Travel-to-work. Which factors matter?

An analysis on regional labor markets in the UK

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2015, June 30th - XVII Riunione Scientifica della Societ
Italiana di Economia dei Trasporti e della Logistica (SIET)

Outline

- 1) Aims and Literature Review
- 2) Theoretical Model
- 3) Econometric Strategy
- 4) Descriptive Statistics
- 5) Results
- 6) Robustness checks
- 7) Conclusions

Aims

▶ Investigate which factors matter in the travel-to-work behaviors among different regional labour markets.

According to the macroeconomic literature, people should be freely to move across regions in response to asymmetric shocks and better opportunities. But...

In the real-world there are some rigidities (institutional, howeownership, etc.)

Literature Review

It has been previously investigated - for instance - that:

- Homeownership produces inferior labor market outcomes due to greater transaction costs from moving among places in response to asymmetric shocks or opportunities (Oswald 1997);

- As a consequence of individual homeownership there is an increase in the likelihood to be unemployed while renters would be fully employed due to the absence of transaction costs;

- Munch et al. (2008) argue that homeowners have greater probability to stay more within the job also because they are less likely to find a job in another local labor market (-14%);

- Gardner et al. (2000), using UK data, show that homeowners are less mobile in the labor market.

Literature Review

However, migration is not always possible not only because of transaction costs but also because of the presence of psychological barriers related to the change in the environment, habits or familiar relationships. Commuting is, hence, an alternative to migration.

- ▶ Longer commuting is associated with low populated residence areas. Public sector workers are less likely to commute compared to those of the private sector (Sandow, 2008);

- ▶ Individuals in a dual-earner household are more likely to have greater commuting before and after a moving than single earners because of spatial constraints (Clark et al. 2003);

- ▶ 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;

- ▶ Female workers are more likely to have shorter commuting because of household responsibilities (Turner and Niemeier 1997; Sandow 2008; Prashker et al. 2008; McQuaid and Chen 2012).

Literature Review

- Sandow and Westin (2010) find a strong gender effect on the probability of continuing long-distance commuting ($\geq$ 30 km) with women loosing more when their spouse is the long-distance commuter;

- So et al. (2001) find that a change in 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 high education workers have a greater probability to accept jobs traveling more than 40 mins;

- Housing market conditions significantly affect the commuting pattern. High relative housing price encourage in-commuting by discouraging in-migration. (Cameron and Muellbauer 1998).

Literature Review

What seems to be missing is the role of greater monetary incentives on the propensity to commute longer. Should earnings play an important in explaining the propensity to move?

Few papers attempt to analyze this relationship:

- McQuaid and Chen (2012) consider the role of gross monthly wages on the propensity to commute more than a certain threshold (30 mins, 45 mins);

- Sandow and Westin (2010) consider different thresholds of annual gross income (High, Middle, Low) and change in income during the period of observation. Women with long-distance commute have a better income development compared to non-commuter. Long-distance commuting is a strong economic incentive;

- For Plaut (2006), salaries (log individual salaries) do not have impact on commuting time but only on distance.

Some Facts (from the ONS)

According to 2011 Census Analysis - Distance Travelled to Work.

- ▶ The average distance commuted to work in England and Wales increased from 13.4 km (2001) to 15.0 km (2011);

- ▶ On average workers living in the East of England (17 km) had the longest commutes while working residents in London had the shortest commutes (11 km);

- ▶ In both 2001 and 2011, males commuted further than females. In 2001, 39% of males and 25% of females commuted more than 10 km. By 2011, the rates of commuting such distances had increased to 42% for males and 30% for females;

- ▶ Full-time workers commuted longer distances in 2011 than their part-time counterparts. While 55% of part-time workers commuted less than 5 km, 38% of full-time workers did the same;

Theoretical model

Let consider the workers' utility function 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);

- 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.

Theoretical model

Let consider the worker $i = 1 \ldots I$, 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

$$V_l(Y_l, L_l, qh_l, R_l) > V_r(Y_r, L_r, qh_r, R_r)$$

Ruling out the situation of indifference and substituting both constraints within the functional form we obtain

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

Theoretical model

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 $q = 1$).

The Econometric Strategy

Since we observe only the current workplace regardless the residence, we need to predict the unobserved wage for the region of usual residence.

For doing it, the econometric strategy is based on two steps:

- ► 1) Estimation of the hypothetical wage for the region of usual residence;
  Construction of an index comparing it with the current (observable) wage;

- ► 2) Estimation of the likelihood to move to another region given a set of independent variables.

The Econometric Strategy - 1

In the first step, we regress the current wage on several variables (defined according to the literature). Then we predict the unobserved wage (wage*).

