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ARE COMMUTING AND RESIDENTIAL MOBILITY DECISIONS SIMULTANEOUS?: THE CASE OF CATALONIA (SPAIN)

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ABSTRACT: In this paper we study the commuting and moving decisions of workers in Catalonia (Spain) and its evolution in the 1986-1996 period. Using a microdata sample from the 1991 Spanish Population Census, we estimate a simultaneous, discrete choice model of commuting and moves, thus indirectly addressing the home and job location decisions. The econometrical framework is a simultaneous, binary probit model with a *commute* equation and a *move* equation.

KEYWORDS: Commuting; Residential location choice; Suburbanization.

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RESUMEN: En el presente documento se estudian las decisiones de movilidad laboral obligada (*commuting*) y de cambio de residencia de los trabajadores en Cataluña y su evolución en el período 1986-1996. Utilizando una muestra de datos individuales procedentes del Censo de Población de 1991, se estima un modelo de elección discreta y ecuaciones simultáneas para las variables *movilidad* y *cambio de residencia*, recogiendo por lo tanto, de manera indirecta, las decisiones de localización del hogar y del puesto de trabajo. El modelo econométrico especificado es un Probit binario y simultáneo, con una ecuación de *movilidad* y otra de *cambio de residencia*.

PALABRAS CLAVE: Movilidad, Localización residencial, Suburbanización.

RESUM: En aquest document s'estudien les decisions de mobilitat laboral obligada (*commuting*) i de canvi de residència dels treballadors residents a Catalunya i la seva evolució durant el període 1986-1996. Utilitzant una mostra de dades individuals provenint del Cens de Població de 1991 s'estima un model d'elecció discreta i equacions simultànies per a les variables *mobilitat* i *canvi de residència*, recollint per tant, de manera indirecta, les decisions de localització de la llar i del lloc de treball. El model economètric especificat és un Probit binari i simultani, amb una equació de *mobilitat* i altra de *canvi de residència*.

PARAULES CLAU: Mobilitat, Localització Residencial, Suburbanització

1.- Introduction

It is usually assumed that residential and workplace decisions taken by workers are closely correlated (see, for example, WHITE, 1988; ZAX, 1991, 1994; ZAX and KAIN, 1991; SIMPSON, 1992 or HOTCHKISS and WHITE, 1993). The outcome of the two decisions determines workers' commuting patterns. For example, a job change or a move can make the new home-workplace combination sub-optimal, meaning that either a new move or a new job location is needed in the long term[1] (see, for example, ZAX, 1991, 1994; ZAX and KAIN, 1991 or RENKOW and HOOVER, 2000). So a model that concentrates on only one of these choices is clearly partial, and can be improved if both decisions are addressed simultaneously.

This paper has four main goals:

Our first objective is to analyse the commuting and moving decisions of individual workers in Catalonia (Spain): using a microdata sample from the 1991 Spanish Population Census, we estimate a simultaneous, discrete choice model of commuting and moves, which indirectly addresses home and job location decisions. The econometric framework is a simultaneous, binary probit model with a *commute* equation and a *move* equation.

In second place, we are also interested in the effect of individual characteristics of workers on their *commuting* and *migration* decisions. Information included in the Population Census allows us to control a wide

[1] In an ideal monocentric city all jobs are concentrated in the central business district, so the residential decision is the only important one. In a more realistic model, with decentralized jobs and more than one centre, workers and families are able to choose both their residence and workplace.

spectrum of personal, professional and family variables. We compare our results with the theoretical predictions.

Our third objective is the comparison between Spanish workers' commuting and migration decisions and their counterparts in other countries. Many authors have found that the European labour and housing markets are more rigid than their U.S. counterparts (BLANCHARD and KATZ, 1992; KRUGMAN, 1993; DECRESSIN and FATÁS, 1995; BOYLE, 1998; SANROMÀ and RAMOS, 1998; LOPEZ-TAMAYO *et al*, 2000). There are also substantial differences between European countries: generally speaking, the housing and labour markets of Southern European countries are more rigid than those of Britain, Benelux or Germany. Spain presents quite an extreme case: although employment has risen through the second half of the 1990s, the unemployment rates are still among the highest in Europe[2], a fact that discourages workers from leaving and changing jobs. As Spanish laws have traditionally favoured home ownership, the housing rental market is small and the accommodation available expensive: changes of residence and internal migration are relatively uncommon[3]. Most research in this field has used data from the U.S. or from Northern Europe, from countries such as the U.K. or the Netherlands. We believe it is important to test some of the Residential Location Model's predictions (see STRASZHEIM, 1987, for an overview of this model) for a less mobile, more rigid market.

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[2] 16.14% in 1991 and 22.27% in 1996. In the Spanish region of Catalonia, figures were 12.3% in 1991 and 18.7% in 1996 (data from Spanish and Catalan Statistical Institutes, respectively).

[3] In 1991, less than 0.2% of Spanish residents changed their residence region. In Catalonia, in 1991, 1.98% of the population changed their municipality of residence (1.95% in 1997). Only 0.42% left Catalonia for another Spanish region or a foreign country (0.4% in 1997).

Lastly, the case of Catalonia (a Spanish NUTS-II region: see map 1) is also significant for a second reason. Traditionally, Catalonia has been a highly centralized region: the city of Barcelona has accounted for more than one third of the population. The last ten years have seen a strong trend towards suburbanization, with workers and families moving out of Barcelona and into the surrounding cities and towns. Commuting patterns are also changing, with an increase of *reverse-commuting* and *cross-commuting*. The study of this phenomenon may provide conclusions which are relevant to similar European regions.

The paper is organised as follows: in section 2 we briefly develop the theoretical model and its empirical application. In section 3 we present a descriptive analysis of the evolution of commuting and changes of residence in Catalonia in the 1986-1996 period. Section 4 discusses the estimation of the model. Finally, section 5 concludes.

2.- Residential location, workplace, moves and commuting: a model

The original formulation of the *standard urban model* (ALONSO, 1964) ignored the simultaneous nature of home location – workplace decision-making by placing all jobs in the city centre. This assumption was later considered too restrictive. Alternative formulations of the model appeared which allowed for non-central jobs (see, for example, STRASZHEIM, 1987; WHITE, 1988 or SIMPSON, 1992). The simultaneous nature of the decisions was empirically tested by ZAX (1991, 1994), ZAX and KAIN (1991), MCMILLEN and SINGELL (1992) or WENKE (1999).

As we noted above, commuting distance is a function of several factors, mostly of the utility provided by home and workplace locations,

$$D_i = f[U(h_i , w_i)] , \qquad (1)$$

where *D* is the commuting distance, *h* home location and *w*, workplace location. As in a monocentric model all jobs are assumed to be in the *central business district*, so the only relevant variable is *h* (home location).

In a model of commuting behaviour of individual workers, the following assumptions from the standard urban model must be relaxed for our model to be a reasonable representation of reality:

- Homogeneity of workers, families and jobs.
- Workplace concentration and location into the *central business district*.
- Homogeneous land except for the distance to the *central business district*.

If we eliminate these assumptions, some of the model's less realistic results (for example, the absence of reverse commuting) will also disappear.

