DOCUMENT DE TREBALL

XREAP2014-05

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XARXA DE REFERÈNCIA EN ECONOMIA APLICADA

JOB ACCESSIBILITY, EMPLOYMENT AND JOB-EDUCATION MISMATCH IN THE METROPOLITAN AREA OF BARCELONA

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Abstract:
This paper analyses the effect of job accessibility by public and private transport on labour market outcomes in the metropolitan area of Barcelona. Beyond employment, we consider the effect of job accessibility on job-education mismatch, which represents a relevant aspect of job quality. We adopt a recursive system of equations that models car availability, employment and mismatch. Public transport accessibility appears as an exogenous variable in the three equations. Even though it may reflect endogenous residential sorting, falsification proofs suggest that the estimated effect of public transport accessibility is not entirely driven by the endogenous nature of residential decisions.
Keywords: employment, job-education mismatch, job accessibility, public transport, Barcelona
JEL Classifications: J61, J21, O18, P25, R41

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Acknowledgements: the Authors would like to thank Enrique López-Bazo and Raul Ramos for their valuable comments and suggestions. Thanks are also due to Joachim Möller and all the participants at the 2014 IAB/RCEA/ZEW Workshop on "The Spatial Dimensions of the Labour Market: the Relocation of Jobs". Anna Matas and Josep Lluís Raymond gratefully acknowledge the financial support from the MEC grant ECO2010-20718 "Infraestructuras y capital humano como factores de crecimiento".

1) Introduction

In this paper we analyse the relevance of job accessibility in labour market outcomes in the metropolitan area of Barcelona, placing special emphasis on the role played in job accessibility by public transport facilities. The general framework of our analysis is grounded on the Spatial Mismatch Hypothesis, which claims that living in segregated areas that are poorly connected to employment centres has a negative effect on labour market outcomes, especially among ethnic minorities and disadvantaged workers. In the context of employment decentralisation in metropolitan areas in the US, Kain (1968) showed that disconnection between residential and job location negatively affected employment among African Americans, who tend to be concentrated in the inner city. After this seminal work, several empirical studies have confirmed that insufficient job accessibility has a negative effect on labour market outcomes in decentralized cities and accounts for a substantial part of the labour market penalization experienced by the most vulnerable workers (for a review, see Ihlanfeldt & Sjoquist, 1998, Ihlanfeldt, 2006 and Zenou, 2008). While the initial focus of the spatial mismatch hypothesis was on ethnic minorities living in metropolitan areas in the US, more recent papers have emphasized that the physical disconnection between residential and job locations might affect a wider range of the population. In particular, an increasing number of empirical studies support the negative effect of job accessibility on labour market outcomes for European cities[1] that have experienced a decentralisation process (see Patacchini and Zenou, 2005 for England; Åslund et al. 2010 and Norman et al. 2012 for Swedish cities; Matas et al. 2010 for two Spanish cities and Korsu & Wenglenski, 2010 for Paris-Île-de France).

Gobillon, Selod & Zenou (2007) reviewed the mechanisms underlying the spatial mismatch hypothesis that have been proposed by theoretical models. The main theoretical explanation for the poorer labour market performance of spatially mismatched workers is that the lack of job

[1] Nonetheless, results for European cities are less conclusive than for America. For instance, Gobillon & Selod (2008) reported only slight evidence of a negative effect of job accessibility on the probability of finding a job in Paris. Moreover, Dujardin et al. (2008) found that distance to jobs is not significant in explaining employment probability in the area of Brussels.

accessibility reduces the efficiency of job search[2]. This theoretical prediction is based on two main arguments. On the one hand, information flows regarding job opportunities are subject to a distance decay effect. On the other hand, workers may incur in higher search costs (time and monetary costs), leading to a spatially restricted job search that tends to be limited to the area surrounding their neighbourhood of residence. Moreover, physical distance from jobs could also hamper job searches by negatively affecting local social interactions, as recently suggested by Zenou (2013). The idea is that since all workers residing in a spatially disconnected neighbourhood are affected by the detrimental effect of distance, the average unemployment rate tends to be higher and it is consequently more difficult to obtain information on job opportunities from social networks (which are likely to operate on the local level). Therefore, spatially mismatched workers are denied access to good network connections that are likely to foster employment and job quality.

To summarise, under the spatial mismatch hypothesis, unemployed workers that live far from employment centres are less likely to find a job. Moreover, distance from jobs might induce some workers to accept low quality jobs that are closer to their residence. However, distance *per se* should not be the main factor explaining the labour outcome gaps of spatially disconnected workers in terms of both employment and job quality, since what really matters is job connectivity and the resulting commuting costs. It is clear that commuting costs (both in terms of time and money) depend on the modes of transport available. In a context of decentralised employment and residences, private transport has become even more advantageous than public transport regarding flexibility and time costs. For those living far from job centres, cars are quicker and are often the only alternative for connecting places of residence and job opportunities. Therefore, since workers who are limited to using public transport to commute will usually face higher time costs to reach the same job opportunities as car users, alternative modes of transport must be taken into account when explaining spatial differences in labour market outcomes (see Gautier & Zenou, 2010 for more

[2] A second relevant mechanism is that workers may refuse a job that requires commuting costs that are too high in relation to the wage offered. This mechanism would apply only to the most disadvantaged groups and, since in this paper we consider the whole population of workers (taking into account gender differences), we retain the job search explanation to build up the theoretical justification for this current study.

detailed theoretical arguments). Indeed, several papers confirm that access to car ownership significantly offsets the adverse effects of disconnection (Shen, 1998, Raphael and Rice, 2002, Ong & Miller, 2005, Patacchini & Zenou, 2005 and Korsu & Wenglenski, 2010). There is also empirical evidence that increased accessibility to public transport has a positive impact on labour market outcomes (Sanchez, 1999, Kabawata, 2003, Holzer et al. 2003, Matas et al. 2010 and Korsu & Wenglenski, 2010).

Based on this general framework, our research focuses on the impact of job accessibility on the employment and job quality of individuals residing in the metropolitan area of Barcelona. This metropolitan area is particularly relevant for our analysis, since it has experienced significant decentralization of employment and places of residence in recent decades. More specifically, we extend on the previous study by Matas et al. (2010) by considering not only the effect of job accessibility on the likelihood of being employed, but also its potential impact on an extremely relevant aspect of job quality, namely how matched an individual's completed education is to his/her attained occupation (i.e. job-education mismatch). The extensive literature on job-education mismatch (see Leuven & Oosterbeek 2011) especially highlights that having a job below the attained qualification level (i.e., being overeducated, which is a specific aspect of vertical job-education mismatch) represents a situation of underemployment and generates a waste of human capital. Indeed, overeducation is associated with lower productivity, lower remuneration (in relation to equally-educated but well-matched workers), an increased risk of quitting jobs and job dissatisfaction.

The above-mentioned spatial mismatch hypothesis suggests that the lack of connections to job opportunities is likely to be detrimental for employment and for job quality. Therefore, based on this empirical prediction, we argue that job-education mismatch, especially in the form of overeducation, might be (among other things) the result of spatially constrained job searches. Therefore, in addition to unemployment, the incidence of overeducation should be higher among spatially constrained workers. In other words, increased job accessibility should reduce the risk of

being overeducated in urban labour markets. Since the seminal study by Büchel & van Ham (2003), a growing number of papers have been concerned with the role played by spatial flexibility in explaining employment probabilities and the propensity to become overeducated, which represents a specific case of having a low quality job (see Hensen, 2009 for the Netherlands, Jauhiainen, 2011 for Finland, Huber, 2012 for several EU countries, Iammarino & Martinelli, 2012, Devillanova, 2013 and Croce & Ghignoni, 2013 for Italy, and Ramos & Sanromà, 2013 for Spain). The general lesson that can be derived from these papers[3] is that fostering spatial flexibility (especially in terms of commuting or private transport accessibility to the workplace) is beneficial for employment and, in general, reduces the probability of suffering some kind of job-education mismatch. However, to the best of our knowledge, none of the existing papers have explicitly examined the role played by job accessibility by public transport in explaining the risk of overeducation. Indeed, we consider improved accessibility to private transport (i.e. car availability) to of course be relevant, but it also generates additional congestion and pollution costs. Therefore, with our paper we try to fill this significant gap in the literature relating spatial flexibility and job quality, by providing evidence regarding the importance of public transport connectivity to employment centres in reducing job-education mismatch in an urban labour market.

