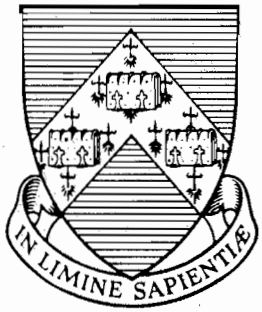

UNIVERSITY
OF YORK

INSTITUTE FOR RESEARCH IN THE SOCIAL SCIENCES
CENTRE FOR HEALTH ECONOMICS

Public Sector Costs of Caring for Mentally Handicapped Persons in a Large Hospital

by

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DISCUSSION PAPER 1

INSTITUTE FOR RESEARCH IN THE SOCIAL SCIENCES

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PUBLIC SECTOR COSTS OF CARING FOR MENTALLY HANDICAPPED PERSONS IN A LARGE HOSPITAL.

MAR. 1984

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Preface

The work presented in this paper forms part of a research project financed by the Department of Health and Social Security into the costs of alternative forms of care for mentally handicapped persons. The main aim of the project is to compare the costs of care in hospitals and in smaller units within the community. This paper concentrates on analysing the variation in costs between wards in one large hospital.

We would like to acknowledge the help provided to us by the officers of the District Management Team and the Unit Management Team for Mental Handicap in Lancaster. Acknowledgement is also made to the Department of Health and Social Security for a research grant to the Centre for Health Economics at the University of York. However, the authors take responsibility for any errors in the paper.

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Section 1

Introduction

This paper analyzes the total cost of individual wards in the Royal Albert Hospital, Lancaster during the financial year 1981/2. The hospital concerned provides care for over 800 mentally handicapped residents and the average cost per patient day is within a few pence of the national average for such hospitals. Furthermore since costs isolated are not distorted by the existence of an exceptional preponderance of residents of any particular age, sex or dependency level, the cost structures may be found to be representative nationally.

Our analysis has attempted to assess the total cost of wards at this hospital. As such we have widened the scope of the work to include not only N.H.S. costs but also the cost consequences of providing support to the hospital by the Local Education Authority and local Social Services Department.

The following section presents the methodologies used to allocate the costs from all three sources to ward level at the hospital. Table 5 brings together the results for all three cost centres and section 3 is a statistical examination of the variations found in the total cost per patient day between the different wards.

Initially it was hoped to include all wards at the hospital in the analysis. However, upon further examination three 'non-comparable' wards were excluded. The ward on which the hospital infirmary was based was excluded on the basis that it was primarily providing convalescent care for illnesses of an acute nature. A community unit set up outside the hospital and a minimally staffed community training unit inside the hospital were also excluded in order to avoid some unnecessary distortions in the costs of providing care for mentally handicapped people on 'normal' wards within a large specialist hospital.

Section 2 - Hospital cost allocation to ward level

2.1 Costs to the N.H.S.

The finance department of the Local Health Authority undertook, during the financial year 1981/2, a ward costing exercise covering the period 1st October 1981 to 31st March 1982. Although during this period 76.5% of total hospital expenditure was directly traced to ward level the difficulty of tracing certain costs meant that in some cases a different procedure had to be used to relate hospital costs to wards. Where cost allocations became necessary (for example with 'administration') then an 'appropriate' method of allocating central hospital costs was used. Cost allocations were not made to wards which were known not to use the particular service being allocated.

The aim of the ward costing exercise was to trace as high a proportion of hospital cost as possible to the individual ward concerned in order to minimize any possible distortion which may be introduced into the ward costings by the use of allocation procedures. In addition by tracing costs over such a lengthy period of time it is believed that any possible distortions introduced by the exceptionally heavy short-term utilization of any service by any particular ward will be evened out. The methodologies used in tracing/allocating different costs to ward level are given below.

Given the dominant role of nursing staff in determining total hospital cost, a great deal of effort was undertaken to accurately relate nursing costs to ward level. Time sheets were filled in weekly by all nursing staff covering a period of approximately five months. Thus it became possible to relate the cost of nursing staff directly to the wards on which they were working by allocating the total nursing expenditure of the hospital in proportion to the time spent by the nursing staff upon each ward.

A similar methodology of asking staff to quantify their input into each ward was used for Domestics, Physiotherapists, Psychologists, Occupational Therapists, Industrial Therapists and Chiropodists. The cost of laundry and linen services was traced to ward level on the basis of an analysis supplied by the hospital laundry concerning the weight of articles laundered from each ward.

Porters were in part directly traced and in part allocated. Where a porter was based solely upon one ward then the cost was allocated to that ward. Porters, with more general duties, were allocated equally to each ward in the belief that each ward would require the same number of visits/deliveries irrespective of its size. The same assumption of a constant number of deliveries irrespective of ward size was

behind the equal division of expenditure on transport between all the wards.

The drugs ledger was used to assess the actual cost of drugs used by patients from each ward and the proportion of drugs expenditure on each ward was also used to allocate the medical staff input to each ward. This approach was necessary because the medical staff were not able to accurately disaggregate the proportion of their time spent with patients upon each ward. As such, expenditure on drugs (held to indicate medical 'need') was felt to be the best allocation procedure available. In turn expenditure on medical and surgical supplies was disaggregated to ward level in relation to each wards transfer points.

Building and Engineering maintenance was traced to ward level in accordance with a schedule of regular maintenance provided by the engineer at the hospital. 'General Estate Expenses', 'Energy and Utility', and 'Grounds and Gardens' were all allocated to ward level on the basis of ward volumes. Patient numbers were used to allocate hospital expenditure to ward level for Pathology, Dental Staff Services, Optical Services and Catering Services provided to patients. Staff catering costs were split in proportion to nursing expenditure. The expenditure on miscellaneous para-medical services (primarily dieticians) was split in proportion to the special diet sheet provided by the hospital dietician, and miscellaneous expenditure (including domestic repairs and renewals, shop and cafe expenditure) was traced to individual wards in the case of ward based staff. 'General' hospital staff in this category was allocated to ward level upon a patient day basis.

The individual cost categories, traced in the above manner, are given in Table 1. Table 2 provides a summary and assesses the total unit cost to the N.H.S. of providing care upon the wards of this hospital. The average annual cost to the N.H.S. of supporting a patient in this hospital, as given in table 2, is £8,800. The range of ward costs, however, varies from £19,754 to £5,479. Thus standardizing average hospital cost to an index of 100 the cost index of the most expensive ward is 225 and the cost index of the least expensive ward is only 62. This massive inter-ward variation in cost emphasises the inherent dangers of analysing the costs of a large mental handicap hospital in the aggregate.