The regression is the standard OLS:

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

where:

- $\mathbf{X}$ is the vector of labor market characteristics (tenure, size of the firm, whether part-time, sector, the role within the workplace and whether the worker is also looking for another job);

- $\mathbf{Z}$ includes all the unknown coefficients of individual socio-economic characteristics (age, age of completed education, being a couple and presence of children, health problems that limit the work activity, annual dummies, homeownership or presence of mortgage, region of residence);

Then, using the predicted wage *wage∗* and the current *wage*, we construct a continuous index $\frac{wage}{wage*}$.

A discrete index is used for better capturing the non-linearity. The thresholds are defined as follows:

$$\text{thr\_index}=0 \text{ if } 0.90 \leq \tfrac{wage}{wage*} < 1.10$$

$$\text{thr\_index}=1 \text{ if } \tfrac{wage}{wage*} < 0.90$$

$$\text{thr\_index}=2 \text{ if } 1.10 \leq \tfrac{wage}{wage*} < 1.20$$

$$\text{thr\_index}=3 \text{ if } \tfrac{wage}{wage*} \geq 1.20$$

As benchmark threshold we use (thr_index=0), defined as the situation for which the current wage is at most 10% greater or lower than the predicted.

Data

- The model is implemented using data from the LFS - 4th quarter (2004-2011).

- Since data considers the period 2004-2011, the hourly pay has been previously deflated using the Consumer Price Index (CPI) provided by ONS (Office for National Statistics).

- The dataset has been manipulated keeping only the employed (not self-employed) 23-65 y.o. with an average gross hourly pay greater than 2 sterlings.

- In order to have a homogeneous sample, all the predicted wages* less than 2 pounds per hour have been dropped.

- The dataset for the second step contains 76899 out of 77056 initial observations.

Descriptive Statistics

We consider the GORs (GovernmentOffice Regions) as defined within the LFS, which consider more homogeneous territorial agglomerations:

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

Descriptive Statistics

Table 2 - Descriptive Statistics

	Overall	Female	Male	In Region	Out and <30	Out and 30-45	Out and > 45
Commuting time	26.44 mins	23.31 mins	29.96 mins	22.04 mins	21.39 mins	41.75 mins	80.74 mins
Commuting by car_motorbike	72.55	70.28%	75.12%	73.39%	87.35%	76.34%	47.63%
Commuting by public transport	13.13%	13.65%	12.54%	10.33%	6.68%	21.66%	50.83%
Hourly wage	11.52	10.25	12.96	10.8	12.26	15.35	18.53
Predicted hourly wage (wage*)	11.53	10.26	12.96	11.09	12.06	14.18	15.55
wage/wage*	1.02	1.01	1.02	1	1.04	1.08	1.18
							[b]
N. Observations	76899	40758	36141	65420	4086	2392	5001

Descriptive Statistics

Some considerations:

- On average men (around 30 minutes) commute longer than women (around 23);

- The use of the public transport is increasing in the commuting time while the converse holds for the use of the car;

- The average hourly wage rate is greater when workers move to other regions and it is increasing in the commuting time;

- The predicted hourly wage for the region of residence seems producing a better fit.

OLS

Table 3. OLS - Wage regression

Dep. Variable: wage*	Overall	Only Female	Only Male
Age	0.499***	0.396***	0.623***
	(0.014)	(0.019)	(0.022)
Age^2	-0.005***	-0.004***	-0.006***
	(0.000)	(0.000)	(0.000)
Age Completed Education	0.423***	0.456***	0.386***
	(0.010)	(0.013)	(0.016)
Couple	0.535***	0.111*	0.935***
	(0.040)	(0.048)	(0.067)
Children < 15 y.o.	0.210***	-0.265***	0.576***
	(0.057)	(0.063)	(0.101)
Health Problems that limit activity	-0.450***	-0.310***	-0.653***
	(0.055)	(0.061)	(0.097)
Female	-1.633***		
	(0.048)		
Job type (Ref: Routine occupations)			
Semi-routine occupation	0.270***	0.300***	0.054
	(0.049)	(0.075)	(0.070)
Lower supervisory and technician	1.280***	0.946***	1.394***
	(0.056)	(0.099)	(0.069)
Intermediate occupation	1.310***	1.253***	1.617***
	(0.058)	(0.079)	(0.107)
Lower Managerial and professional	4.664***	4.449***	4.858***
	(0.061)	(0.086)	(0.091)
Higher Managerial and professional	8.981***	8.625***	9.041***
	(0.095)	(0.150)	(0.125)
Industry sector dummies	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes
R-squared	0.439	0.424	0.429
N	77029	40847	36182