More specifically, the main contribution to the literature made by this paper consists of analysing the effect on job accessibility of public transport connections to employment centres not only in terms of the chances of finding employment, but also of the incidence and the extent of job-education mismatch (in the form of overeducation). In doing so, on the one hand, we explicitly recognize the relevance of private transport accessibility and, on the other, we enable public transport accessibility to affect car ownership at the family level. More specifically, our econometric strategy relies on a recursive system of equations with correlated errors that explains the number of cars per adults in the household, the likelihood of being employed and job-education

[3] Note that the results reported by Devillanova (2013) suggest that while short-distance commuting has a beneficial effect on reducing the probability of being overeducated, internal migration seems to increase job-education mismatch when migration decisions are taken as endogenous, which appears to be somewhat at odds with the predictions of the Spatial Mismatch Hypothesis.

mismatch. Moreover, we allow car availability to appear endogenously in the employment and mismatch equations, whereby the measure of public transport accessibility appears as an exogenous variable in the mismatch and employment equations, as well as in the one that explains car availability (following Matas et al., 2009). We thus account for the fact that private and public transport represent substitutive forms of commuting from the place of residence to the workplace (which might affect employment and job quality) and that disposing of better public transport connections might modify the propensity to have more cars in the household (keeping other factors constant). All the estimations are carried out separately for males and females, in order to highlight gender differences in terms of the effect of public and private transport accessibility on employment and mismatch. An additional contribution of this paper is that we focus our analysis on a specific urban area, which would implicitly limit the importance of unobserved territorial heterogeneity, while other existing studies on the issue of overeducation usually draw on data at the national/country level (and rely on the use of control or territorial fixed effects to control for local labour market effects).

It should be noted from the outset that public transport accessibility to reach the workplace is considered to be an exogenous variable in our empirical analysis. However, since this variable is intrinsically based on place of residence, it might be argued that the estimated effect of public transport accessibility on the three outcomes that we analyse throughout the paper could be biased by the presence of endogenous residential sorting (i.e. individuals who tend to perform better in the labour market because of unobservable favourable traits might be more likely to reside in neighbourhoods that are better covered by the public transport network). We recognize that residential sorting represents a relevant issue for our analysis (as suggested by Dujardin et al., 2009 and by Åslund et al., 2010, among others) but, unfortunately, we cannot directly deal with this issue because we do not possess exogenous predictors of place of residence. However, as in previous literature, we present two falsification proofs that seek to verify whether restricting the sample to individuals for whom place of residence can be reasonably assumed to be less affected by

endogeneity provide similar results or not. The results of these robustness checks suggest that endogenous residential sorting is not the main driver of the overall results presented in what follows. The rest of the paper is organized as follows: in the next section we describe the data used in the empirical analysis and in section 3 we introduce the econometric strategy. Section 4 presents the results and some robustness checks (subsection 4.1) and finally section 5 concludes.

2) Data and Descriptive Statistics

This study draws on data from the 2001 Spanish Micro-census, which covers 5% of the Population Census. The main advantages of this dataset are its large sample size and the level of spatial disaggregation of the information, which enables the definition of territorial variables using very small spatial units (census tract level). Therefore, the 2001 Micro-census is the only source of information[4] that can be used to locate jobs on a municipal level and, hence, construct a precise measure of job accessibility. The database also provides information on several individual characteristics (among others: age, gender, nationality, marital status, level of education, field of tertiary education, labour market status and occupation) and on a large number of household characteristics (household composition, number of children, number of working adults, number of cars, availability of second residence, housing tenure and housing size). Since our aim is to analyse the impact of job accessibility on labour market outcomes, we selected individuals aged between 16 and 64 who are not receiving education, are not permanently retired and are not disabled. We also excluded individuals who are either self-employed or employers, because of the intrinsic difficulties to define job-education mismatch for these groups of workers, as well as individuals whose occupation has fewer than 20 observations (as required to construct job-education mismatch, see

[4] Note that even if the 2001 database is somewhat dated, it is the latest (census population) database that enables obtaining a precise and reliable estimate of the spatial location of jobs. The novel data from the new Spanish Microcensus of 2011 does not represent a valid alternative to identify the number of jobs at the municipality level, since census-tract identifiers are not provided.

below). Finally, we also excluded the small number of individuals living in households where there are multiple families, since the number of cars is defined at the household level while the number of adults (and family composition in general) is defined at the family level. We ended up with a sample comprising 93,038 observations belonging to the Barcelona's metropolitan area (44,077 males and 48,961 females).

In 2001, this metropolitan area measured 3,263 square km and had 4.4 million inhabitants distributed among 164 municipalities, which implies an average density of 1,380 inhabitants per km^2. The central city, with a relatively small area of around 100 km^2, concentrates somewhat more than one third of the whole population, with a population density of 15,150 inhabitants per km^2. Job density shows substantial differences between municipalities, with an average of 476 jobs per km^2 in the metropolitan area and 7,828 in the city of Barcelona. In recent decades, a process of employment and residential decentralization has taken place, due to which the central city has lost both population and jobs in comparison with the metropolitan area as a whole. It is interesting to note that the process of population suburbanisation has been lower for high income people, whereas employment decentralisation has been lower for jobs filled by the population with post-compulsory education levels.

As previously commented, the labour market outcomes that we analyse in this paper are employment and job-education mismatch, where the latter is considered to be a meaningful measure of job quality (among the employed subsample). There are several alternative ways of defining job-education mismatch (i.e. whether the individual is more/less qualified than what is actually required for his/her job) and the discussion about which method is better than the others is still open (see Hartog, 2000, McGuinnes, 2006, Verhaest & Omey 2006, 2010 and Leuven & Oosterbeek 2011 for more details). Usually, as is the case with the present study, the ultimate choice mostly depends on data availability. Since the Census database does not contain any direct information about qualification requirements in the workplace, we define job-education mismatch using the Method of Realized Matches, which relies on the difference between individual's years of schooling and

average schooling in the corresponding occupation (two-digit national classification). Therefore, an individual is considered to be under/overeducated if he/she has less/more schooling than the average for his/her occupation, minus/plus one standard deviation point.

The main variables of interest to this study are those related with (potential) accessibility from the neighbourhood of residence to the workplace, which may influence individual performance in the labour market in terms of employment and job quality. In order to measure disconnection between jobs and places of residence, we distinguish between private and public transport accessibility to job opportunities. With respect to accessibility by private transport, we selected the number of cars per adult in the household. Matas et al. (2010) suggest that the relevant variable to approximate distance to jobs is not commuting time with private transport, but rather car availability in the household[5]. Regarding public transport, the measure of job accessibility that we used in this paper is the employment potential for each zone of residence[6]. Following Rogers (1997), a measure of market potential should take into account the spatial distribution of jobs and the distance or cost to reach them. The employment potential fulfils both requirements. According to the literature, the most suitable variable for capturing employment potential should be the number of vacancies but, unfortunately, we do not have information on job vacancies. Therefore, the total number of jobs located in each zone has been taken as a proxy for vacancies. The implicit assumption is that zones with a higher number of jobs will also generate a higher number of vacancies (Rogers, 1997). More specifically, job accessibility by public transport has been defined as:

$$pta_k = \sum_j \frac{empl_j}{t_{kj}}$$

[5] Note that we do not explicitly consider which member of the household actually uses the car(s), since this would introduce further complications to the empirical analysis. However, under the assumption that each member of the household has the same probability of using the car(s), taking the number of cars per adults represents a parsimonious way of approximating potential car availability in the family.

[6] As suggested by Bunel & Tovar (2013), the use of alternative measures of job accessibility might lead to different results. Therefore, we checked for the sensitivity of our results obtained under different definitions of job accessibility by public transport. Firstly, in order to take into account how there are a limited number of job opportunities available in the area, we computed an alternative index that uses occupied jobs and active workers. Secondly, we tested an exponential decay function by weighting public transport time by parameters ranging between 0.5 and 2. In all cases the results appeared fairly robust with respect to the original ones. Therefore, we retained the results obtained using the simplest non-weighted measure of employment.

where $empl_j$ is the number of jobs located in zone j, t_{kj} is the travel time on public transport between k and j, k is the individual's zone of residence and j is the destination zone. Therefore, job accessibility for an individual resident in zone k depends on the sum of employment opportunities in each destination zone j, inversely weighted public transport travel time between k and j. Regarding residential areas, transport zones represent the geographic unit of analysis. These are a subdivision of municipalities used to calculate travel time matrices. Destination zones are defined at the municipal level, as this is the smallest spatial unit for which the number of jobs is available. However, in order to improve the accuracy of the accessibility measure within the city of Barcelona, jobs are calculated at the district level. The index is computed using job locations from the 2001 Population Census. Commuting times are based on real network data and are obtained from the official travel time matrices. For intrazonal trips, a commuting time was assigned according to the implicit radius corresponding to the surface of each municipality or district. Overall, this variable provides a measure of the extent to which the lack of public transport can diminish potential job opportunities.

