Commuting In Ireland: An Analysis of Inter-County Commuting Flows

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Abstract: Commuting has become a much discussed policy issue in Ireland, as a consequence of a significant increase in the number of commuters and car users and the resulting increase in congestion. Despite this interest in commuting there has been little research on the causes of the increase in commuting and the pattern of commuting. This paper proposes a simple framework which links the decision of individuals to commute with the housing market, the labour market and commuting costs. Furthermore this paper investigates the empirical validity of the main predictions of this simple framework using a new data set on inter county commuting flows. The findings of the empirical analysis offer support for the analytical framework. Thus, relative wages and relative house prices between counties are important factors in determining commuting choice.

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1. Introduction

Over recent years the phenomenon of commuting, and particularly long distance commuting has become widespread. It is clear that the increase in commuting has high costs associated with it. For example the individual commuter faces higher transport costs and has less leisure time. The community looses out since less leisure time means that people are less likely to get involved in community activities and are less likely to interact with their neighbours. Nationally commuting reduces national income, as less time is available to work, increased commuting causes additional congestion which is reflected in less punctuality of workers, and increases transport costs to industry (see IBEC, 2002). Finally, high levels of car based commuting increase pollution levels. It is therefore not surprising that commuting has become the focus of a number of research papers over recent years. Commuting in and around the Greater Dublin Region has attracted particular attention since this region is experiencing extremely rapid economic and population growth that has resulted in tremendous problems with congestion (see Williams and Shiels, 2000, Williams, 2001 and Morgenroth, 2001). However, there has also been some recent interest in commuting throughout the country (see Horner, 1999).

These existing studies have focused on showing the extent of commuting, likely future trends and some of the possible causes of the commuting pattern. Thus, despite this recent interest, a detailed empirical study that has firm theoretical foundations has so far not been carried out. As a consequence concrete evidence on the processes that have led to this rapid increase in commuting has not been put forward. The commuting pattern is likely to be shaped by a number of interrelated factors. Thus, individuals choose where to work and where to live in way that maximises their welfare. Therefore, the labour and housing markets are of particular significance in determining the pattern and extent of commuting. This also implies that commuting is most readily analysed in an economic framework which analyses individual choices, while an ad hoc analysis that lacks a sound theoretical foundation is unlikely to uncover the complex interaction of different factors that give rise to the extent and pattern of commuting in Ireland. Furthermore, such an analysis is unlikely to be yield robust policy recommendations.

This paper is an attempt to formalise some of the underlying processes that ultimately lead to the commuting pattern that is currently observed. In doing so it proposes a conceptual framework that incorporates the main elements that are relevant in an individuals decision making. Furthermore, an augmented gravity model of aggregate inter-county commuting flows that incorporates these key variables is estimated using recent data. This paper therefore overcomes one of the main difficulties in empirical research on commuting in Ireland; namely lack of data.

The paper is organised as follows. Section 2 outlines some basic facts about the commuting. A conceptual framework of the factors that determine the decision of individuals to commute is outlined in section 3. An empirical model based on the conceptual framework is developed and estimated in section 4 and section 5 summarises the main findings and draws some policy conclusion.

2. Some Basic Facts

Before starting with the more serious analysis it is useful to review some of the basic facts about commuting such as the distance travelled and transport mode chosen. These are important variables since the costs of commuting that were outlined above increase with commuting distance and vary with mode of transport. Furthermore, changes in these variables indicate important trends that point to the likely future developments in the pattern of commuting

2.1. Commuting Patterns

In order to gauge the extent of commuting the data contained in the CSO Census of Population and the CSO Quarterly National Household Survey Travel to Work module, shed light on the commuting behaviour of individuals both in terms of distance travelled and transport mode used. However, one of the difficulties with the Census and QNHS data is that neither records the destination of travel which limits the usefulness of the data.

First of all the overall level of long distance commuting is shown in Table 2.1. The table shows the number of individuals in each county travelling more than 15 miles to work, both for 1991 and 1996. The table clearly shows that the numbers are quite large with over 140,000 individuals commuting more than 15 miles in 1996. More importantly, there has been an increase of 52% in these absolute numbers. Of course this increase might merely reflect an increase in the size of the labour force. However, the last two columns of the table show that the share of workers travelling more than 15 miles has increased. Finally the table clearly shows that long distance commuting is particularly prevalent in the rural counties that surround the major urban centres.