Table 1. Individual cost categories at Ward level £ - 1981/82

Ward	Medical & Dental	Nursing	Med. & Surg.	Pharmacy	Physio.	Psycho-logy	Occ. & Ind. Therapy	Misc. Paramed.	Catering	Laundry & Linen	Admin.	Domestic/ Cleaning	Portering & Transport	Estate Management	Misc. Services and expenses
1	3121	110471	248	1925	49	6529	-	222	14319	15567	5484	7801	6061	14397	5036
2	2619	106984	326	1563	50	-	-	278	18393	16197	7212	19010	6061	14513	6477
3	2582	106081	352	1527	582	158	33	392	19756	6042	7789	12841	3241	14556	6959
4	674	97050	235	335	-	-	821	345	13477	11582	5193	14848	3241	15241	4742
5	1903	70036	117	1188	417	3216	57	129	6989	7882	2596	21897	4428	24796	2454
6	3511	64683	196	2202	296	226	-	146	11042	11582	4327	10918	4428	24796	3888
7	3703	73325	339	2263	-	51	1446	486	18689	11582	7501	12964	4428	13878	6590
8	5314	163442	895	3313	2070	-	-	442	19738	12372	7501	26953	4428	35095	6940
9	1736	45909	52	1068	6849	4286	-	100	8079	3731	3173	18343	4428	28674	2846
10	3522	114769	222	2198	898	-	854	329	12997	10781	4904	12726	4428	17540	4569
11	4060	164419	196	2560	1080	4685	796	172	12203	11582	4327	16337	4428	19135	4276
12	5087	154580	600	3049	17	-	6837	496	33354	11290	13274	9850	4428	26706	11655
13	866	53157	287	438	-	-	1735	188	15710	3854	6347	5449	4428	19827	5542
14	8604	113386	574	5354	-	-	5706	431	31502	11582	12694	21555	4428	34800	11111
15	13486	195196	365	8628	3638	689	2083	275	21479	15345	8078	27383	4428	32828	7548
16	3970	162027	326	2442	73	6855	538	239	19035	11582	7212	23441	5798	19880	6692
17	2409	53966	117	1518	4275	11	208	82	6802	3114	2596	17184	4428	17464	2392
18	4272	105098	470	2576	928	51	877	793	25918	8692	10386	15463	4428	22743	9138
19	4005	75054	352	2455	-	664	1288	345	19395	12985	7789	19793	4428	17329	6839
20	2357	159445	352	1380	16	1056	3485	392	20377	11583	7789	22324	4428	17822	7167
21	4652	115398	2154	2894	6353	51	-	218	17806	18466	6924	26252	8355	34526	6368
22	1239	161062	157	738	2540	51	1166	124	10106	8950	3462	21740	4428	14370	3536
23	1945	62070	248	1158	49	-	2241	618	13756	11582	5481	12010	4428	14262	4848
24	3627	135565	522	2133	8	921	5462	583	29016	3854	11540	17863	4428	60382	10227
25	2947	90049	261	1805	1467	-	4256	212	14767	11582	5770	9663	4428	21766	5200
26	3046	176534	378	1818	1272	1506	4620	341	21948	11582	8366	28069	4428	22061	7719
27	4208	116049	610	2471	1132	51	5160	569	33592	11322	13559	27005	4428	38552	11849
28	2605	109284	339	1547	1212	51	1905	426	19107	14746	7501	19605	4428	21466	6730
29	2346	167585	352	1373	1022	677	4775	502	20473	9896	7789	16529	4428	28175	7198
30	10768	221882	418	6835	469	5297	110	439	24533	11683	9231	36625	12284	66271	8622
total	115184	3544466	12060	70754	36762	37082	56459	10224	554358	322590	215795	552440	146885	754651	195158

Table 2. Summary of N.H.S. Costs

Ward	Total Direct Services	Total Paramed.	Total General	Total Ward Cost to N.H.S.	No. of In-patient days	N.H.S. Ward Cost/ I.P. day	Annual Equivalent £
1	115765	6800	68665	191230	6935	27.57	10063
2	111402	328	87863	199593	9125	21.87	7983
3	110452	1132	71184	182858	9855	18.55	6771
4	98294	1166	68324	167784	6570	25.54	9322
5	73244	3762	71042	148048	3405	43.48	15870
6	70592	668	70981	142241	5475	25.98	9483
7	79630	1983	75632	157245	9370	16.78	6125
8	172964	2512	113027	288503	9428	30.60	11169
9	48765	11235	69274	129274	3895	33.19	12114
10	120711	2081	67945	190737	6205	30.74	11220
11	171235	6733	72288	250256	5355	46.73	17056
12	163316	7350	110557	281223	16910	16.63	6070
13	54748	1923	61157	117828	7848	15.01	5479
14	127918	6137	127672	261727	15878	16.48	6015
15	217675	6685	117089	341449	10220	33.41	12195
16	168765	7705	93640	270110	9005	30.00	10950
17	58010	4576	53980	116566	3285	35.48	12950
18	112416	2649	96768	211833	13260	15.98	5833
19	81866	2297	88558	172721	9855	17.53	6398
20	163534	4949	92930	260873	9975	26.15	9545
21	125098	6622	118697	250417	8760	28.59	10435
22	163196	3881	66592	233669	4318	54.12	19754
23	65421	2908	66367	134696	7055	19.09	6968
24	141847	6974	137310	286131	14538	19.68	7183
25	95062	5935	73176	174173	7420	23.47	8567
26	181776	7739	104173	293688	10523	27.91	10187
27	123339	6912	140207	270457	17035	15.88	5796
28	113775	3594	93583	210952	9490	22.23	8114
29	171656	6976	94488	273120	9673	28.24	10308
30	239903	6315	169248	415466	11680	35.57	12983
Total	3742464	140527	2741877	6624868	272346	24.33	8880

2.2 Costs to the Local Education Authority

The L.E.A. is involved in three forms of educational provision. The children resident at the hospital are provided with school places and adult provision may be in the form of either adult or further education. The costs, to the L.E.A. of these three sources of education are assessed in the following three sections.

a) Costs of the ESN(S) School Serving the Hospital

The hospital has an attached ESN(S) School. During the period of study the School had 49 children on roll between the ages of 8 and 19. 32 of the pupils were boys, 17 were girls and all but four of the pupils lived at the hospital.

Although this school is primarily financed by the L.E.A. there exists a certain degree of cross subsidization from the N.H.S. The school uses N.H.S. stores, catering facilities and many other services which would need to be specifically provided in an ESN(S) school located in the community.

The cost to the L.E.A. of the hospital school is given in Table 3. All costs refer to the 1981/2 financial year and are broken down between premises cost (maintenance, heating, lighting, cleaning etc.), furnishings, capitation, teaching staff and non-teaching staff. The cost of the latter two elements is the total cost to the L.E.A. of employing these staff inclusive of all employers' costs such as national insurance. The total cost to the L.E.A. was allocated to wards in proportion to the number of pupils taken from each ward.

Table 3. Total cost of the ESN(S) School 1981/82 (£/year)

Cost category	
premises	9900
furnishings	5
capitation	1159
teaching staff	107328
non-teaching staff	16187
Total	134579

b) The costs to the L.E.A. of providing Adult Education to residents at the Albert

Whereas the L.E.A. provides two teachers for Adult Education purposes at the Hospital, no other costs are incurred in the provision of Adult Education facilities. In respect of this study, the total cost to the L.E.A. of employing the senior teacher was £9267 (including superannuation etc.) while the junior

teacher cost £7848.