Across the metropolitan area of Barcelona, the index ranges from 10 for the zone with the lowest accessibility to 61,427 for the zone with the highest, with an average of 32,087[7]. The spatial distribution of public transport job accessibility is depicted in Figure 1, which shows that job opportunities can be more easily reached by public transport in the Capital City, along the coast to the south of Barcelona and in the west of its metropolitan area.

[FIGURE 1 ABOUT HERE]

Since public and private transport are clearly alternative ways of reaching job opportunities, we expect families residing in areas served by better public transport infrastructure to be, on average, less dependent on private transport. To get a first impression of this relationship, Figure 2 shows a scatter plot of the (census tract average) number of cars per adults with respect to job accessibility

[7] Note that the measure of public transport accessibility has been divided by 10,000 for the purpose of descriptive statistics and the subsequent econometric analysis.

on public transport, which highlights a negative and significant relationship between these two variables.

[FIGURE 2 ABOUT HERE]

The same relationship can be also appreciated in Table 1, which indicates that the higher the quintile of job accessibility, the lower the proportion of families with more than one car per adult (and the higher incidence of having no car in the household). Moreover, the same table reports, separately for males and females, row differentials in unconditional employment probabilities by public and private transport accessibility respectively. In general, the share of employed individuals is significantly higher in the male subsample, since a significant proportion of women declare that they do housework (30% versus 0.62% among males), while the incidence of unemployment is similar for both genders. The increase in car availability improves the chances of being employed for both genders, although the employment differential between males and females appears to be the same for those who have at least one car per adult in the household. On the contrary, the statistical association between public transport accessibility and employment is less clear for females and even appears to be negative for males. In addition, both forms of job accessibility seem to be negatively associated with job quality (defined in terms of job-education mismatch), since the extent of job-education mismatch (i.e. the difference between years of schooling and the corresponding average for the occupation), as well as the proportion of individuals who are classified as overeducated[8] (i.e. mismatch greater that the standard deviation of schooling within each occupation), increase with job accessibility using public and private transport.

[TABLE 1 ABOUT HERE]

Nevertheless, the bivariate relationship between private and public transport accessibility to the workplace, employment and job-education mismatch that we observed in the raw data is likely to be confounded by other individual and family/household characteristics that co-vary with these

[8] The incidence of overeducation that we obtain from our sample (about 16% and similar for males and females) is somewhat lower than what was reported in other studies of the Spanish economy (see Ramos & Sanromà, 2013 for a review), probably because our data refers to the metropolitan area of Barcelona where the demand for high-skilled work is substantially higher than in other parts of the Spanish territory.

variables. Educational attainments represent the clearest example: in fact, more educated individuals might reside in neighbourhoods endowed with a better public transport network and, in principle, they are more prone to being able to afford the expense of buying a (more) car(s), but at the same time they face a higher risk of being overeducated. Also the bivariate relationship between public transport accessibility and car availability might be affected by confounding factors such as family structure, family wealth and neighbourhood effects. Therefore, in what follows we present the empirical strategy that we adopted to rule out the effect of covariates from the (complex) relationship between job accessibility by public and private transport, and obtaining a *ceteris paribus* effect of our variables of interest in a multivariate framework.

The explanatory variables have been selected according to standard literature related to each of the three endogenous variables that we want to explain (i.e. car ownership, employment and job-education mismatch) and are listed (together with basic descriptive statistics by gender) in Table 1A in the Appendix. As individual characteristics we considered age, educational attainment, field of study, country of birth, marital status and potential work experience (measured as age minus years of schooling[9] minus six). Regarding household composition, we use the number of adults (aged 20 or more), the number of children of different ages and the percentage of working adults. A shortcoming of the census data is that no information is provided on the level of household income. Given that income is a crucial determinant of the number of cars, we have partially circumvented this weakness by considering a set of variables that can be considered proxies for household income such as educational attainments, housing size, second residence ownership and housing tenure. We also constructed a dummy variable that takes value 1 if the individual perception of the quality of public transport in the neighbourhood is poor and 0 otherwise (since we expect perceived low quality of transport networks to increase the propensity to have at least one car in the household)

[9] Years of schooling have been imputed from completed education level using the following conversion rule: 0 years for illiterate, 2 for uncompleted primary education, 6 for completed primary education, 8 for lower secondary education, 12 for upper secondary education, 12 for vocational training, 14 for advanced vocational training, 15 for short-term university degree, 17 for university degree and 20 for doctoral studies. The same variable has been used to compute job-education mismatch using the realized matches approach.

and another that covers households located in the central city (which has been included in order to account for the highest congestion and parking costs for those households located in the central city, as well as the higher quality of public transport). Notice that local labour market characteristics and residential segregation might represent another potential confounding factor, especially regarding the impact of public transport accessibility (which varies at the local level) on car availability, employment and mismatch. Although relying only on the metropolitan area of Barcelona would implicitly reduce the extent of labour market heterogeneity (possibly correlated with our measure of public transport accessibility), we also included in our empirical analysis the local unemployment rate (defined at census tract level[10]) as a proxy for neighbourhood effects (as in Büchel & van Ham, 2003, Hensen et al., 2009, Jauhiainen, 2010, Matas et al., 2010, Croce & Ghignoni, 2013, Ramos & Sanromà, 2013 among others).

3) Econometric Model

In this section, we present the empirical strategy that we adopted to disentangle the relationship between public-and-private transport accessibility to the workplace, employment and job-education mismatch. Our main aim consists of estimating the impact of job accessibility on the likelihood of being employed and on the extent of mismatch between attained education and job requirements. Moreover, we allow public transport accessibility to affect the number of cars per adult in the household, in order to take into account the interrelation and the potential substitutability between public and private transport. In doing so, we will face two main econometric problems. First, given that job-education mismatch can be observed only among employed individuals, the job-education mismatch equation should be estimated on the condition of sample-selection based on unobservable

[10] This variable provided a better fit than other alternative measures such as the distribution of working-age residents in the neighbourhood by citizenship, the distribution of working-age residents in the neighbourhood by education or the distribution of dwellings by age of construction.

factors that affect both employment decisions and job quality (following Büchel & Van Ham, 2003, Jauhiainen, 2011, Rubb, 2011, Devillanova, 2013, Sanromà & Ramos 2013 and Croce & Ghignoni, 2013). Second, we consider private transport availability to represent a potential determinant of both employment and job-education mismatch, which is also likely to be related with unobservable factors that affect these two labour market outcomes (as noted by Raphael & Rice 2002, Gurley & Bruce 2005, Baum 2009, Bansak et al., 2010 among others). Therefore, the empirical analysis is based on a recursive system of equations that enables these issues to be handled meaningfully and consistently.