Table 2.1: Change in Absolute Numbers of Commuters Travelling Over 15 Miles, 1991 to 1996

	Total Number travelling 15 miles and over		absolute change	%change	Number travelling 15 miles or more as %ge of the total	
	1991	1996	91-96	91-96	1991	1996
Carlow	1,081	1,632	551	51.0	8.8	12.2
Dublin Co. Borough	2,171	4,013	1,842	84.8	1.3	2.2
Dun Laoghaire-Rathdown	1,929	2,956	1,027	53.2	2.8	3.9
Fingal	5,702	8,414	2,712	47.6	10.8	12.8
South Dublin	1,730	3,344	1,614	93.3	2.5	4.0
Kildare	7,904	12,756	4,852	61.4	19.5	24.8
Kilkenny	1,870	2,789	919	49.1	8.0	10.6
Laois	1,525	2,575	1,050	68.9	9.7	14.5
Longford	869	1,168	299	34.4	9.6	11.6
Louth	2,505	3,925	1,420	56.7	14.7	12.6
Meath	6,660	10,613	3,953	59.4	20.0	26.4
Offaly	1,986	3,095	1,109	55.8	11.4	15.7
Westmeath	1,596	2,510	914	57.3	8.1	11.3
Wexford	2,628	3,886	1,258	47.9	8.7	11.2
Wicklow	6,161	8,702	2,541	41.2	20.5	24.2
Clare	4,036	5,535	1,499	37.1	13.5	16.3
Cork Co. Borough	1,293	1,683	390	30.2	3.4	4.1
Cork County	9,251	13,978	4,727	51.1	10.0	13.2
Kerry	2,834	4,333	1,499	52.9	7.7	10.4
Limerick Co. Borough	1,233	1,403	170	13.8	8.2	8.2
Limerick County	4,773	6,599	1,826	38.3	13.2	16.0
Tipperary, N.R.	1,516	2,578	1,062	70.1	8.4	12.6
Tipperary, S.R.	1,945	3,087	1,142	58.7	8.5	12.1
Waterford Co. Borough	247	447	200	81.0	1.9	3.1
Waterford County	1,237	1,936	699	56.5	7.7	10.8
Galway Co. Borough	719	987	268	37.3	4.2	4.6
Galway County	5,560	8,255	2,695	48.5	13.7	18.4
Leitrim	920	1,266	346	37.6	11.7	15.4
Mayo	2,657	4,198	1,541	58.0	8.0	11.7
Roscommon	1,500	2,329	829	55.3	8.7	12.9
Sligo	1,522	2,240	718	47.2	8.6	11.3
Cavan	1,401	2,059	658	47.0	8.3	11.3
Donegal	3,148	4,617	1,469	46.7	9.1	11.8
Monaghan	1,118	1,770	652	58.3	6.9	9.8
State	93,227	141,678	48,451	52.0	8.2	10.9

Note: The above figures were calculated using the CSO Census of Population, 1991 and 1996.

It is generally accepted that commuting has increased in more recent times and it is therefore necessary to draw on other sources of data to establish the current extent of commuting. The Quarterly National Household Survey, Travel to Work (2000), contains more up-to date data on commuting but is again limited, in that it does not contain information regarding the destination of commuters and the data is only available by region. However, since the data refers to the same questions as those asked in the Census of Population it allows for a comparison between the situation in 1996 and that in 2000. However, due to slight differences in definition the figures for short distances are not fully comparable and threfore a comparison of those has only limited value. Importantly this does not apply for long distances in excess of 15 miles which are the major focus of this paper. Table 2.2 shows the distribution of commuting distances for residents in all counties again for two years, 1996 and 2000. As one would expect, the table shows that short distances to work are most common, while intermediate distances are least common. An interesting pattern emerges with regard to the regional differences in commuting distances in that long distances are particularly common in the Mid-East region. In terms of changes in distances travelled, journeys of less than one mile and those over distances in excess of 15 miles have been increasing, but this may be due to the differing definitions used in the two surveys. In other words some people have reduced their commuting distance while others have increased theirs.

Table 2.2: Percentage of Persons Aged 15 years and Over in each Region Classified by Distance Travelled to Work, 1996 and 2000

