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How Local is Hospital Treatment? An Exploratory Analysis of Public/Private Variation in Location of Treatment in Irish Acute Public Hospitals

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Abstract: This paper undertakes an exploratory examination of the factors that affect where patients receive treatment from Irish acute public hospitals, with particular regard to the influence of patients' public/private status. National univariate statistics indicate that private discharged patients are slightly more likely to be treated outside their county of residence than their public counterparts. A multivariate model necessarily estimated at the county level provides indirect support for this finding for the category of day patients, but not for planned and emergency in-patients. The effects of the other patient characteristics also varied across the three models, although there was consistency in the impact of supply-side factors, such as the type and availability of services. As there appears to be some tendency for private day patients to have a slightly greater propensity to travel for acute public hospital treatment, further research is required to identify the reasons for this, as well as the consequences for public and private patients resident in the source and destination counties.

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1. Introduction

There has been much discussion of the unusual mix of public and private health care in Ireland (for example, Layte, 2007; Wiley, 2005a; Nolan and Nolan, 2004; Nolan, 2004; Department of Health and Children, 2001; Harmon and Nolan, 2001; Nolan and Wiley, 2000). This paper conducts a pragmatic empirical analysis which explores, for the first time, the public/private mix in the utilisation of local versus non-local acute public hospital services. *A priori*, all patients, irrespective of their public/private status, may be expected to prefer to be treated at a local hospital on the grounds of convenience when there are no other discernible differences between the local hospital and non-local alternatives. This paper tests that hypothesis by investigating whether there is any systematic relationship between the private/public status of discharges and the location of treatment. Any systematic relationship – be it positive or negative – would indicate that private patients were more or less likely than public patients to receive treatment within their locality of residence *ceteris paribus*. Other influences on the location of treatment (including other characteristics of discharges and the supply of services) are also considered. This analysis of the geographical flows of public and private patients provides valuable information for planning health care services and is particularly timely given the current plans for transforming acute hospital services in Ireland (Health Service Executive, 2006). While a full analysis of this planned transformation is outside the scope of this paper, one example of an initiative within this programme is the proposal to centralise specialist acute hospital services in the North East in a single regional hospital with routine elective and ambulatory services concentrated in local hospitals; and to rationalise services at the existing five public hospitals in the region (Health Service Executive, 2007; Teamwork Management Services, 2006).

The following section provides a brief overview of the factors that may influence the location of treatment, as well as the potential impact of patient flows on the provision of hospital care. The data and methods used in this study are outlined in Section 3. Section 4 presents univariate statistics on the extent of inter-county flows among private and public patients. These descriptive statistics identify a slightly higher propensity among private discharges to receive treatment outside their county of residence. The exploratory multivariate analysis in Section 5 provides some indirect support for this finding for one group of private patients. It examines, at the county level, the impact of private status on the proportion of discharged patients who are treated locally, controlling for other influences such as demographic characteristics and the type and availability of local services. Some conclusions are discussed in Section 6.

2. Location of Treatment: Influences and Impacts

Previous international studies have reached broad consensus on many of the key determinants of the location of treatment. No detailed studies have been conducted using Irish data, but there is no obvious reason why the general conclusions from the existing literature would not hold. Desirable hospital attributes, such as the range of services offered and affiliation with a medical school, were found to influence decisions regarding treatment location (Adams et al., 1991). It has been argued that while teaching hospitals are considered to have better facilities, they could also attract more complex cases (Propper et al., 2004). Distance is a key consideration, with most hospitals selected for their convenience (Mahon et al., 1993; Chernew et al., 1998; Klauss et al., 2005). Indeed, for some patients, distance from a hospital was negatively associated with the likelihood of receiving treatment (Nattinger et al., 2001). There is comparatively less agreement, however, regarding the impact of patient characteristics on the location of treatment. Chernew et al. (1998), for example, claim that patient characteristics do not directly affect the probability of receiving care at a particular hospital. In contrast, Matter-Walstra et al. (2006) conclude that emergency and elderly patients were more likely to be treated locally. In their descriptive analysis of variation in the delivery of health care, Gittelsohn and Powe (1995) suggest that the range of factors that affect hospital use include demography, morbidity, the availability and accessibility of medical resources, selection for care and the practices of medical staff. Using English data on hospital admissions, Propper et al. (2007) found that socio-economic status was associated with the distance travelled: poorer patients made fewer longer journeys, controlling for location.

The particular effect of privately-funded health care on the location of treatment has received considerably less attention in this literature, but the results that do exist suggest that it is an influential variable. Private bed designation has been associated with increased patient flows with private patients more likely to travel to be accommodated in a private bed (Matter-Walstra et al., 2006); and the search for quality health care resulted in greater patient flows among enrolees of a health maintenance organisation (Chernew et al., 1998). Another approach is to examine whether the perceived ability to exercise choice over location of treatment is a driver of the decision to purchase private health insurance. Although the specific subject of treatment location was not directly addressed in the survey for Ireland reported by Harmon and Nolan (2001), the ability to exercise choice in relation to consultant and the timing of care were considered to be important reasons for purchasing private health insurance.

On the supply side, the facility for patients to travel for care should exert pressure on providers to "raise their game" (Propper et al., 2006) by improving services to attract patients. This point is particularly pertinent in the context of the financing system for acute public hospitals in Ireland, where both hospitals and consultants have an economic incentive to maximise the treatment of private patients due to the differential reimbursement mechanisms for public and private patients (Simeons and Hurst, 2006; Colombo and Tapay, 2004a and 2004b; Nolan and Nolan, 2004; Gosden et al., 2001; Nolan and Wiley, 2000; Hurst, 1991; Donaldson and Gerard, 1989). In Siciliani's (2005) dynamic model, however, the increase in demand for a particular hospital induced by a reduction in waiting times subsequently puts pressure on waiting times, and thereby could entirely negate the effect of the initial reduction. Empirically, Dawson et al. (2004) found that the introduction of patient choice was associated with a convergence in waiting times, which fell in the hospital trusts participating in the initiative.