OLS

Table 3. OLS - Wage regression

Dep. Variable: wage*	Overall	Only Female	Only Male
Lenght of employment (Ref: less than two years)			
2 - 5 years	0.276***	0.308***	0.253**
	(0.057)	(0.066)	(0.095)
5 - 10 years	0.594***	0.555***	0.736***
	(0.058)	(0.067)	(0.098)
10 - 20 years	1.187***	1.153***	1.292***
	(0.065)	(0.078)	(0.107)
> 20 years	1.580***	1.781***	1.372***
	(0.079)	(0.101)	(0.121)
Size of firm (Ref. Less than 25)			
25 - 49	0.397***	0.286***	0.572***
	(0.058)	(0.069)	(0.099)
40 - 500	0.866***	0.609***	1.251***
	(0.048)	(0.058)	(0.079)
> 500	1.627***	1.049***	2.390***
	(0.064)	(0.072)	(0.109)
Looking for another job	-0.555***	-0.304**	-0.755***
	(0.073)	(0.095)	(0.111)
Part-time	-0.230***	-0.068	-0.316*
	(0.051)	(0.053)	(0.153)
Homeowner/Mortgage	1.332***	1.016***	1.659***
	(0.044)	(0.051)	(0.071)
Constant	-14.531***	-12.146***	-17.946***
	(0.434)	(0.743)	(0.616)
Industry sector dummies	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Yearly dummies	Yes	Yes	Yes
R-squared	0.439	0.424	0.429
N	77029	40847	36182

OLS - Some comments

- ▶ Sex differences are evident, according to the main literature (Oaxaca, 1973). The unobserved wage increases with the age in a non-linear way;

- ▶ The predicted wage is greater in London, East Anglia, Southern East, East Midlands and Scotland, suggesting that regional characteristics matter (the coefficients are available upon request);

- ▶ Looking for another job has a strong impact on the wage determination, mainly for men. This negative relation can be associated to lower productivity and then lower wages;

- ▶ Working for longer in the same place leads to increased wages for both genders but also an increase in the gender pay gap;

- ▶ Male workers are likely to benefit more than their female counterparts in presence of bigger companies.

OLS - Some comments

- The household composition lead to asymmetries, with men paid 0.935 more when married or have children (0.576) while women experience a motherhood wage penalty of 0.26, which may be due to conflicts between family and job (Waldfogel, 1995)

- This means also a reallocation of time and role between husband and wife (Lundberg and Rose 2000);

- Health problems that reduce the working activity significantly and negatively affect the hourly wage, with a greater reduction for men (-0.653).

Using the Multinomial Logit (MNL), we We estimate the propensity to move to other regions, considering different thresholds of commuting time.

The dependent variable is built on 4 levels:

$$y = 0 \text{ if } region_{working} = region_{living}$$

$$y = 1 \text{ if } region_{working} \neq region_{living} \text{ and } commuting\_time < 30 \text{ minutes}$$

$$y = 2 \text{ if } region_{working} \neq region_{living} \text{ and } 30 < commuting\_time < 45$$

$$y = 3 \text{ if } region_{working} \neq region_{living} \text{ and } commuting\_time > 45 \text{ minutes}$$

The Econometric Strategy - 2

The probability of each alternative is defined as follows:

$$\Pr(Y = j) = \frac{exp(\alpha_{ij} + X_i\beta_j')}{(1 + \sum_{k=1, k \neq 0}^{y} exp(\alpha_{ij} + X_i\beta_j')} \text{ for } j \neq 0 \text{ and } j = 1, 2, 3 ;$$

$$\Pr(Y = 0) = \frac{1}{(1 + \sum_{k=1, k \neq 0}^{y} exp(\alpha_i j + X_i t \beta_j')}$$

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.