Region		1 < mile	1-2 miles	2-3 miles	3-4 miles	4-5 miles	5-9 miles	10-14 miles	15 miles and more	Not stated or no fixed distance
Dublin	1996	4.0	11.3	10.5	11.5	9.3	28.9	9.6	4.6	10.3
Dublin	2000	9.3	12.1	13.4	12.0	12.3	23.2	8.1	4.0	11.8
Mid-East	1996	9.0	13.0	6.1	4.4	3.5	13.5	13.4	25.1	10.4
Mid-East	2000	12.4	9.0	4.1	3.6	3.6	13.5	15.9	27.4	5.6
Mid-West	1996	14.4	14.0	8.7	7.4	4.5	13.0	8.8	14.3	14.8
Mid-West	2000	15.8	12.7	8.8	7.8	6.2	12.7	9.9	15.1	11.1
South-East	1996	15.6	18.1	9.7	6.3	3.7	12.4	8.6	10.4	15.2
South-East	2000	22.8	16.4	8.5	4.3	4.5	13.4	9.6	12.9	7.6
South-West	1996	13.6	14.7	9.5	8.0	5.1	15.6	7.8	10.6	15.2
South-West	2000	17.6	12.7	10.2	7.7	7.1	15.5	8.3	12.5	8.4
Border	1996	14.6	16.7	9.3	6.6	4.1	14.0	8.1	11.8	14.9
Border	2000	21.7	13.8	8.1	5.3	6.3	15.1	7.9	12.4	9.6
Midlands	1996	16.0	16.0	8.3	5.6	3.5	13.5	8.7	13.4	14.9
Midlands	2000	20.0	13.9	7.2	4.5	4.4	12.5	8.5	17.3	11.9
West	1996	17.8	14.2	8.4	6.4	3.8	12.7	7.6	13.1	16.0
West	2000	15.1	13.3	6.3	5.1	5.0	13.3	11.5	19.4	11.0
State	1996	11.0	14.0	9.2	8.1	5.8	18.5	9.1	10.9	13.3
State	2000	14.8	12.6	9.6	7.8	7.8	17.1	9.6	12.4	8.3

Source: Central Statistics Office, Census of Population, 1996, Volume 6 and Quarterly National Household Survey, Travel to Work, 1st Quarter 2000.

The data shown in Table 2.2 can also be used to calculate the total number of miles travelled every day and once one is willing to make an assumption about the average speed of travel the total time spent commuting can be calculated. For QNHS data for the first quarter of the year 2000, such a calculation shows that the total daily miles travelled were 9,845,696 miles, which at an average speed of 30 miles per hour would yield a 328190 hours as the total number of hours spent commuting. This can be converted into money value if one assumes that individuals could earn the national minimum wage if they spent their time working rather than travelling. Since the national minimum wage is currently €6 this would yield €1,969,140 each day or around €718 million per year[1]. Clearly this figure excludes costs such as the deterioration of the road surface, fuel costs, vehicle depreciation and environmental costs. While such a calculation is highly speculative and should not be taken too seriously as it depends on the assumptions made, it does nevertheless show that the costs of commuting are significant. It must also be noted that a reduction of commuting is not going to eliminate this estimated cost completely.

2.2. Transport Mode

The mode of transport used by individuals is an important variable since this has wide ranging policy implications. For instance, a high level of car usage results in higher levels of road congestion, which could be tackled either by building more roads or by persuading car users to use other modes of transport. However, a shift in transport mode is only feasible if there are adequate alternatives such as public transport which in turn might need to be expanded. A high level of public transport usage might also result in overcrowding of buses or trains which again would need to be addressed otherwise passengers may prefer to use private transport such as cars.

Table 2.3 gives a breakdown of the means of transport as measured by the percentage of those travelling to work who use each of the means of transport listed. This data is drawn from the 1996 Census of Population and the special module on Travel to Work in the Quarterly National Household Survey, 2000. The table clearly shows that the car is by far the most frequently used means of travel to work and that its share has grown substantially since 1996. Furthermore, public transport accounts for a small proportion of the total number

[1] This is roughly 0.8% of GNP.

of travellers, particularly outside of the Greater Dublin Region. In addition to this the share of workers using public transport is declining.

Table 2.3: Percentage of Those Travelling to Work by Means of Transport, 1996 and 2000

Region	Year	Car (driver)	Car (passenger)	Motor-cycle	Bus	Train or Dart	On Foot	Bicycle	Other or Not Stated	Working from Home
Dublin	1996	45.1	6.1	1.1	17.0	4.2	11.2	5.6	5.6	4.0
Dublin	2000	50.3	5.1	1.4	16.1	4.0	12.1	3.7	5.1	2.2
Mid East	1996	51.8	9.2	0.9	4.8	2.8	9.7	2.7	7.4	10.7
Mid East	2000	59.7	10.1	0.7	4.6	1.8	8.3	1.0	5.9	7.9
Mid-West	1996	46.7	10.5	0.7	3.7	0.1	11.7	2.7	7.8	16.1
Mid-West	2000	56.4	10.0	0.6	3.1	0.1	11.7	1.1	3.7	13.3
South-East	1996	49.8	10.9	1.3	2.1	0.2	13.2	3.5	9.2	19.5
South-East	2000	55.6	9.1	0.8	1.7	0.2	11.4	1.7	5.5	14.1
South-West	1996	47.9	9.3	1.0	3.6	0.3	12.1	2.2	8.3	15.2
South-West	2000	55.4	9.4	0.7	2.6	0.5	12.7	0.8	4.2	13.8
Border	1996	44.9	11.2	0.6	3.3	0.3	12.1	2.5	8.8	16.4
Border	2000	53.0	11.9	0.2	2.2	0.2	13.1	1.5	6.7	11.1
Midlands	1996	45.9	10.0	0.8	1.7	0.5	10.8	3.5	8.5	18.3
Midlands	2000	55.3	11.2	0.2	1.3	0.5	10.5	1.7	3.7	15.6
West	1996	45.1	9.6	0.5	2.8	0.1	10.7	2.5	8.7	19.9
West	2000	55.2	10.4	0.2	2.0	0.0	8.6	1.1	4.3	18.2
State	1996	46.3	8.7	0.9	7.6	1.7	11.5	3.6	7.4	12.3
State	2000	54.1	8.6	0.8	6.9	1.6	11.0	2.0	5.0	10.0