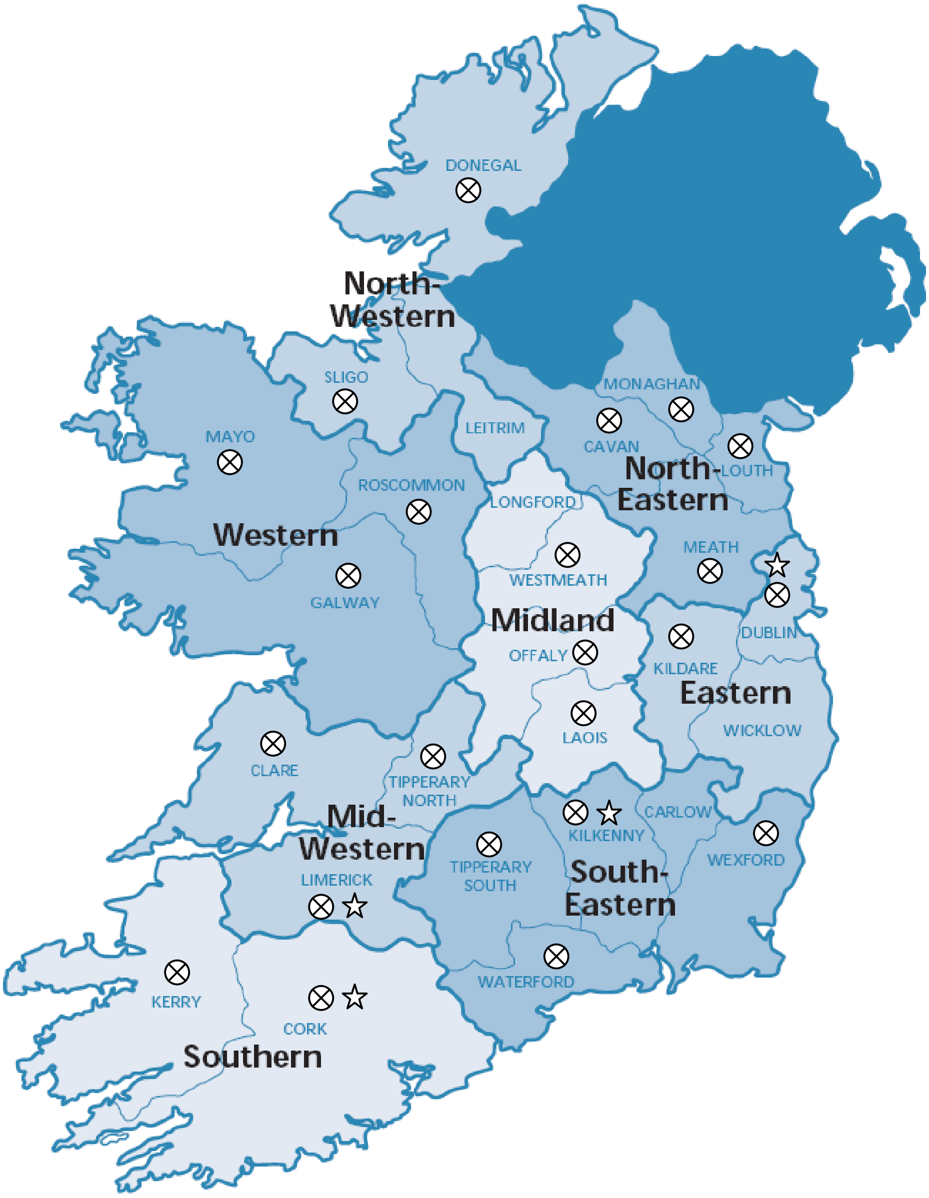
3. Data and Methods

The main data source used to analyse inter-county flows of public and private patients in Ireland was the Hospital In-Patient Enquiry (HIPE) Scheme, which collects administrative, demographic and clinical information on discharges from, and deaths in, Irish public hospitals. This analysis focuses on acute public hospitals in Ireland, all of which participate in HIPE. Hospitals were excluded from the analysis if they were long stay, did not report data for each year during the period under consideration (2000 to 2004), or did not have data available on beds.[1] Of the 61 public hospitals which potentially could be included in the analysis, just five were omitted on the basis of these exclusion criteria. The omitted hospitals accounted for less than 1 per cent of discharges reported to HIPE by public hospitals during the period of interest. This suggests that any potential sample selection bias arising from these exclusions will be small.

In considering the determinants of the location of treatment, a key factor is the geographical structure and distribution of acute public hospital services. Importantly, the Hanly report (National Taskforce on Medical Staffing, 2003) recognised “regional gaps in certain specialties” (p. 106). Furthermore, it is widely considered appropriate that some services (referred to as ‘national specialties’, such as organ transplants) are provided on a single site in the country. These factors suggest that it may be necessary for patients to travel outside their home county to receive treatment for certain conditions. Figure 1 shows the geographical distribution of the 56 acute public hospitals that were included in this study. The vast majority of counties possess at least one general hospital, but hospitals specialising in a particular specialty are only present in four counties located in the East and South. Dublin has the highest concentration of both general and special hospitals (for example, the two paediatric hospitals in Ireland are both located in this county). In four counties, there was no HIPE hospital included in this study.

[1] A small number of long stay hospitals are included in the HIPE scheme for historical reasons. During the period under consideration, two private hospitals reported data to HIPE. These hospitals were also excluded from the analysis. The exclusion of these and other non-HIPE private hospitals from the analysis means that it is not possible to examine the extent to which private patients travel for treatment to a private hospital.

Figure 1: Geographical Distribution of Acute Public Hospitals Included in this Study



Note: ⊗ denotes at least one general hospital included in the analysis. ☆ denotes at least one special hospital included.
Source: Amended from Department of Health and Children, 2003.

The type of data collected in HIPE has been discussed in detail elsewhere (O'Reilly and Wiley, 2007; Wiley, 2005b); thus, what follows concentrates on the particular aspects most important for this study. An important point is that the data are only available at discharge, not patient, level because unfortunately there is no unique patient identifier used within the Irish health system. The data therefore only permit examination of inter-county flows at the discharge, rather than the patient, level. The principal variable of interest for the purposes of this analysis is the public/private status indicator, relating to whether the patient paid for consultant care, on discharge, on a public or private basis. A detailed discussion of this parameter, and its imperfections, is contained in O'Reilly and Wiley (2007). As this variable was introduced into HIPE in 1999, the time period under analysis here is 2000 to 2004.

For this study, it is necessary to identify patients who were treated outside their county of residence. Although patient address is collected within hospitals, this information is not exported outside the hospital. Instead, the national data available through HIPE only state the county in which patients are usually resident.[2] Therefore, this analysis had to be undertaken at the county level, with the location of treatment defined as the county in which the relevant hospital is located. The analysis is based on 27 counties, with the county of Tipperary divided into North and South Riding.

Discharges from the 56 acute public hospitals included in the analysis were excluded if the patient's sex, marital status or medical card status were recorded as unknown; if they were usually resident outside Ireland; or where there were inconsistencies in the data record. These exclusions comprised 7.4 per cent of total discharges reported to HIPE by public hospitals over the period under consideration (or ignoring those who are usually resident outside Ireland, 6.8 per cent of total discharges). Given the relatively small proportion of discharges excluded from the analysis, the potential for any consequent sample selection bias is likely to be small.

Discharges were classified according to their county of residence and location of treatment. Discharges ordinarily resident within county *i* were divided into those who were treated within that county (hereafter referred to as locally-treated discharges) and those who were treated outside county *i* (non-locally treated discharges). For these groups of discharges, a utilisation index has been calculated (see Matter-Walstra et al., 2006; Klauss et al., 2005). The localisation index (LI_{it}) captures the proportion of discharges resident in county *i* in year *t* who were treated within their area of residence and is calculated as:

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[2] Although for discharges resident in Dublin postal code is recorded.

$$LI_{it} = \frac{Locally\!-\!Treated\ Resident\ Discharges_{it}}{(Locally\!-\!Treated\ Resident\ Discharges_{it} + Non\!-\!Locally\,Treated\ Resident\ Discharges_{it})} \times 100.$$

The localisation index takes a value between 0 and 100. A value of 100 would indicate that all resident discharges were treated locally. Conversely, a value of 0 implies that all resident discharges were treated outside their county of residence.

The following section examines the variation in the localisation index for public and private discharges and by patient type. The characteristics of those discharges treated locally are also compared to those treated outside their home county.

4. Univariate Statistics

4.1 Extent

At the national level, the majority of discharges reported to HIPE were treated within the county in which they usually resided. The localisation index for total discharges, reported in Table 1, was consistently around 71 to 72 per cent during the period under consideration: thus, less than three out of every ten discharges travelled outside their county of residence for treatment. If public/private status was not an influence in determining whether a patient is treated in their home county, then one would expect that similar proportions of public and private discharges would receive local treatment, *ceteris paribus*. However, the localisation index systematically differed for public and private discharges. In each year, a higher proportion of private discharges received treatment outside their area of residence: the localisation index was approximately 73 per cent for public discharges versus 68 per cent for private discharges – a gap of 4.57 percentage points in 2004 or equivalent to almost an additional 11,000 private patients. Although not particularly large in absolute terms, these differences were statistically significant.[3] While this finding is suggestive of a slightly higher propensity amongst private discharges to be treated outside their area

[3] Z-statistics in excess of 30.

of residence, this univariate analysis does not control for other factors, such as patient characteristics and the availability of local services, which may act as confounding variables. For instance, private discharges are typically younger and have a lower level of comorbidity than public discharges (O'Reilly and Wiley, 2007), and thus may be more able to travel for treatment. Therefore, multivariate analysis (conducted in Section 5) is required to more rigorously examine the impact of private status on the location of treatment, after controlling for these other influences.

Table 1: Number of Public and Private Discharges by Location of Treatment, 2000-2004

	2000	2001	2002	2003	2004	2000-2004 % Change
Public						
Locally-treated discharges (% of total)	395,458 (72.58)	433,945 (72.43)	452,185 (72.61)	474,550 (72.71)	495,997 (72.49)	25.42
Non-locally treated discharges (% of total)	149,425 (27.42)	165,153 (27.57)	170,562 (27.39)	178,152 (27.29)	188,189 (27.51)	25.94
Total (%)	544,883 (100)	599,098 (100)	622,747 (100)	652,702 (100)	684,186 (100)	25.57
Private						
Locally-treated discharges (% of total)	115,877 (68.45)	137,460 (68.85)	139,493 (68.31)	149,246 (68.09)	161,976 (67.92)	39.78
Non-locally treated discharges (% of total)	53,416 (31.55)	62,180 (31.15)	64,709 (31.69)	69,953 (31.91)	76,505 (32.08)	43.22
Total (%)	169,293 (100)	199,640 (100)	204,202 (100)	219,199 (100)	238,481 (100)	40.87
Total (Public and Private)						
Locally-treated discharges (% of total)	511,335 (71.60)	571,405 (71.54)	591,678 (71.55)	623,796 (71.54)	657,973 (71.31)	28.68
Non-locally treated discharges (% of total)	202,841 (28.40)	227,333 (28.46)	235,271 (28.45)	248,105 (28.46)	264,694 (28.69)	30.49
Total (%)	714,176 (100)	798,738 (100)	826,949 (100)	871,901 (100)	922,667 (100)	29.19

Note: Percentages are reported in parentheses.