Multinomial Logit

	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
Age bands (Ref: 20-29)									
30 - 49	0.0302	0.0581	0.210***	0.0419	0.109	0.239**	0.0373	0.0449	0.215*
	(0.55)	(0.85)	(3.66)	(0.55)	(1.20)	(3.14)	(0.47)	(0.43)	(2.41)
50 - 59	0.0307	0.0275	0.249***	0.0474	0.0730	0.352***	0.0357	0.00668	0.0981
	(0.47)	(0.33)	(3.55)	(0.66)	(0.88)	(3.88)	(0.38)	(0.05)	(0.86)
Over 60	0.0373	-0.185	0.192	-0.00928	-0.119	0.309*	0.172	-0.349	-0.0413
	(0.43)	(-1.44)	(1.91)	(-0.08)	(-0.77)	(2.55)	(1.28)	(-1.39)	(-0.22)
child<15 years	-0.0585	-0.0820	0.0623	-0.0189	0.0768	0.216***	-0.103	-0.334**	-0.269**
	(-1.30)	(-1.36)	(1.30)	(-0.30)	(1.04)	(3.72)	(-1.57)	(-3.15)	(-3.07)
Couple	0.0793*	0.110*	0.216***	0.0431	0.0571	0.189***	0.111*	0.156*	0.198**
	(2.13)	(2.28)	(5.42)	(0.82)	(0.89)	(3.63)	(2.08)	(2.07)	(3.13)
Mortage/Homeownership	0.240***	0.505***	0.806***	0.286***	0.486***	0.824***	0.163*	0.502***	0.732***
	(4.92)	(7.74)	(15.00)	(4.25)	(5.81)	(11.91)	(2.29)	(4.79)	(8.57)
Address Stability (Ref. <24 months)									
2- 10 years	-0.0181	0.00805	-0.0504	0.0509	0.0734	-0.0164	-0.0983	-0.0924	-0.118
	(-0.36)	(0.13)	(-1.02)	(0.74)	(0.91)	(-0.26)	(-1.36)	(-0.97)	(-1.46)
>10 years	-0.0541	-0.241***	-0.315***	0.0514	-0.0160	-0.189**	-0.169*	-0.601***	-0.511***
	(-0.99)	(-3.39)	(-5.48)	(0.68)	(-0.18)	(-2.62)	(-2.12)	(-5.21)	(-5.33)
Part-time	-0.117*	-0.609***	-0.545***	-0.233*	-0.457**	-0.843***	-0.0818	-0.582***	-0.394***
	(-2.47)	(-7.84)	(-8.78)	(-2.12)	(-2.95)	(-6.06)	(-1.48)	(-6.35)	(-5.36)
Job type (Ref:low-skilled)									
Intermediate Occupation	0.0885	0.536***	0.855***	0.0999	0.465***	0.796***	0.0702	0.739***	0.932***
	(1.82)	(6.83)	(12.32)	(1.51)	(4.90)	(9.34)	(0.98)	(5.01)	(7.65)
Managerial Professions	0.214***	1.005***	1.405***	0.217***	0.935***	1.403***	0.211**	1.215***	1.417***
	(4.80)	(14.25)	(22.21)	(3.69)	(11.28)	(18.57)	(3.07)	(8.76)	(12.25)
Annual Dummies		Yes			Yes			Yes	
Regional Dummies		Yes			Yes			Yes	

Multinomial Logit

Table 4 - Generalized Multinomial Logit

	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
Lenght of employment (Ref: < 2 years)									
2 - 5 years	-0.117*	-0.273***	-0.247***	-0.0691	-0.268**	-0.312***	-0.166*	-0.268**	-0.118
	(-2.32)	(-4.24)	(-4.71)	(-0.98)	(-3.23)	(-4.68)	(-2.31)	(-2.61)	(-1.39)
5 - 10 years	-0.154**	-0.313***	-0.259***	-0.158*	-0.299***	-0.316***	-0.153*	-0.318***	-0.146
	(-3.02)	(-4.78)	(-4.86)	(-2.19)	(-3.58)	(-4.71)	(-2.11)	(-2.99)	(-1.65)
10 - 20 years	-0.153**	-0.330***	-0.410***	-0.0922	-0.362***	-0.474***	-0.232**	-0.258*	-0.298**
	(-2.86)	(-4.78)	(-7.15)	(-1.25)	(-4.13)	(-6.66)	(-2.96)	(-2.28)	(-3.04)
> 20 years	-0.140*	-0.446***	-0.325***	-0.0640	-0.619***	-0.492***	-0.288**	-0.109	-0.0227
	(-2.24)	(-5.38)	(-4.97)	(-0.78)	(-5.95)	(-6.23)	(-2.88)	(-0.79)	(-0.19)
Public firm	-0.310***	-0.253***	-0.413***	-0.348***	-0.231***	-0.355***	-0.256***	-0.243***	-0.405***
	(-8.02)	(-5.09)	(-10.15)	(-5.87)	(-3.40)	(-6.58)	(-4.98)	(-3.29)	(-6.42)
Female	-0.249***	-0.583***	-0.757***						
	(-6.64)	(-12.06)	(-19.20)						
Threshold Index (Ref: 90-110)									
<90	-0.160***	-0.344***	-0.434***	-0.217***	-0.312***	-0.458***	-0.0860	-0.386***	-0.384***
	(-3.76)	(-6.08)	(-9.14)	(-3.67)	(-4.28)	(-7.77)	(-1.40)	(-4.26)	(-4.78)
110-120	0.0479	0.135	0.252***	0.153	0.207	0.170	-0.0825	0.0445	0.421***
	(0.73)	(1.63)	(3.70)	(1.72)	(1.93)	(1.95)	(-0.84)	(0.33)	(3.84)
>119	0.0792	0.219***	0.505***	0.0683	0.227**	0.450***	0.0904	0.215*	0.617***
	(1.68)	(3.69)	(10.56)	(1.04)	(2.93)	(7.44)	(1.31)	(2.31)	(7.79)
Car_Motorbike	1.293***	2.288***	2.152***	1.197***	2.168***	2.034***	1.395***	2.458***	2.393***
	(18.38)	(15.11)	(17.40)	(12.30)	(11.95)	(14.22)	(13.62)	(8.87)	(9.43)
Public Transport	-0.0138	1.964***	2.976***	-0.154	1.693***	2.650***	0.109	2.304***	3.501***
	(-0.15)	(12.62)	(24.08)	(-1.15)	(8.96)	(18.42)	(0.82)	(8.21)	(13.90)
Constant	-3.133***	-5.572***	-6.333***	-3.131***	-5.693***	-6.499***	-3.401***	-6.158***	-7.036***
	(-23.58)	(-25.15)	(-32.33)	(-17.27)	(-20.40)	(-25.95)	(-17.37)	(-16.27)	(-20.46)
Pseudo R-squared	20.96%			19.27%			21.68%		
N	76899			36141			40758		