Source: *Central Statistics Office, Census of Population, 1996, Volume 6 and Quarterly National Household Survey, Travel to Work, 1st Quarter 2000*.

The increase in car usage is likely to be a result of a number of reasons. With increased prosperity, car ownership has increased dramatically over recent years. The dispersion of employment to suburban business parks, which are more difficult to reach with public transport than more central locations necessitates the use of the car. More dispersed settlement patterns, particularly outside of the major urban centres, have resulted in a smaller proportion of individuals having access to public transport. Finally, public transport is either seen as impractical, expensive and unreliable. Clearly, this increase in the use of the car has important implications. Car based commuting generates a higher level of pollution per person transported than any other form of land transport since it involves the use of a motor vehicle for the use of a small number of people. Furthermore, this increase in car usage also increases congestion which reduces the usefulness of roads, increases the cost of transport to the individual both directly through higher fuel costs and through longer time spent travelling and finally increases transport costs to industry, making Ireland less competitive and a less attractive location for foreign direct investment.

3. Explaining Commuting: A Conceptual Framework

In order to focus on the important features that determine the pattern of commuting it is useful to employ a theoretical framework. Instead of developing a fully specified formalised model, the main building blocks and interactions between these will be outlined in this section.

A substantial body of research, both theoretical and empirical, exists on the economics of job search activity by individuals (see Mortensen, 1986, Bloem, 1997). In this literature individuals maximise the discounted sum of future utility flows subject to a budget constraint and the random job offer process. The optimal strategy for the individual is to set some minimum reservation wage below which a job will not be accepted. This type of framework can easily be extended to incorporate space by allowing for job search in different regions and it is this framework that will be utilised in this section (see Rouwendal and Rietveld, 1994, Rouwendal 1999 and Gitlesen and Thorsen, 2000).

The starting point is an individual who is searching for a job. Whether he already has a job is not important for the analysis. As in the standard job search models this individual will want to maximise his discounted future welfare. This welfare depends on a number of factors including income and personal characteristics. He will receive job offers randomly but the probability of being offered a job depends on the intensity of job search activity. The probability of being offered a job in a particular location is not evenly distributed across space. Thus, some locations will offer more jobs and others less, reflecting differences in overall economic activity in these locations[2]. Of course since jobs are distributed across space even if all jobs offer the same wage rate, commuting costs will differ between locations which implies that income net of commuting costs will differ. Another factor that affects the welfare of the individual is the cost of housing which differs across space. Thus, commuting costs may not be overcome through migration as would be the case when housing costs are equal across space. Nevertheless, migration is also possible in this model.

The individual accepts or rejects a job offer so as to maximise his income net of commuting and housing costs. He may also take into account the probability of getting another offer and personal factors. This framework is useful in teasing out the interaction of commuting, the labour market and the housing market. To demonstrate this imagine that there are two counties A and B. In the absence of commuting costs the individual would prefer to work in A if he receives a higher wage in A. He would also prefer to live in A if housing costs are lower in A. However, the introduction of commuting costs complicates this decision. Thus, assuming the individual currently lives in B and housing costs are very high in A, then the wage difference between A and B must exceed the commuting costs if the individual is to accept the job. Of course if both housing costs and the wage are better in A than in B then the individual will move to A. It is clear that more complicated situations are also possible where the decision to move or commute depends on the difference between commuting and housing costs. Furthermore, individuals may try to move closer to areas with higher relative wages without incurring higher housing costs.

This simple framework thus indicates that the relative wage, commuting costs and relative housing costs are the factors that determine which job is accepted

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[2] This could also encompass scale effects where larger centres offer disproportionately more jobs.

and therefore what pattern of commuting emerges. The impact of these variables on the actual pattern of commuting needs to be explored empirically, which is the focus of the next section. Of course both the labour market and the housing market in Ireland has been subject to tremendous change over recent years so this analysis is particularly interesting.