The standard urban model takes all jobs, workers and families as equal. Therefore, the utility of a home - workplace combination will be the same for all workers. If we relax these assumptions, this utility will become a function of the factors mentioned above. They are represented by the vectors *P, Pr, S, V* and *L*. These vectors represent workers' principal features (personal, professional, family and home features): $P\ (N\times p)$ represents each worker's main personal and family features. $Pr\ (N\times pr)$ includes the worker's main professional features (education, qualification, experience...). $S\ (N\times s)$ represents the main features of the sector in which the individual works. $V\ (N\times v)$ reflects attributes of the family home (mostly size, as deduced from the monocentric model) and $L\ (N\times l)$ is related to the main features of the area where the family lives:

$$U(h_i, w_i) = g(P_i, Pr_i, S_i, V_i, L_i) \tag{2}$$

In the original formulation of the standard urban model, all jobs were located in the *central business district,* so we could rewrite (1) as:

$$D_i = h[P_i, Pr_i, S_i, V_i, L_i], \tag{3}$$

If we assumed land, housing and jobs to be homogeneous and we knew the home - workplace distance $D\ (N\times 1)$, we would be able to estimate the following model:

$$D = \alpha + P\beta + Pr\gamma + S\delta + V\lambda + L\mu + U \tag{4}$$

As we have said, commuting distance (or the decision to commute) depends also on the housing decision and *vice versa*. If we considered land and housing as homogeneous, and all jobs were concentrated in the city centre, equation (4) would be sufficient. As both land and housing are heterogeneous and jobs are decentralized (WHITE, 1988), two workers with the same commuting distance might take very different housing decisions, as well as work in different places. This means that a distance equation on its own is not enough. Two equations must be considered: one for the decision regarding the workplace and the other one for that regarding housing:

$$W_i = y[P_i , Pr_i , S_i , V_i , L_i , H_i] \qquad (5)$$

$$H_i = z[P'_i , Pr'_i , S'_i , V'_i , L'_i , W'_i], \qquad (6)$$

where W_i is the location of the *i*-th worker's workplace, and H_i is the location of the same worker's home. Vectors from equations (5) and (6) may have different compositions, as some variables might influence the commuting equation but not the residential location equation, or *vice-versa*.

If our city is monocentric (even a monocentric city with decentralized jobs, as in WHITE's (1988) model), we can consider W_i and H_i as the distance from the city centre. The problem is that WHITE's (1988) model is still monocentric in spirit, but we are not analysing a monocentric region. In spite of the importance of Barcelona, other Catalan cities can also be considered as *central business districts*. The situation is similar to GIULIANO and SMALL's (1991) description of the Los Angeles region or VAN DER LAAN's (1998) characterization of the Dutch Randstadt region. As we are talking about a region with several cities and several centres, we cannot use one of them to act as the reference point and ignore the rest. Instead, we should consider alternative models, such as NAKAGOME's (1991) or TURNBULL's (1992): in these models, workers live in suburbs and can decide to work either in the city centre or locally (that is, in the area in which they live). Although both models consider just one centre or *central business district*, this restriction can easily be relaxed, so the worker can choose either to work in the local labour market or to commute. Henceforth, the workplace variable (W_i)

becomes a binary one (we will call it C_i), which represents the worker's choice whether or not to work in his local labour market.

As regards the housing decision, following ZAX (1991, 1994) or ZAX and KAIN (1991) we assume that a worker or a family keeps his residence until his utility can be increased by a move[4]. In such a case, we can construct a binary variable M_i , which reflects the decision to move (whether the worker has changed his place of residence or not)[5].

Our model thus takes the following form:

$$C_i = y[P_i , Pr_i , S_i , V_i , L_i , M_i] \quad (7)$$

$$M_i = z[P_i' , Pr_i' , S_i' , V_i' , L_i' , C_i] \quad , \quad (8)$$

where P_i , Pr_i , S_i , V_i and L_i are the vectors of relevant variables related to the commuting decision, and P_i' , Pr_i' , S_i' , V_i' and L_i' are their counterparts in the decision to change residence. Some explicative variables are significant in the *commute* equation, but not in the *move* equation (for example most of the means of transport used), and *vice-versa* (for example, the number of household members). Thus, the model could be estimated in a Probit framework using a maximum-likelihood, complete

[4] A referee considered that the move decision is a nested one: in a first step, the family decides to move, and in the second step, where to move. This may be true in a long-distance migration process, but not in moves inside a small region like Catalonia, in which the family has enough information for a direct comparison between its present utility and the expected utility of alternative housing locations.

[5] ZAX (1991, 1994) and ZAX AND KAIN (1991) also consider a *quit* equation, since another way to increase a worker's utility could be a workplace change. Unfortunately, the Spanish Population Census (the source of our data) does not provide this information. Nonetheless, it is not a serious problem, as voluntary job change rates in Spain are very low: in 1991, 63% of Spanish workers in employment had been working in the same job for more than three years. Only 2.6% of the employed were actively looking for another job, and only 13.02% of the unemployed had voluntarily quit their previous job. In 1998, the figures were 60.56%, 3.2% and 11.56%.

information procedure (MADDALA, 1983, GREENE, 1993). The model will be discussed and estimated in section 4.

2.1.- Expected effect of the independent variables

2.1.1.- Personal features

Variables included in this vector (such as *age, marriage status* and *family role*) are likely to influence the utility provided by the chosen home-workplace combination, and therefore, commuting and migration behaviour. They can be used as a proxy for personal and family preferences, which are not observable.

Age can affect commuting behaviour in two ways:

- First, workers' earnings change with experience (which increases along with *age*), relaxing budget restrictions on their preferences for land and accessibility (Simpson, 1992).
- Workers' preferences depend on the stage of the life-cycle they are in (HOOVER and VERNON, 1959).

The *family situation* of a worker also has an important influence on his commuting behaviour: workers with tight time constraints, such as *mothers* or *partners* (of the principal person in the household) are less likely to commute than the rest of workers. This behaviour is consistent with theoretical models that consider more than one worker per family (usually, a *principal worker* and a *secondary worker*): see HEKMAN (1980), TURNBULL (1992) or HOTCHKISS and WHITE (1993).

We should expect life-cycle and *family role* to affect *moves* too[6].

2.1.2.- Professional features

Several theoretical models (for example, SIMPSON, 1992) lead us to expect that the more skilled a professional category, the higher its commuting probabilities. There are two possible (and compatible) explanations for these behaviours:

- High-skill workers have more bargaining power, while low-skill workers' earnings are determined in a competitive way (NAKAGOME, 1991; SIMPSON, 1992; TURNBULL, 1992). As their wages are similar everywhere, low-skill workers maximise their utility by finding a job as close at home as possible. High-skilled workers have greater bargaining power.
- Low-skill workers use informal job-search methods, which are most efficient in short distances than in long distances (HOLZER *et al*, 1994).

2.1.3.- Sectoral characteristics

If both sectors and firms are heterogeneous and they have different territorial distribution, the commuting behaviour of a worker will depend on

[6] "[…] only in a few years, a large youth population seeking apartments near the centre of the city may become a large population of families with young children seeking suburban housing and amenities." (SIMPSON, 1992).

the sector in which he works. For example: retail shops are very homogeneously dispersed, so a shop clerk will find it easier to obtain a job close to his home. Alternatively (as an extreme example), there are only two nuclear plants in Catalonia, so the choice of workplace of a nuclear technician is highly restricted. On the other hand, some sectors might have side-effects that make their neighbourhood an unattractive place to live: there is nothing wrong in living next to a retail shop, but many people would be reluctant to live near a nuclear plant!

So we expect the sector to be an explanatory variable in the worker's commuting behaviour. As a general rule, sectors in which large plants are common should have higher commuting probabilities *ceteris paribus* than dispersed sectors.

2.1.4.- Home ownership and equipment

On the basis of theoretical models, we make two predictions on how home ownership and equipment will affect commuting decisions:

- Workers will accept longer commuting distances in exchange for larger, cheaper or better-equipped homes (this trade-off is the basis of the Alonso-Mills-Muth model).
- Owners will commute more than tenants, since tenants find it easier to reduce their commuting distance by changing their residence to one closer to their workplace (ZAX and KAIN, 1991).

One of the main reasons for a residence change is to achieve a better utility level, by means of a larger or more comfortable home: so we expect workers residing in such homes to show higher *moving*[7] probabilities than the rest.

2.1.5.- Residence region

As population and jobs are unequally distributed throughout the territory, we expect to find high job-density zones and low job-density zones. Workers living in a high job-density zone have higher probabilities of finding a suitable job in their residence area, and thus, do not need to commute outside it. On the other hand, high job-density *regions* have higher land prices and side-effects (such as congestion or pollution) that make them less attractive to live in, so this variable is likely to affect both *commuting* and *moves*.