In order to allocate expenditure the Adult Education teachers provided a list of the residents at the Albert who were provided with Adult Education. These pupils were then traced to their wards and the staff cost allocated to these wards.

c) The costs to the L.E.A. of providing further education to residents at the Hospital

Further education is undertaken by hospital residents at local colleges. The residents attend ordinary classes causing no additional staff requirements at any of the colleges. Although no specialist courses are provided for the mentally handicapped, the D.E.S. pays the college 90p per student hour for the type of non-vocational classes undertaken by the residents. In order to estimate the cost of education received at the local colleges the number of contact hours between residents from each ward was estimated.*

In the ward level analysis it was assumed that each course undertaken by hospital residents lasted 30 weeks. This gave an estimated 5937 contact hours with local colleges which was costed at £0.90 per hour. In this way a total estimated cost to the D.E.S. of providing further education facilities to the hospital residents was produced.

As before the allocation of this cost to ward level was based on the actual number of contact hours spent in further education by the residents of each ward.

* This information was provided by the hospital administrator.

Table 4. Total L.E.A. cost at Ward level (£/year)

Ward number	ESN(S)	Adult	Further	Total
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	517	-	517
5	19245	86	-	19331
6	-	259	-	259
7	-	681	-	681
8	-	-	-	-
9	16419	-	-	16419
10	-	345	-	345
11	-	172	-	172
12	-	431	-	431
13	-	587	1350	1937
14	-	2184	445.5	2629.5
15	-	-	-	-
16	2692	-	-	2692
17	24763	-	-	24763
18	-	431	-	431
19	-	259	-	259
20	-	949	378	1327
21	2692	-	-	2692
22	-	86	-	86
23	-	-	-	-
24	-	1753	1012.5	2765.5
25	-	517	-	517
26	21936	673	108	22717
27	-	517	216	733
28	-	-	-	-
29	-	250	-	250
30	-	86	-	86
Total	87747	10783	3510	102040

2.3 Costs to the Social Services Department

The costs imposed by the residents of the hospital on the Social Services Department were of two kinds. Firstly, services (such as social work) which were geographically located at the hospital and secondly, services which were provided within the community but utilized by the residents of the hospital. The latter source was more difficult to evaluate as it became necessary to trace individual residents who used social service facilities into the community and then to allocate the cost of such utilization back to their wards at the hospital.

The only cost incurred at the hospital was that of social services staff providing social work support to residents. The total cost of this staff to the social services departments* (including national insurance, superannuation and travel reimbursement) during 1981/2 was £36180.

The social work input provided at the hospital appeared to be very much of a support service. Social work help was supplied as and when it was required by residents and their families. Since each resident was seen as being equally likely to call upon the specialist skills of the social worker and given the general 'supportive' nature of such social work staff, it was decided to allocate expenditure equally between residents. As such the allocation made to each ward depended upon the total number of patient days care provided in each ward.

The hospital concerned provided 296,499 inpatient days to its residents over the year which implied a social work cost of 12.2p per patient day. This amount was multiplied by the number of patient days upon each ward in order to isolate a cost allocation for each ward.

As mentioned above, costing the utilization of community social service facilities was expected to be much more difficult to assess. Comprehensive statistics on the number and type of social services utilized by residents of the hospital were not available. However given the high level of provision of occupational/social therapy by the Health Services at the hospital, utilization of community social service facilities was assumed not to be high. Indeed the only cost which could be isolated was that of one resident who attended the Local Authority Training Centre - at the cost to the social services of £44.05 per week (1981/82 prices). This cost was allocated to the ward on which the patient was resident.

* As provided by the Director of Social Services.

Table 5. Total public sector cost of large scale provision for the mentally Handicapped 1981/82

Ward	(£)N.H.S. Cost	(£) L.E.A. cost	(£)S.S. cost	No. of I.P. Days	Total ward cost (£) per I.P. day
	Childrens Wards				
5	148048	19331	415	3405	49.28
9	129274	16419	475	3895	37.53
17	116566	24763	401	3285	43.14
	Adult Wards				
1	191230	-	846	6935	27.70
2	199593	-	1113	9125	22.00
3	182858	-	1203	9855	18.68
4	167784	517	802	6570	25.75
6	142241	259	668	5475	26.15
10	190737	345	757	6205	30.92
11	250256	172	653	5355	46.89
12	281223	431	2063	16910	16.78
13	117828	1937	958	7848	15.38
14	261727	2629	4228	15878	16.92
15	341449	-	1247	10220	33.53
16	270110	2692	1099	9005	30.42
19	172721	259	1203	9855	17.67
20	260873	1327	1217	9975	26.41
21	250417	2692	1069	8760	29.02
22	233669	86	527	4318	54.26
24	286131	2765	1774	14538	19.99
26	293688	22717	1284	10523	30.19
27	270457	733	2079	17035	16.04
28	210952	-	1158	9490	22.35
29	273120	250	1180	9673	28.38
30	415466	86	1425	11680	35.70
	Wards for the elderly				
7	157245	681	1143	9370	16.98
8	288503	-	1150	9428	30.72
18	211833	431	1618	13260	16.13
23	134696	-	861	7055	19.21
25	174173	517	905	7420	23.67
Total	6624868	102039	35521	296499	22.81

2.4 Other potential sources of public sector cost incurred by the hospital

Only two potential cost centres not included in this analysis were mentioned by any of the N.H.S., L.E.A. or social service officials approached.

Firstly the L.E.A. provided an Autistic Centre which was used by mentally handicapped people in the local area. The utilization of this community facility by hospital residents was, however, very low (with only two residents using the centre over the past eight years). Given this low rate of utilization the cost of this facility was excluded from our analysis.

The second potential cost centre was an early diagnostic centre based in the community and used for the assessment of pre-school children. Given the very young age of the children involved very few of them were already residents of the hospital. For this reason this facility was also excluded from our final analysis.

Section 3 - Construction of a Ward 'costliness' index and explanation of variations in ward 'costliness'

3.1 Introduction

The initial aim of this section is to isolate factors which to some extent 'explain' variations in cost per patient day between wards. This is done by undertaking a multiple regression analysis utilizing data concerning variations in ward characteristics. The regression analysis provides an estimate of 'expected ward costliness' (dependent upon the characteristics of the ward included in the regression and the 'form' of the regression). Comparing actual ward costs with the computer generated estimate of 'expected' ward costs provides an estimate of the comparative 'costliness' of each ward.

It would obviously be impossible to include in the regression analysis all factors which could be expected to influence cost per patient day in each ward. As such we have to choose specific variables which are expected to exert the strongest and most systematic influence upon ward costliness. Once the impact of these 'explanatory' factors has been taken into account the remaining variations in ward 'costliness' may be highly dependent upon the individual circumstances facing each ward. In explaining variations in ward costliness it is possible that qualitative rather than quantitative analysis may become of primary importance.