Table 1 shows the differential growth rates for public and private discharges over the 5-year period. In 2004, total private discharges were almost 41 per cent higher than their level in 2000, whereas the growth in public discharges over the same period was much slower.[4] The rate of growth was almost identical for public discharges irrespective of whether or not they were locally treated. By contrast, non-locally treated private resident discharges recorded a slightly higher growth rate than their locally-treated counterparts (43 per cent and 40 per cent respectively). Thus, the gap in the proportions of public and private discharges treated locally increased marginally over the time period from 4.13 percentage points in 2000 to 4.57 percentage points in 2004. Given fixed resources, at least in the short term, this relatively rapid increase in the absolute number and proportion of private discharges being treated outside their county of residence may impact on the distribution of acute hospital resources between public and private patients in the whole country. Of those who travelled for treatment, approximately 66 per cent of public discharges and 70 per cent of private discharges were treated in a neighbouring county; again, the difference between the two groups does not appear to be especially large in absolute terms. These figures also indicate that most patients do not travel particularly far for treatment and may reflect distorting county boundary effects whereby patients are crossing borders to get to the nearest hospital. Unfortunately, in the absence of detailed data on patient address, it is not possible to further examine these boundary effects. What can be said is that, on average, almost identical proportions (approximately 16 per cent over the entire period) of public and private discharges resident in other counties were treated in Dublin. This shows that it is not the case, as is sometimes argued, that overall proportionately more private patients are travelling to the national capital, which has the highest concentration of acute public hospitals.

Table 2 presents the localisation indices for public and private discharges by patient type over the period 2000 to 2004. It shows that a higher proportion of emergency in-patients are treated within their county of residence, compared to day patients and planned in-patients. This unsurprising result is consistent with that found in other studies (for example, Matter-Walstra et al., 2006); for obvious reasons, the urgent nature of care required by emergency in-patients is likely to reduce their ability to travel for treatment. The figures in Table 2, though, indicate that the proportion of emergency in-patients treated outside their county of residence is still quite high in

[4] These differential growth rates have been discussed in detail in O'Reilly and Wiley (2007).

absolute terms. This inter-county flow of emergency in-patients may relate to the availability of local emergency services or boundary effects. Of the two categories of planned discharges – namely day patients and planned in-patients – the latter had the lowest localisation index and thus the highest proportion of resident discharges not locally treated.

Table 2: Localisation Index (%) by Patient Type and Public/Private Status, 2000-2004

	2000	2001	2002	2003	2004
Day Patient					
As % of Total Discharges	33.37	36.30	38.46	40.31	42.02
Public LI	71.31	70.60	71.14	71.37	71.15
Private LI	67.88	68.87	67.84	67.13	67.25
Difference	3.43	1.73	3.30	4.23	3.90
Planned In-Patient					
As % of Total Discharges	19.30	17.90	19.69	18.93	18.47
Public LI	63.28	63.39	64.88	65.23	65.15
Private LI	61.92	61.96	63.22	63.51	62.81
Difference	1.35	1.43	1.65	1.71	2.33
Emergency In-Patient					
As % of Total Discharges	47.33	45.80	41.85	40.77	39.51
Public LI	76.86	76.99	77.11	77.06	76.92
Private LI	72.52	72.51	72.26	72.05	71.99
Difference	4.34	4.48	4.85	5.02	4.93

Notes: LI, localisation index.
Calculated across all discharges, rather than as means across counties.
Difference refers to the difference, in percentage points, between the public and private localisation indices.

For each type of patient, the localisation indices for private discharges were consistently lower than those for public discharges, indicating that a higher proportion of private discharges were treated outside their county of residence compared to their public counterparts. These differences were only small in absolute terms, but were statistically significant.[5] The public-private gap in the localisation indices was larger

[5] Z-test statistics in excess of 8 for day patients, 4 for planned in-patients and 23 for emergency in-patients.

for day patients than planned in-patients. Surprisingly, the public-private gap for emergency in-patient discharges was always the largest of the three categories. Again, these results suggest a slightly greater propensity of private patients to travel at a national level, but as noted above, confounding factors need to be taken into account.

Figure 2 shows the annual ratios of localisation indices for private and public discharges for each county.[6] A value of unity indicates that identical proportions of private and public resident discharges were treated in their county of residence. A value in excess of (below) unity indicates that the localisation index for private discharges was greater (less) than that for public discharges. In each year across the three categories of discharges, the majority of observations had a ratio below unity, indicating that in most Irish counties, proportionately more private discharges went outside their county of residence for treatment. There were relatively few county-year observations in which the proportion of private discharges treated in their home county exceeded that for public discharges. Furthermore, Figure 2 shows there exists inter-county and temporal intra-county variability in the proportion of private relative to public locally-treated resident discharges, which may be a consequence of differential service provision both within a particular county over time and across counties. Evidently, there was more variation in the ratios across counties than in a given county over time, which may be expected given that county characteristics (including the type of services available) were unlikely to change considerably over the relatively short period of five years under examination. Of the three patient types depicted in Figure 2, there was a relatively higher number of observations for day patients where the localisation index for private discharges was greater than that for public discharges. In contrast, for emergency in-patients the ratios were almost always less than 1, indicating that on the basis of these descriptive statistics, private emergency in-patients were more likely to travel compared with their public counterparts in most counties in most years.

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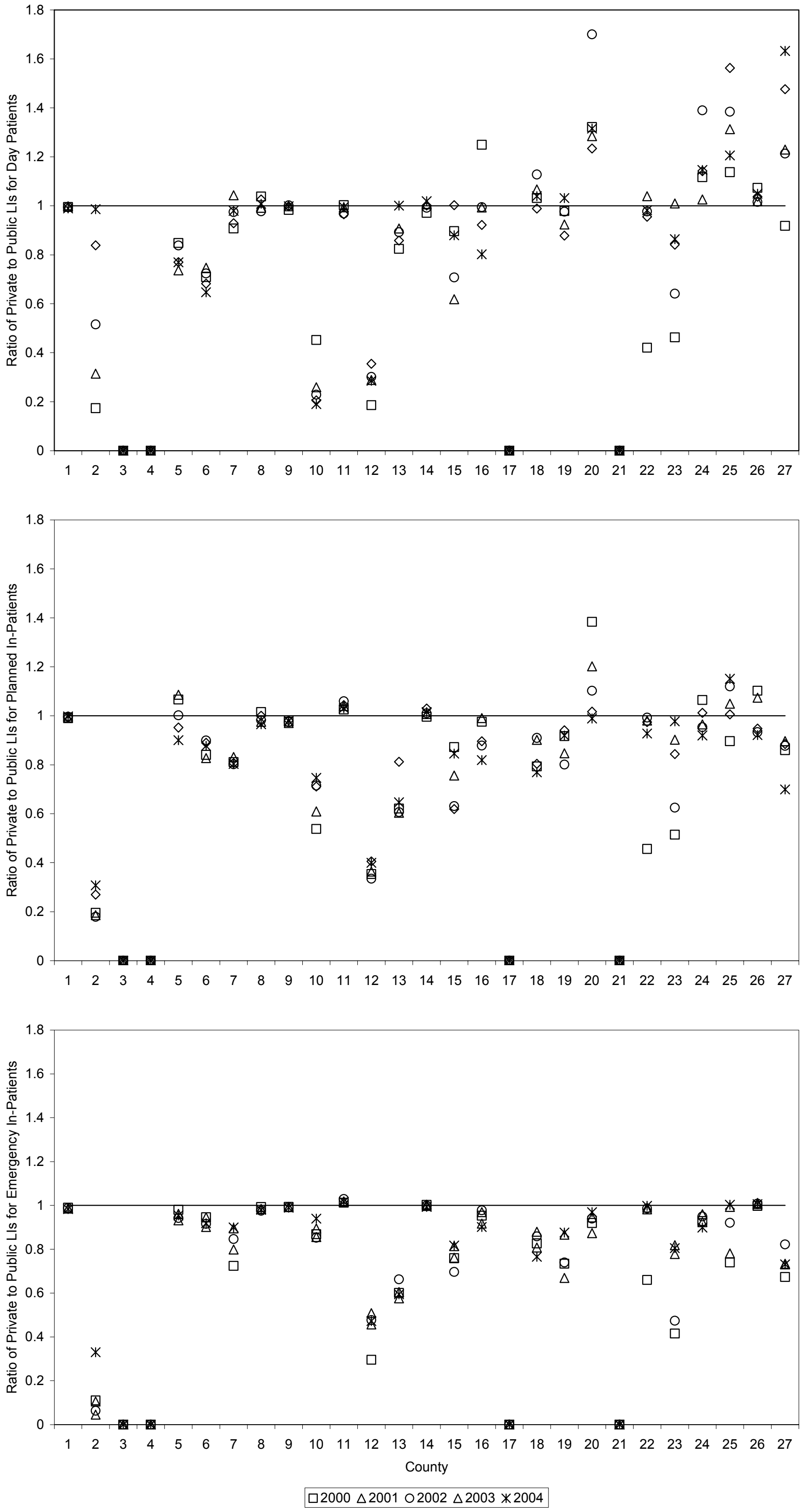
[6] These ratios were calculated as the proportion of private discharges treated in their county of residence divided by the proportion of public discharges treated in their county of residence. Thus, the ratios are $LI_{it}^{PR}/LI_{it}^{PU}$, where LI_{it} represents the proportion of resident discharges in county i in year t treated in their area of residence and *PR* and *PU* denote private and public respectively.