4. An empirical Model of Commuting

The previous section outlined the main aspects that are taken into account in the decision making process of an individual who is looking for a job and who would, depending on the location of the job he is offered, needs to decide whether to commute, move or reject the offer. In this section some of the important variables that determine the decision are incorporated in an empirical model. Ideally, this should be a micro-econometric model that focuses on individual decision making. However, since appropriate micro level data is not available in Ireland it is necessary to move from the individual to an analysis across space namely an analysis of aggregate commuting flows between counties in Ireland. This is not unreasonable since this implies an aggregation over individuals so that average effects should still be measurable in such an aggregate framework.

4.1. Model

The empirical model must encompass the main features of the conceptual framework. Thus, it must incorporate commuting costs, relative wages and relative housing costs. A model that has traditionally been used to investigate commuting flows is the gravity model (see Sen and Smith, 1995). The gravity model relates the size of the flow (the number of people who commute) from location i to location j (e.g. two counties), to the distance between the two locations (counties) and a variable which measures “mass” of both locations (counties). This “mass” variable captures the strength of attraction of a location. Since a high mass in the origin location will determine the potential size of the commuting flow from that location this mass variable is entered for the origin and the destination locations. Distance is used as a measure of transport costs. This basic gravity model can be written as:

$$C_{ij} = D_{ij}^{\alpha} M_i^{\beta} M_j^{\gamma}$$

where C_{ij} denotes the commuting flow from the origin county i to the destination and M_i and M_j denote the mass of the origin and destination respectively and α, β and γ are parameters which need to be estimated. The parameters can then be estimated using ordinary least square. The parameter for distance is expected to be negative since one would expect the commuting flows to decline with increasing distance between the origin and the destination. The parameter for the destination mass is expected to be positive since a higher mass attracts a larger commuting flow. The sign of the parameter for the origin mass is expected to be positive since a higher origin mass will result in a higher absolute flow of commuters. However, since a higher mass in the origin will also constitute a force for preventing individuals from commuting thereby reducing the proportion of individuals who commute, the absolute size of the coefficient is expected to be smaller than that of the destination mass.

Clearly this model needs to be extended through the inclusion of labour market and housing market variables in order to reflect the conceptual framework. Thus, additional variables are added to the basic specification. Most importantly, the relative wage and the relative house price between the two locations were shown to be important determinants in the decision to accept a job in a particular location which also impacts on the commuting pattern. Thus, the relative wage and relative housing costs between two counties are added to the model which is then written as:

$$C_{ij} = D_{ij}^{\alpha} M_i^{\beta} M_j^{\gamma} RW_{ij}^{\sigma} RH_{ij}^{\phi}$$

where RW_{ij} and RH_{ij} denote the relative wage and the relative house price. Additional variables that are also likely to be relevant are the house price inflation, house completions, and relative unemployment rate. The former two variables are an indication of the demand and supply in the housing market while the latter indicates the tightness of the labour market.

In order to estimate this model it is usual to apply a logarithmic transformation, and the addition of a constant and a disturbance term. The model can then be written as:

$$\log C_{ij} = \theta + \alpha \log D_{ij} + \beta \log M_i + \gamma \log M_j + \sigma \log RW_{ij} + \phi \log RH_{ij} + e_{ij}$$

or

$$c_{ij} = \theta + \alpha d_{ij} + \beta m_i + \gamma m_j + \sigma rw_{ij} + \phi rh_{ij} + e_{ij}$$

where the lower case variables denote the variables in logarithms.

4.2. Data

The data contained in the Census of Population is not suitable for the estimation of a commuting belt around Dublin since it does not contain information regarding the direction of travel. For this reason it is necessary to draw on data made available by the Revenue Commissioners. This dataset is organised as a matrix of the total number of individuals resident in one county by county in which they work. This matrix contains a total of 702 (26x27 inter-county flows) elements which refer to a commuting flow from one county to another for the second quarter of 2000.[3] This data is therefore much more up-to-date than the Census data.

This data has the drawback that it is subject to measurement error since the employment is measured at the location from where the firm makes a tax return, which overcounts the employment in headquarters (from where tax returns are

[3] For the analysis presented here Tipperary could not be broken down into North Riding and South Riding and similarly Cork could not be broken down into city and county.

made) and undercounts the employment in branch plants and subsidiaries. Similarly, there may be some mismeasurement if individuals use a different address for tax matters than their usual address. However, in the regression framework outlined below mismeasurement of the dependent variable will not have any negative consequences.

As a measure of the 'mass' of the origin and destination counties ($M_{origin}, M_{Destination}$), the total number of resident workers is used. This means that up-to date figures on the population which are not readily available need not be used. Distance between counties is measured as the straight line (Euclidean) distance between the centroid of each county. While this may introduce some misemeasurement, especially if the majority of the population of one county live closer to the edge of the county. However, a population weighted centroid is in most case close to the one chosen on the basis of distance alone.