Specifically, we estimate the following three-equation system by means of Limited Information Maximum Likelihood[11]:

$$mismatch_i = \alpha + \beta' X_i + \gamma \cdot pta_i + \delta \cdot nca_i + \varepsilon_i \quad if\ empl_i = 1 \tag{1}$$

$$\text{Prob}(empl_i = 1) = \text{Prob}(empl_i^* > 0),\ empl_i^* = \mu + \omega' Z_i + \pi \cdot pta_i + \gamma \cdot nca_i + u_i \tag{2}$$

$$nca_i = \varphi' W_i + \tau \cdot pta_i + v_i \tag{3}$$

$$(\varepsilon_i, u_i, v_i) \sim N(0, \boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \begin{pmatrix} \sigma_\varepsilon & \sigma_{\varepsilon u} & \sigma_{\varepsilon v} \\ & 1 & \sigma_{uv} \\ & & 1 \end{pmatrix} \tag{4}$$

Equation (1) relates job-education mismatch with a vector of control variables (X_i) and with job accessibility by public transport (*pta*) and by private transport (*nca*) where, as explained above, the latter form of job accessibility is approximated by the number of cars per adult in the household. Note that we preferred to use as the LHS variable in the job-mismatch equation the continuous variable "mismatch" (i.e. the difference between an individual's years of schooling and the average for his/her corresponding occupation) rather than the discretized variable "overeducation", since this latter option would cause the loss of information. However, in what follows we will recover the impact of our variables of interest in terms of the "amount" of overeducation (as explained in the following section). A more fundamental issue is that, as commented above, the mismatch equation

[11] The estimations are carried out using the STATA routine "cmp", developed by Roodman (2011). Given that the three equations contain public transport accessibility in the list of regressors, which is defined at the census-tract level, we cluster the standard errors at the census-tract level in order to account for the potential correlation between the error terms of individuals who reside in the same (census-based) area.

is defined only for the subsample of individuals who are regularly employed at the time of the survey (i.e. if "$empl_i = 1$"), which generates the aforementioned issue of sample-selection bias. In order to account for that, we specify the employment equation (eq. (2)), which explains the probability of being employed (using a Probit specification) as a function of individual and family characteristics (Z_i), plus public-and-private job accessibility. Finally, the number of cars per adult is modelled using a linear equation (eq. (3)), which includes a set of individual and family covariates, housing and local variables (included in vector W_i), plus public transport accessibility. Note also that the error terms of these three equations are allowed to be correlated (as expressed by equation (4)) and are assumed to follow a Multivariate Normal Distribution. This means that we enable the unobservable determinants of the number of cars per adult, employment and mismatch to share common elements that would bias the coefficient of interest if the three equations were estimated separately[12].

The specified system of equations follows a recursive structure, in the sense that the outcome of equation (3) enters as determinant of equations (1) and (2) and equation (2) identifies the subsample used to estimate equation (1), but (e.g.) the final outcome of equation (1) does not enter the list of explanatory variables of equation (3). This means that the potential simultaneous relationship between the three outcomes of interest is not directly modelled, but is instead captured by the implied correlation between the error terms. Given the non-linearity of equations (2), the recursive system would be identified even if the variables included in the three equations were exactly the same. However, in order to avoid weak identification, we introduce several exclusion restrictions to the employment and car ownership equations, i.e. variables that are strong determinants of employment and car availability but can be assumed to be unrelated to job-education mismatch. The finding of valid exclusion restrictions usually represents a challenge in this framework, since the existing databases that enable the capture of spatial effects (such as the microcensus) contain a huge

[12] In the results section we also provide estimates of the correlation between error terms and their statistical significance. Failing to reject the null hypothesis of zero (pairwise) correlation means that the separate estimation of the underlying equations would produce biased parameters.

amount of information but few "plausibly" exogenous identifying variables. Our choice for this paper was driven by data availability, together with what has been found elsewhere in the literature. Family structure and especially the number/presence of children has been largely employed as an exclusion restriction for the employment equation in several empirical works[13] (in the context of wage regression and selection into employment, see, for example, Martins, 2001, Mulligan & Rubinstein, 2008, Lee, 2009 and Chang, 2011). In this paper, we exploit the information on the number of children of different age ranges (0-4, 5-9, 10-15 and 16-19 respectively) as exclusion restrictions for the employment equation. We assume that, conditional to job accessibility and to other covariates, the number of children of different ages only affects job-education mismatch indirectly, through self-selection into employment.

Regarding the cars per adult equation, some studies have addressed the endogeneity of car ownership with respect to labour market outcomes by adopting the standard Instrumental Variables approach. Raphael and & Rice (2002) instrumented car ownership using insurance and gas tax costs and Ong and Miller (2005) used the cost of car ownership, the number of activities that can be conducted within the neighbourhood and the availability of alternative transportation as exclusion restrictions. The intrinsic difficulty of finding appropriate instruments for car availability (i.e. strong predictors of car availability unrelated with the final outcome of interest) is well recognized in the literature. The few exceptions are those studies that rely on exogenous changes in car ownership related policies. For example, Baum (2009) controlled for potential endogeneity bias by jointly estimating employment and car ownership in a maximum likelihood framework, using differences in state vehicle asset rules governing welfare eligibility as instruments to identify the effect of car ownership. Bansak et al. (2010), referring to the same context, estimated a two-stage least square equation instrumenting car ownership with asset-related welfare. In this paper, the available variables that were selected as exclusion restrictions are the fraction of employed adults in the

[13]Note that Devillanova (2013) used the number of adults in the household as an exclusion restriction for the employment equation. However, in our case the number of adults in the family cannot be included in the employment equation, since it is already included in the right-side of the equation (i.e. in the denominator of the variable "nca"). Therefore, we retained only the information on the presence of children of different ages.

household (excluding the individual's contribution), housing-related variables (dummies for housing tenure and availability of a second residence, as well as usable space in housing), which are likely to proxy family wealth. Moreover, we also include an indicator that reflects the self-assessed judgment about transport network quality in the neighbourhood of residence and another that refers to residents in the municipality of Barcelona (within its metropolitan area). The choice of these variables as determinants of car availability is in line with the general literature on car ownership (Matas et al. 2009). Moreover, household-related variables (such as housing tenure and mortgage payment) have been previously used as exclusion restrictions in similar studies (see, for example, Devillanova, 2013 and Croce & Ghignoni, 2013). In addition, the system's identification is reinforced by the fact that a) we include dummies for tertiary education in the mismatch equation (which appear not to be significant in the other two equations) and b) employment and car availability are explained as a quadratic function of age, while mismatch contains potential labour market experience in the list of covariates (following Büchel & van Ham, 2003 and Rubb, 2011). To the best of our knowledge, there is still no formal way of testing for the validity of overidentifying restrictions in this three-equation framework with sample selection. Therefore, caution should be exercised when reading the results that follow as true causal effects (rather than conditional correlations), since this definitively depends on assumptions that cannot be directly tested from the data.

There is an additional issue that should be taken into consideration. Our empirical strategy is based on the assumption that public transport accessibility represents an exogenous variable. However, the associated coefficient might reflect, at least to some extent, endogenous residential sorting. This means that individuals who are intrinsically more likely to be employed and less likely to be mismatched might be more prone to reside in areas endowed with better public transport networks (for a detailed review of the issue of endogenous residential sorting, see Dujardin et al., 2009). Åslund et al. (2010) suggested that endogenous residential sorting affects the relationship between job proximity and labour market outcomes. Using a (very specific) sample of Swedish

refugees, they solved this problem by exploiting a natural experiment generated by a refugee policy that randomly assigned individuals to places of residence and showed that job accessibility still matters (even under random residential sorting). Unfortunately, we were unable to directly deal with this issue, mostly because of the lack of exogenous predictors of job accessibility on public transport. However, in the subsection on robustness checks, we report additional results that can be taken as falsification tests for the relevance of residential sorting in the relationship between public transport accessibility and our outcomes of interest. Specifically, we first repeat all the estimations only for those individuals who did not change their residence in at least the last 10 years, for whom place of residence can be reasonably assumed to have been exogenous at the time of the survey. Secondly, we estimate the three equations only for those individuals who live with their parents (following Dujardin et al., 2008), since their place of residence within the urban area is mostly determined by their parents. Although in these cases better public transport accessibility might also be capturing long-standing unobserved family characteristics that are positively related to labour market outcomes, similar results in these additional estimations could be taken as evidence of the meaningfulness of our results (at least in qualitative terms).

4) Results

The results that we obtained from the three equation recursive system (separately estimated for males and females) are reported in Table 2. We first briefly comment on the estimates associated with the control variables[14] included in each equation, which are in line with the results previously obtained in the literature, and then discuss in more detail the results regarding job accessibility variables.

[14]The estimated coefficients for control variables obtained from independent equations are roughly the same and are not discussed here for brevity reasons. We only report the detailed results (estimated elasticities for each outcome) with respect to public and private job accessibility for comparison (see Table 2A in the Appendix).

The results from the cars per adult equation show that, as expected, more educated individuals have a higher number of cars per adult in the family, with similar effects for males and females, and car availability is lower for immigrants than for natives. Being married and having more children in the family increases the propensity to have more cars per adult, keeping the number of adults constant (which displays the unsurprising negative sign), as is the case for the percentage of employed adults (other than the individual). The estimates associated to household and neighbourhood variables indicate that housing tenure, housing size and having a second residence have the expected effect on car availability, suggesting that these variables capture how family wealth favours the affordability of cars. Moreover, individuals who consider the quality of the public transport network in their place of residence to be low are more likely to have more cars (per adult), while we observe the opposite effect for those who reside in the capital city. Finally, residents in areas with higher unemployment rates have fewer cars per adults in the family, which reflects the general idea that residential segregation is often accompanied by insufficient job accessibility by private transport.