Multinomial Logit - Some comments

▶ The willingness to move to other regions change according to distance and gender.
  All coefficients for women are not significant at any level. Male workers are increasing in the probability to travel for more than 45 minutes as long as the age increases but only until 60 y.o.;

▶ Being married or living as a couple positively affect the probability of working in other regions (even commuting more than 45 minutes, for which the variable is significant at 5%);

▶ Children affects gender differently. Women are less likely to commute more than 30 minutes in presence of children with age less than 15 y.o. (-0.334 and -0.269 respectively for the case of commuting time of 30-45 minutes and more than 45 minutes);

▶ Why? Women may need more flexibility in order to solve conflicts between the family and the job.

Multinomial Logit - Some comments

- Managers 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).
  Also in this case, sex differences are significant and interesting.

- If we consider the type of job as related to the level of education, then more educated workers are more likely to commute (Cassel et al., 2013). Hence, there are heterogeneity in women's behaviors.

Multinomial Logit - Some comments

▶ Homeownership and mortgages are consistent with the theory. Workers are more likely to commute because of the high costs of changing location or re-negotiating the mortgage;

▶ This may not be the case of the long run when, according to the theory, these costs may be relaxed;

▶ 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.

▶ Indeed, 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).

Multinomial Logit - Some comments

- 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;

- Hence, not clear what comes first? Job or Housing. Open question.

- Workers of public firms/administrations are less likely to commute confirming previous findings:

- Part-time jobs are less likely to be found in other job-markets because of the higher disutility of commuting.

What about earnings?

- ▶ Both male and female increase their probability to do longer commuting in presence of greater monetary incentives;

- ▶ For the "*wratio*" lower than 0.90, both genders are significantly less likely to commute;

- ▶ The greater significance of the threshold indexes for the case distances $> 45 mins$ 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.

Marginal effect

Table 6 - Margins for Multinomial Logit

Threshold Index (Ref: 90-110)	Overall			Male			Female		
	Out <30	*Out 30-45*	*Out > 45*	*Out <30*	*Out 30-45*	*Out >45*	*Out <30*	*Out 30-45*	*Out > 45*
<90	-0.005**	-0.007***	-0.015***	-0.008**	-0.007***	-0.022***	-0.022	-0.006***	-0.008**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
110-120	-0.001**	0.003	0.011***	0.007	0.007	0.008	-0.004	-0.000	0.013***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.006)	(0.004)	(0.003)	(0.004)
>119	-0.000***	0.004*	0.024***	-0.000	0.005*	0.029***	0.002	0.002	0.020***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)

Robustness check - 1

- 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 firstly a new OLS (not reported here) for the prediction of the expected wage in the region of residence and then the Multinomial Logit model;