2.1.6.- Migration and commuting

ALONSO's (1964) original formulation of the *monocentric model* and most models based on it predict that workers will change their residence in order to reduce their journey to work[8]. The theory would predict that workers

[7] We are considering recent *past* moves, not future or expected moves.

[8] "Distance to workplace is important because commuting costs are assumed to be proportional to distance so that consumers who choose sites closer to the workplace incur in lower commuting costs. […] Each household-consumer prefers to be closer to the central workplace, generating excess demand for central land sites" (ALONSO, 1964). If we consider de-centralised jobs, "De-centralisation of employment in cities reduces the required commuting distance, but commuting distance is minimised only if each worker lives in the suburban portion of the ray connecting the city centre, the workplace and the residential location. Otherwise, a job exchange or a housing exchange can improve the welfare of those involved in the exchange […] since each worker will be closer to his workplace" (Simpson, 1992).

who have moved recently have lower commuting probabilities than the rest. The opposite is expected to be true in the *migration* equation.

3.- Commuting and residence changes in Catalonia, 1986-1996: a descriptive analysis

Catalonia is a NUTS-II level region, which is further sub-divided into four *provinces* (NUTS-III level, with capitals in Barcelona, Tarragona, Lleida and Girona), 41 *comarcas* and 944 municipalities. *Provinces* are too large to be informative, and both *municipalities* and *comarcas* are too small (in extension and population) to be considered *local labour markets*. Thus, for the purpose of this study, we have divided Catalonia into 16 *sub-regions* (see table 3). As the western part of Catalonia has a lower population density than the coastal area, *sub-regions* are a compromise between three desirable features: *population homogeneity, extension homogeneity* and *socio-economic homogeneity* of the territorial units used in our analysis. We consider that a worker *commutes* when he lives in one *sub-region* and works in another.

To summarise aggregate Catalan commuting patterns, we have calculated the following commuting indexes for the 16 *sub-regions* for the years 1986, 1991 and 1996 (see tables 1 to 4 and figure 2 for more details): *percentage of sub-region out-commuting*; *percentage of sub-region internal commuting*; *commuting balance*; and *openness index*.

Until 1986, commuting showed a mostly monocentric pattern. Most commuting flows went towards the Barcelonès (the Barcelona *sub-region*), and to the other three province capitals, Girona (the Gironès and Selva *sub-*

region), Lleida (the Segrià *sub-region*) and Tarragona (the Tarragonès *sub-region*), which could be considered secondary centres.

Decentralization of population has been very strong in this period: the Barcelonès *sub-region* has been losing population since 1991; the municipality of Barcelona had started to lose population even before 1986, and the Girona and Lleida *sub-regions* presented no population growth between 1991 and 1996. Workers and families are changing their residence from the province capitals to the surrounding regions (*suburbanization*). Decentralization of jobs is also an important trend, although its pace has been slower than population decentralization.

As a result of these trends, the Metropolitan Area of Barcelona (Barcelonès, Baix Llobregat, Maresme, Vallès Occidental and Vallès Oriental *sub-regions*) is now a multi-centred region; its main centre is still Barcelona, but there are strong employment centres in the Vallès Occidental and Vallès Oriental *sub-regions*. As a result, there is strong cross-commuting between the Barcelonès, Vallès Occidental, Vallès Oriental, Baix Llobregat and Maresme *sub-regions*. Nearby regions (such as the Penedès *sub-region*) are also becoming part of the Metropolitan Area of Barcelona. Workers are gradually changing their places of residence from the Barcelonès *sub-region* to other zones; this trend towards suburbanization is also reflected in job locations, albeit more slowly.

In contrast, Girona, Lleida and Tarragona *sub-regions* remain mostly monocentric. Commuting flows between all *sub-regions* increased in the 1986-1996 period, and even rural zones (such as Ebre or Ponent), which in 1986 were closed local labour markets are gradually becoming integrated in a single Catalan labour market.

Internal commuting in *sub-regions* seems mostly related to the region's urban structure: the *sub-regions* with higher internal commuting tend to have a homogeneous urban network, without a dominant city, as in the Central *sub-region*, a mainly industrial zone.

4.- The individual model: estimation and discussion

4.1.- Model estimation

As we noted in section 2, commuting and migration decisions are taken by individuals or families. We obtained a sample of 24199 Catalan employed workers from the 1991 Spanish Population Census (1.05% of all Catalan employed workers in 1991) to analyse their commuting and residence change behaviour by means of the model presented in section 2 (equations 7 and 8). The dependent variables were C_i , a binary variable that takes the value 1 if worker i commutes outside his residence *sub-region* (15.49% of the sample) and 0 otherwise, and M_i , also a binary variable with a value of 1 if the worker changed his municipality of residence in the 1986-1991 period (22.70% of the sample) and 0 otherwise. The model was estimated by a maximum-likelihood with complete information Probit framework. The variables chosen for both equations are presented and described in table 5. We can see from this table that both equations are *over-identified* (there is a total of 70 independent variables; twenty appear only in the *commuting* equation; 19 only in the *migration* equation and the remaining 31 appear in both). Results from both the individual and joint estimations are also shown in Table 5. Although the number of explicative variables is high, the Variance Inflation Factor and the Condition Number of the X'X matrixes show no signs of multicolinearity.

First, uniequational estimations were performed for both the *commuting* and the *migration* equations. Both endogenous variables were significant when used as explicative in the other equation, so there was a chance of a *simultaneity bias* in the resulting estimates. In order to test this situation, we re-estimated the model using a simultaneous equation, maximum-likelihood with complete information Probit framework. The model shows a good fit (see tables 6 and 7 for the proportion of correct and wrong predictions). Both coefficient values and significance levels for the exogenous variables are very similar, regardless of the estimation method chosen (table 5). This is not true for the endogenous variables C_i (commuting) and M_i (residence change). This shows the existence of *weak exogeneity*[9] between C_i (commuting) and M_i (residence change) variables (see GREENE, 1993 or ERICSSON, 1994). This conclusion is reinforced by the Hausman exogeneity test (see MADDALA, 1983): its value for the *commuting* equation is 1.37, much lower than a chi-square distribution with 51 freedom degrees (68.70 for α=5%). The same result is obtained for the *residence change* equation (Hausman test: 1.41; chi-square (50 freedom degrees; α=5%: 49.30)). Thus, the null hypothesis (exogeneity) cannot be rejected in either equation. In any case, as the estimates for C_i and M_i are biased in the single-equation models, the joint estimation is better, both econometrically and conceptually, than the independent estimations. The correlation of the residuals of both equations was unremarkable (-0.01 in the uniequational estimation and 0.29 in the joint estimation).

[9] In case of *weak exogeneity* between two or more equations, the uniequational estimates are unbiased (though not efficient) for the exogenous variables, but not for the endogenous variables. The *maximum likelihood with complete information* procedure provides unbiased and efficient estimates for all coefficients in the model.

4.2.- Discussion of the results

4.2.1.- Personal features

The effect of *age* in **commuting** is not linear: younger workers (*under 25*) commute less than the baseline category (*workers between 35 and 40*). Many of them hold low-wage, part-time jobs, so commuting is not a desirable option for them due to high transport costs and time restrictions. *Workers between 45 and 50* present the highest commuting probabilities. Probabilities for mature workers (*over 50*) then decrease again: they have the same commuting probabilities as the baseline category, probably because they need less residential space. In the **migration** equation, the results for the *age* variable are similar to those obtained in the commuting equation in the sense that the effect of age in migration is not linear. *Workers under 35* have the highest probabilities of a recent residence change, while *workers over 60* have the lowest. These results reflect the fact that young Spanish people leave the family home later than most of their European Community or U.S. counterparts (see note 11 or CABRÉ, 1998).

The worker's *family situation* also has an important influence on his **commuting** behaviour: workers with tight time constraints, such as *mothers* or *partners* (of the principal person in the household) are less likely to commute than other workers[10]. This behaviour is consistent with theoretical models that consider more than one worker per family (usually, a *principal earner* and a *secondary earner*), such as those of HEKMAN (1980),

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[10] The *sex* variable is highly correlated with commuting, but this is due to social practices traditionally associated to gender: our sample contained 12299 people who described themselves as *principal workers* (the one with the higher wages) in the family; only 1077 of them were women. By the same token, of 4800 *partners* (of the principal worker) only 325 were men.