The employment equation suggests that educational attainments represent a fundamental determinant of the chances of being employed and that schooling might mitigate the differences in employment observed between males and females since the coefficients (and the corresponding marginal effects ─ not shown) associated to each education level are significantly higher for females than for males. Those who are born outside Spain, especially if they are males, are in general penalized in terms of employment probability with respect to Spaniards (with some exception due to the low number of observations). As usually reported in the literature, residing in a neighbourhood with a higher incidence of unemployment reduces employment probabilities, with a similar impact (computed as marginal effect on the predicted probabilities) between males and females. The effect of marital status is, as expected, inverted between males and females, since married males are more likely to be employed, while the opposite result is obtained for females. The impact of age on employment probability is an inverted U-shape for both men and women and

slightly more pronounced for the former. Finally, the presence of children is detrimental for employment, but significantly more for females than for males and especially when their age is lower.

Regarding the job-education mismatch equation, we obtain the usual result indicating that more educated individuals are, keeping other factors constant, increasingly exposed to the risk of a positive mismatch (i.e. they are more likely to be overeducated). However, the incidence and the amount of mismatch among university graduates is fairly heterogeneous across different fields of study, since (relative to graduates in social sciences) the difference between individuals' education and the occupation-average is significantly lower, especially for graduates of health disciplines (mostly due to the stringent regulation of health-related professions), for males graduates of technical studies and, to a lesser extent for females who studied hard sciences or humanities. Job-education mismatch decreases with (potential) work experience, which might be explained by both career progression for more tenured workers and/or by the impact of changes in the cohort/education composition of the workforce. Immigrant workers in general suffer a greater degree of mismatch, with the exception of those coming from EU15 countries, who are less likely to be more qualified than the average for their occupations. Finally, being married increases mismatch among male workers, but has the opposite effect among their female counterparts.

We now focus in more detail on the estimates associated to the main variables of interest to this paper, i.e. the measures of job accessibility by public and private transport. To facilitate interpretation of the results, we directly describe the elasticities of the three outcomes with respect to a 10% increase in public and private transport accessibility, respectively. First, the negative effect of public transport accessibility on the number of cars per adult in the family that emerged in the raw data is also present once the effect of other covariates has been partialled out. In fact, the negative and relatively high elasticity of car availability with respect to public transport accessibility confirms that public and private transport represent substitute (albeit imperfect) ways of reaching job opportunities and that individuals residing in areas endowed with better public

transport networks have less incentives to have more cars in the household. Regarding the employment equation, it appears that the probability among females of being regularly employed is especially sensitive to job accessibility and, somewhat contrary to our expectations, the effect of potential accessibility by private transport is slightly higher than the impact of public transport. However, the chances of being employed among males are less dependent on job accessibility, since the impact of public transport accessibility is virtually zero and car availability has only a modest (but significant) elasticity of 0.045. Finally, we also expressed the effect of public and private accessibility to the workplace on job-education mismatch. However, since (as previously commented) the lack of adjustment between formal qualification and job requirements is especially worrisome (and can be viewed as a form of underemployment) when it takes the form of overeducation, we expressed the impact of job accessibility in terms of elasticities with respect to years of overeducation[15] rather than overall mismatch. We consider a focus on the effect of job accessibility on the total number of years of overeducation to be meaningful, since it provides a picture of the amount of human capital that would be prevented from being wasted after an improvement in potential connectivity from places of residence to employment centres. In contrast to what was observed in the descriptive analysis, the evidence obtained from the estimated system of equations indicates that, in general, both forms of job accessibility are relevant for reducing the incidence and the extent of overeducation in the urban labour market, thus confirming the evidence reported in previous studies. More specifically, our results suggest that overeducation has a similar elasticity with respect to car availability for males and females, although job accessibility on public transport is somewhat more important for reducing the positive mismatch between attained qualifications and occupations for men than for women.

[15]More specifically, we computed the percentage difference between the sum of the "observed" number of years of overeducation (i.e. years of education that exceed the average schooling for the individual's occupation plus one standard deviation point) and the sum of the years of "predicted" mismatch that exceeds the respective standard deviation after a 10% increase in public transport accessibility. Note that, in order to ensure comparability between the observed and the predicted amount of overeducation, we imputed the residuals of the mismatch equation to the predicted mismatch resulting from a 10% change in public transport accessibility.

It also seems worth noting that the estimated correlations between the error terms of the three equations are always significant and are in the same direction for both males and females, which means that the interrelation between the unobservable elements that affect car availability, employment and job-education mismatch should be taken into account in order to obtain a consistent estimate of the impact of job accessibility on labour market outcomes. For comparison purposes, we also report the estimated elasticities of public and private transport accessibility that are obtained assuming that the three equations are independent (see Table 2A in the Appendix). This exercise suggests that, although the recursive estimation is relevant in this context (and should be taken as reference for a quantitative interpretation of the results), the evidence produced using independent equations is in the same direction (in qualitative terms) and highlights the robustness of the overall results regarding the relationship between public and private job accessibility and labour market outcomes.

4.1) Robustness Checks

In order to provide additional evidence in favour of the meaningfulness of the results presented in this paper, we performed several robustness checks for our estimates. As previously commented, we are especially concerned about the exogeneity of our measure of public transport accessibility, since it might be argued that it is mostly driven by endogenous residential sorting (see Dujardin et al., 2009). Unfortunately, we do not possess exogenous predictors of this variable that would enable its instrumentation, and arguing that people randomly select their place of residence seems rather implausible. However, we performed two falsification exercises in this regard, which taken together would indicate whether (or not) the conditional relationship between public transport accessibility and labour market outcomes is just a mirror of endogenous residential sorting. Basically, we seek to replicate the analysis for different subsamples of individuals for whom place of residence can be taken as exogenous with respect to labour market outcomes. First, following Matas et al. (2010), we

re-estimate the system of equations restricting the sample to individuals who have not changed their place of residence in at least the last 10 years. Second, following Dujardin et al. (2008), we consider individuals who still live with their parents to have rather limited influence on residential choices. Therefore, the relationship between public transport accessibility and labour market outcomes obtained by selecting this specific subsample would be less contaminated by the endogeneity of residential sorting.

The results of these two alternative falsification exercises are reported in Table 4 (we only report the elasticities of each outcome with respect to a 10% increase in public transport accessibility), together with the baseline results for comparison. The elasticity of public sector accessibility on car availability in both subsamples is very similar to the baseline result and remains insignificant for employment probability among males. Moreover, public transport connectivity still matters for the chances of being employed among females, although the elasticity among females that live with their parents is somewhat lower. However, job-education mismatch (in the form of overeducation) is especially sensitive to public transport accessibility for young women (and, to a lesser extent for young men) in the urban labour market. Additionally, public transport accessibility to the workplace has a similar impact on the extent of overeducation for both males and females who have spent more than 10 years residing in the same place, compared to the baseline results. Taken together, these additional results might be taken to suggest that endogenous residential sorting, even if it happens, does not seem to be the main explanation for the overall evidence reported in this paper[16].

Finally, we also performed an additional robustness check to take into account how car ownership decisions are taken at the family level and the sample contains repeated observations within each family. The most suitable option would be to estimate the cars per adult equation at the

[16] We recognize that the two falsification strategies that we followed in this study are not free of criticisms. In fact, unobserved family characteristics related with residential location might still affect both subgroups of workers if a) these represent long-standing elements and/or b) they are transmitted from parents to children and are shared within the family. Moreover, some kind of endogenous sample-selection might be present, especially among young individuals living with their parents. However, the observation of qualitatively similar results to those obtained with the whole sample is reassuring in terms of the robustness of our empirical analysis.

family level, but this would introduce further complications for estimating the recursive system of equations[17]. Therefore, we repeated the analysis using only observations from individuals who declare that they are the head of the household. The elasticities of private transport accessibility are also reported in Table 4 for both males and females. The results suggest that chances of employment among heads of household are less affected by car availability and this is even more so in the case of women. This is partly because they are more likely to be employed than other individuals in the household (especially if the head of the family is a woman, among whom only 18% do not work compared to 41% from the whole female sample), but also because they could be more prone to being the person who actually makes use of the car. Consistent with this explanation, the overall risk of being overeducated in the labour market is more significantly reduced after an improvement in public transport connectivity among females who are heads of household. This evidence suggests that increasing the quality of public transport networks in urban areas would be especially relevant for job quality among this group of women who, for several possible reasons, tend to participate more actively in the labour market.