Figure 2: County Ratios of Private to Public Localisation Indices, 2000-2004



Notes: LIs, localisation indices.
Counties have been labelled by numbers to maintain anonymity.
These ratios were calculated as the proportion of private discharges treated in their county of residence divided by the proportion of public discharges treated in their county of residence. For counties where no resident discharges were treated locally (that is equivalent to a localisation index of zero), the ratio was set equal to zero.

4.2 Characteristics of Locally-Treated and Non-Locally Treated Discharges

The statistics presented in Table 3 reveal that, for both public and private categories, discharges treated outside their home county were younger and more likely to be male and non-medical card holders compared to their counterparts treated in their county of residence. Compared to their locally-treated counterparts, a slightly higher proportion of public non-locally treated discharges were married, while private non-locally treated discharges were marginally less likely to be married.[7]

[7] The noticeable differences between the characteristics of private and public discharges as a whole are examined in O'Reilly and Wiley (2007); the analysis here is only concerned with differences within each of these two groups between those who travelled for treatment and those who did not.

Table 3: Characteristics of Public and Private Discharges by Location of Treatment, 2000-2004

	Locally-Treated Discharges					**Non-Locally Treated Discharges**				
	N	**Age (years: mean, SD)**	**Male (%)**	**Married (%)**	**Medical Card Holder (%)**	**N**	**Age (years: mean, SD)**	**Male (%)**	**Married (%)**	**Medical Card Holder (%)**
2000										
Public	395,458	45.27 (25.55)	44.76	40.10	56.77	149,425	43.37 (24.99)	46.05	44.04	55.51
Private	115,877	42.07 (23.38)	41.45	57.05	7.72	53,416	38.96 (22.94)	41.54	56.91	5.88
2001										
Public	433,945	45.63 (25.22)	44.30	41.11	57.98	165,153	43.59 (24.75)	46.07	44.74	54.92
Private	137,460	43.17 (23.04)	42.37	58.85	12.44	62,180	39.81 (22.91)	42.61	58.06	9.70
2002										
Public	452,185	46.59 (24.89)	44.29	42.62	57.65	170,562	44.18 (24.63)	46.15	45.27	53.57
Private	139,493	43.19 (23.29)	42.15	58.10	14.15	64,709	39.33 (23.32)	43.50	57.03	9.45
2003										
Public	474,550	46.99 (24.90)	44.05	42.64	59.03	178,152	44.39 (24.78)	45.86	45.30	54.12
Private	149,246	43.67 (23.22)	42.07	58.66	15.75	69,953	39.81 (23.28)	42.65	57.47	10.85
2004										
Public	495,997	47.06 (24.89)	43.90	42.18	59.41	188,189	44.42 (24.66)	46.07	45.54	53.05
Private	161,976	44.18 (23.34)	42.56	58.63	16.95	76,505	40.38 (23.33)	43.47	57.77	12.14

Notes: Calculated across all discharges, rather than as means across counties. Includes day patient and planned and emergency in-patient discharges.
SD, standard deviation.
Standard deviations are reported in parentheses.

Non-locally treated public and private discharges had fewer diagnoses than their locally-treated counterparts, which is suggestive of a lower level of comorbidity, but underwent more procedures (see Table 4). This finding, together with the slightly older age profile of locally-treated discharges, is consistent with a higher level of comorbidity for the locally-treated group, on average, which may prohibit them from travelling and also from receiving surgical procedures. However, it is difficult to draw definitive conclusions from these figures because the size of the standard deviations in Tables 3 and 4 imply that the differences between those who are and are not treated locally are not statistically significant.

Table 4: Diagnoses and Procedures for Public and Private Discharges by Location of Treatment, 2000-2004

	Locally-Treated Discharges						Non-Locally Treated Discharges					
	N	Number of Diagnoses (mean, SD)	Number of Procedures (mean, SD)	Percentage of Discharges with: More than one diagnosis	At least one procedure	More than one procedure	N	Number of Diagnoses (mean, SD)	Number of Procedures (mean, SD)	Percentage of Discharges with: More than one diagnosis	At least one procedure	More than one procedure
2000												
Public	395,458	2.59 (1.59)	1.36 (1.12)	67.34	79.62	32.79	149,425	2.43 (1.49)	1.47 (1.10)	65.36	85.33	36.81
Private	115,877	2.40 (1.49)	1.55 (1.15)	64.26	85.66	40.05	53,416	2.26 (1.36)	1.64 (1.12)	63.31	90.02	42.81
2001												
Public	433,945	2.58 (1.61)	1.56 (1.17)	66.55	85.28	39.19	165,153	2.43 (1.51)	1.62 (1.13)	64.56	89.50	41.19
Private	137,460	2.45 (1.52)	1.69 (1.16)	65.20	90.08	43.72	62,180	2.31 (1.40)	1.76 (1.14)	63.91	92.62	46.77
2002												
Public	452,185	2.89 (2.12)	1.89 (1.69)	67.12	88.53	42.90	170,562	2.65 (1.92)	1.90 (1.62)	64.39	91.76	44.36
Private	139,493	2.72 (1.93)	2.06 (1.72)	67.52	91.88	48.78	64,709	2.52 (1.74)	2.11 (1.68)	65.32	94.49	51.51
2003												
Public	474,550	2.93 (2.17)	2.03 (1.84)	67.16	89.98	45.31	178,152	2.71 (1.99)	2.03 (1.77)	64.14	92.52	46.92
Private	149,246	2.76 (1.98)	2.23 (1.89)	67.78	92.97	51.30	69,953	2.58 (1.79)	2.26 (1.84)	66.22	95.15	53.69
2004												
Public	495,997	2.88 (2.17)	2.08 (1.87)	65.67	90.97	45.52	188,189	2.68 (1.99)	2.07 (1.81)	63.91	93.23	46.70
Private	161,976	2.74 (1.99)	2.28 (1.93)	66.57	93.58	51.38	76,505	2.56 (1.81)	2.31 (1.90)	65.17	95.57	53.52

Notes: Calculated across all discharges, rather than as means across counties. Includes day patient and planned and emergency in-patient discharges.
SD, standard deviation.
Standard deviations are reported in parentheses.

In summary, the preceding univariate analysis suggests that a slightly higher percentage of private discharges received treatment outside their county of residence than public discharges. This result holds irrespective of patient type; however, interestingly the private-public percentage-point gap is larger for emergency in-patients than that for day patients (although in all cases the absolute differences are not particularly sizeable). Compared to locally-treated discharges, both public and private non-locally treated discharges were younger, more likely to be male and non-medical card holders, and had fewer diagnoses, but underwent more procedures. Of those private and public discharges who travelled for treatment, a high proportion of both public and private discharges were treated in their neighbouring county, suggesting a potentially large county boundary effect which may distort the results.

The following section attempts to refine the identification of the effect of private status on inter-county discharge flows by undertaking regression analyses which controls for other demand- and supply-side factors.

5. Regression Analysis

5.1 Regression Model

Regression analyses were used to examine the impact of the proportion of resident discharges in county i in year t who were private on the localisation index for that county/year observation. Unlike the univariate statistics presented in Section 4, the regression analysis presented in this Section controls (inevitably imperfectly) for the effect of factors in addition to public/private status that may influence the localisation index. In the absence of a unique patient identifier, however, multivariate analysis has had to be undertaken with a unit of analysis (the county) which is more aggregated than the discharge-level unit used in the previous Section. With this aggregation, it is likely that some of the variation present in the raw data will be diminished.