One further use of this form of analysis is in the estimate of the expected cost level arising from the opening of a new ward of given characteristics. Given the 'characteristics' of the proposed ward and the nature of its patient set then an estimate of the expected cost level of the new ward can be constructed. Obviously such an estimate may vary from actual ward costliness owing to factors affecting the new ward alone (higher staffing ratios, more cost efficient design, etc.). If knowledge of such factors is available then the expected ward costliness figures can be adjusted accordingly. In addition one can use this form of analysis to assess the resources potentially saved by the closing of a ward. This second usage is perhaps more realistic in present circumstances.

3.2 Regression analysis of variations in cost per patient day

A large number of regression analyses of different forms were undertaken in an attempt to isolate the most significant variables. This procedure was undertaken for all wards as a whole and for a more homogenous sample of wards excluding those for elderly patients or children. Even more important than the results gained for individual regressions is the stability of the results gained from different specifications. Little confidence can be placed in rankings of ward costliness which alter significantly depending upon the form of the regression being

considered. In such a case the results gained may be little more than a series of random numbers given form by a particular functional specification. In the case where the underlying trend of results appear to be invariant with respect to the functional form chosen then greater confidence may be placed in the chosen rankings of ward costliness.

Three regressions are reported and analyzed in the main text, following two main forms of specification in the Linear regression form and the log-linear form. The results of other regressions are provided in appendix one. The Spearmans rank correlation coefficients estimated between the different regression analyses are given in appendix two. The comparative rankings between different regression analyses appear to be remarkably stable.

3.2.1 Linear Regression Results

It would appear from the regression results in Table 6 that the relationship between the costs and the proportion of people in different states of physical handicap and behavioural disturbance are not statistically significant. These variables were included to test whether they exerted an influence upon ward costs which was not adequately captured in the Wessex dependency classification. It would appear that they do not. The 'BEDSQ' variable was included to test for the possibility of a minimum cost bedstock at ward level. If such an optimum ward bedstock existed then ward cost per patient day would tend to be higher in wards above this optimum. The insignificance of the 'BEDSQ' variable implies that this may not be the case.

The dominant influence upon costs at ward level, as given by the regression analysis, is the average age of residents in each ward. As the average age of residents increases the cost per patient day at ward level falls. This result, however, may not be as straight forward as it appears.

One possible problem in Table 6 is the potential for multi-collinearity between the explanatory variables. 'Younger' residents tend to be the most severely handicapped (high WD 4%, high BDPC, high PHYPC) and be in the smallest wards (low Bed). Thus the age variable was dropped from the analysis to assess the impact that this had on the results which are set out in regression 2 in Appendix 1.

Omitting the age variable greatly increased the significance of the ward bedstock variables and the influence upon costs of the proportion of residents in Wessex dependency category 4. Given that almost all of the child residents are in small wards and are of Wessex dependency category 4 this is perhaps to be expected.

The inclusion of separate variables to measure both Wessex dependency classifications and behaviour disturbance/physical handicap (which are included in the Wessex dependency classification) was also held to be a potential source of multicollinearity. As such separate regressions were run excluding either the Wessex dependency classifications or the Behaviour disturbance/physical handicap terms. The ommission of the behaviour disturbance/physical handicap terms had very little impact upon either the shape of the regression or the significance of any of the other variables (this was perhaps to be expected given the insignificance of the terms omitted). The ommission of the Wessex dependency categories was, however, more significant. The results of the analysis run omitting the Wessex dependency terms is given in regression 3 in Appendix 1.

3.2.2 Log-linear Regression Analysis

The use of the linear form inherently assumes that the relationship between the explanatory and dependent variables was constant irrespective of their values. In effect this implies for instance that a given percentage reduction in age would correspond with a given percentage increase in ward costs. To test whether such an assumption appears to be supportable the analysis was rerun utilizing the log linear form.

The use of the log-linear form also necessitated additional changes to the analysis. The 'BEDSQ' variable had to be dropped given that in log form it was perfectly linearly related to the 'BED' variable. In addition all variables where a zero value occurs for particular wards (PHYPC, BDPC, WD3% and WD4%) had a constant 1% added to their values. This process surmounts the problems involved in logging zero values while at the same time not distorting the comparative relationship between each ward for these values.

The initial log linear analysis for each ward is given in Table 7. As in the linear analysis the negative relationship between age and ward costs appears to exert the most significant influence. Regression 5 (see appendix 1) presents the results with the age variable omitted. As with the linear analysis the primary impact of omitting the age variable would appear to be to greatly increase the significance of the negative relationship between ward costs and ward bedstock. Again omitting the variables concerning physical handicap and behavioural disturbance in the analysis made very little difference to the results. In order to compare the results with the linear regression analysis the results of omitting the Wessex dependency terms is given in regression 6 in Appendix 1.

3.2.3 Further refinements in the analyses

Two other methods were used in order to take account of the overpowering influence that the average age of residents exerts upon the level of ward costs. Firstly the analysis was undertaken excluding childrens wards (defined as those wards with an average residents age of less than 18) and wards for the elderly (defined as those wards with an average residents age of over 60). It is possible that exceptional results for these wards with extremely young or extremely old residents may be distorting the analysis. The effect of excluding childrens wards and wards for the elderly in a linear regression analysis is given in regression 7 in Appendix 1.

The results of this work indicate that the 'age' variable is still the major factor accounting for the variation in costs even when the extreme values found in childrens wards and elderly wards are excluded. When the age variable is excluded the bedstock variables attained increased prominence. Unfortunately the overall fit (as measured by R^2) of the regression is greatly reduced. As such this regression result is not reported here.

The data for 'adult' units is analysed in the log-linear form in Table 8. The age variable again dominates and the 'fit' of the regression is better than the unlogged formulations.

3.2.4 The use of Dummy variables

The second manner in which an attempt was made to examine the influence of residents age was by the use of 'dummy variables'. The wards were disaggregated into three different age categories. 'Childrens' units were defined as units where the average age of residents was below sixteen. 'Adult' units had an average age of residents between 16-65 and units for the 'Elderly' had an average age of residents of over 65. 'Dummy variables' assign a value of 1 to the presence and 0 to the absence of the attribute in question. In this analysis 'DUM 1' was '1' in the case of the three childrens wards and '0' for all other wards. 'DUM 2' was '1' in the case of the five wards for the elderly and '0' in all other other wards.

Regression 9 (see appendix 1) includes the dummy variable in addition to the age variable. This is to test whether 'childrens wards' and 'Elderly wards' have specific cost inflationary/deflationary effects which are not totally captured by the age variable. The dummy variable may possibly capture a difference in attitude towards the desired relative level of funding of the different types of ward. In using dummy variables we are, in fact, postulating that in certain types of wards (Childrens, Adult and Elderly) the intercept of the cost function will vary. This

model appears to be more realistic than assuming that attitudes towards funding the different types of ward would affect the slope and not the intercept of the cost function. Utilizing dummy variables upon both the intercept and the slope would be equivalent to running separate equations upon the three different 'types' of ward. The small number of childrens and elderly wards involved precludes us from doing this.