5) Conclusions

In this paper we have analysed the effect of job accessibility by public and private transport on labour market outcomes in a urban labour market. As such, this is the first paper that concerns with the importance of public transport connectivity in explaining the extent of mismatch between individuals' schooling attainment and the educational requirement in their jobs. More specifically, drawing on Census data from the Metropolitan Area of Barcelona, we examined the relevance of job accessibility in terms of employment probabilities and, among those individuals who are

[17] Another option to take into account how car availability is the same for each individual belonging to the same household could be to cluster the standard error at the family level. However, this could only be applied to households with more than one member in the sample, which would introduce selection bias (especially because we split the sample between males and females).

regularly employed as salaried workers, of job quality. We referred to job-education mismatch as a measure of job quality, placing special emphasis on the status of overeducation (i.e. having more educational qualifications than required in the workplace), since it can be assimilated to a general case of underemployment that generates a waste of human capital. Regarding job accessibility by private transport we considered the number of cars per adult in the family, whereas public transport accessibility has been approximated using a standard measure that reflects the spatial distribution of employment potential in each zone, relative to its commuting cost in terms of public transport time. Our methodological framework is based on a recursive system of equations that takes into account that car availability, employment and job-education mismatch are interrelated processes that should be jointly estimated, as well as the existing substitutive relationship between public and private transport accessibility. The estimations have been carried out separately for males and females, in order to check for gender differences in the impact of public and private transport accessibility to the workplace.

The results indicate that, in general, job accessibility matters for both employment and job-education mismatch. Improving job accessibility can be viewed as an increase in the size of the (local) labour market and, consequently, it would improve labour market performance. It appears that both forms of job accessibility have a substantial and similar effect in terms of the chances of being employed among females, although only private transport seems to have a positive and moderate impact on the likelihood of being employed among males. Moreover, our results suggest that both car availability and public transport accessibility have a positive effect on reducing the incidence and the amount of overeducation, for both males and females. Additional robustness checks suggest that our results are not driven by the potential endogeneity of residential sorting, although we were not able to explicitly deal with this issue due to the lack of identifying variables.

Overall, our analysis confirms the evidence reported in other studies regarding the importance of private transport accessibility for employment outcomes and job-education mismatch, which also holds for the urban labour market of the metropolitan area of Barcelona. The evidence reported in

this paper also highlights the special importance of public transport connectivity to the workplace, which was never explored before. Therefore, the general implication of this study is that public policies that are designed to reduce commuting costs (both in time and money) will help to improve employment and job quality. However, the processes of both urban sprawl and employment decentralization of the Barcelona's metropolitan area took place in a context of weak metropolitan-wide planning. This growth pattern represents an important challenge in the development of an efficient (and cost-effective) public transport network that can satisfy transport needs, especially for working-related trips that take place outside central cities. Indeed, individuals who have to commute from residential areas to low job-density area are subject to more and more car dependence (the case of industrial estates located far away from the city centres represent an extreme example). Therefore, although our results favour public policies addressed at increasing public transport accessibility ─ especially in the light of the environmental sustainability of public transport in dense urban areas ─ urban planners cannot disregard that having access to a car could be crucial to reaching jobs located at the periphery of the city.

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TABLES AND FIGURES

Figure 1: Public Transport Job Accessibility in the Metropolitan Area of Barcelona

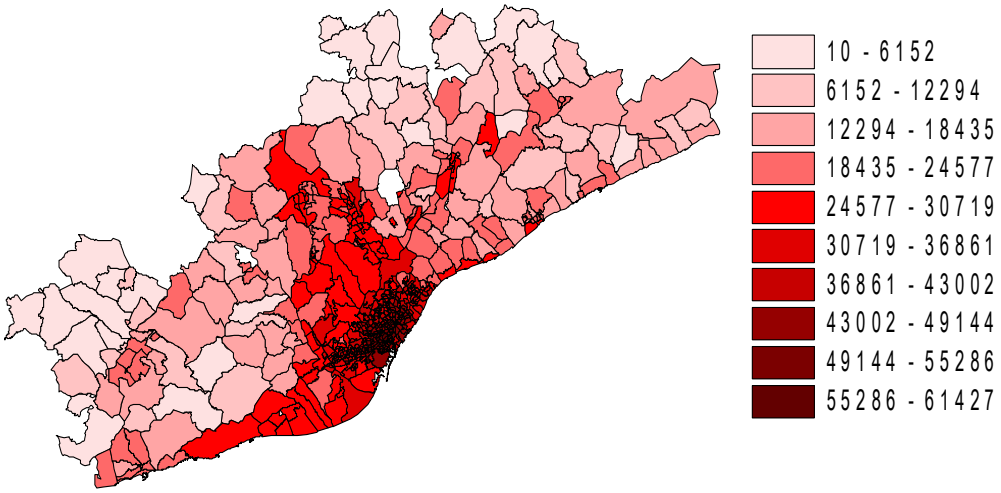

Figure 2: Public Transport Accessibility and Number of Cars per Adult in the Household

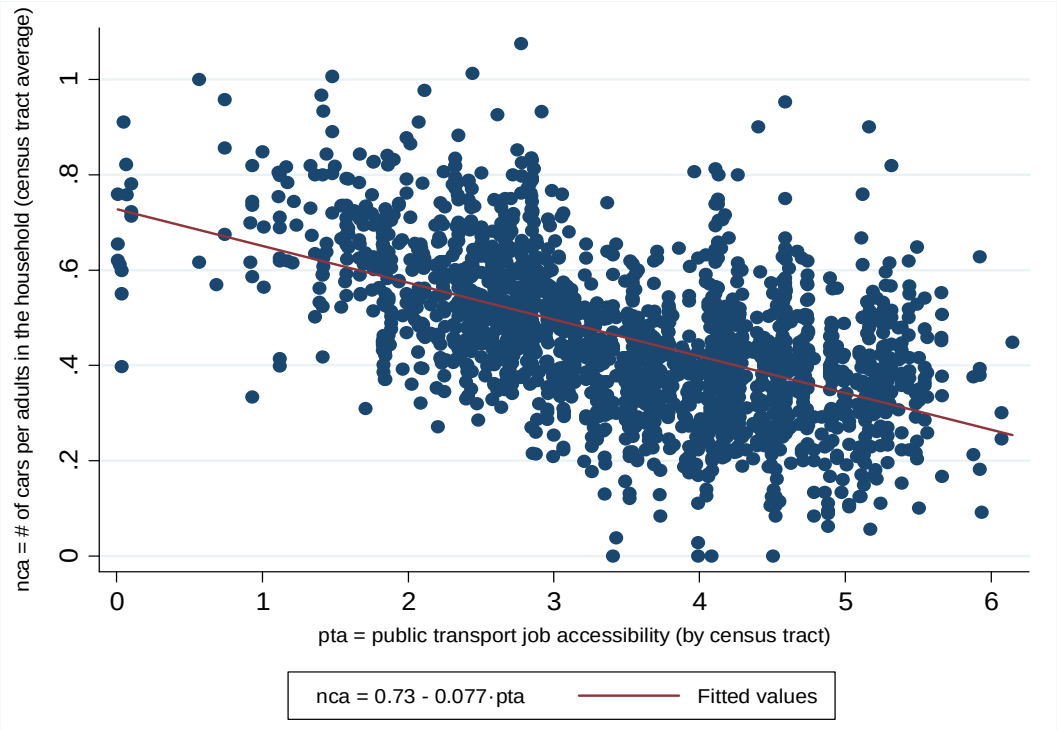

Table 1: Public and Private Transport Job Accessibility, Employment and Job-Education Mismatch