The absence of a statistically significant relationship between the proportion of private resident discharges and the localisation index, after controlling for other factors including local availability of services, may suggest that the receipt of treatment in their home county is independent of a patient's public/private status. Conversely, any statistically significant relationship – either positive or negative – would imply that private status was an influential factor in explaining local treatment *ceteris paribus*.

Given the disparate results in the literature, other patient characteristics were included as independent demand-side variables in the regression models: namely mean age of resident discharges and mean age squared; the proportion of resident discharges who were male, married, held a medical card, had more than one diagnosis, and had at least one procedure; together with an index of county disposable income per person relative to the national average (Central Statistics Office, 2007).[8] Supply-side explanatory variables included the annual ratio of day patient and in-patient beds to population in county *i*; annual bed occupancy (for in-patient beds only); the number and type of hospitals in the county, as well as their teaching status.[9] The latter are only imperfect measures of the local availability of services. This model does not include variables to capture the specific types of services provided within county *i*.

[8] It may be argued that the relationship between the localisation index and age might be non-monotonic, in which case it could be more appropriate to use age groups, rather than mean age and its quadratic, as regressors. However, given the relatively small sample size as well as the relatively large number of explanatory variables already included, it was thought that it would be necessary to use broad age ranges, which would possibly not be a much more sensitive measure of the impact of age on localisation index.

[9] Data on bed occupancy were available for the period 2000-2003 on in-patients only (Department of Health and Children, 2003 and 2006). Estimates for 2004 were derived as the unweighted means over the period 2000-2003. The majority of these variables (such as number and type of hospitals and hospital teaching status) did not change over the relatively short timeframe under consideration in this study. The only exception was one hospital that changed its status in 2001. Thus, the remainder of these variables may be considered time invariant. Population estimates for the years 2000 to 2004 were obtained from the Population Health Intelligence System (PHIS).

In addition, the geographic size of county *i* was included as an independent variable to capture non-uniform distributions of patients and hospitals within a county (Central Statistics Office, 2003). Thus, this parameter tests whether residents in geographically smaller counties were more likely to travel for treatment simply because they were, on average, closer to a county boundary than residents in larger counties. Dummy variables were also included for health board/regional authority and year.[10] Fuller descriptions of the variables included in the regression models, and their sources, are contained in Appendix A.

To take account of potential differences in the extent to which location of treatment may be decided in advance, separate models were estimated for day patients, planned in-patients and emergency in-patients. *A priori*, it would be expected that the private status variable (the critical variable under review) may be correlated with some of these explanatory variables, especially some of the other patient characteristics. In the presence of such multicollinearity, it could be difficult to observe the true individual effects of the collinear variables. Thus, where the private variable was found to be individually statistically insignificant, joint tests of significance were undertaken to test for multicollinearity.

The dependent variable, the localisation index, was expressed in terms of proportions.[11] Models with proportional dependent variables can be estimated using ordinary least squares (OLS) if a logit transformation is performed on the dependent variable. However, it is not possible to perform such a transformation on a proportion that takes values of 0 and 1 as is the case with the localisation index. Therefore, as an alternative to OLS, the Papke-Wooldridge estimator was used (Wooldridge, 2002;

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[10] Ideally, data on consultant staffing would also be included in the regression models. Unfortunately, these data were not readily available at county level. While these data were available at health board/regional authority level (Comhairle na nOspidéal, 2001-2004), including this variable would not greatly increase information because the numbers would vary with the health board/regional authority dummy variables. This was confirmed by exploratory tests whereby variables capturing consultant staffing were found to be statistically insignificant. Therefore, the health board/regional authority dummy variables capture a variety of idiosyncrasies within health boards/regional authorities, such as staffing, and potentially may also act as crude controls for distance.

[11] This is in accordance with the definition used in Matter-Walstra et al. (2006) and Klauss et al. (2005). In the analysis presented in Section 4, the conventionally-expressed localisation index was multiplied by 100 for ease of expression.

Papke and Wooldridge, 1996).[12] One of the key assumptions in regression analysis is that residuals are independent. Moulton (1990) has suggested that this assumption may be violated when independent variables are aggregated. The analysis presented in this paper relates to 27 counties within eight health boards, and it is very possible that the localisation indices within each health board may not be independent. To take account of such intra-group correlation, the standard errors should be adjusted for clustering effects. However, robust cluster standard errors may be downwardly biased when the number of clusters is small (Donald and Lang, 2007), as appears to be the case here. Consequently, any intra-group correlation has instead been taken into account in this analysis by including dummy variables for health boards.[13]

The model framework adopted here implies that the characteristics of discharges will be used to explain one aspect of these discharges. While this is less than satisfactory, in the absence of detailed annual information pertaining to the demographic and, particularly, the health status of the population at risk (that is, characteristics of county populations as a whole), there is unfortunately no readily available alternative. (This issue is discussed in more detail in O'Reilly and Wiley, 2007.)

5.2 Regression Results

The results of the three localisation index regressions are presented in Table 6. The proportion of resident discharges who were private, the key parameter of interest in this analysis, was found to have an individually statistically significant negative effect on the localisation index in the day patient model. Thus, in counties where there was a high proportion of private resident discharges, there was a greater propensity for

[12] To model the proportional dependent variable, a generalised linear model was used with a logit link function and a binomial distribution of the dependent variable. The regression models had to be estimated with robust standard errors. To check the sensitivity of the results to the estimation technique, an OLS regression was also undertaken on the untransformed proportional dependent variable (even though it was acknowledged that using OLS on the transformed dependent variable may estimate predicted values which are outside the bounds of 0 and 1) and was compared with the marginal effects obtained from the regression with the Papke-Wooldridge estimator (see Appendix B). The OLS results and the marginal effects, as shown in Appendix B, are similar; indicating that the results are robust to the estimation technique.

[13] The intra-group correlation seemed to be small in all three models (0.09449 in the day patient model; 0.09704 in the planned in-patient model; and 0.11952 in the emergency in-patient model).

resident discharges to receive day patient treatment outside their county of residence, *ceteris paribus*. However, this parameter was not statistically significant in the other two models: a result which may be anticipated for emergency in-patients (despite the indications of the descriptive statistics), but seems contrary to expectations for planned in-patients. The lack of an individually statistically significant relationship between the proportion of private resident discharges and the localisation indices for the two in-patient models may be a result of multicollinearity, with the correlation between the private variable and other explanatory variables making it impossible to isolate the individual effects of the correlated variables. However, tests of the joint statistical significance of the private variable and other individually statistically insignificant variables in the two in-patient models did not indicate any jointly statistically significant effects, even at the 10 per cent level. Therefore, it is not obvious that private status is an influential factor in determining the location of treatment for the two categories of in-patients, which, as Table 2 shows, account for the majority of discharges reported to HIPE over the period under study.

The apparent impact of other characteristics of a county's resident discharges on the localisation index highlighted some interesting similarities and differences across the three models. The impact of age on the localisation index was found to differ depending on whether discharges were treated on a day patient, planned or emergency in-patient basis. In both the day patient and emergency in-patient models, age had an overall positive effect, indicating that counties with an older age profile of discharges had a higher localisation index. The opposite was the case in the planned in-patient model. This finding is consistent with the existing literature (Matter-Walstra et al., 2006). One of the age variables was statistically significant in the day patient model and both age variables were jointly statistically significant in the two in-patient models. The male variable had a negative coefficient in the two elective models, indicating that male discharges were more likely to be treated outside their county of residence, but the estimated coefficient was statistically significant only in the day patient model. In contrast, counties with a higher proportion of male resident discharges were statistically significantly more likely to have a higher localisation index for emergency in-patients. Marital status was not found to be statistically significant in explaining the localisation index in either the day patient or emergency in-patient models, but was so in the planned in-patient model.

As entitlement to a medical card is dependent on age, income or the presence of certain chronic conditions, it may be expected that medical card status may be correlated with these variables. Contrary to this expectation, however, the proportion of resident discharges who hold a medical card was found to have a positive and statistically significant effect on the localisation indices for planned and emergency in-patients, but no statistically significant effect in the day patient model. It is not certain that the day patient regression model reported in Table 6 will be able to isolate the true individual effect of the medical card status due to the potential multicollinearity between this variable and some of the other explanatory variables. In the day patient regression model, medical card status was found to be jointly statistically significant with the diagnosis variable (P-value = 0.0196), which is not surprising given that the latter was individually statistically significant, but jointly statistically insignificant with the age variables (P-value = 0.1704) and the income variable (P-value = 0.2138).