TURNBULL (1992) or HOTCHKISS and WHITE (1993). *Mothers* and *partners* are usually *secondary earners* in the family and have traditionally carried the burden of looking after the house (CABRÉ, 1998). For their part, *children* (workers living in their parents' home[11]) have higher than average commuting probabilities. *Children* are not free to choose their home location until they start living on their own, and many have very restricted workplace choices since youth unemployment rates in Spain are high (CABRÉ, 1998). *Workers unrelated to the principal* are either in domestic service (and do not commute) or room-renters, who usually choose a residence close to their workplace. Their commuting probabilities are low. In the **migration** equation, *children* (of the principal person in the household, which is the baseline category for the family status) and *mothers* show low probabilities of recent migration. In contrast, *partners* (of the principal worker) and *workers unrelated to the principal* show very high migration probabilities. *Unrelated workers* are usually room-renters, people sharing an apartment or domestic service, so this finding seems reasonable.

The only marital status category that shows an influence on **commuting** are *widowers* (usually old-aged people), who have low commuting probabilities, and *legally separated* (who have a high commuting probability). However, *marital status* also shows an important influence on the **migration** equation: *legally separated* and *divorced* workers have high migration probabilities, while *single* and *widowed workers* present the opposite trend, which is consistent with the life-cycle hypothesis. In the case

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[11] 57.5% of Catalan adults born between 1961 and 1970 lived with their parents until they were 30 or older (CABRÉ, 1998). This behaviour is related to high youth unemployment rates and housing prices in Spain. In Catalonia in 1991, the unemployment rate of workers under 25 was 23%, compared with 10% of unemployed workers over that age. The mean monthly wages for full-time workers in Spain in 1991 were 150.000 pta (933.73 Euros), while the housing sale price in Barcelona was

of *single workers*, the coefficient reflects a growing trend of Spanish young workers to live in their parents' home until marriage (CABRÉ (1998) has shown that 70% of people under 30 leaving their parents' home do so because of marriage).

Two variables also show an important influence in the **migration** equation: *previous migration* and *family size*. *Previous migration* is a dummy variable that takes the value of 1 if the worker lived outside Catalonia prior to 1986 and migrated into Catalonia between 1981 and 1986 and 0 otherwise. We have added this variable to test the effect of the workers' previous migration history.

It has been empirically observed in the U.S. that *repeat migration* is an important issue in migration studies: a small proportion of workers show a higher than average migration propensity (they migrate many times during their working life), while the migration propensity of most workers is well below average (DIERX, 1988; EVANS, 1990; BORJAS *et al*, 1992; GRUBER and ZEAGER, 1994; NEWBOLD, 1997). Some authors divide workers into "movers" and "stayers" according to their migration propensity. Following this hypothesis, workers who have previously migrated will be more likely to move again than the rest. To test this situation for the Spanish case, we added the *previous migration* variable and found exactly the opposite result: the coefficient of the *previous migration* variable is negative and strongly significant, meaning that workers who moved to Catalonia recently have a lower migration probability than the rest.

210.925pta/m^2 (1270.63 Euros). The housing rental offer is limited and expensive, as Spanish laws have usually favoured home ownership (CABRÉ, 1998).

Lastly, larger families have a lower migration probability than smaller families probably because they had already found a suitable home before the family size grew. This is quite consistent with the *life-cycle* hypothesis.

4.2.2.- Professional features

The first variable to consider is the worker's qualification, which has been proxied by *completed years of formal education*. Our model shows that each additional education year increases the probabilities of **commuting** by 2.90%. We have included also a group of dummy variables to reflect workers' professional categories. Both the result of the *education years* variable and the theoretical models (for example, Simpson, 1992; see 2.1.2) lead us to expect that the more skilled a professional category, the larger commuting probabilities it has. This prediction is supported by our model: the reference category are *clerical and administrative workers*. Compared with them, we can see that *managers and executives, professionals, teachers, artists* and *technicians* show the highest commuting probabilities, followed by *supervisors* and *salespeople*. In contrast, *shop clerks and assistants* and *farmers* (both low-qualification categories) show lower commuting probabilities than the baseline category.

Results for the **migration** equation are very similar, with the exception of *teachers*[12].

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[12] *Teachers* show lower probabilities of a residence change than the baseline category (*clerical workers*). Most teachers in Catalonia are women (62% of the sample), and the proportion of *partners* of the principal worker in the household among teachers (37%) is significantly higher than that in the sample as a whole (20%).

4.2.3.- Sectoral characteristics

Our results are consistent with the hypothesis discussed in 2.1.3: **commuting** probabilities are highest in sectors where large plants and factories are the norm, or concentrated sectors (such as *chemical industry* and *metal and machinery industry*), and lowest in dispersed sectors, such as *banking and finance*. The baseline category is *retail, repair, restaurants and hotel trade*, which is a territorially dispersed sector. **Migration** is less influenced than commuting by workers' sectoral affiliation: the only sector that shows significant influence is *construction*. Public sector workers and civil servants show no substantial differences with regard to the rest, so these categories have not been included in the definitive model.

4.2.4.- Home ownership and equipment

Our results confirm predictions stated in 2.1.4 with one important exception: *Renters of non-furnished homes* have the same **commuting** probabilities as owners. The explanation may lay in the Spanish laws regarding rented property, which imposed very long rental periods and low rents. These laws do not apply to rent agreements made since the mid-80s, but are still in force for older ones. We presume that many (or most) *renters of non-furnished homes* in 1991 were still "old renters", while most *renters of furnished homes* have short-term agreements, and were, therefore, "new renters". "Old renters" face high fixed costs if they change their residence, as they will lose very favourable conditions without compensation, so they are likely to behave in the same way as owners.

One of the main reasons for a residence change (**migration**) is to achieve a better utility level, by means of a larger or more comfortable home. As in the commuting equation, the indicator we used was the *number of bathrooms*, in order to avoid the bias of old residential buildings (in rural or formerly rural areas, but also in central districts of large cities). These buildings tend to be large homes, but they are also poorly maintained and lack most modern amenities. The *number of bathrooms* is correlated with home size; however it allows us to avoid the distortion mentioned (CARIDAD and BRAÑAS, 1997 or SANROMÀ and RAMOS, 1999, adopted a similar approach). Our model shows that workers who moved from one municipality to another in the 1986-1991 period tend to live in larger and better equipped homes than those who did not.

Home ownership also influences the migration decision: the most significant variable in the migration equation is *mortgaged property*, indicating that most workers who move buy their new homes. *Rented home* also has a positive coefficient, as does, to a lesser extent, *home leased by the employer*. On the other hand, workers with a lower probability of moving are those who *inherited* their home.

4.2.5.- Residence sub-region

We have included a dummy variable for the residence *sub-regions*: for *sub-region j* and worker *i*, the variable takes a value of 1 if worker *i* lives in *sub-region j* and 0 otherwise. The results for these variables match the descriptive analysis performed in section 2 almost exactly: workers residing in *sub-regions* with a mostly residential profile (in particular, those next to the province capitals: *Baix Llobregat, Maresme, Vallès Occidental, Vallès Oriental, Baix Camp-Priorat, Camp de Tarragona* and *Ponent Nova*) have higher **commuting** probabilities than the reference category (*Barcelonès*, the Barcelona *sub-region*). On the other hand, agricultural zones (in particular the *Ebre sub-region*, the southernmost *sub-region* in Catalonia) have lower commuting probabilities, as does the *Comarques Centrals sub-region* (a zone with a strong, but dispersed, consumer goods manufacturing sector and deficient communications) and the *Gironès* and *Segrià sub-regions*.

Results for the **migration** equation are very similar, except for positive and significant coefficients for *Gironès* and *Segrià sub-regions* (home of Girona and Lleida, both province capitals). These results confirm the suburbanization trend in Catalonia (see SAU, 1993 or ROMANÍ, 1999*a*).