Finding appropriate variables to capture the housing market and the labour market is not straightforward. While incomes exist at county level these are not fully reflective of wage rates since they are subject to distortions through commuting. The only source of county wage rates is the Census of Industrial Production (CIP) that however, is limited to industry that neglects wages in agriculture, construction and services. Nevertheless, the wage levels in industry might reflect wage levels in other sectors since these compete for labour in the same labour market. The data from the CIP is only available up to 1998. However, the fact that this data is not fully up to date may not be much of a drawback since the aggregate commuting flows are a function of decisions made by individuals at many points in time, rather than just in 2000. In order to capture this adequately the relative wage rate is calculated as the average relative wage (RW_{ij}) between two counties for the period 1996 to 1998. It is expected that if the wage rate in the origin county is higher than in the destination county, fewer people commute which implies that the coefficient for this variable should be negative.

Similarly, information on house prices at the county level is not readily available. However, data collected by the Irish Permanent in relation to their mortgage business, that is used to construct the Irish Permanent House Price Index was made available. Again, this was constructed as the average relative house price (RH_{ij}) for the period 1996 to 2000. Again, the conceptual framework suggests that a county that has higher housing costs would attract fewer commuters since these would incur commuting costs on top of higher housing costs. Therefore, the coefficient for this variable is again expected to be negative.

While not in the conceptual framework, additional variables that reflect the state of the housing market can be added to the model. For example house price inflation has been a much discussed topic which is linked to commuting since commuters have generated extra demand for housing in some areas pushing up prices. Thus, counties with a higher relative house price inflation (RHI_{ij}) might also have higher numbers of commuters. Similarly, a high level of house completions reduces the pressure on the housing market and makes available housing units to commuters. Therefore, counties with high levels of house completions relative to the number of workers resident in that county (HC_{origin}) might have more commuters than those with fewer house completion. This variable is calculated as the sum of all house completions over the period 1996 to 1999, which was obtained from the Department of the Environment and Local Government, Housing Statistics. Finally, an additional variable to capture the state of the labour market in each county, namely the relative unemployment rate (RU_{ij}) can be entered into the model. Since recent county level unemployment rates are not available those for 1996 calculated from Census of Population data are used. Since this variable is not available for the period from 1996 this variable is clearly not reflective of recent differences in the labour market of the counties, however if the relative rates are constant then this variable may still capture some of the variation in labour markets.

In order to take account of specific factors which may be important for flows to or from a particular location it is possible to enter dummy variables which take account of these specific differences. In the model estimated below, dummy variables are entered for flows to the counties containing the major urban centres Cork, Dublin City, Galway and Limerick. Furthermore, a contiguity dummy is added which takes account of the higher flows between counties that share a common boundary.

4.3. Estimation and Results

The basic model can be estimated using ordinary least squares (OLS). However, since the commuting behaviour between counties is quite heterogeneous, many of the observed flows are quite small with only few larger flows. Furthermore, the data is of a discrete nature. Consequently, alternative estimators that take account of these characteristics may yield superior results to the simple OLS. Since many of the observations are very small, the commuting flows are not normally distributed the use of OLS may be questionable, since the mean may not well describe the central tendencies of the data, which can be better modelled using the Least Absolute Deviation method of estimation, which fits the model to the median rather than the mean of the data. Alternatively, a poisson model can be used. Therefore, all three methods, i.e. OLS, LAD and Poisson estimators are used, although the latter should be preferred. Clearly the estimation may suffer from deviations from the standard assumptions necessary for the methods to provide valid estimates, and in particular heteroscedasticity is likely to be a problem. This can be tested for using a simple LM test, and results of this test are reported for the OLS estimators.

The results of the estimation are shown in Table 4.1, Table 4.2 and Table 4.3. Overall, the model estimated using OLS and LAD explains 67 per cent of all commuting flows which is good considering that the explanatory variables are likely to be subject to substantial measurement error. The pseudo R-squared for the Poisson model is considerably lower but this can not be compared with the two other estimators. For the OLS estimator the test for heteroskedasticity indicates the residual is not homoskedastic while this appears to be much less of a problem for the LAD estimation. Consequently the standard errors for the OLS estimation are heteroskedasticity robust, as are those for the Poisson model.

As expected the coefficient for distance is negative, while those for the mass variables are positive. Thus, commuting flows decrease with increasing distance but increase with an increasing number of workers. As expected the coefficient for the origin destination is smaller than that for the destination population. For the OLS and LAD estimators the dummy variables for the destination counties Dublin and Galway are statistically significant and positive indicating that these counties attract larger numbers than other counties. In part of this may be explained by the nature of the data which records place of work at the place of the headquarter, this size of the coefficients suggests that there are other factors at work. In the case of Cork the results indicate that there are either fewer commuters travelling to Cork than might be expected or that there is no difference between Cork and the rest of the country. This might be explained by the size of Cork where most commuting is within the county, however the inclusion of the physical size of the destination county in the estimation does not change this result (these results are not reported here). A similar result is found for Limerick. Interestingly, for the Poisson model the coefficient for the Dublin dummy is negative but not significant while the sign and significance levels of the other coefficients is not affected by the use of the Poisson technique. Finally, flows between contiguous counties are higher than those for counties that do not share a common border.

