b>Child&lt;15 y.o</b>	-0.054 (0.047)	-0.088 (0.062)	0.047 (0.05)	-0.025 (0.06)	0.054 (0.072)	0.186** (0.059)	-0.093 (0.069)	-0.308** (0.103)	-0.265** (0.083)
<b>Couple*wageband</b>									
Couple*ww<200	0.004 (0.189)	-0.086 (0.289)	-1.019*** (0.236)	0.284 (0.299)	0.552 (0.481)	-0.771 (0.412)	-0.327 (0.387)	-0.752 (0.402)	-1.707*** (0.367)
Couple*ww200-500	-0.006 (0.169)	-0.484* (0.193)	-0.761*** (0.161)	0.163 (0.212)	-0.444* (0.219)	-0.461* (0.189)	-0.291 (0.382)	-0.796* (0.345)	-1.507*** (0.308)
Couple*ww500-1000	-0.036 (0.172)	-0.254 (0.19)	-0.620*** (0.152)	0.177 (0.21)	-0.014 (0.203)	-0.323 (0.174)	-0.439 (0.386)	-0.806* (0.355)	-1.443*** (0.311)
<b>wageband(Ref: Grsswk&lt;200)</b>									
ww200-500	0.207 (0.113)	0.634** (0.212)	0.493** (0.157)	0.181 (0.235)	0.695 (0.404)	0.127 (0.303)	0.226 (0.119)	0.475 (0.248)	0.566** (0.202)
ww500-1000	0.401** (0.123)	0.898*** (0.228)	0.982*** (0.169)	0.389 (0.248)	0.801 (0.421)	0.704** (0.305)	0.400** (0.151)	0.926*** (0.27)	0.877*** (0.23)
ww>1000	0.26 (0.188)	0.773** (0.288)	0.563* (0.221)	0.455 (0.298)	0.861 (0.461)	0.514 (0.354)	-0.254 (0.349)	0.484 (0.378)	-0.082 (0.355)
<b>Mon. Incentive (Ref: 90-110)</b>									
<90	-0.091* (0.046)	-0.193** (0.066)	-0.211*** (0.055)	-0.123 (0.066)	-0.141 (0.082)	-0.234** (0.071)	-0.043 (0.066)	-0.268** (0.102)	-0.190* (0.089)
110-120	0.002 (0.072)	0.095 (0.091)	0.211** (0.074)	0.118 (0.111)	0.229 (0.123)	0.131 (0.103)	-0.136 (0.106)	-0.104 (0.159)	0.400*** (0.119)
>119	0.076 (0.052)	0.134* (0.065)	0.406*** (0.051)	0.084 (0.077)	0.187* (0.091)	0.371*** (0.075)	0.091 (0.077)	0.053 (0.101)	0.530*** (0.085)
<b>Mortgage/Homeownership</b>	0.214*** (0.051)	0.447*** (0.065)	0.739*** (0.056)	0.257*** (0.067)	0.444*** (0.081)	0.748*** (0.077)	0.147* (0.07)	0.439*** (0.109)	0.708*** (0.099)
<b>Address Stability (Ref: &lt;2 y.)</b>									
2- 10 years	-0.015 (0.051)	0.014 (0.066)	-0.05 (0.051)	0.051 (0.07)	0.073 (0.078)	-0.01 (0.066)	-0.094 (0.074)	-0.077 (0.093)	-0.124 (0.082)
>10 years	-0.051 (0.056)	-0.233** (0.074)	-0.310*** (0.058)	0.054 (0.077)	-0.015 (0.089)	-0.179* (0.073)	-0.168* (0.082)	-0.580*** (0.115)	-0.524*** (0.096)
<b>Part-time</b>	0.018 (0.062)	-0.319*** (0.094)	-0.132 (0.073)	-0.114 (0.139)	-0.306 (0.193)	-0.501** (0.169)	0.033 (0.071)	-0.278* (0.113)	-0.083 (0.09)
<b>Job type (Ref: low-skilled)</b>									
Intermediate Occupation	0.057 (0.049)	0.461*** (0.086)	0.738*** (0.07)	0.063 (0.072)	0.407*** (0.1)	0.677*** (0.083)	0.027 (0.074)	0.644*** (0.156)	0.803*** (0.123)
Managerial Professions	0.117* (0.052)	0.756*** (0.088)	1.052*** (0.071)	0.109 (0.07)	0.730*** (0.096)	1.053*** (0.083)	0.119 (0.076)	0.900*** (0.169)	1.101*** (0.126)
<b>Tenure (Ref: &lt; 2 y.)</b>									
2 - 5 years	-0.123* (0.052)	-0.291*** (0.067)	-0.272*** (0.057)	-0.078 (0.068)	-0.284*** (0.082)	-0.340*** (0.072)	-0.170* (0.068)	-0.287** (0.109)	-0.143 (0.092)
5 - 10 years	-0.166** (0.053)	-0.345*** (0.066)	-0.301*** (0.055)	-0.173* (0.071)	-0.326*** (0.082)	-0.369*** (0.069)	-0.164* (0.072)	-0.348*** (0.105)	-0.178* (0.087)
10 - 20 years	-0.176** (0.055)	-0.388*** (0.071)	-0.491*** (0.058)	-0.116 (0.073)	-0.409*** (0.086)	-0.557*** (0.074)	-0.251** (0.078)	-0.318** (0.11)	-0.376*** (0.1)
> 20 years	-0.171** (0.063)	-0.521*** (0.088)	-0.427*** (0.064)	-0.094 (0.087)	-0.679*** (0.101)	-0.595*** (0.08)	-0.318** (0.103)	-0.198 (0.142)	-0.121 (0.116)
<b>Public firm</b>	-0.320*** (0.037)	-0.261*** (0.051)	-0.425*** (0.041)	-0.349*** (0.058)	-0.225*** (0.068)	-0.356*** (0.052)	-0.273*** (0.051)	-0.267*** (0.076)	-0.432*** (0.065)
<b>Car_Motorbike</b>	1.274*** (0.07)	2.275*** (0.158)	2.126*** (0.123)	1.186*** (0.096)	2.162*** (0.192)	2.012*** (0.156)	1.368*** (0.106)	2.460*** (0.295)	2.371*** (0.263)
<b>Public Transport</b>	-0.023 (0.096)	1.956*** (0.169)	2.961*** (0.121)	-0.152 (0.14)	1.689*** (0.199)	2.645*** (0.152)	0.08 (0.141)	2.304*** (0.299)	3.476*** (0.256)
<b>Constant</b>	-3.306*** (0.156)	-6.018*** (0.292)	-6.633*** (0.25)	-3.296*** (0.293)	-6.195*** (0.461)	-6.470*** (0.401)	-3.537*** (0.206)	-6.371*** (0.443)	-7.317*** (0.37)
Annual Dummies		Yes			Yes			Yes	
Regional Workplace Dummies		Yes			Yes			Yes	
Pseudo R-squared		0.213			19,6%			0.22	
N		77029			36182			40847	