We have used the *unemployment rate* and the *growth rate of resident workers* in each *sub-region* as a proxy for the employment opportunities (both have been calculated for each *sub-region* and professional category): If the *unemployment rate* is high, chances of finding a suitable job in the residence *sub-region* decrease, so workers have an incentive to out-commute. The same will happen if the number of resident workers rises faster than the number of available jobs. Again, our model supports this hypothesis: if resident workers of the same category as worker *i* increase by 1%, worker *i*'s **commuting** probabilities rise by 1.20%. For a 1% increase in the unemployment rate, commuting probabilities increase by 4%.

Lastly, we should take account of facility of access and transport infrastructures. As a proxy, we have used the workers' usual *means of transport*[13] (the baseline category is *bus travel*). The results are intuitive:

[13] It could be debated whether the variables in this group, which define the transport facilities used by the workers in our sample, are a cause or an effect of commuting. In any case, there are two main reasons for keeping them in our model: first, if they are omitted, none of the remaining variables changes its sign or level of significance, and the model's predictive power increases if they are kept. Second, the transport variables work as proxy

some means of transport, such as *private car, company bus, regional railway* and *national railway* are associated with high **commuting** probabilities, as they are used for long trips, while other forms of transportation, such as *subway, motorbike/bicycle* or *walking* are best suited for short journeys, and workers who use them have, *ceteris paribus*, lower commuting probabilities.

The only transport variable that shows a significant coefficient in the **migration** equation is *car*: workers who have moved recently tend to commute by car more than those who do not. This may reflect the fact that suburban zones have a weaker public transport infrastructure (specially, subway and railway) than central zones.

4.2.6.- Migration and commuting

ALONSO's (1964) original formulation of the *monocentric model* and most models based on it predict that workers will change their residence in order to reduce their journey to work. Our model shows exactly the opposite effect: workers who moved in the 1986-1991 period were more likely to commute than those who did not. The reason could be the rigidity of Spanish housing market, caused by a strong preference for ownership over rental. As a consequence, the rental housing offer is limited and expensive[14]. Young workers who leave their parents' home are forced to find a place of residence further away from their job than their previous home, as they usually have to move to the capital's periphery or even further away. In addition, many

variables for the better (or worse) accessibility of the workers' residence *region*.

[14] With a small down-payment and a 20 or 30-year mortgage, a small apartment in Barcelona's Metropolitan Area can be paid with lower monthly instalments than the monthly payments for a similar rental apartment. Therefore, workers and families who can afford it prefer home ownership to home renting.

young families with children and increasing income want to move to larger, better equipped homes or to individual houses (i.e. not flats or apartments). This particular housing offer is more likely to be found in suburban towns rather than in large cities or province capitals.

The results for the *commuting* variable (C_i) in the **migration** equation are consistent with the findings in the commuting equation and the descriptive analysis: workers who moved in the 1986-1991 period tend to commute more than those who did not. As we have seen, most residence changes following a suburbanization pattern, and most of these workers tend to keep their central jobs, as suburban jobs are still scarce.

In the migration and commuting literature one question is frequently asked: *Do people follow jobs, or do jobs follow people?* From the results of our simultaneous commuting-migration model, the answer seems to be: “Jobs follow people, but relatively slowly”.

5.- Conclusions and policy implications

In this paper, we have inferred and estimated a model that permits simultaneous estimation of the decisions taken by individual workers concerning commuting and changing residence. Our starting point the standard urban model (see STRASZHEIM, 1987), modified in order to bring it closer to reality, so it could be empirically estimable. Our results show the existence of *weak exogeneity* between the *commuting* and the *migration* equations, so the estimates of *commuting* and *migration* when used as independent variables in the single equations are biased. We therefore performed a maximum-likelihood, complete information, joint estimation of both equations to obtain the unbiased coefficients for the *endogenous* variables (*commuting* and *migration*). Both variables are significant when acting as explicative, indicating a) that the *commuting* decision influences the *migration* decision and *vice-versa*: workers who have recently changed residence are more likely to out-commute from their residence *sub-region* than the rest, and b) that commuting patterns are an explicative variable in the *residence change* equation.

Our results show that Catalan workers' commuting and residence change patterns are similar to those observed in other European countries, such as the Netherlands (see VAN DER LAAN, 1998; ROUWENDAL, 1996, 1999), the United Kingdom (BOYLE, 1998; CRAMPTON, 1990) and Germany (WENKE, 1999), or the U.S. (ZAX, 1991, 1994; ZAX and KAIN, 1991). Although the *commuting* and *migration* levels are lower in Catalonia (and in the rest of Spain) than in other European countries or in the United States, the variables that influence these decisions are largely the same: workers' preferences, family characteristics, professional characteristics and life-cycle stage).

However, the Spanish case presents several particular features of its own. Workers' preferences are similar, but the structural rigidities that characterize the labour and housing markets create certain differences. The preference for home ownership (only 25% of the workers in our sample lived in rented or leased homes) is due in part to these rigidities. As a result, young Spanish workers leave their parents' home later than their European or U.S. counterparts. Furthermore, workers migrate less, due to the higher costs associated to home changes.

These rigidities may have a negative effect on economic growth. For example, a new firm or a growing sector located away from the metropolitan areas will find it difficult to attract workers even if unemployment is high in metropolitan areas, since the migration propensity is low. Firms in this situation have sometimes been forced to build or buy housing to lease to their workers, as an incentive to migration.

The solution appears to lie in a policy change. The national and regional governments in Spain have traditionally tried to incentivate young workers to leave their homes and become home-owners; 25% of our sample were workers who still lived at their parents' home, and 27% of these were older than 30. The instruments used by governments have been the provision of subsidies to home-buyers, or promoting the construction of "protected housing" (homes that have to meet certain characteristics and are sold at a fixed price). The problem is that most young workers still find prices too high (see note 10) and cannot obtain bank loans. The only alternative for many is to delay leaving their parents' home and marriage until they can afford to buy their own home, which places the burden on parents. Our estimates show positive migration probabilities until 35 years old, mostly due to workers who leave their parents' home.

Home renting is not considered a feasible alternative in most cases, because the offer of rental accommodation is limited and expensive. The demand for ownership rises, and so the rental offer falls still further. As we have seen, 75% of the workers in our sample live in homes that they or their family own, and workers who change their residence tend to buy rather than rent. So it is really a "vicious circle"; or, to use a Spanish saying, "a fish biting its own tail". The problem is compounded by the fact that housing policy is a matter for national and regional governments as well as the local authorities, and often no consensus is reached.

The most sensible solution appears to be to support the development of an efficient and cheap rental market, although this does not seem to be the path chosen by Spanish authorities.

APPENDIX: FIGURES AND TABLES

TABLE 1: SECTORAL 23-BRANCHES CLASSIFICATION

BRANCH	% SUB-REGION OUT-COMMUTING [a]		% SUB-REGION INTERNAL COMMUTING [b]		BRANCH NAME
	1991	1996	1991	1996	
Sector 1	12.76	15.69	4.25	6.08	Agriculture, cattle and silviculture
Sector 2	11.68	14.62	6.22	7.27	Fishing
Sector 3	33.42	39.26	20.21	23.21	Petroleum, natural gas and radio-active minerals
Sector 4	23.16	26.28	16.20	22.15	Electricity, gas and water
Sector 5	30.61	33.18	17.26	19.17	Extraction and transformation of minerals
Sector 6	22.66	25.41	23.85	28.43	Chemical Industry
Sector 7	26.82	28.21	19.23	22.24	Metal, machinery and electrical supplies
Sector 8	30.43	31.64	23.73	31.49	Transportation Material
Sector 9	24.54	27.73	13.75	16.97	Food, Beverage and Tobacco
Sector 10	22.01	26.55	8.93	11.73	Textile, confection and leather
Sector 11	22.39	25.73	11.35	11.78	Wood and furniture
Sector 12	23.40	25.61	18.84	24.12	Paper, printing and book editing
Sector 13	25.79	30.26	18.79	19.72	Gum, plastics and other manufactured products
Sector 14	22.08	24.09	16.39	19.44	Construction and civil engineering
Sector 15	17.19	20.30	12.17	16.56	Retail and repair
Sector 16	17.18	20.26	10.62	13.44	Restaurants, cafés and hotel trade
Sector 17	18.74	22.70	16.92	23.05	Transportation and Communications
Sector 18	15.01	18.60	14.42	20.82	Finance and insurance
Sector 19	15.09	19.10	17.33	22.71	Services for firms
Sector 20	15.13	18.79	15.01	19.86	Civil services, defence and social security
Sector 21	18.00	20.87	19.04	21.29	Education, research and culture
Sector 22	17.00	20.75	15.92	21.11	Health and social assistance
Sector 23	18.54	18.46	13.15	16.70	Other services
CATALONIA	20.26	22.44	15.18	19.31	Catalonian average

[a] %. of workers who live and work in different municipalities in the same *region*.