Multinomial Logit - Without London

<div align="center">

Table 5 - MLN Without London

</div>

	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*
Age bands (Ref: 20-29)									
30 - 49	0.0694	0.0936	0.266***	0.193*	0.227	0.325**	-0.0274	-0.0326	0.219
	(1.07)	(1.03)	(3.36)	(2.09)	(1.86)	(3.23)	(-0.30)	(-0.24)	(1.68)
50 - 59	0.0731	0.0693	0.390***	0.218*	0.253	0.488***	-0.0492	-0.193	0.256
	(0.96)	(0.63)	(4.12)	(2.04)	(1.76)	(4.12)	(-0.45)	(-1.10)	(1.58)
Over 60	0.111	-0.119	0.230	0.206	-0.0120	0.302	0.0948	-0.352	0.188
	(1.10)	(-0.71)	(1.63)	(1.52)	(-0.06)	(1.83)	(0.60)	(-1.04)	(0.65)
child<15 years	-0.115*	0.0344	0.0103	-0.0523	0.181*	0.146	-0.184*	-0.243	-0.375**
	(-2.17)	(0.47)	(0.16)	(-0.72)	(2.02)	(1.93)	(-2.33)	(-1.82)	(-2.86)
Couple	0.0951*	0.162*	0.0904	0.0140	0.160	0.0829	0.166**	0.120	0.0317
	(2.17)	(2.56)	(1.67)	(0.23)	(1.92)	(1.21)	(2.61)	(1.20)	(0.35)
Mortage/Homeownership	0.299***	0.471***	0.553***	0.381***	0.453***	0.628***	0.175*	0.488**	0.375**
	(4.86)	(4.98)	(6.85)	(4.47)	(3.81)	(6.24)	(1.97)	(3.10)	(2.76)
Address Stability (Ref. <24 months)									
2- 10 years	-0.0536	0.0771	0.0173	0.0309	0.106	0.0377	-0.149	0.0371	-0.0370
	(-0.90)	(0.93)	(0.25)	(0.38)	(1.00)	(0.45)	(-1.75)	(0.28)	(-0.31)
>10 years	-0.0960	-0.221*	-0.255**	0.0242	-0.0695	-0.158	-0.225*	-0.480**	-0.465**
	(-1.48)	(-2.33)	(-3.21)	(0.27)	(-0.58)	(-1.64)	(-2.39)	(-3.05)	(-3.25)
Part-time	-0.170**	-0.707***	-0.820***	-0.248	-0.366	-1.206***	-0.142*	-0.726***	-0.593***
	(-3.02)	(-6.82)	(-8.30)	(-1.88)	(-1.87)	(-5.18)	(-2.19)	(-5.89)	(-5.20)
Job type (Ref:low-skilled)									
Intermediate Occupation	0.0917	0.528***	0.970***	0.0950	0.461***	0.907***	0.0938	0.771***	1.244***
	(1.65)	(5.39)	(9.29)	(1.26)	(3.96)	(7.67)	(1.12)	(3.97)	(5.34)
Managerial Professions	0.206***	1.058***	1.925***	0.210**	0.984***	1.783***	0.206*	1.289***	2.384***
	(3.99)	(12.08)	(20.52)	(3.13)	(9.74)	(17.09)	(2.54)	(7.02)	(10.87)
Annual Dummies		Yes			Yes			Yes	
Regional Dummies		Yes			Yes			Yes	

Multinomial Logit - Without London

Table 5 - MLN Without London

	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
Lenght of employment (Ref: < 2 years)									
2 - 5 years	-0.113	-0.254**	-0.338***	-0.0199	-0.235*	-0.362***	-0.217*	-0.269*	-0.274*
	(-1.90)	(-3.05)	(-4.86)	(-0.24)	(-2.22)	(-4.27)	(-2.53)	(-1.98)	(-2.25)
5 - 10 years	-0.176**	-0.355***	-0.502***	-0.129	-0.284**	-0.522***	-0.227**	-0.445**	-0.444***
	(-2.94)	(-4.26)	(-7.12)	(-1.53)	(-2.74)	(-6.14)	(-2.64)	(-3.15)	(-3.51)
10 - 20 years	-0.157*	-0.471***	-0.711***	-0.0928	-0.501***	-0.732***	-0.240**	-0.366*	-0.670***
	(-2.54)	(-5.34)	(-9.35)	(-1.08)	(-4.52)	(-8.06)	(-2.63)	(-2.48)	(-4.78)
> 20 years	-0.177*	-0.616***	-0.858***	-0.101	-0.753***	-0.923***	-0.304**	-0.277	-0.740***
	(-2.45)	(-5.81)	(-9.49)	(-1.07)	(-5.75)	(-8.78)	(-2.63)	(-1.53)	(-4.16)
Public firm	-0.343***	-0.234***	-0.375***	-0.498***	-0.258**	-0.441***	-0.204***	-0.202*	-0.251**
	(-7.47)	(-3.64)	(-6.74)	(-6.85)	(-2.94)	(-6.04)	(-3.35)	(-2.08)	(-2.80)
Female	-0.237***	-0.605***	-0.853***						
	(-5.37)	(-9.51)	(-15.43)						
Threshold Index (Ref: 90-110)									
<90	-0.177***	-0.408***	-0.391***	-0.248***	-0.426***	-0.451***	-0.0862	-0.377**	-0.252*
	(-3.61)	(-5.62)	(-5.96)	(-3.66)	(-4.71)	(-5.73)	(-1.20)	(-3.10)	(-2.11)
110-120	-0.00880	0.0335	0.205*	0.0730	-0.0386	0.137	-0.117	0.155	0.377*
	(-0.12)	(0.32)	(2.23)	(0.72)	(-0.28)	(1.20)	(-1.04)	(0.95)	(2.38)
>119	0.0584	0.199**	0.597***	0.0507	0.179	0.547***	0.0707	0.255*	0.717***
	(1.07)	(2.69)	(9.32)	(0.68)	(1.91)	(7.09)	(0.88)	(2.08)	(6.14)
Car_Motorbike	1.355***	2.464***	1.525***	1.341***	2.403***	1.324***	1.361***	2.496***	2.135***
	(14.54)	(9.44)	(9.52)	(9.94)	(7.51)	(7.58)	(10.51)	(5.52)	(5.17)
Public Transport	-0.128	1.579***	2.257***	-0.252	1.456***	1.944***	-0.0348	1.693***	3.071***
	(-0.84)	(5.38)	(13.25)	(-1.04)	(3.93)	(10.15)	(-0.17)	(3.45)	(7.29)
Constant	-3.180***	-5.786***	-5.739***	-3.353***	-6.003***	-5.868***	-3.270***	-6.247***	-6.985***
	(-20.49)	(-17.97)	(-23.78)	(-15.47)	(-14.94)	(-20.14)	(-14.56)	(-11.33)	(-13.39)
Pseudo R-squared		12.34%			11.09%			12.21%	
N		67528			31194			36334	