Thus for childrens wards the cost function becomes ....

TWCPD = (C + DUM1) + Bed + Bed sq....

and in the case of the wards for the elderly .....

TWCPD = (C + DUM2) + Bed + Bed sq....

In both cases the dummy variables fail to attain significance (see regression 9). Such a result should not, perhaps, prove surprising given the small numbers of childrens and elderly wards involved. The results, therefore, are primarily indicative in nature. In the case of childrens wards it would appear that their very nature implies a cost level (above that which would be expected given ward size and the age and type of patients) £3 per patient day higher than would be expected. The cost increase in the case of wards for the elderly appears to be almost double this.

Table 6.

Dependent variable : Total Ward Cost per Patient Day
(= N.H.S. + Educ.+Soc. Serv. Costs)

Independent	Estimated coefficient	T Statistics
C	29.3279	*1.81
BED	-0.4017	-0.47
BEDSQ	0.0030	0.23
AGE	-0.2949	*-2.02
OCC %	0.1571	0.87
PHYSHAN %	0.0038	0.08
BEHAV %	-0.0463	-0.62
WESDEP 3%	0.1375	1.28
WESDEP 4%	0.0841	1.31

Adjusted R-squared = 0.494

Number of observations = 30

* signifies t statistic significant at 5%

Definition of variables

Bed = Number of beds on Ward

Bedsq = (Number of beds on ward)^2

AGE = Average age of residents on ward

OCC% = Average percentage bed occupancy upon each ward

PHYSHAN % = Percentage of residents with a physical handicap

BEHAV % = Percentage of residents exhibiting behaviour disturbance

WESDEP 3% = Percentage of residents classified as Wessex dependency level 3.

WESDEP 4% = Percentage of residents classified as Wessex dependency level 4.

Table 7.

Dependent variable: Log of total ward cost per patient day

Right hand variable	Estimated coefficient	T-statistic
C	3.0191	1.54
LBED	-0.1841	-1.02
LAGE	-0.3764	* -2.36
LOCC	0.4289	0.91
LPHYSHAN %	0.0080	0.25
LBEHAV %	0.0077	0.17
LWESDEP 3%	0.0189	0.34
LWESDEP 4%	0.0638	1.53

Adjusted R-squared = 0.514

Number of observations = 30

* = significant at 2½% level of confidence

Definition of variables

LBED	=	Log of number of beds on Ward
LAGE	=	Log of average age of residents
LOCC	=	Log of average percentage bed occupancy
LPHYSHAN %	=	(Percentage +1) of residents with a physical handicap
LBEHAV %	=	Log of (percentage +1) of residents exhibiting behavioural disturbance
LWESDEP 3%	=	Log of (percentage +1) of residents classified as Wessex dependency level 3.
LWESDEP 4%	=	Log of (percentage +1) of residents classified as Wessex dependency level 4.

Table 8.

Dependent variable: Log of total ward cost per patient day

Right hand variable	Estimated coefficient	T-statistic
C	2.8985	0.59
LBed	-0.1656	-0.67
LAGE	-0.4266	-1.35
LOCC	0.5000	0.46
LPHYSHAN %	0.0136	0.35
LBEHAV %	-0.0035	-0.06
LWESDEP 3%	-0.0022	-0.03
LWESDEP 4%	0.0663	1.35

Adjusted R-squared = 0.323

Number of observations = 22

Definition of variables

- As in Table 7 but with data restricted to adult units.

3.3 Construction and use of a ward 'costliness' index - existing wards

Table 9 compares the rankings of absolute ward cost with the ward costliness figures derived from the regression analyses presented in Tables 6-8. Ward costliness is defined as ...

$$\frac{\text{Actual ward costs}}{\text{Expected ward costs}} \times 100$$

... where 'expected' values are predicted from the results of the regression analysis.

It would appear from the comparative ward rankings that in each case the regressions are reflecting a similar trend of underlying 'costliness' between wards.

Of all the analyses performed, the results presented in Table 7 appear to explain the highest proportion of variations in cost per patient day between wards. The results gained from this logged form of regression are utilized to construct the 'costliness' indices analyzed in this section.

Explanations for the variations in 'costliness' of individual wards will depend in large part upon the individual circumstances facing the ward. The circumstances facing the six 'most costly' and the six 'least costly' wards are now examined in detail in an attempt to find possible explanations for their extreme positions.

3.3.1 The six most costly wards (as derived from the regression analysis presented in table 7)

(a) Ward 8

Ward 8 is a mixed ward containing residents of a wide range of dependency and ability. The unique factor associated with this ward is the extreme age of the majority of its residents. 10 of the 15 hospital residents aged over 80 are resident on this ward. It is possible that residents of such extreme age require a much higher staffing level than residents slightly younger. To test for the possibility of an upturn in costs in wards with the most elderly patients, the analysis in Table 7 was rerun with the inclusion of an age-squared variable. The results gained from adding an age-squared variable supports the belief in a 'u' shaped relationship between average age of residents and ward costliness. The results are given in regression 10 in Appendix 1 and the new ward costliness ranking derived from this regression is given in table 10. It can be seen that by dropping the assumption of a simple linear relationship between average ward costliness and age of resident, the costliness index for ward 8 (the ward with the oldest residents in the hospital) is reduced considerably from 143.8 to 110.4. In addition Ward 8 is no longer seen as being exceptionally costly, dropping to 11th in the ranking of most costly wards. Conversely the impact of assuming non-linearity between resident age and costs exerts little impact upon the other wards defined as being costly by table 7 and hence analyzed in this section. Ward 26 becomes the most costly ward, ward 11 the second most costly,

Table 9

Comparison of absolute cost and costliness indices between wards

Ward Number	Absolute cost rank	costliness indices* unlogged Index	TAB.6 rank	Logged Index	TAB. 7 rank	Adult Index	TAB. 8 rank
1	14	80.2	23	93.8	18	95.9	13
2	20	70.0	28	81.9	25	84.3	16
3	23	70.1	27	71.2	29	69.4	21
4	17	74.8	25	86.3	21	83.9	17=
5	2	114.7	9	107.6	11	-	-
6	16	74.2	26	66.9	30	65.8	22
7	25	85.5	21	77.5	27	-	-
8	9	156.5	1	143.8	1	-	-
9	5	102.0	15	107.4	12	-	-
10	8	105.2	13	116.5	9	118.2	8
11	3	128.5	4	131.4	5	133.1	3
12	27	74.9	24	84.0	23	85.6	15
13	30	62.4	30	78.6	26	80.7	19
14	26	85.2	22	84.3	24	83.9	17=
15	7	126.6	5	133.7	3	133.8	2
16	10	100.3	16	106.9	13	107.9	10
17	4	96.0	17	85.6	22	-	-
18	28	117.0	8	87.5	20	-	-
19	24	68.1	29	72.1	28	74.6	20
20	15	10988	11	133.5	4	123.2	6
21	12	94.5	19	104.4	15	92.8	14
22	1	123.2	7	130.8	6	129.2	4
23	22	94.4	20	88.0	19	-	-
24	21	124.7	6	119.7	8	122.1	7
25	18	113.2	10	106.8	14	-	-
26	11	135.0	2	136.9	2	137.2	1
27	29	105.1	12	97.8	16	96.4	12
28	19	94.8	18	95.9	17	97.3	11
29	13	104.4	14	112.3	10	111.9	9
30	6	130.4	3	126.7	7	127.3	5

* For the Spearman rank correlation coefficients between these regressions and others - see appendix 2.

ward 15 the third most costly, ward 22 the fourth most costly. Ward 20 is the only other of these six wards whose assessment is significantly affected by the inclusion of the 'agesq' variable. In the new ranking ward 20 becomes the 9th most costly ward overall.