Bootstrapped Standard Errors are provided.

Table 7: Multinomial Logit controlling for the Household Responsibility Hypothesis

significant at 1% and 5% only for women and combining the effect of couple and the interaction term, lead women to have slightly positive effects on the probability of moving out of regions.

Even under this setting, we find a gender gap, with female workers less likely to move out of the regions, regardless the distance and also support for the childcare responsibility asymmetrically allocated to women, who experience a reduction in probability for all commuting greater than 30 minutes where men experience an increase in the probability for distances greater than 45 minutes. As expected, the introduction of weekly earnings partially offsets the direct effect of the monetary incentive, with the consequence that women are more willing than men to commute more than 30 minutes for intermediate hourly monetary incentives (10-20%) since the variable is not significant for men. By contrast, looking at the marginal effect (Table 5), for distances greater than 45 minutes of travel time, men have a greater probability of moving outside their own region with respect to their female counterparts. From Table 5 it is quite interestingly to see that, once the interaction term is introduced, the gender gap decreases to 0.5% for monetary incentives greater than 20% in presence of 45 minutes of travel time. Under these controls, the average marginal effect of the monetary incentive is 2.2% for men and 1.7% for women.

To summarize, with the introduction of these further controls (weekly wage band and the interaction term), it becomes clearer the heterogeneity in couples' behaviors according to their economic stability. The monetary incentive variable is partially off-setted by the introduction of the gross weekly wage, which is able to capture the absolute role of earnings. Married female workers with higher weekly wages are more willing to commute longer than those with lower wages, whose probability to move to other regions is even below that of the average non-married (or not living as a couple) worker.