Marginal effect - Without London

Table 7 - Margins No London

Threshold Index (Ref: 90-110)	Overall			Male			Female		
	Out <30	Out 30-45	Out > 45	Out <30	Out 30-45	Out > 45	Out<30	Out 30-45	Out> 45
<90	-0.005**	-0.007***	-0.008***	-0.009***	-0.009***	-0.014***	-0.022	-0.004***	-0.003*
	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)
110-120	-0.001	0.000	0.006**	0.007	-0.002	0.006	-0.004	0.002	0.006**
	(0.003)	(0.002)	(0.003)	(0.005)	(0.004)	(0.005)	(0.004)	(0.002)	(0.003)
>119	-0.001	0.003**	0.019***	-0.000	0.004	0.026***	0.001	0.003*	0.013***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)

Robustness check - 1

- 20% greater wage increases the probability to commute by 0.03% for the case of 30-45 minutes and by 1.9% for distances longer than 45 minutes. However, this result is mainly driven by the gender differences, which are greater than before;

- Male workers increase their probability to move to other regions and territorial agglomerations commuting more than 45 minutes by 2.6% (while it was 2.9% in the previous case) while women only by 1.3%, that is 0.7% less than the marginal effect considering the full sample;

- Excluding the region of Greater London from the sample leads to a raise from 0.9% to 1.3% in the gender gap in the probability of commuting more than 45 minutes.

- Intuition: female workers working in London are more willing to commute than their national counterpart.

Robustness check - 2

As further control we test the "HRH" (Household Responsibility Hypothesis).

▶ This is done considering heterogeneity in the household composition in terms of wealth, that is whether couples with a relatively higher wage are more willing to commute longer ;

▶ In this way we also take into account the direct effect of the monetary incentive once the control for the gross (weekly) wage is provided.

▶ The econometric strategy is based on the introduction of a new variable *wageband*, which assumes values equal to 0 for weekly wages < 200 ; 1 for 200-500 ; 2 for 500-1000 ;

▶ The interaction term couple*wageband is used to consider the joint effect of being a couple and gross weekly earnings.