Ward 11

Ward 11 is a locked female ward containing the most severely behaviourally disturbed female residents in the hospital who are fully ambulant and need close supervision. Only 25% of the residents have the ability for full communication, and their destructive behaviour resulted in a high level of repairs and maintenance expenditure. The measure utilized in this analysis to capture the impact of behaviour disturbance (% of residents behaviourally disturbed) may not adequately reflect the degree of behaviour disturbance of residents which would contribute to the apparent costliness of this particular ward. Unfortunately it is not possible to test this proposition as detailed data concerning the nature and the severity of behavioural disturbance suffered by residents upon each ward are not available, but needs to be taken into account when interpreting the results of the regression analysis.

Ward 22

Ward 22 contains a number of severely physically handicapped patients. 3 of the residents are blind, the majority of the residents are non-ambulant, 3 of the residents have limited speech and the rest are unable to communicate. The cost impact of such severe physical handicaps may not be adequately captured by the measure utilized in this analysis to capture the compounding impact of physical handicap (% of residents with a physical handicap). The ward used to be a childrens ward and was staffed accordingly. Now that the majority of the residents are over 16 the ward is no longer designated as such. The staffing levels, however, appear still to be more comparable with those found upon a childrens ward.

Ward 26

The majority of the residents are of average ability with 5 residents being of high ability within the mental handicap range. Although the ward contains no residents below the age of 16 a number in the 16-19 age group (approximately 8) still attend the childrens school. Given the costly nature of school provision this utilization will obviously increase the costs directly traceable to this ward.

Ward 20

Most residents are of average ability within the mental handicap range and are able to communicate verbally. The age of residents range from under 30 to over 50.

Table 10 - Costliness index derived from regression 10 (in appendix 1)

Ward No.	Costliness index	Rank of Ward*
1	89.0	20
2	69.7	29
3	77.6	28
4	82.0	23
5	99.0	16
6	77.9	27
7	79.3	24
8**	110.4	11
9	100.6	15
10	116.8	8
11	131.8	2
12	78.9	25
13	78.2	26
14	93.9	19
15	129.2	3
16	100.7	14
17	88.1	21
18	84.6	22
19	65.0	30
20	113.5	9
21	103.8	13
22	125.9	4
23	96.3	17
24	118.2	6
25	110.7	10
26	146.0	1
27	124.3	5
28	95.1	18
29	104.9	12
30	116.4	7

* From most to least costly.

** Designated in other regression analyses as being the most costly ward.

Many residents progress from this ward to more independent living within the hospital with a view to training and possible rehabilitation back to the community.

Ward 15

An all male ward with no obvious 'exceptional' characteristics. The residents are mixed both in terms of their ages and dependencies.

3.3.2 Is there a common explanation of costliness?

The six wards defined as being the 'costliest' in this analysis do not appear to have common characteristics which might have helped explain their ranking. As the data below shows the wards are mixed in terms of their residents ages (and range of ages) dependency (and range of dependency), physical size and in their provision of beds designated for short term care. The only factor that they would appear to have in common is that they all spend an above average proportion of their total cost upon direct treatment services (primarily nursing). This fact is emphasised in table 11 below. The other tables analyse for these wards other possible factors which might be expected to contribute to the 'exceptionality' of particular wards.

Table 11

Direct Treatment Service

Ward No.	% of cost devoted to direct treatment service	* Rank in hospital
8	59.2	11
11	68.6	2
15	63.3	6
20	63.7	4
22	69.8	1
26	62.5	7
Average for Hospital	56.4	

* of the 30 hospital wards considered.

Table 12

Designated short term care bed

Ward No.	no. of beds designated	%
8	-	-
11	2	13
15	2	7
20	2	7
22	1	9
26	2	7
Average for Hospital		6%

Table 13

Physical size of ward

Ward No.	No. of bed	Units of 70ft^2 *
8	28	27
11	15	15
15	28	28
20	N/A	28
22	10	11
26	21	28

* 70 ft^2 = designated hospital 'norm' space per bed.

Table 14

Table of mix dependency on wards

% in each Dependency category

Ward no.	Dep 1	Dep 2	Dep 3	Dep 4
8	39	13	35	13
11	7	7	29	57
15	29	8	25	38
20	76	24	0	0
22	0	0	50	50
26	65	15	15	4
Average for hospital	30	18	19	33

Table 15

Age of residents

Ward no.	Age category*				
	0-16	17-39	40-59	60-79	80x
8	0	0	0	13(56)	10(44)
11	0	12(86)	2(14)	0	0
15	0	5(21)	9(38)	10(42)	0
20	0	9(50)	9(50)	0	0
22	3(30)	7(70)	0	0	0
26	0	5(28)	5(28)	8(44)	0

* percentage of residents from each ward in each age category are given in brackets.

3.3.3 The six least costly wards (as derived from the regression analysis presented in table 7)

Ward 6

There are 16 medium to high dependency young adult male residents. Six residents are recognised to have behavioural problems and the ward is locked for the protection of 'wanderers'. The majority of residents remain upon the ward each day and are on 'goal programmes'. The surroundings appear bleak and unattractive and the whole environment is 'institutional'. Beds are grouped together on the ward and the level of staffing appears to be low in relation to the training requirements set out in goal programmes.

Ward 3

Ward 3's residents are elderly men with an average degree of mental handicap. As 'graduates' of the institutional system behavioural problems are minimal with residents complying with 'expected' behaviour. Daytime staffing levels (1 trained nurse and 1 assistant) would have been totally inadequate but for the supervisory function performed by certain of the residents (who prevented wandering or disruption by others). The daytime provision for the ward is a large room with chairs grouped around the walls. The focal point of the 'daytime activity' appears to consist of a table on which games are available. The level of external stimuli available to the residents appears to be severely restricted by the shortage of resources available for the use of ward staff

Ward 19

Of the 24 female residents on this ward 18 are aged under 40 years, 9 exhibit behavioural problems and all but 4 are unable to communicate. Half of the residents of the ward are of low ability and half range from low to average ability. The majority of the residents appear to spend their days on the ward, and there is very little activity or stimulation available.