[b] % of workers in the branch who live and work in different *regions*.

TABLE 2: COMMUTING AND PROFESSIONAL CATEGORIES (1991 and 1996)

CATEGORY	WORKERS		% SUB-REGION OUT-COMMUTING		% SUB-REGION INTERNAL COMMUTING	
	1991	1996	1991	1996	1991	1996
Professionals	296738 (13,16%)	306398 (13.96%)	21.24%	24.26%	16.76%	19.94%
Managers	54332 (2,41%)	83858 (3.82%)	22.27%	24.49%	14.55%	16.56%
Clerical	366364 (16,24%)	414193 (18.87%)	15.68%	18.72%	18.71%	23.02%
Sales	303748 (13,47%)	289879 (13.21%)	13.07%	14.37%	14.63%	20.64%
Services	234042 (10,38%)	257914 (11.75%)	12.26%	16.04%	18.26%	22.35%
Farmers	82154 (3,64%)	61717 (2.81%)	4.38%	5.04%	11.87%	13.95%
Blue-collars	913028 (40,48%)	779356 (35.51%)	15.03%	18.46%	25.61%	28.62%
Military	5024 (0,22%)	1148 (0.05%)	9.87%	23.25%	11,70%	19.90%

TABLE 3: REGIONAL COMPOSITION AND MAIN FIGURES (1991 and 1996)

SUB-REGION NAME	COMARCAL COMPOSITION	AREA (KM^2)	POPULATION		DENSITY		NUMBER OF MUNICIPALITIES
			1991	1996	1991	1996	
Baix Camp Priorat	Priorat, Baix Camp	1191.50	141074	149752	118.40	125.68	51
Baix Llobregat	Baix Llobregat	486.50	610192	643419	1254.24	1322.54	29
Barcelonès	Barcelonès	143.10	2302137	2131378	16087.61	14894.32	5
Camp de Tarragona	Alt Camp, Conca de Barberà, Baix Penedès	1489.10	90097	100238	60.50	67.31	59
Centrals	Berguedà, Bages, Solsonès, Cerdanya, Anoia, Osona	6153.10	414222	425007	67.31	69.07	180
Comarques de Girona	Alt Empordà, Baix Empordà, Garrotxa, Ripollès, Pla de l'Estany	3998.50	274984	286064	68.77	71.54	155
Gironès	Gironès and Selva	1571.00	224130	233877	142.66	148.87	53
L'Ebre	Ribera d'Ebre, Baix Ebre, Montsià, Terra Alta	3261.90	154952	155670	47.50	47.72	52
Maresme	Maresme	396.90	293103	318891	738.48	803.45	30
Penedès	Alt Penedès, Garraf	776.50	146778	163631	189.02	210.72	33
Ponent	Alt Urgell, Alta Ribagorça, Vall d'Aran, Pallars Sobirà, Pallars Jussà	5139.40	46986	48310	9.14	9.39	60
Ponent Nova	Noguera, Pla d'Urgell, Urgell, Segarra, Garrigues	4144.60	129842	130367	31.32	31.45	111
Segrià	Segrià	1393.70	162904	163691	116.88	117.45	38
Tarragonès	Tarragonès	317.10	155881	169016	491.58	533.01	21
Vallès Occidental	Vallès Occidental	580.70	649699	685600	1118.82	1180.64	22 (23 in 1996)
Vallès Oriental	Vallès Oriental	851.90	262513	285129	308.15	334.69	43
Total Catalonia		31895.50	6059494	6090040			

TABLE 4: REGIONAL COMMUTING RATIOS (1991 and 1996)

SUB-REGION	RESIDENT WORKERS		COMMUTING BALANCE (%)[a]		OPENNESS INDEX (%)[b]		SUB-REGION OUT-COMMUTING (%)[c]		SUB-REGION INTERNAL COMMUTING (%)[d]	
	1991	1996	1991	1996	1991	1996	1991	1996	1991	1996
Baix Camp / Priorat	50224	52486	-14.07	-14.29	29.53	36.12	20.59	25.21	10.53	12.26
Baix Llobregat	222242	232112	-11.78	-9.30	60.73	68.33	37.22	38.82	22.53	25.86
Barcelonès [e]	855530	730881	5.67	8.19	30.38	41.58	12.18	16.70	17.29	17.91
Camp de Tarragona	33365	35854	-3.16	-7.88	27.28	35.54	16.06	21.71	17.07	19.42
Centrals	159102	157901	-3.37	-4.43	12.64	14.35	8.69	9.39	28.49	32.29
Comarques de Girona	107414	110395	-3.54	-4.78	12.48	14.53	8.74	9.65	24.26	28.39
Gironès [e]	89472	93357	3.07	2.20	21.76	22.28	11.71	10.04	28.22	30.89
L'Ebre	53556	50802	-4.23	-2.76	12.77	8.54	10.63	5.65	18.85	21.44
Maresme	108314	115324	-15.40	-20.20	31.24	39.04	23.18	29.62	18.80	20.93
Penedès	53859	60415	-3.92	-9.65	24.51	32.03	14.73	20.84	22.30	25.04
Ponent	18059	17206	-6.68	-6.36	13.69	15.67	9.53	11.02	13.26	17.70
Ponent Nova	47594	47488	-7.15	-7.29	21.62	19.73	17.38	13.51	17.01	20.78
Segrià[e]	60172	58906	-0.01	0.97	11.11	15.24	5.04	7.13	10.89	13.09
Tarragonès[e]	56594	61198	6.80	7.71	30.76	38.02	11.63	15.16	15.47	19.82
Vallès Occidental	237454	247997	1.16	3.80	39.77	47.28	19.13	21.74	21.39	26.23
Vallès Oriental	102463	110271	6.14	2.40	43.64	53.29	18.63	25.44	31.59	32.92
Total Catalonia	2255414	2182493	---	---	31.11	38.61	15.92	19.31	20.27	22.90

[a] (Workers who commute into the *sub-region* - resident workers who work outside) / Resident workers
[b] (Workers who commute into the *sub-region* + resident workers who work outside) / Resident workers
[c] Resident workers who commute outside the *sub-region* / Resident workers
[d] Resident workers who commute to another municipality in the same *sub-region* / Resident workers
[e] These *sub-regions* contain the province capitals