### 6.3 Considering different levels of the wage ratio

A further test for checking the robustness of our results is to test changes in the levels of the threshold-index, derived on the basis of the OLS and capturing the differences between the current (and observed wage) and the predicted wage for the region of residence. In the benchmark model, the analysis has been pursued considering four different levels ( $< 0.90$ ;  $0.90 - 1.10$ ;  $1.10 - 1.20$ ;  $> 1.20$ ) using the baseline outcome of 10% deviation of the current wage with respect to that predicted. In this section, we restrict the interval considering as baseline outcome only a 5% deviation and, hence, looking at the following different levels ( $< 0.95$ ;  $0.95 - 1.05$ ;  $1.05 - 1.20$ ;  $> 1.20$ ).

Looking at coefficients provided by Table 8, the sign and the magnitude is roughly the same as in

**Table 8 - Multinomial Logit with different monetary incentives**

	Overall			Male Only			Female Only		
	<i>Out &lt; 30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>	<i>Out &lt; 30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>	<i>Out &lt; 30</i>	<i>Out 30-45</i>	<i>Out &gt; 45</i>
<b>Age bands (Ref: 20-29)</b>									
30 - 49	0.043 (0.052)	0.080 (0.065)	0.236*** (0.059)	0.052 (0.080)	0.123 (0.093)	0.250** (0.077)	0.050 (0.077)	0.080 (0.099)	0.266** (0.096)
50 - 59	0.041 (0.061)	0.042 (0.084)	0.265*** (0.073)	0.055 (0.098)	0.082 (0.111)	0.356*** (0.096)	0.048 (0.090)	0.027 (0.126)	0.130 (0.118)
Over 60	0.060 (0.091)	-0.155 (0.135)	0.230* (0.098)	0.002 (0.130)	-0.102 (0.155)	0.323** (0.119)	0.205 (0.124)	-0.293 (0.249)	0.050 (0.198)
child<15 years	0.076 (0.039)	0.106* (0.049)	0.212*** (0.040)	0.042 (0.054)	0.056 (0.061)	0.186*** (0.053)	0.109* (0.054)	0.150* (0.074)	0.196** (0.062)
Couple	-0.059 (0.047)	-0.083 (0.061)	0.060 (0.050)	-0.017 (0.058)	0.078 (0.071)	0.215*** (0.059)	-0.104 (0.069)	-0.340** (0.108)	-0.272*** (0.082)
Mortgage/Homeownership	0.242*** (0.050)	0.508*** (0.063)	0.813*** (0.055)	0.292*** (0.069)	0.495*** (0.080)	0.835*** (0.074)	0.162* (0.069)	0.498*** (0.109)	0.733*** (0.098)
<b>Address Stability (Ref: &lt;2 y.)</b>									
2- 10 years	-0.021 (0.051)	0.003 (0.066)	-0.059 (0.051)	0.046 (0.070)	0.066 (0.080)	-0.024 (0.065)	-0.099 (0.075)	-0.091 (0.092)	-0.128 (0.081)
>10 years	-0.062 (0.056)	-0.251*** (0.074)	-0.331*** (0.057)	0.041 (0.081)	-0.029 (0.091)	-0.203** (0.074)	-0.175* (0.080)	-0.607*** (0.117)	-0.528*** (0.096)
Part-time	-0.118* (0.047)	-0.609*** (0.077)	-0.551*** (0.059)	-0.229* (0.110)	-0.460** (0.158)	-0.862*** (0.137)	-0.087 (0.054)	-0.584*** (0.095)	-0.402*** (0.069)
<b>Job type (Ref:low-skilled)</b>									
Intermediate Occupation	0.090 (0.047)	0.539*** (0.084)	0.860*** (0.068)	0.097 (0.069)	0.470*** (0.096)	0.800*** (0.078)	0.074 (0.072)	0.730*** (0.149)	0.937*** (0.121)
Managerial Professions	0.211*** (0.044)	1.003*** (0.074)	1.404*** (0.063)	0.213*** (0.058)	0.937*** (0.087)	1.404*** (0.073)	0.210** (0.066)	1.202*** (0.149)	1.416*** (0.114)
<b>Tenure (Ref: &lt; 2 y.)</b>									
2 - 5 years	-0.114* (0.052)	-0.277*** (0.066)	-0.247*** (0.057)	-0.069 (0.070)	-0.273*** (0.080)	-0.312*** (0.071)	-0.161* (0.069)	-0.269* (0.109)	-0.121 (0.091)
5 - 10 years	-0.151** (0.052)	-0.314*** (0.066)	-0.256*** (0.054)	-0.158* (0.074)	-0.300*** (0.084)	-0.313*** (0.069)	-0.148* (0.070)	-0.318** (0.105)	-0.146 (0.087)
10 - 20 years	-0.150** (0.054)	-0.331*** (0.070)	-0.409*** (0.057)	-0.090 (0.074)	-0.362*** (0.085)	-0.472*** (0.071)	-0.229** (0.078)	-0.260* (0.111)	-0.300** (0.100)
> 20 years	-0.136* (0.062)	-0.446*** (0.087)	-0.321*** (0.063)	-0.060 (0.087)	-0.617*** (0.097)	-0.485*** (0.078)	-0.285** (0.098)	-0.113 (0.137)	-0.029 (0.113)
Public firm	-0.306*** (0.037)	-0.248*** (0.050)	-0.407*** (0.041)	-0.344*** (0.059)	-0.225** (0.069)	-0.347*** (0.053)	-0.254*** (0.053)	-0.239** (0.079)	-0.403*** (0.065)
Female	-0.247*** (0.036)	-0.580*** (0.048)	-0.754*** (0.038)						
<b>Mon. Incentive (Ref: 95-105)</b>									
<95	-0.124* (0.059)	-0.341*** (0.075)	-0.427*** (0.063)	-0.138 (0.091)	-0.254* (0.105)	-0.368*** (0.081)	-0.093 (0.080)	-0.444*** (0.115)	-0.508*** (0.095)
105-120	0.028 (0.072)	0.062 (0.092)	0.152* (0.074)	0.173 (0.102)	0.191 (0.129)	0.207* (0.096)	-0.133 (0.106)	-0.090 (0.148)	0.105 (0.119)
>119	0.107 (0.062)	0.212** (0.079)	0.502*** (0.064)	0.146 (0.095)	0.276* (0.110)	0.529*** (0.086)	0.073 (0.088)	0.143 (0.114)	0.483*** (0.096)
Car_Motorbike	1.290*** (0.070)	2.288*** (0.158)	2.153*** (0.123)	1.198*** (0.098)	2.167*** (0.187)	2.034*** (0.156)	1.390*** (0.103)	2.464*** (0.286)	2.400*** (0.261)
Public Transport	-0.018 (0.096)	1.966*** (0.168)	2.978*** (0.121)	-0.154 (0.142)	1.692*** (0.198)	2.650*** (0.151)	0.100 (0.141)	2.312*** (0.294)	3.505*** (0.256)
Constant	-3.161*** (0.141)	-5.557*** (0.229)	-6.323*** (0.203)	-3.206*** (0.191)	-5.731*** (0.278)	-6.559*** (0.260)	-3.387*** (0.193)	-6.088*** (0.407)	-6.931*** (0.323)
Annual Dummies		Yes			Yes			Yes	
Regional Workplace Dummies		Yes			Yes			Yes	
Pseudo R-squared		21.00%			19,3%			21,7%	
N		77029			36182			40847	