The results show that the relative wage is indeed an important variable in the commuting decision with fewer people commuting from places with higher wages, as is suggested by the negative coefficient. Thus, workers who live in high wage areas work there rather than commute to low wage areas. The results on the relative housing costs are not conclusive even though the coefficient is negative as expected but it is not always statistically significant. This result would suggest that fewer commuters live in areas of high house prices. The weak results may be explained by the fact that the house price may in fact be endogenous which is suggested by the coefficient of the relative house price inflation which is positive and significant. This implies that more people commute out of areas with higher house price inflation. Of course the house price inflation may be the consequence of pressure on the housing market due to commuters. While house completions in the origin county increase commuting flows this effect is not statistically significant. Finally, the relative unemployment rate has a negative effect, implying that fewer people commute from areas of high relative unemployment, but this is only statistically significant in the case of the Poisson model. This is somewhat surprising but may be explained by the fact that the data only refers to those employed at that time. Thus, a finding of a negative impact could be entirely unrelated, or it may be point to a relative immobility of the unemployed, especially in the absence of convenient public transport so that they would not be able to commute to an area with lower unemployment.

Table 4.1: Results of the Gravity Model of Commuting Flows (2000)

Variable	OLS	OLS	OLS	OLS
Constant	-12.54 (1.12)*	-12.38(1.12)*	-12.50 (1.16)*	-12.50 (1.15)*
D_{ij}	-1.04 (0.13)*	-1.03(0.13)*	-1.04 (0.13)*	-1.04 (0.13)*
M_{origin}	0.77 (0.05)*	0.84 (0.06)*	0.78 (0.13)*	0.79 (0.13)*
$M_{destination}$	1.33 (0.08)*	1.25 (0.09)*	1.26 (0.10)*	1.25 (0.10)*
RW_{ij}		-0.50 (0.28)	-0.71 (0.28)*	-0.77 (0.31)*
RH_{ij}		-0.25 (0.22)	-0.45 (0.23)*	-0.50 (0.27)
RHI_{ij}			0.55(0.14)*	0.58 (0.17)*
HC_{origin}			0.07 (0.16)	0.08 (0.14)
RU_{ij}				-0.08 (0.23)
$D_{neighbour}$	1.40 (0.16)*	1.41 (0.16)*	1.41 (0.16)*	1.40 (0.16)*
D_{Cork}	-0.87 (0.18)*	-0.77 (0.19)*	-0.84 (0.19)*	-0.82 (0.19)*
D_{Dublin}	0.45 (0.27)	0.55 (0.26)*	0.49 (0.27)	0.48 (0.27)
D_{Galway}	1.11 (0.19)*	0.87 (0.18)*	0.58 (0.20)*	0.57 (0.20)*
$D_{Limerick}$	-0.21 (0.11)	-0.18 (0.12)	-0.33 (0.14)*	-0.33 (0.16)*
$\bar{R}^2$	0.66	0.67	0.67	0.67
$Logl$	-1075.7	-1072.6	-1066.8	-1066.7
LM Hetero test	7.29 (0.007)	8.38 (0.004)	7.21 (0.007)	7.33 (0.007)

Note: Standard errors in parenthesis are heteroskedasticity robust. * denotes that the coefficient is statistically different from zero at the 95% confidence level.

Table 4.2: Results of the Gravity Model of Commuting Flows (2000)