Ward 7

A ward containing 26 male residents aged between 48 and 78 years of age. 5 residents are of 'high grade' ability the rest are of average ability. The 7 residents under 65 years of age all work. Again the ward is one containing 'graduates' of the system in an 'institutional' environment. The residents are, in large part, self supervising and self policing and the primary problems to staff concern frail residents who are suffering the problems of ageing. Despite the help provided by more able residents, resource shortages make it very difficult to produce a stimulating environment.

Ward 13

This mixed ward has 12 residents of medium to average ability and aged between 42-72 years. The residence is $\frac{1}{2}$ mile away from the main hospital, located in a large house with its own gardens. The environment is domestic with 3 residents to each bedroom. Personal decoration is encouraged in bedrooms. The majority of residents undertake occupational therapy or work in the departments of the main hospital, but return to the ward for their meals. Usually only the 3 retired residents are to be found in the unit during the day. This fact together with the relatively high ability of the residents means that the provision of 1 staff member day and night appears to be adequate.

Ward 2

This ward deals with adult residents of average severity. The majority have been in institutional care for a significant period and few exhibit any form of behaviour disturbance. Should any resident become 'difficult' then he would probably have to be moved unless staff cover was increased. The ward is merely a long room where surroundings are unattractive and spartan and where the sole distraction is a television set.

3.3.4 Is there a common explanation of low cost?

The overpowering element that five of the six wards have in common is a

sense of deprivation. The exception is ward 13. Ward 13 is physically separate from the main hospital, and may well inspire a sense of independence in its residents. It is also possible that this separability has distorted the ward costing exercise, if for example, resources used by the residents had not been allocated back to the separate unit. This is unlikely however. The most probable reason for the low costs exhibited by Ward 13 is the relatively high ability and independence of the residents (as evidenced by their ability to walk the ½ mile to the main hospital along a busy road) and their absence from the unit during the day.

The other five wards tend to be large, sparsely furnished, understaffed and with little provision of educational/recreational facilities. The residents who have been in hospital for a long time, also in large part tend to have been "institutionalized". They tend to accept peer group pressure to conform and, as such, are in large part self-supervising. Thus the 'supervisory' function can be undertaken with little staff input. The whole staffing structure could change if it was deemed suitable to involve the people on those wards in more training or occupational activities.

The following tables assess the same factors that were analyzed previously for the six costliest wards.

Table 16

Direct Treatment Services

Ward No.	% of cost devoted to direct treatment services	* Rank in hospital
2	55.4	15=
13	46.4	28
7	50.6	19
19	47.9	26
3	60.0	10
6	48.5	24
Average for hospital	56.4	

* of the 30 hospital wards considered.

Table 17

designated short-term care beds

Ward No.	No. of beds designated	%
2		-
13		100
7		8
19		7
3		-
6		14
Average for hospital		6

Table 18

Physical size of ward

Ward No.	No. of beds	Units of $70ft^{2}$*
2	25	N/A
13	15	15
7	26	23
19	30	29
3	27	N/A
6	14	18

* $70ft^{2}$ = designated hospital 'norm' space per bed.

Table 19

Mix of dependency on wards

% of people in each category

Ward No.	Dep 1	Dep 2	Dep 3	Dep 4
2	0	21	12	67
13	75	0	25	0
7	61	17	9	13
19	35	23	31	12
3	4	11	50	36
6	8	31	15	46
Average for hospital	30	18	19	33

Table 20

Ward No.	Age of residents Age category*				
	0-16	17-39	40-59	60-79	80+
2	0	4(17)	17(71)	3(12)	0
13	0	1(12)	5(63)	2(25)	0
7	0	1(4)	5(22)	17(74)	0
19	0	14(54)	11(42)	1(4)	0
3	0	3(11)	17(61)	8(29)	0
6	2(14)	12(86)	0	0	0

* Percentage of residents from each ward in each age category are given in brackets.

3.4 Further uses of the analysis: Estimating the cost implications of expansion or contraction in hospital size

In this section, the regression results are used in an attempt to forecast the expected revenue consequences of an expansion or contraction in the number of wards in the hospital.

3.4.1 Estimating the expected cost of a new ward

A great many problems arise in attempting to estimate the expected revenue consequences involved in setting up a new ward. The analysis reported here can, however, provide a useful estimate of the expected cost level (or expected range of costs) that will require funding for a ward of certain characteristics treating a defined patient mix. Given data upon the proposed size of the ward, its expected occupancy level and the dependency and nature of residents to be admitted, the regression analysis will provide a range of initial estimates of 'expected' ward cost levels. An underlying assumption of these estimates is that the proposed new ward will exhibit the same relationship between cost levels and ward characteristics as that prevalent in existing wards. Should it be expected that the proposed new ward differs in any significant manner from existing wards then the 'expected' cost levels forecast will have to be adjusted to take account of these unique characteristics. Use of the estimated regression analysis simply provides the first step in the calculation of the 'expected' costs of any proposed new ward development.

Example 1 estimates the 'expected' cost level involved in opening a new ward. In the example it is assumed that the new ward has two factors which would distort costs away from the cost level applicable to existing wards. Firstly a new more efficient ward design is estimated to provide a cost saving of approximately ten per cent. The second factor unique to the proposed

new ward is the proposed use of the ward as an intensive training facility. The greater emphasis upon training and rehabilitation is expected to increase the cost level of the ward by an estimated five per cent, in comparison to existing wards.

The regression analysis is also of great potential value to the decision maker in evaluating the optimum size of ward to be constructed. Where a decision has been made on all the other factors included in the regression analysis ('type' of resident, expected occupancy level etc.) a cost function can be constructed relating ward size (in terms of number of residents) to expected cost per patient day.

Obviously expected unit costs is only one factor to be taken into account when deciding upon the size of any new proposed ward. What a cost analysis such as this will emphasize, however, is the additional cost incurred in developing a ward of a non cost-minimizing size. Such a decision could then be based upon the rational comparison of the expected comparative cost levels in wards of different sizes with the comparative benefits expected to be derived from wards of varying size.

Example 1 - calculation of expected ward costs for a ward of given characteristics

Ward characteristics (expected)

Size of ward = 10 beds
Average age of residents = 35
Occupancy level = 90%
Percentage of physically handicapped residents = 50%
Percentage of behaviourally disturbed residents = 50%
Residents in Wessex Dependency Classification 3 = 50%
Residents in Wessex Dependency Classification 4 = 50%

Including the above factors in the regression analysis* provides an estimated ward cost per patient day of £38.36. The assumed average of 9 residents in the ward over a 365 day year (10 beds with an average occupancy of 90%) implies that the total annual cost of this proposed new ward development would be £126.029 - assuming that this ward shares the characteristics of existing wards.

The new ward however, also exhibits various 'individual' factors not shared by existing wards. These individual factors will distort costs away from the regression generated average ...

Factor	Cost Impact
New Ward design (estimated cost saving of 10%)	-12,603
More intensive use of training/rehabilitation services (estimated cost increase of 5%)	+ 6,301
Total impact of individual factors	- 6,302

This implies that the total 'expected' cost of the proposed new ward development would be £119,727. This implies a total cost per patient day of £36.45.