Comorbidity, captured as the proportion of resident discharges with more than one diagnosis, was a statistically significant factor in determining the localisation index in all three patient-type models. The results consistently indicated that a county's resident discharges were more likely to travel to be treated if a higher proportion of them had more than one diagnosis. While the proportion of resident discharges with at least one procedure had statistically significant effects in both in-patient models, the direction of these effects differed; the coefficient had a positive sign in the emergency in-patient model and a negative one in the planned in-patient model. The estimated coefficient on the relative county income index variable was negative in all three models, suggesting that where the level of disposable income per capita in a county is estimated to be greater than that of the State, residents are more likely to travel for treatment. However, this variable was never statistically significant.

Supply-side factors were found to have a consistent effect across all three models in line with expectations. The number of hospitals located in a county had a statistically significant, positive effect on the localisation index. As well as quantity, the type of hospital also had a statistically significant impact with counties with voluntary, county and regional hospitals consistently treating a higher proportion of their resident discharges. Conversely, but perhaps understandably, a county containing a hospital concentrating on the treatment of a single specialty statistically significantly reduced the localisation index. More surprising, though, was the finding that the presence of a teaching hospital – which some have argued is a proxy for quality in other countries (Allison et al., 2000) – in a county had a negative and statistically significant effect on the proportion of resident discharges treated locally in all three models.

Unsurprisingly, the ratio of beds to resident population in a given county had a positive and statistically significant impact in all three models. Occupancy, too, was found to have a positive and statistically significant effect but only in the day patient and emergency in-patient models. This result may be thought to be contrary to expectations as one might expect that patients would not be treated in counties with "full" hospitals. However, this finding may well reflect the alternative argument that counties possessing hospitals which have a high level of productivity and/or a high patient throughput are able to treat more patients locally and, therefore, maintain a high level of occupancy.

The coefficient on the county geographical size variable was estimated to be statistically significant in all three models, but its sign differed. In the elective day patient and planned in-patient models, the variable had a positive effect on the localisation index, but in the emergency in-patient model, the effect was negative. These results provide mixed support for the hypothesis that residents in geographically smaller counties may be more likely to travel to another county for treatment, at least partly because of boundary effects. The year dummies were individually and jointly statistically insignificant in all three models. Finally, almost all health board dummy variables were statistically significant, reflecting idiosyncratic differences across health boards, such as staffing.

In summary, the regression results suggest that both demand- and supply-side factors determine the extent to which Irish patients (both elective and emergency) will be treated within their county of residence. Of particular interest for this study, private status was found to negatively affect the localisation index, and hence increase the proportion of discharges travelling to another county for treatment, but only individually statistically significantly so in the day patient model. Indeed, the general importance of patient characteristics in the day patient model, in particular, suggests that this group of patients may have potentially greater influence over the location of their treatment and may also reflect their greater willingness to travel for care when they are being treated on a day patient basis, as opposed to being treated as an in-patient. This and other divergences in the results for day patients and planned and emergency in-patients suggest that these patient types need to be treated separately by researchers and policy makers. That said, in all three models, the provision and availability of acute hospital services on the supply-side were found to a greater or lesser extent to be important determinants of the prevalence of local treatment.

Table 6: Regression Results – Localisation Index

	Day Patient		Planned In-Patient		Emergency In-Patient	
	Coefficient	**Z-statistic**	**Coefficient**	**Z-statistic**	**Coefficient**	**Z-statistic**
Demand-side variables						
Private	-3.3897	-2.62***	-1.0432	-0.97	0.0749	0.05
Age	1.4744	1.68*	-0.6054	-1.41	0.0099	0.04
Age squared	-0.0151	-1.61	0.0049	1.11	-0.0026	-0.78
Male	-10.0881	-3.08***	-1.0038	-0.42	5.8695	1.71*
Married	4.1055	1.33	4.8012	1.67*	-6.3477	-1.38
Medical card	-1.2939	-1.62	1.6880	2.43**	3.7691	3.62***
Diagnosis	-3.2910	-2.38**	-3.2515	-1.97**	-2.5098	-1.76*
Procedure	-0.1747	-0.05	-1.7318	-1.80*	1.8750	2.44**
County income index	-0.0194	-0.77	-0.0170	-1.20	-0.0260	-1.38
Supply-side variables						
Number of hospitals	0.4204	5.27***	0.3597	11.56***	0.1577	4.19***
Voluntary hospital	0.9406	2.11**	1.9658	7.04***	1.4675	3.64***
County hospital	2.6984	4.68***	2.4231	7.88***	2.4654	5.81***
Regional hospital	3.9525	6.17***	2.2604	7.43***	2.2013	4.94***
Special hospital	-0.3664	-1.72*	-1.0960	-4.95***	-0.8722	-2.99***
Teaching hospital	-1.4065	-2.03**	-2.4226	-7.40***	-1.3143	-3.11***
Beds/10,000[a]	0.1973	2.34**	0.0782	9.77***	0.0645	6.03***
Bed occupancy	1.2616	2.03**	0.1500	0.40	2.6722	6.36***
Other variables						
County size[b]	0.0164	2.03**	0.0174	2.51**	-0.0262	-2.48**
2001	-0.0064	-0.05	0.0476	0.61	0.0735	0.58
2002	0.1245	0.76	-0.1693	-1.28	0.0020	0.01
2003	0.0435	0.24	-0.0472	-0.37	0.0327	0.18
2004	-0.0686	-0.35	0.0667	0.50	-0.0111	-0.05
Midland HB	2.0864	5.30***	1.6072	5.81***	0.1576	0.51
Mid-Western HB	1.5469	5.29***	1.8478	4.88***	1.3178	3.20***
North-Eastern HB	1.7410	4.02***	1.5870	6.63***	1.3372	4.47***
North-Western HB	2.3242	3.62***	1.2933	4.21***	1.6768	4.38***
South-Eastern HB	2.3717	5.17***	2.1362	6.61***	0.8398	2.01**
Southern HB	2.0290	3.43***	2.4256	5.87***	2.8780	4.98***
Western HB	1.5593	3.51***	1.6982	6.05***	1.9228	4.91***
Constant	-35.3221	-1.53	12.8168	1.34	-1.0469	-0.16

Table 6: Regression Results – Localisation Index (contd.)

	Day Patient	Planned In-Patient	Emergency In-Patient
N[c]	135	135	135
AIC	1.076	1.057	1.012
BIC	-355.443	-298.073	-427.335
Link test[d]	-0.0586	-0.0207	-0.0438
(P-value)	(0.472)	(0.815)	(0.743)
Joint significance of:			
Year DVs	2.38	6.15	0.57
(P-value)	(0.6667)	(0.1880)	(0.9661)
Age variables	4.31	29.00	27.29
(P-value)	(0.1160)	(0.0000)	(0.0000)
Health board DVs	54.67	64.65	76.11
(P-value)	(0.0000)	(0.0000)	(0.0000)

Notes: Dependent variable is the localisation index (divided by 100) in county *i* in year *t*. The localisation index is calculated as the proportion of resident discharges who were treated within their county of residence. Reference group: females; non-married; not medical card holders; public; year 2000; no voluntary, regional, county, special or teaching hospital; Eastern Regional Health Authority.

Regressions estimated with robust standard errors.

*** significant at 1 per cent level. ** significant at 5 per cent level. * significant at 10 per cent level.

AIC, Akaike Information Criterion. BIC, Bayesian Information Criterion. HB, Health Board. DVs, dummy variables.

[a] In the day patient model, this parameter relates to the number of day beds per 10,000 head of estimated county population. In the two in-patient models, this parameter relates to the number of in-patient beds per 10,000.

[b] For the purposes of illustration, the coefficients of this variable have been multiplied by 10,000.

[c] Number of county/year observations (1 observation = 1 county in 1 year).

[d] Statistic reported relates to test statistic for coefficient on the square of the predicted values. Link test was undertaken with a logit link function and a binomial distribution of the dependent variable.

6. Conclusion

This study used data from the Hospital In-Patient Enquiry (HIPE) Scheme to begin an investigation of the relationship between private status and the proportion of discharges treated in their county of residence. According to the univariate statistics, the localisation index (the proportion of discharges treated in their county of residence) was lower for private discharges than it was for their public counterparts, regardless of patient type. However, although private patients were found to be more likely to travel outside their home county for treatment, the difference in absolute terms was quite small. An exploratory regression analysis (indirectly) suggested that the association between the localisation index and private status differed according to patient type. In the day patient model, a statistically significant negative coefficient on the private status variable indicated that counties with a high proportion of private resident discharges had a low localisation index *ceteris paribus*, and hence a relatively higher proportion of locally-resident discharges not treated locally. Thus, the private status of a county's resident discharges apparently helps to explain some of the variability in the localisation index for day patients, even when other demand- and supply-side factors were taken into account, including the local availability of services. In contrast, the private status variable did not have an individually or jointly statistically significant effect in the planned or emergency in-patient models. Thus, there was no discernible association between private status and the location of treatment for in-patients, which account for the majority of discharges reported to HIPE over the period under investigation.