Variable	LAD	LAD	LAD	LAD
Constant	-10.96 (1.11)*	-10.62 (0.80)*	-11.91 (0.80)*	-12.14 (0.80)*
D_{ij}	-1.25 (0.09)*	-1.22 (0.09)*	-1.11 (0.09)*	-1.16 (0.09)*
M_{origin}	0.74 (0.05)*	0.81 (0.05)*	0.77 (0.10)*	0.87 (0.10)*
$M_{destination}$	1.28 (0.12)*	1.17 (0.07)*	1.24 (0.07)*	1.19 (0.08)*
RW_{ij}		-0.25 (0.21)	-0.66 (0.22)*	-0.87 (0.25)*
RH_{ij}		-0.36 (0.17)*	-0.68 (0.17)	-0.85 (0.20)*
RHI_{ij}			0.66 (0.12)*	0.75 (0.14)*
HC_{origin}			0.05 (0.10)	0.04 (0.10)
RU_{ij}				-0.50 (0.18)*
$D_{neighbour}$	1.34 (0.17)*	1.43 (0.12)*	1.58 (0.12)*	1.47 (0.12)*
D_{Cork}	-0.44 (0.28)	-0.21 (0.20)	-0.67 (0.20)*	-0.56 (0.21)*
D_{Dublin}	0.87 (0.32)*	1.01 (0.23)*	0.80 (0.23)*	0.71 (0.23)*
D_{Galway}	1.19 (0.25)*	1.23 (0.18)*	0.77 (0.19)*	0.55 (0.19)*
$D_{Limerick}$	0.12 (0.24)	0.24 (0.18)	-0.04 (0.18)	-0.04 (0.18)
$\bar{R}^2$	0.66	0.67	0.67	0.67
Logl	-1073.3	-1069.3	-1059.9	-1058.9
LM Hetero test	2.99 (0.08)	3.38 (0.07)	3.32 (0.07)	3.69 (0.06)

Note: Standard errors in parenthesis. * denotes that the coefficient is statistically different from zero at the 95% confidence level.

Table 4.3: Results of the Gravity Model of Commuting Flows (2000)

Variable	Poisson	Poisson	Poisson	Poisson
Constant	-2.12 (0.28)*	-2.05 (0.28)*	-2.09 (0.29)*	-2.09 (0.29)*
D_{ij}	-0.15 (0.04)*	-0.16 (0.04)*	-0.15 (0.03)*	-0.15 (0.04)*
M_{origin}	0.14 (0.01)*	0.15 (0.02)*	0.14 (0.03)*	0.13 (0.03)*
$M_{destination}$	0.27 (0.02)*	0.25 (0.03)*	0.26 (0.03)*	0.26 (0.03)*
RW_{ij}		-0.12 (0.07)	-0.16 (0.07)*	-0.17 (0.08)*
RH_{ij}		-0.03 (0.05)	-0.08 (0.05)	-0.08 (0.06)
RHI_{ij}			0.10 (0.04)*	0.11 (0.04)*
HC_{origin}			0.02 (0.03)	0.02 (0.03)
RU_{ij}				-0.02 (0.06)
$D_{neighbour}$	0.27 (0.04)*	0.27 (0.04)*	0.27 (0.04)*	0.27 (0.04)*
D_{Cork}	-0.20 (0.04)*	-0.18 (0.04)*	-0.19 (0.04)*	-0.19 (0.04)*
D_{Dublin}	-0.10 (0.07)	-0.07 (0.07)	-0.08 (0.07)	-0.08 (0.07)
D_{Galway}	0.14 (0.03)*	0.15 (0.03)*	0.10 (0.04)*	0.09 (0.04)*
$D_{Limerick}$	-0.04 (0.02)	-0.04 (0.03)	-0.07 (0.03)*	-0.07 (0.03)*
Pseudo $\bar{R}^2$	0.11	0.11	0.12	0.12

Note: Standard errors in parenthesis are heteroskedasticity robust. * denotes that the coefficient is statistically different from zero at the 95% confidence level.

5. Conclusions

This paper has investigated the pattern and extent of inter-county commuting in Ireland. It showed that long-distance commuting is increasing and that public transport is loosing out in favour of cars. These trends paint a bleak picture for the public in that they are likely to spend more time travelling to work due to congestion and increased commuting distance. Policy makers too will be unsettled by these trends in that difficult choices need to be made to address congestion problems.

The paper proposed a framework that ties the decision to commute together with the housing and the labour markets. This is important, since it is these interactions that can be used for policy making. For example, an active policy that ensures that affordable housing is available in the vicinity of areas with strong demand for labour will result in reduced commuting distances. Alternatively, policies that encourage the location of employment in areas where there is a demand for jobs will also reduce commuting distances. The results of the empirical model show that particularly the relative wage is an important determinant of commuting decisions. Thus, the extra earnings that can be achieved by commuting to other areas exceed the commuting costs. This fact coupled with the high level of congestion suggests that commuting costs may be too low, particularly around the major cities.

Clearly this analysis needs to be extended. Firstly, the conceptual framework needs to be formalised and this formal theoretical model will then need to be solved mathematically. This is likely to yield further insights into the interaction between the different variables. Secondly, the empirical analysis needs to be extended to account for the endogeneity of the housing market variable. This is likely to yield more precise estimates of their effects on commuting. Furthermore, the econometric model can be refined further to take account of spatial effects which are currently neglected.

While this paper has not dealt with the issue of transport modes this is clearly an important topic that merits further research. However, it is clear from that basic data that is available that individuals prefer the car. This might be due to the fact that public transport is inconvenient or even absent for many people or that they simply prefer the flexibility of their own car.

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