TABLE 5: COMMUTING AND RESIDENCE CHANGE EQUATION ESTIMATES

		Commuting - Individual Estimation			Commuting - Joint Estimation			Migration - Individual Estimation			Migration - Joint Estimation		
		Coefficient	t-ratio	Impact factor	Coefficient	t-ratio	Impact factor	Coefficient	t-ratio	Impact factor	Coefficient	t-ratio	Impact factor
AGE15-20	Workers aged 15-20	-0.355	-3.35	-49.87%	-0.357	-3.58	-49.67%	1.154	13.24	239.58%	1.159	14.32	233.65%
AGE 20-25	Workers aged 20-25	-0.120	-2.81	-19.81%	-0.101	-2.48	-16.75%	1.123	22.97	256.91%	1.146	25.74	256.08%
AGE 25-30	Workers aged 25-30	---	---	---	---	---	---	1.250	34.51	315.87%	1.246	36.29	305.07%
AGE 30-35	Workers aged 30-35	---	---	---	---	---	---	0.735	25.62	154.59%	0.717	26.93	146.42%
AGE 45-50	Workers aged 45-50	-0.049	-1.31	-8.51%	-0.073	-2.07	-12.26%	---	---	---	---	---	---
AGE 50-55	Workers aged 50-55	0.012	0.28	2.19%	-0.017	-0.41	-2.91%	---	---	---	---	---	---
AGE >60	Workers aged more than 60	---	---	---	---	---	---	-0.499	-9.33	-55.95%	-0.503	-10.20	-55.75%
PARTNER	Partner of the principal worker in the household	-0.074	-1.67	-12.55%	-0.091	-2.19	-15.06%	0.161	4.12	25.92%	0.176	4.73	28.05%
CHILDREN	Sons of the principal worker in the household	0.068	2.13	12.87%	0.135	4.16	26.53%	-1.182	-24.53	-86.73%	-1.175	-30.93	-86.19%
NORELATION	Unrelated to the principal worker in the household	-0.268	-1.42	-40.12%	-0.270	-1.60	-39.90%	0.600	4.88	110.44%	0.602	5.73	108.48%
OTHER RELATION	Other relation to the principal worker in the household	---	---	---	---	---	---	0.071	1.19	10.78%	0.075	1.41	11.18%
SINGLE	Single	---	---	---	---	---	---	-0.250	-6.30	-31.41%	-0.237	-7.04	-29.71%
WIDOWER	Widower	-0.201	-1.72	-31.55%	-0.202	-1.84	-31.35%	-0.236	-2.28	-30.82%	-0.239	-2.37	-30.76%
SEPARATED	Separated	0.113	1.47	21.98%	0.111	1.56	21.18%	0.478	6.95	85.15%	0.481	8.31	84.02%
DIVORCED	Divorced	---	---	---	---	---	---	0.248	2.71	40.62%	0.249	3.20	40.10%
MOTHER	Mother	-0.113	-2.31	-18.70%	-0.120	-2.62	-19.57%	-0.302	-6.99	-37.36%	-0.286	-7.19	-35.33%
PREVMIGR	Moved to Catalonia between 1981 and 1986	---	---	---	---	---	---	-0.480	-11.80	-54.36%	-0.457	-13.32	-52.01%
FAMNUM	Number of household members	---	---	---	---	---	---	-0.097	-10.50	-13.54%	-0.063	-7.76	-8.83%
WRKNUM	Number of workers in the household	---	---	---	---	---	---	0.010	0.69	1.49%	0.039	2.86	5.81%
EDUYEARS	Completed years of formal education	0.015	4.35	2.75%	0.019	5.46	3.34%	0.034	11.38	5.06%	0.008	2.87	1.22%
PRO	Professional	0.510	8.31	127.16%	0.514	8.46	125.81%	0.076	1.44	11.61%	0.076	1.48	11.45%
TECH	Technician	0.377	6.05	86.74%	0.377	5.93	85.00%	-0.135	-2.31	-18.54%	-0.133	-2.26	-18.07%
ART	Artist	0.515	3.81	127.16%	0.515	3.81	124.40%	0.223	1.97	36.05%	0.224	2.17	35.63%
PROFESSOR	Teacher	0.411	6.61	96.84%	0.415	7.24	96.11%	---	---	---	---	---	---
EXEC	Executive / Manager	0.817	10.13	237.13%	0.816	10.87	230.74%	0.187	2.90	29.95%	0.187	3.02	29.31%
SUPERVISOR	Supervisor	0.156	2.47	31.08%	0.147	2.45	28.76%	---	---	---	---	---	---
SKWORK	Manual, skilled worker	---	---	---	---	---	---	-0.035	-1.33	-5.01%	-0.035	-1.39	-5.02%
SALES	Salespeople	0.329	5.90	73.48%	0.327	6.04	71.57%	---	---	---	---	---	---
DEPEND	Shop clerk	-0.078	-1.66	-13.31%	-0.078	-1.75	-13.08%	---	---	---	---	---	---
FARMER	Farmer	-0.174	-1.67	-27.75%	-0.170	-2.03	-26.90%	---	---	---	---	---	---
MINECHEM	Mining/ Chemical	0.159	3.42	31.79%	0.154	3.55	30.34%	---	---	---	---	---	---
METALMAC	Metal/ Machinery	0.128	3.90	25.29%	0.110	3.60	21.09%	---	---	---	---	---	---
CONSTRUC	Construction	0.162	3.90	32.61%	0.163	4.15	32.32%	0.105	2.67	16.31%	0.108	2.72	16.49%
ENERG	Energy	---	---	---	---	---	---	0.075	0.80	11.36%	0.079	0.89	11.84%

OTHERIND	Rest of industry	---	---	---	---	---	---	-0.039	-1.31	-5.53%	-0.038	-1.33	-5.34%
TRANSCO	Transports / Communications	---	---	---	---	---	---	-0.080	-1.76	-11.31%	-0.076	-1.69	-10.62%
FINAN	Banking/insurance	-0.075	-1.74	-12.81%	-0.071	-1.61	-12.01%	-0.028	-0.73	-4.04%	-0.023	-0.61	-3.23%
INHERID	Inherited home	0.133	2.57	26.23%	0.148	3.07	28.93%	-0.177	-3.40	-23.68%	-0.175	-3.58	-23.22%
RENT	Rented home	-0.177	-1.87	-28.23%	-0.181	-1.85	-28.52%	0.905	12.54	180.36%	0.913	12.35	177.38%
OLDRENT	Home rented without furniture	---	---	---	---	---	---	0.282	10.10	48.24%	0.294	10.79	49.74%
MORTGAGE	Mortgaged ownership	---	---	---	---	---	---	0.833	32.24	187.45%	0.824	32.25	180.09%
LEASED	Home leased by employer	---	---	---	---	---	---	0.274	3.38	45.22%	0.273	3.45	44.29%
NBATH	Number of bathrooms	0.000	-2.48	-0.03%	0.000	-3.02	-0.04%	0.000	2.53	0.03%	0.000	3.57	0.04%
HOTWATER	Hot water	0.191	2.57	43.05%	0.182	2.85	40.10%	0.128	1.93	21.46%	0.132	2.01	21.81%
REFRIG	Refrigeration	-0.177	-3.83	-28.11%	-0.189	-4.33	-29.50%	-0.051	-1.25	-7.31%	-0.054	-1.35	-7.64%
GAS	Gas	---	---	---	---	---	---	-0.119	-5.17	18.72%	-0.119	-5.19	18.75%
RESBCPR	Resident in Baix Camp / Priorat	0.440	6.62	104.64%	0.462	7.27	109.18%	---	---	---	---	---	---
RESBLLOB	Resident in Baix Llobregat	0.779	21.06	232.99%	0.785	22.38	229.51%	0.142	3.74	22.36%	0.112	2.88	17.09%
RESCAMTA	Resident in Camp de Tarragona	0.209	2.50	43.22%	0.214	2.64	43.63%	0.529	7.21	95.91%	0.537	6.99	95.49%
RESCENTR	Resident in Comarques Centrals	-0.147	-2.90	-23.86%	-0.149	-3.08	-23.90%	0.324	8.08	55.38%	0.332	8.50	55.94%
RESEBRE	Resident in l'Ebre	-0.248	-2.90	-37.50%	-0.237	-3.35	-35.75%	---	---	---	---	---	---
RESGIRON	Resident in Gironès	-0.244	-3.56	-36.96%	-0.244	-3.61	-36.66%	0.377	7.40	65.36%	0.388	7.68	66.24%
RESMARES	Resident in Maresme	0.580	11.22	151.37%	0.577	11.15	147.10%	0.324	6.72	55.09%	0.317	6.65	52.86%
RESNORES	Resident in Comarques de Girona	---	---	---	---	---	---	0.342	7.00	58.47%	0.340	7.23	57.15%
RESPONOV	Resident in Ponent Nova	0.267	3.33	57.28%	0.269	3.53	56.86%	0.306	4.43	51.32%	0.305	4.50	50.32%
RESSEGRI	Resident in Segrià	-0.139	-1.84	-22.69%	-0.144	-1.99	-23.16%	0.241	4.27	39.49%	0.245	4.46	39.45%
RESVAOC	Resident in Vallès Occidental	0.037	0.91	6.85%	0.038	1.00	7.02%	0.208	5.61	33.86%	0.211	5.78	33.75%
RESVAOR	Resident in Vallès Oriental	0.286	5.34	62.30%	0.287	5.56	61.45%	0.354	7.14	60.78%	0.357	7.35	60.33%
INCR	Growth rate of resident workers	0.007	7.72	1.25%	0.003	3.79	0.56%	---	---	---	---	---	---
UNEMP	Unemployment rate	0.022	6.39	3.95%	0.010	3.05	1.73%	0.005	1.99	0.78%	-0.004	-1.65	-0.60%
FERROCA	Regional railway	0.973	10.52	297.54%	0.981	11.29	292.07%	---	---	---	---	---	---
RENFE	National Railway	1.299	17.36	446.32%	1.308	19.35	435.56%	---	---	---	---	---	---
METRO	Subway	-0.303	-5.67	-43.86%	-0.299	-5.79	-43.05%	---	---	---	---	---	---
COMPBUS	Company bus	0.539	8.26	135.65%	0.537	8.68	132.33%	---	---	---	---	---	---
CAR	Car	0.126	3.23	25.49%	0.103	2.70	19.96%	0.049	2.28	7.47%	-0.006	-0.29	-0.87%
BIKE	Motorbike/bicycle	-0.363	-5.51	-50.52%	-0.357	-5.55	-49.50%	---	---	---	---	---	---
WALK	Walk	-1.035	-19.35	-88.05%	-1.038	-21.07	-87.83%	---	---	---	---	---	---
NOTMOVE	Not move	-2.346	-7.35	-99.83%	-2.346	-10.12	-99.82%	---	---	---	---	---	---
C	Commute outside residence region	---	---	---	---	---	---	0.119	4.17	18.70%	1.310	29.93	331.71%
M	Residence change, 1986-1991	0.103	3.77	20.03%	1.263	31.56	569.26%	---	---	---	---	---	---
CONSTANT		-2.006	-19.22	-99.54%	-2.011	-20.97	-99.53%	-1.447	-15.98	-95.04%	-1.442	-16.70	-94.79%