Consistent with some previous studies, other characteristics of patient discharges (such as age) were also found to affect the proportion of a county's resident discharges treated locally. Again, though, there were differences across the three patient-type models estimated. However, the association between local treatment and supply-side factors was, as may be expected, generally consistent across the different models. For instance, measures such as the number and type of hospitals and proxies for the availability of services were almost always statistically significant. Interestingly, teaching hospitals appeared to have a statistically significant negative effect on the localisation index, even though some studies for other countries have found that teaching status is perceived as a proxy for quality. On location of treatment, the results above also suggested that there were no discernable disparities between public and private discharges travelling to Dublin for treatment from other counties.

It should be reiterated that, given the nature of the data available through HIPE, this study has had to adopt a pragmatic empirical approach. In the absence of a unique patient identifier in the Irish health system, it was not possible to undertake analysis at the patient level using the HIPE data. It must therefore be assumed that the results of regressions at county level, based on aggregated averages and proportions of discharges, carry over to individual patients. The potential multicollinearity of the key explanatory variable is another problem in interpreting the regression results. Moreover, the lack of detailed information on patient address meant that it was not possible to include an explicit measure of distance in the model; and also forced the analysis to concentrate on inter-county discharge flows, which may be distorted by county boundary effects, leaving intra-county discharge flows entirely neglected. The analysis would also have benefited from the inclusion of other variables, such as family composition, which may help to explain local treatment but unfortunately were not readily available. Furthermore, the measures used to control for the availability of local services were focused on the number and types of hospitals and, therefore, are unlikely to perfectly capture the full range of public services available locally. Another limitation of the analysis was that it was not possible to examine the extent to which private patients travel for treatment to private hospitals. Finally, it is important to note that it is not possible to draw strong conclusions from the above analysis regarding access since the data used related to those patients who accessed acute public hospital services, but do not include those who did not or could not access these services.

These caveats aside, the potential consequences of the apparent differential in public/private patient flows identified in this paper are complex and require further research. It is reasonable to postulate that patients – whether public or private – wish to be treated in their home county where possible, except when the required services are not available locally or local services are perceived as being inadequate. The univariate and regression analyses presented above identified a propensity of one group of private patients (albeit a numerically small group) to receive treatment outside their county of residence. The results, then, imply that the potential inequality between public and private patients is actually manifest only for day patients – assuming that the multicollinearity issue is not serious, that the supply-side variables adequately capture the availability of local services, and that these findings at county level carry over to the individual patient level. *A priori*, though, it is difficult to explain the reasons for the negative relationship between private day patient status and the localisation index, and hence the implications for public and private discharges resident in the source and destination counties. The negative association between private status and local treatment must reflect some sort of disequilibrium between the type of local services available and those required by private day patients. This could be due to private patients being attracted by non-local services ('pull factors'), alternatively private discharges may seek treatment outside their county of residence because of high levels of utilisation of local services by other patients ('push factors'). Which set of factors dominate in reality affects the implications. For example, if push factors prevail, then private resident discharges would be crowded out from local services. The consequent pressure for non-local treatment of private discharges may result in an efficient allocation of resources if private discharges, who cannot be treated in their county of residence, were treated in another county where there was insufficient demand from local residents. Alternatively, such non-local treatment could crowd out public and/or private discharges resident in the destination counties. In short, while this study has established that there is an apparent relationship between private status and non-local treatment for one category of patient, further research is required to more specifically determine the factors impacting on this relationship, and its implications for private and public patients resident in the source and destination counties.

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Appendix A: Description of Variables

Table A1: Descriptions and Sources of Variables

Variable Name	Description	Source	Notes
Demand-side variables			
Private	Proportion of discharges resident in county *i* in year *t* who were private	HIPE	
Age	Mean age of discharges resident in county *i* in year *t*	HIPE	
Age squared	Mean age squared of discharges resident in county *i* in year *t*	HIPE	
Male	Proportion of discharges resident in county *i* in year t who were male	HIPE	
Married	Proportion of discharges resident in county *i* in year t who were married	HIPE	
Medical card	Proportion of discharges resident in county *i* in year t who were holders of a medical card	HIPE	
Diagnosis	Proportion of discharges resident in county *i* in year t with more than one diagnosis	HIPE	
Procedure	Proportion of discharges resident in county *i* in year t with at least one procedure	HIPE	
County income index	Ratio of disposable income per person in county *i* to that for the state in year *t*	Central Statistics Office (2007)	County income was included in the regression as an index value relative to that for the state. This takes account of the CSO's note that county estimates of disposable income per person are not always sufficiently robust and, therefore, they should be regarded as indicative of relative levels rather than as accurate absolute figures.

Table A1: Descriptions and Sources of Variables (contd.)

Variable Name	Description	Source	Notes
Supply-side variables			
Hospital number	Number of acute public hospitals in county *i* in year *t*	Derived from HIPE.	Number of acute public hospitals, participating in HIPE, located in county *i* in year t
Voluntary hospital	Dummy variable which is equal to 1 if there is at least one voluntary hospital located in county *i* in year *t;* 0 otherwise	Derived from HIPE.	Management authorities for this group of hospitals vary widely. Some are owned and operated by religious orders, others are incorporated by charter or statute and work under lay boards of governors. These are financed to a large extent by State funds (Department of Health and Children, 2003). In HIPE, joint board hospitals are categorised as voluntary hospitals.
County hospital	Dummy variable which is equal to 1 if there is at least one county hospital located in county *i* in year *t;* 0 otherwise	Derived from HIPE.	A county hospital is administered by a health board/regional authority and financed by State funds (Department of Health and Children, 2003).
Regional hospital	Dummy variable which is equal to 1 if there is at least one regional hospital located in county *i* in year *t;* 0 otherwise	Derived from HIPE.	As with a county hospital, a regional hospital is administered by a health board/regional authority and financed by State funds (Department of Health and Children, 2003).
Special hospital	Dummy variable which is equal to 1 if there is at least one special hospital located in county *i* in year *t;* 0 otherwise	Derived from HIPE.	A special hospital specialises in the provision of medical and surgical services in a particular area – such as maternity hospitals, cancer hospitals or orthopaedic hospitals.
Teaching hospital	Dummy variable which is equal to 1 if there is at least one teaching hospital located in county *i* in year *t;* 0 otherwise	Derived from HIPE.	A teaching hospital is considered to be located in county *i* if at least one hospital is categorised as a Group I hospital by the Case Mix Programme.
Day Beds per 10,000	Number of day beds per 10,000 members of the population in county *i* in year *t*	Department of Health and Children	Population data were prepared by PHIS and obtained from INISPHO.
In-Patient Beds per 10,000	Number of in-patient beds per 10,000 members of the population in county *i* in year *t*	Department of Health and Children	Population data were prepared by PHIS and obtained from INISPHO.
Occupancy	Proportion of in-patient bed days available that were used in county *i* in year *t*	Department of Health and Children (2003, 2006)	Figures for 2004 were calculated as the unweighted mean of the four previous years.
Consultant staffing	Consultant posts in health board/regional authority *j* in year *t*	Comhairle na nOspidéal (2001, 2002, 2003, 2004)	

Table A1: Descriptions and Sources of Variables (contd.)