Multinomial Logit - Additional controls

Table 8 - Generalized Multinomial Logit with interactions

	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
child<15 years	-0.0532	-0.0884	0.0472	-0.0254	0.0520	0.184**	-0.0925	-0.303**	-0.261**
	(-1.18)	(-1.46)	(0.98)	(-0.40)	(0.70)	(3.15)	(-1.40)	(-2.85)	(-2.96)
Female	-0.212***	-0.487***	-0.633***						
	(-5.46)	(-9.70)	(-15.42)						
Couple	0.0889	0.416**	0.817***	-0.130	0.194	0.487***	0.442	0.915**	1.587***
	(0.55)	(2.66)	(6.80)	(-0.70)	(1.05)	(3.51)	(1.25)	(3.05)	(6.57)
Couple*wageband									
couple*ww<200	0.0150	-0.0553	-1.040***	0.321	0.553	-0.825*	-0.333	-0.722	-1.714***
	(0.08)	(-0.21)	(-4.73)	(1.07)	(1.28)	(-2.22)	(-0.90)	(-1.82)	(-5.24)
couple*ww200-500	-0.00414	-0.485**	-0.761***	0.164	-0.446*	-0.467**	-0.286	-0.795*	-1.497***
	(-0.02)	(-2.83)	(-5.65)	(0.83)	(-2.14)	(-2.86)	(-0.79)	(-2.50)	(-5.83)
couple*ww500-1000	-0.0338	-0.253	-0.621***	0.175	-0.0172	-0.327*	-0.436	-0.801*	-1.441***
	(-0.20)	(-1.50)	(-4.78)	(0.88)	(-0.08)	(-2.16)	(-1.18)	(-2.52)	(-5.59)
couple*ww>1000				omitted for collinearity					
wageband(Ref. Grsswk<200)									
ww200-500	0.214*	0.671***	0.486**	0.210	0.701	0.0980	0.219	0.516*	0.546**
	(2.09)	(3.34)	(3.10)	(0.94)	(1.91)	(0.35)	(1.81)	(2.09)	(2.79)
ww500-1000	0.409***	0.944***	0.991***	0.418	0.812*	0.696*	0.397**	0.981***	0.861***
	(3.47)	(4.46)	(6.01)	(1.80)	(2.16)	(2.45)	(2.59)	(3.61)	(3.96)
ww>1000	0.279	0.839**	0.597**	0.499	0.890*	0.540	-0.248	0.560	-0.0839
	(1.52)	(3.27)	(2.97)	(1.75)	(2.15)	(1.72)	(-0.77)	(1.49)	(-0.28)
Threshold Index (Ref: 90-110)									
<90	-0.108*	-0.202***	-0.227***	-0.156**	-0.183*	-0.234***	-0.0411	-0.225*	-0.236***
	(-2.42)	(-3.39)	(-4.53)	(-2.51)	(-2.38)	(-3.75)	(-0.64)	(-2.35)	(-2.80)
110-120	0.0310	0.0873	0.188**	0.138	0.170	0.110	-0.0995	-0.0202	0.368***
	(0.47)	(1.04)	(2.74)	(1.55)	(1.57)	(1.25)	(-1.01)	(-0.15)	(3.34)
>119	0.0504	0.0971	0.355***	0.0369	0.125	0.312***	0.0854	0.0537	0.492***
	(1.00)	(1.50)	(6.77)	(0.52)	(1.47)	(4.64)	(1.18)	(0.53)	(5.73)
Annual Dummies	Yes			Yes			Yes		
Regional Workplace Dummies	Yes			Yes			Yes		
Other controls	Yes			Yes			Yes		
Pseudo R-squared	21.24%			19.48%			21.83%		
N	76,899			36,141			40,758		

Marginal effect - Additional controls

Table 9 - Margins for Multinomial Logit with interactions

Threshold Index (Ref: 90-110)	Overall			Male			Female		
	Out <30	Out 30-45	Out >45	Out <30	Out 30-45	Out > 45	Out <30	Out 30-45	Out >45
<90	-0.004*	-0.004**	-0.008***	-0.006**	-0.004	-0.011***	-0.001	-0.004**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
110-120	0.001	0.001	0.008**	0.007	0.005	0.004	-0.005	-0.002	0.012***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.004)	(0.003)	(0.004)
>119	0.001	0.001	0.016***	-0.000	0.002	0.019***	0.002	-0.001	0.015***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)

▶ The direct effect of being in a couple for commuting > 45 mins is positive.
However, 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 < 200 and this happens for both men and women;

▶ For weekly wage 500-1000 , the variable is significant at 1% and 5% only for women.
Combining the effect of couple and the interaction term, lead women to have slightly positive effects on the probability of moving out of regions;

▶ Female workers are less likely to move out of the regions, regardless the distance and also support for the childcare responsibility asymmetrically allocated to women.
Men experience an increase in the probability for distances greater than 45 minutes;

Robustness check - 2

- The weekly earnings partially offset the direct effect of the threshold index; Women are more willing than men to commute more than 30 minutes for intermediate hourly monetary incentives (10-20%). The variable is not significant for men;

- The gender gap decreases to 0.4% for monetary incentives greater than 20% in presence of 45 minutes of travel time. In particular, the marginal effect w.r.t. the threshold index of reference is 1.9% for men and 1.5% for women;

- In the original model, the marginal effect only 2.9% and 2% respectively, with a gender gap equal to 0.9%.

Conclusions

- 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 "HRH" (Household Responsibility Hypothesis) is confirmed with women less wiling than male to commute for longer:

- Earnings in absolute and relative values play an important role in explaining the commuting behaviour among territorial ares;

- People working in London have a greater propensity to commute and also to be attracted by greater monetary incentives:

- The index created in order to take into account how much predicted earnings diverge from the current seems to work well.

Thanks for the attention!

Any suggestion is welcome!