				Males	Females	Males	Females	Males	Females
public transport accessibility (pta)	***% nca = 0***	***%0 < nca < 1***	***% nca ≥ 1***	***% employed***		***average mismatch***		***% overeducated***	
quintile 1	10.06	60.91	29.03	89.89	56.88	-0.230	-0.061	14.25	14.69
quintile 2	12.49	65.28	22.23	89.90	57.22	-0.251	-0.096	14.62	14.52
quintile 3	16.02	66.98	17.00	89.33	56.49	-0.157	-0.006	15.66	15.59
quintile 4	24.67	65.13	10.20	87.48	57.50	-0.049	0.186	17.17	17.24
quintile 5	31.72	57.85	10.43	87.83	64.98	0.367	0.395	19.61	20.50
# of cars per adult in the household (nca)				***% employed***		***average mismatch***		***% overeducated***	
nca = 0				80.32	59.89	-0.394	-0.050	14.21	15.78
0 < nca < 1				90.02	55.00	-0.110	0.067	16	16.62
nca ≥ 1				93.44	70.48	0.334	0.316	18.48	17.55
Total	***18.96***	***63.25***	***17.79***	***89.91***	***58.65***	***-0.070***	***0.095***	***16.19***	***16.65***

Estimation results

Table 2: Estimation Results

	Males			Females		
	nca	***empl***	***mis-match***	***nca***	***empl***	***mis-match***
constant	0.921[a]	-0.150	-5.465[a]	0.678[a]	-0.579[a]	-6.094[a]
	(36.937)	*(-1.404)*	*(-63.551)*	*(30.542)*	*(-6.616)*	*(-52.842)*
no education	*reference category*					
primary education	0.035[a]	0.015	3.939[a]	0.020[a]	0.042[c]	3.943[a]
	(5.274)	*(0.424)*	*(123.702)*	*(3.871)*	*(1.796)*	*(72.715)*
lower secondary education	0.065[a]	0.077[b]	5.315[a]	0.052[a]	0.194[a]	5.119[a]
	(9.935)	*(2.239)*	*(150.797)*	*(9.814)*	*(8.186)*	*(91.821)*
upper secondary education	0.095[a]	0.134[a]	5.861[a]	0.085[a]	0.486[a]	6.096[a]
	(12.828)	*(3.161)*	*(123.350)*	*(13.330)*	*(16.249)*	*(94.123)*
vocational education - low grade	0.094[a]	0.165[a]	8.767[a]	0.082[a]	0.396[a]	8.386[a]
	(11.841)	*(3.694)*	*(180.412)*	*(11.152)*	*(12.085)*	*(116.421)*
vocational education - high grade	0.118[a]	0.313[a]	9.721[a]	0.104[a]	0.579[a]	9.569[a]
	(14.820)	*(5.929)*	*(178.754)*	*(13.723)*	*(15.685)*	*(127.321)*
short university degree	0.119[a]	0.243[a]	8.768[a]	0.123[a]	0.956[a]	9.023[a]
	(14.006)	*(4.422)*	*(114.561)*	*(17.002)*	*(26.148)*	*(111.705)*
university degree	0.129[a]	0.354[a]	9.330[a]	0.125[a]	1.059[a]	9.836[a]
	(15.316)	*(6.133)*	*(123.704)*	*(17.077)*	*(27.342)*	*(112.034)*
doctoral education	0.129[a]	0.539[a]	11.001[a]	0.112[a]	1.143[a]	11.418[a]
	(7.999)	*(4.366)*	*(83.737)*	*(6.346)*	*(11.641)*	*(65.195)*
field of study (only for tertiary education) = social sciences			*reference category*			
field of study (only for tertiary education) = humanities			0.064			-0.166[c]
			(0.475)			*(-1.725)*
field of study (only for tertiary education) = health disciplines			-1.796[a]			-1.161[a]
			(-16.482)			*(-15.315)*
field of study (only for tertiary education) = hard science			-0.113			-0.285[b]
			(-0.956)			*(-2.434)*
field of study (only for tertiary education) = technical disciplines			-0.638[a]			-0.181
			(-8.187)			*(-1.440)*
potential experience (= age - years of schooling - 6)/10			-0.175[a]			-0.317[a]
			(-16.514)			*(-21.752)*
born in Spain	*reference category*					
born in EU15 countries	-0.076[a]	-0.300[a]	-0.394[a]	-0.038[b]	-0.400[a]	-0.518[a]
	(-4.240)	*(-3.320)*	*(-2.714)*	*(-2.093)*	*(-5.400)*	*(-2.939)*
born in other European countries	-0.155[a]	-0.114	1.006[a]	-0.092[a]	0.156	0.879[a]
	(-5.254)	*(-0.731)*	*(4.060)*	*(-3.219)*	*(1.164)*	*(2.961)*
born in Africa	-0.122[a]	-0.282[a]	0.289[a]	-0.125[a]	-0.063	0.052
	(-9.824)	*(-4.502)*	*(4.263)*	*(-8.650)*	*(-0.912)*	*(0.349)*
born in the Americas	-0.175[a]	-0.178[a]	0.791[a]	-0.157[a]	0.190[a]	1.281[a]
	(-15.974)	*(-2.790)*	*(8.779)*	*(-16.887)*	*(3.906)*	*(12.683)*
born in other countries	-0.141[a]	0.031	0.369[b]	-0.136[a]	0.095	0.876[a]
	(-8.402)	*(0.297)*	*(2.500)*	*(-7.004)*	*(0.814)*	*(3.842)*
local unemployment rate	-0.609[a]	-3.134[a]	2.704[a]	-0.545[a]	-1.677[a]	1.171[a]
	(-11.452)	*(-11.266)*	*(8.120)*	*(-10.618)*	*(-8.435)*	*(2.627)*
public transport job accessibility (pta)	-0.049[a]	0.006	-0.168[a]	-0.059[a]	0.099[a]	-0.107[a]
	(-18.656)	*(0.629)*	*(-14.320)*	*(-23.525)*	*(13.328)*	*(-7.427)*
# of cars per adult in the household (nca)		0.614[a]	-0.553[a]		0.803[a]	-0.572[a]
		(8.440)	*(-7.459)*		*(13.583)*	*(-5.429)*

Note: [a] significant at 1% level, [b] significant at 5% level, [c] significant at 10% level; t-Statistics in parenthesis, standard errors clustered at the censustract level.

Table 2: Estimation Results (*continued*)

	Males			Females		
	nca	***empl***	***mis-match***	***nca***	***empl***	***mis-match***
marital status = single			*reference category*			
marital status = married	0.095[a]	0.407[a]	0.099[a]	0.100[a]	-0.519[a]	-0.232[a]
	(19.588)	*(15.195)*	*(3.342)*	*(21.118)*	*(-24.583)*	*(-5.991)*
marital status = others	0.051[a]	-0.135[a]	0.037	-0.033[a]	0.200[a]	0.420[a]
	(5.896)	*(-3.524)*	*(0.751)*	*(-4.333)*	*(6.958)*	*(8.473)*
age/10	-0.032[a]	0.697[a]		0.030[a]	0.459[a]	
	(-3.329)	*(14.109)*		*(3.327)*	*(12.565)*	
age^2/100	0.002	-0.083[a]		-0.005[a]	-0.090[a]	
	(1.489)	*(-15.235)*		*(-4.615)*	*(-18.834)*	
# children aged 0-4		-0.042[c]			-0.252[a]	
		(-1.698)			*(-15.600)*	
# children aged 5-9		-0.020			-0.217[a]	
		(-0.748)			*(-13.569)*	
# children aged 10-15		-0.054[b]			-0.153[a]	
		(-2.461)			*(-10.919)*	
# children aged 16-19		-0.055[a]			-0.059[a]	
		(-2.853)			*(-4.453)*	
# children aged 0-19	0.030[a]			0.032[a]		
	(12.656)			*(13.739)*		
number of adults in the household = 1			*reference category*			
number of adults in the household = 2	-0.369[a]			-0.280[a]		
	(-37.621)			*(-29.581)*		
number of adults in the household = 3	-0.459[a]			-0.358[a]		
	(-46.782)			*(-37.159)*		
number of adults in the household = 4	-0.503[a]			-0.401[a]		
	(-49.473)			*(-40.127)*		
number of adults in the household ≥ 5	-0.557[a]			-0.456[a]		
	(-51.224)			*(-42.306)*		
% of employed adults in the household	0.095[a]			0.119[a]		
	(23.849)			*(27.394)*		
housing tenure = rental	-0.100[a]			-0.088[a]		
	(-19.136)			*(-19.116)*		
second residence available	0.067[a]			0.071[a]		
	(13.316)			*(15.753)*		
usable housing space (in m^2/100)	0.116[a]			0.118[a]		
	(17.251)			*(21.399)*		
perceived quality of transport network (% bad)	0.025[a]			0.016[a]		
	(5.327)			*(3.771)*		
resident in Barcelona	-0.043[a]			-0.025[a]		
	(-7.310)			*(-4.577)*		
$\rho_{\varepsilon,u}$			0.418[a]			0.739[a]
			(12.83)			(39.11)
$\rho_{\varepsilon,v}$			0.069[a]			0.053[a]
			(5.339)			(3.479)
$\rho_{u,v}$			-0.085[a]			-0.200[a]
			(-3.881)			(-10.72)
Number of observations	44077			48961		

Note: [a] significant at 1% level, [b] significant at 5% level, [c] significant at 10% level; t-Statistics in parenthesis, standard errors clustered at the census tract level.