Variable Name	Description	Source	Notes
Other variables			
County size	The measurement of the area of county *i* in hectares as reported in the 2002 Census of Population.	Central Statistics Office (2003)	These areas are exclusive of the areas of lakes, rivers and tideways.
Midland HB	Dummy variable which is equal to 1 if county *i* is located in the Midland Health Board; 0 otherwise	Derived from HIPE.	
Mid-Western HB	Dummy variable which is equal to 1 if county *i* is located in the Mid-Western Health Board; 0 otherwise	Derived from HIPE.	
North-Eastern HB	Dummy variable which is equal to 1 if county *i* is located in the North-Eastern Health Board; 0 otherwise	Derived from HIPE.	
Northern HB	Dummy variable which is equal to 1 if county *i* is located in the Northern Health Board; 0 otherwise	Derived from HIPE.	
South-Eastern HB	Dummy variable which is equal to 1 if county *i* is located in the South-Eastern Health Board; 0 otherwise	Derived from HIPE.	
Southern HB	Dummy variable which is equal to 1 if county *i* is located in the Southern Health Board; 0 otherwise	Derived from HIPE.	
Western HB	Dummy variable which is equal to 1 if county *i* is located in the Western Health Board; 0 otherwise	Derived from HIPE.	
2001	Dummy variable which is equal to 1 if the year is 2001; 0 otherwise		
2002	Dummy variable which is equal to 1 if the year is 2002; 0 otherwise		
2003	Dummy variable which is equal to 1 if the year is 2003; 0 otherwise		
2004	Dummy variable which is equal to 1 if the year is 2004; 0 otherwise		

Appendix B: OLS Regression Results and Papke-Wooldridge Estimator Marginal Effects

Table B1: OLS Regression Results

	Day Patient		Planned In-Patient		Emergency In-Patient	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Demand-side variables						
Private	-0.8477	-3.41***	-0.1415	-0.61	-0.2675	-0.76
Age	0.3094	1.87*	0.0264	0.40	-0.0272	-0.42
Age squared	-0.0031	-1.77*	-0.0005	-0.77	0.0001	0.08
Male	-1.1547	-1.65	-0.1815	-0.34	0.3658	0.72
Married	-0.1124	-0.16	-0.8449	-2.05**	-0.7272	-0.89
Medical card	-0.3681	-2.06**	0.0130	0.09	0.3118	2.19**
Diagnosis	-0.4011	-1.55	0.0871	0.20	-0.1360	-0.40
Procedure	-0.1339	-0.21	-0.2791	-1.22	0.1648	0.92
County income index	-0.0061	-1.09	-0.0042	-1.43	-0.0048	-1.14
Supply-side variables						
Number of hospitals	0.0471	3.45***	0.0259	5.11***	0.0216	2.84***
Voluntary hospital	0.1359	1.50	0.2143	3.22***	0.1214	1.48
County hospital	0.2001	1.98*	0.1203	1.71*	0.0721	0.80
Regional hospital	0.5250	5.04***	0.1378	1.93*	0.0095	0.09
Special hospital	-0.0552	-1.09	-0.0702	-1.55	-0.0999	-1.63
Teaching hospital	-0.3396	-2.56**	-0.1895	-3.02***	-0.2215	-2.78***
Beds/10,000[a]	0.0507	2.67***	0.0140	10.72***	0.0148	8.23***
Bed occupancy	0.1076	1.00	-0.1788	-2.20**	0.1565	1.74*
Other variables						
County size[b]	0.0060	2.90***	0.0053	3.64***	0.0026	1.34
2001	0.0186	0.59	0.0133	0.90	0.0114	0.46
2002	0.0212	0.57	-0.0141	-0.52	0.0167	0.50
2003	0.0026	0.06	-0.0041	-0.15	0.0190	0.51
2004	-0.0167	-0.37	0.0100	0.37	0.0191	0.47
Midland HB	0.1535	2.27**	0.0659	1.58	-0.0249	-0.39
Mid-Western HB	0.0833	1.35	0.1494	2.89***	0.1231	1.50
North-Eastern HB	0.1336	1.57	0.0691	1.63	0.0672	1.28
North-Western HB	0.1573	1.30	0.0793	1.99**	0.0460	0.80
South-Eastern HB	0.1782	2.23**	0.1032	2.37**	0.0042	0.05
Southern HB	0.0223	0.19	0.1134	1.56	0.1616	1.74*
Western HB	0.0305	0.37	0.0919	1.92**	0.0765	1.24
Constant	-5.9605	-1.38	0.8809	0.54	1.4422	1.06

Table B1: OLS Regression Results (contd.)

	Day Patient	Planned In-Patient	Emergency In-Patient
N[c]	135	135	135
R^2	0.9100	0.9571	0.9481
Link test[d]	-0.083	-0.005	0.055
(P-value)	(0.295)	(0.932)	(0.388)
RESET test[e]	21.57	9.87	26.81
(P-value)	(0.0000)	(0.0000)	(0.0000)
Joint significance of:			
Year DVs	0.47	0.60	0.09
(P-value)	(0.7547)	(0.6664)	(0.9857)
Age variables	2.82	8.08	5.01
(P-value)	(0.0644)	(0.0005)	(0.0083)
Health board DVs	1.62	1.45	1.76
(P-value)	(0.1375)	(0.1931)	(0.1036)

Notes: Dependent variable is the localisation index (divided by 100) in county *i* in year *t*. The localisation index is calculated as the proportion of resident discharges who were treated within their county of residence. Reference group: females, non-married, not medical card holders, public, year 2000, no voluntary, regional, county, special or teaching hospital, Eastern Regional Health Authority.

Regression with robust standard errors.

*** significant at 1 per cent level. ** significant at 5 per cent level. * significant at 10 per cent level.

HB, Health Board.

[a] In the day patient model, this parameter relates to the number of day beds per 10,000. In the two in-patient models, this parameter relates to the number of in-patient beds per 10,000.

[b] For the purposes of illustration, the coefficients of this variable have been multiplied by 10,000.

[c] Number of county/year observations (1 observation = 1 county in 1 year).

[d] Statistic reported relates to test statistic for coefficient on the square of the predicted values.

[e] Null hypothesis is that there are no omitted variables in the model. Statistic reported relates to F statistic.

Table B2: Papke-Wooldridge Estimator Marginal Effects

	Day Patient		Planned In-Patient		Emergency In-Patient	
	Coefficient	Z-statistic	Coefficient	Z-statistic	Coefficient	Z-statistic
Demand-side variables						
Private	-0.8393	-2.61***	-0.2192	-0.97	0.0185	0.05
Age	0.3651	1.68*	-0.1272	-1.42	0.0024	0.04
Age squared	-0.0037	-1.61	0.0010	1.12	-0.0006	-0.79
Male	-2.4979	-3.09***	-0.2109	-0.42	1.4525	1.71*
Married	1.0166	1.33	1.0088	1.69*	-1.5709	-1.38
Medical card	-0.3204	-1.62	0.3547	2.44**	0.9327	3.64***
Diagnosis	-0.8149	-2.39**	-0.6832	-1.97**	-0.6211	-1.76*
Procedure	-0.0433	-0.05	-0.3639	-1.80*	0.4640	2.43**
County income index	-0.0048	-0.77	-0.0036	-1.20	-0.0064	-1.38
Supply-side variables						
Number of hospitals	0.1041	5.30***	0.0756	12.37***	0.0390	4.19***
Voluntary hospital	0.2296	2.25**	0.4543	7.94***	0.3110	4.61***
County hospital	0.5287	6.98***	0.3859	11.19***	0.5366	7.98***
Regional hospital	0.6704	13.68***	0.5101	8.75***	0.4316	7.10***
Special hospital	-0.0890	-1.77*	-0.1911	-6.50***	-0.2141	-3.13***
Teaching hospital	-0.2995	-2.69***	-0.3122	-16.22***	-0.3105	-3.61***
Beds/10,000[a]	0.0489	2.33**	0.0164	10.39***	0.0160	6.01***
Bed occupancy	0.3124	2.03**	0.0315	0.40	0.6613	6.30***
Other variables						
County size[b]	0.0041	2.03**	0.0037	2.52**	-0.0065	-2.48**
2001	-0.0016	-0.05	0.0101	0.61	0.0181	0.58
2002	0.0309	0.76	-0.0348	-1.31	0.0005	0.01
2003	0.0108	0.24	-0.0099	-0.37	0.0081	0.18
2004	-0.0169	-0.35	0.0141	0.50	-0.0027	-0.05
Midland HB	0.4531	7.32***	0.3752	6.03***	0.0387	0.51
Mid-Western HB	0.3557	6.53***	0.4302	5.38***	0.2840	4.02***
North-Eastern HB	0.3952	5.08***	0.3706	6.83***	0.2917	5.38***
North-Western HB	0.4781	5.76***	0.3044	4.14***	0.3406	6.03***
South-Eastern HB	0.5039	7.43***	0.4857	7.54***	0.1965	2.19**
Southern HB	0.4290	5.15***	0.5382	8.06***	0.4490	11.78***
Western HB	0.3580	4.33***	0.3979	6.43***	0.3741	7.23***

Notes: Marginal effects were calculated at the means of the independent variables.
*** significant at 1 per cent level. ** significant at 5 per cent level. * significant at 10 per cent level.
HB, Health Board.
[a] In the day patient model, this parameter relates to the number of day beds per 10,000 head of the estimated county population. In the two in-patient models, this parameter relates to the number of in-patient beds per 10,000.
[b] For the purposes of illustration, the coefficients of this variable have been multiplied by 10,000.

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