TABLE 6: PROPORTION OF CORRECT PREDICTIONS FOR THE COMMUTING EQUATION

Threshold	% Right 0 Prediction	% Right 1 Prediction	% Total Right Predictions
0,50	97.83	18.53	85.54
0,155 (*)	69.58	77.86	70.04
Proportion of 1 in the sample: 15.49%			

(*): Selected threshold

TABLE 7: PROPORTION OF RIGHT PREDICTIONS FOR THE MIGRATION EQUATION

Threshold	% Right 0 Prediction	% Right 1 Prediction	% Total Right Predictions
0,50	95.07	44.49	83.57
0,227 (*)	78.50	74.26	77.53
Proportion of 1 in the sample: 22.70%			

(*): Selected threshold

FIGURE 1: LOCATION OF CATALONIA

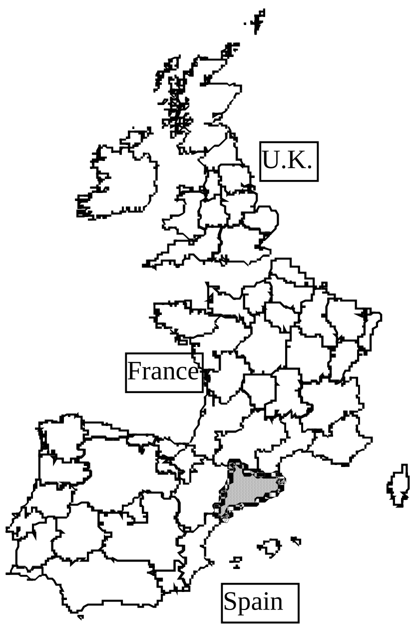
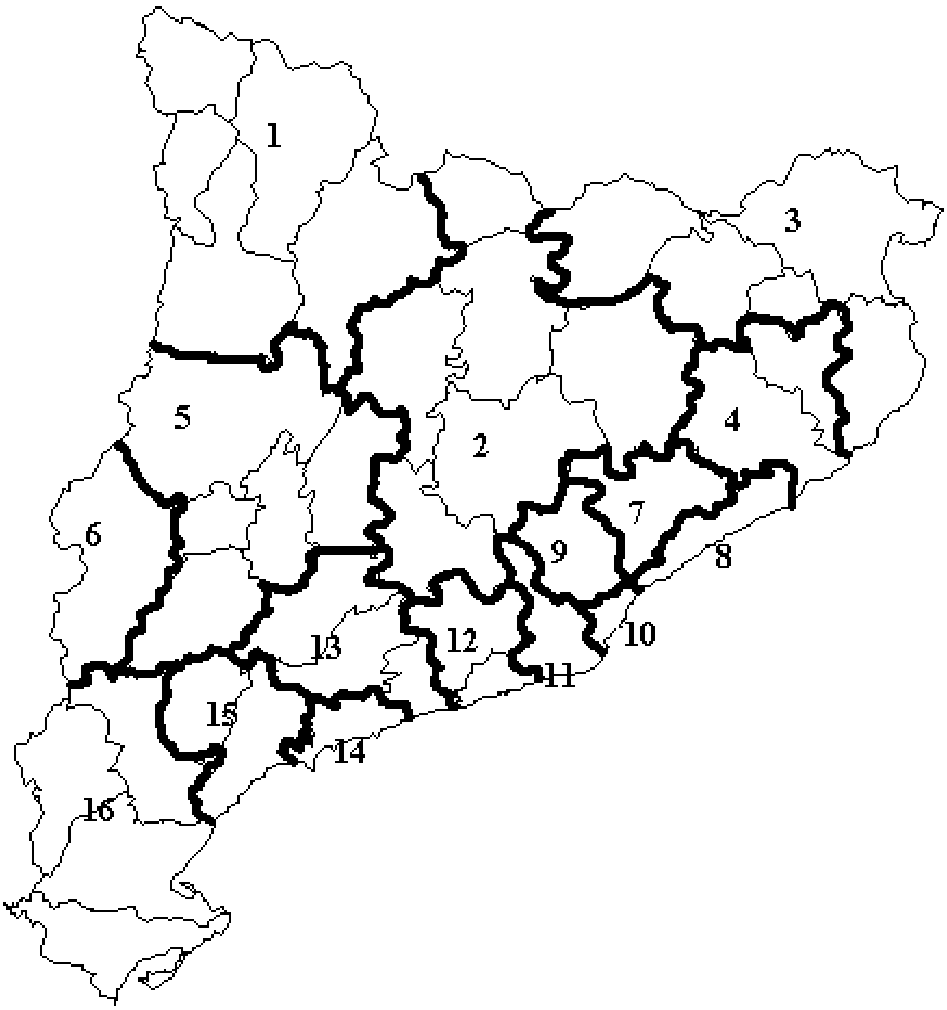


FIGURE 2:
COMARCAL COMPOSITION OF CATALONIA AND *SUB-REGIONS* USED IN THE ANALYSIS



1 Ponent
2 Comarques Centrals
3 Comarques de Girona
4 Gironès and Selva (includes municipality of Girona)
5 Ponent Nova
6 Segrià (includes municipality of Lleida)
7 Vallès Oriental
8 Maresme
9 Vallès Occidental
10 Barcelonès (includes municipality of Barcelona)
11 Baix Llobregat
12 Penedès
13 Camp de Tarragona
14 Tarragonès (includes municipality of Tarragona)
15 Baix Camp and Priorat
16 Ebre

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