Table 3: Average Elasticities with respect to Public and Private Transport Accessibility

	OUTCOME		
	%Δ[years of overeducation]	***%ΔPr[employed]***	***%Δ [# cars per adult]***
MALES			
%Δ(public transport job accessibility)	**-0.113**	0.004	**-0.323**
%Δ(# cars per adult)	**-0.059**	**0.045**	--
FEMALES			
%Δ(public transport job accessibility)	**-0.076**	**0.170**	**-0.402**
%Δ(# cars per adult)	**-0.059**	**0.194**	--

Note: for each possible outcome we report average elasticities computed with respect to a 10% increase in public transport accessibility and in the number of cars per adult in the household respectively. The elasticity of the years of overeducation has been computed considering individuals to be overeducated when they have more years of schooling than the average in their respective occupation plus one standard deviation point (i.e. mismatch greater than the standard deviation of years of schooling in each occupation). Numbers in bold type indicate that the corresponding coefficient is significant at a 5% significance level.

Table 4: Sensitivity Analysis (elasticities of public and private transport job accessibility)

	OUTCOME		
	%Δ[years of overeducation]	***%ΔPr[employed]***	***%Δ [# cars per adult]***
MALES — baseline sample (n = 44077)			
%Δ(public transport job accessibility)	**-0.113**	0.004	**-0.323**
%Δ(# cars per adult)	**-0.059**	**0.045**	--
MALES — only individuals residing in the same place for more than 10 years (n = 22765)			
%Δ(public transport job accessibility)	**-0.115**	-0.018	**-0.355**
MALES — only individuals residing with their parents (n = 11116)			
%Δ(public transport job accessibility)	**-0.139**	0.014	**-0.360**
MALES — only head of household (n = 23545)			
%Δ(# cars per adult)	**-0.058**	**0.014**	--
FEMALES — baseline sample (n = 48961)			
%Δ(public transport job accessibility)	**-0.076**	**0.170**	**-0.402**
%Δ(# cars per adult)	**-0.059**	**0.194**	--
FEMALES — only individuals residing in the same place for more than 10 years (n = 25871)			
%Δ(public transport job accessibility)	**-0.085**	**0.157**	**-0.425**
FEMALES — only individuals residing with their parents (n = 7461)			
%Δ(public transport job accessibility)	**-0.123**	**0.066**	**-0.526**
FEMALES — only head of household (n = 15007)			
%Δ(# cars per adult)	**-0.136**	**0.069**	--

Note: for each possible outcome we report average elasticities computed with respect to a 10% increase in public transport accessibility and in the number of cars per adult in the household respectively. The elasticity of the years of overeducation has been computed considering individuals to be overeducated when they have more years of schooling than the average in their respective occupation plus one standard deviation point (i.e. mismatch greater than the standard deviation of years of schooling in each occupation). Numbers in bold type indicate that the corresponding coefficient is significant at a 5% significance level.

Appendix

Table 1A: Descriptive Statistics by Gender

	MALES		FEMALES	
	mean	*s.d.*	mean	*s.d.*
SOCIO-DEMOGRAPHIC VARIABLES				
age	38.31	*11.93*	40.33	*11.98*
marital status = single	0.388	*0.487*	0.264	*0.441*
marital status = married	0.560	*0.496*	0.650	*0.477*
marital status = others	0.053	*0.224*	0.086	*0.280*
PLACE OF BIRTH				
Spain	0.944	*0.230*	0.954	*0.210*
European Union (EU15)	0.008	*0.091*	0.007	*0.086*
other European Countries	0.003	*0.053*	0.003	*0.052*
Africa	0.020	*0.140*	0.010	*0.098*
Americas	0.018	*0.132*	0.023	*0.151*
others	0.007	*0.084*	0.004	*0.060*
COMPLETED EDUCATION				
Illiterate	0.007	*0.085*	0.012	*0.107*
incomplete primary education	0.055	*0.228*	0.075	*0.263*
primary education	0.179	*0.383*	0.195	*0.396*
lower-secondary education	0.311	*0.463*	0.301	*0.459*
upper-secondary education	0.129	*0.336*	0.121	*0.326*
vocational training (lower grade)	0.080	*0.272*	0.069	*0.253*
vocational training (higher grade)	0.082	*0.275*	0.063	*0.242*
short university degree	0.063	*0.243*	0.078	*0.269*
university degree	0.082	*0.274*	0.081	*0.272*
PhD	0.011	*0.104*	0.006	*0.079*
FIELD OF TERTIARY EDUCATION				
no tertiary education	0.844	*0.363*	0.835	*0.372*
social sciences	0.058	*0.234*	0.082	*0.274*
humanities	0.014	*0.119*	0.025	*0.155*
health-related fields	0.015	*0.120*	0.034	*0.181*
hard sciences	0.016	*0.126*	0.013	*0.115*
technical fields	0.052	*0.223*	0.011	*0.106*
potential experience (= age - schooling - 6)*	22.68	*13.08*	25.02	*14.04*
HOUSEHOLD COMPOSITION				
# children aged 0-4	0.142	*0.405*	0.155	*0.421*
# children aged 5-9	0.133	*0.386*	0.147	*0.403*
# children aged 10-15	0.177	*0.440*	0.194	*0.460*
# children aged 16-19	0.209	*0.471*	0.210	*0.468*
# adults (20 or older) = 1	0.091	*0.288*	0.092	*0.290*
# adults (20 or older) = 2	0.445	*0.497*	0.473	*0.499*
# adults (20 or older) = 3	0.238	*0.426*	0.234	*0.423*
# adults (20 or older) = 4	0.156	*0.363*	0.142	*0.350*
# adults (20 or older) $\geq$ 5	0.069	*0.254*	0.058	*0.234*
% of employed adults in the household	0.513	*0.415*	0.642	*0.397*
HOUSING AND LOCAL VARIABLES				
second residence available	0.118	*0.322*	0.130	*0.336*
housing tenure = rental	0.159	*0.365*	0.152	*0.359*
usable housing space (in m^2)	84.85	*35.82*	86.56	*37.81*
perceived quality of transport network (% bad)	0.143	*0.350*	0.142	*0.349*
local unemployment rate	0.111	*0.035*	0.110	*0.034*
resident in Barcelona city	0.305	*0.460*	0.326	*0.469*
JOB ACCESSIBILITY MEASURES				
public transport job accessibility (pta)	3.182	*1.116*	3.222	*1.130*
number of cars per adult in the household (nca)	0.485	*0.356*	0.471	*0.356*
number of observations	44077		48691	

Table 2A: Average Elasticities with respect to Public and Private Transport Accessibility (Independent Equations)

	OUTCOME		
	%Δ[years of overeducation]	***%ΔPr[employed]***	***%Δ [# cars per adult]***
MALES			
%Δ(public transport job accessibility)	**-0.094**	-0.008	**-0.321**
%Δ(# cars per adult)	**-0.030**	**0.029**	--
FEMALES			
%Δ(public transport job accessibility)	**-0.095**	**0.100**	**-0.389**
%Δ(# cars per adult)	**-0.046**	**0.064**	--

Note: for each possible outcome we report average elasticities computed with respect to a 10% increase in public transport accessibility and in the number of cars per adult in the household respectively. The elasticity of the years of overeducation has been computed considering individuals to be overeducated when they have more years of schooling than the average in their respective occupation plus one standard deviation point (i.e. mismatch greater than the standard deviation of years of schooling in each occupation). Numbers in bold type indicate that the corresponding coefficient is significant at a 5% significance level. The estimates have been obtained from three independent equations.

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