Bootstrapped Standard Errors are provided

Table 8: Multinomial Logit with different monetary incentives

the benchmark model. Moderate monetary incentives (5-20%) are never significant at 5% but highly significant when negative ( $<0.95$ ) and substantially higher ( $>1.20$ ). This is due to changes in the reference level, which is now more restrictive, accounting only for changes of 5% in the wage ratio.

From Table 5, it is possible to compare average marginal effects. Quite surprisingly, the gender gap under this setting is widening reaching 1.8%, with men increasing the probability to commute longer distances by 3.4% and women only by 1.6%.

## 7 Conclusions

This study confirms the main results defined by the commuting time analysis and provides a new way of interpreting the travel-to-work between regions considering the role of monetary incentives. As suggested by data, people tend to move to other regions for having greater wage and because of better job opportunities, confirming the presence of differentiated labor markets. With this study, we find that the role of the monetary incentive increases as long as the distance increases and also that managerial professions have multi-regional job markets while routine jobs are local. Earning more is a strong incentive for geographical mobility with women who face a peculiar trade-off between higher wage and commuting distance, suggesting that they are more mobile if the effort worth enough.

Moreover, evidences suggest how a certain degree of flexibility matters in the short (mortgage) and in the long run (length of the contract; stable residence) as well as sex differences asymmetrically react when changes in the household structure occur. We also find a gender gap of 1% with male more likely to move outside their own territorial area and commuting more than 45 minutes and this gap is strengthen when the analysis does not consider the Region of Greater London. We also provide support for the “household responsibility hypothesis”, concluding that women are less willing to commute longer and to move outside their own region compared to their counterparts.

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