3.4.2 Estimating the expected savings that arise through ward closure

Given present policy towards the mentally handicapped the impact of ward closure would appear to be a far more topical question than the potential cost of opening a new ward. The question addressed in this section concerns the value of resources potentially released for use outside the hospital (institutional inflexibility permitting) by closing any particular ward.

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* The regression used in this example is ...

TWCPD = 29.33 - 0.402 (Bed) + 0.003 (Bed squared) -0.295 (Age)
+ 0.157(OCC) + 0.004 (PHY) - 0.046 (Beh. Dist.)
+ 0.137 (WD3) + 0.084 (WD4).

The ward costing exercise estimates the value of hospital resources utilized by any particular ward. These resources include those that can be directly traced to each ward (e.g. nursing and use of paramedical services) and central hospital resources whose use is allocated to each ward (e.g. Administration and transport). In large part the value of resources which become potentially available depends upon three factors; firstly the scale of ward being closed (its significance in terms of the total hospital), secondly the time scale under consideration (all ward resources may become potentially recoverable in the very long term) and thirdly the proposed use to which the potentially available resources are put. These factors are analysed in more detail below.

1. Size of ward being closed

The impact of ward scale in assessing the effects of closure is derived from the probability of discontinuities in central hospital costs allocated to each ward. Where a ward is small then it is probable that the number of hospital administrators, van drivers and other services provided centrally for each ward, will be unaffected by ward closure. A large ward, however, which uses a significant amount of central hospital services will almost certainly allow savings to be made in the provision of such services. Given discontinuities in the cost function faced in providing central hospital services it is obviously difficult to generalise about the impact of the closure of any particular ward upon central hospital costs. What is certain, however, is that the larger the ward (and hence the larger the proportion of central hospital resources it uses) the greater the potential for savings in these services and the greater the possibility that such savings in central services may be compounded by possible discontinuities in the cost function faced in providing such services. In addition, the release of resources from one ward for redeployment elsewhere will vary over time. In the short-term few resources will be released, but with the increase in the number of patients discharged, the point will be eventually reached where the whole ward can be closed, and the full value of that wards resources become available for redistribution elsewhere.

2. Alternative use of resources

The problems encountered here are very strongly related to the question of time scale. As an example let us examine three possible alternative uses for resources ....

1. Redeployment in other wards
2. Redeployment into the community mental handicap sector
3. Realisation of financial savings/redeployment of resources outside the mental handicap sector.

In the first case the shift of resources may be made almost immediately. Nurses will need a relatively small period of adjustment to new residents, new colleagues and a new environment but on the whole the cost of such a resource transition can be held to be minimal. The effect of this move will be to raise the average cost per in patient day and hence also possibly the quality of care, given that the same value of resources are now being spread over fewer patients.

In the second case the problems of resource transition may be more severe. The nurses may require special training to meet the new forms of care and treatment. However, the effect of this move would be to reduce total hospital costs. The impact upon cost per day depends in large part upon the value of resources being released. This will in large part reflect the 'type' of ward which is being closed.

The third case obviously presents the most severe problems in terms of reallocating nursing or other specialised resources. The level of financial savings available will be closely related to the nature of resources released through ward closure.

3.4.3 Estimated savings through ward closure - The Royal Albert

This section is concerned with attempting to estimate the marginal impact upon hospital resource use of closing any specified ward. What value of resources would be potentially released by the closure of a specified ward?

In this section the value of resources which can be directly traced to ward level is used as an estimate of the marginal value of resources released in the short term through ward closure. Resource use is dichotemised between directly tracable costs (assumed to approximate ward variable costs) and allocated central hospital cost, (assumed to approximate ward fixed costs). The allocated costs were assumed to be simply redirected to other wards in the event of ward closure. Given this assumption the estimated resource savings through closure of the wards in our sample are given in table 17. The table, emphasises the large variation in the potential 'recoverability' of resources which may arise from the closure of different wards.

Table 17 - Directly traced costs as an estimate of marginal savings through ward closure

Ward No.	No. of in-patient days	Total ward cost	% Directly traced	Total Estimated Savings	Estimated Savings/I.P.D.
1	6935	192692	80.4	154883	22.33
2	9125	201079	77.7	156274	17.13
3	9855	184356	74.1	126591	13.86
4	6570	168620	79.7	134431	20.46
5	3405	151300	77.4	117126	34.40
6	5475	145493	70.5	102553	18.73
7	9370	157306	71.4	112390	11.99
8	9428	292414	77.7	227090	24.09
9	3895	132121	69.5	91878	23.59
10	6205	189834	82.5	156563	25.23
11	5355	249435	87.0	217117	40.54
12	16910	277606	72.6	201576	11.92
13	7848	118009	65.6	77408	9.86
14	15878	261378	65.6	171544	10.80
15	10220	343774	77.9	267689	26.19
16	9005	271620	82.2	223141	24.78
17	3285	118214	75.3	88984	27.09
18	13260	213094	70.1	149376	11.27
19	9855	171029	73.2	125240	12.71
20	9975	256693	82.7	212321	21.29
21	8760	254812	73.1	186284	21.27
22	4318	233739	88.2	206247	47.76
23	7055	131166	74.2	97290	13.79
24	14538	281706	68.1	191937	13.20
25	7420	171638	78.5	134785	18.17
26	10523	290858	83.1	241720	22.97
27	17035	270540	66.6	180292	10.58
28	9490	208947	76.0	158733	16.72
29	9673	265516	80.4	213533	22.07
30	11680	422605	76.9	325036	27.83
Total	296499	7270033	76.4	5552965	18.73

Section 4 - Summary

This paper sets out the results of a comprehensive ward costing exercise undertaken in a large (900 bedded) hospital for the mentally handicapped. Significant variations in total cost per patient day at the ward level were isolated. The most expensive ward (£54.12 per patient day) utilized resources valued at over three times those used by the least expensive ward (£15.01 per patient day).

Several analyses were carried out to try to establish what caused the variation in these costs but the only significant correlation identified was that between cost per patient day and the age of patients such that the highest costs were associated generally with the care of children under 16. There was also some indication that costs per patient day began to increase in those wards which cared for elderly patients. The correlations which accounted for most variations were used to develop a 'ward costliness index' which compared actual ward costs with the costs predicted by the statistical analysis. In terms of 'costliness' wards ranged from producing almost 50% more inpatient days care than expected (an index of 146.0) to providing less than two-thirds of the amount expected (an index of 65.0). A Spearmans rank correlation test was undertaken to see whether the ranking of wards in terms of 'costliness' differed significantly between the different form of each statistical analysis. In each case the Spearmans coefficient appeared to indicate that the same underlying pattern of 'real' ward costliness was being reflected.

The six most 'costly' wards were then examined and it seems that they spend a larger than average proportion of their resources upon direct treatment services. In addition specific factors (extreme age of residents, nature of physical handicap, nature of behavioural disturbance) were identified as explanations of the position of three of the six costliest wards. Examination of the six least costly wards was equally fruitful. With one exception (an exceptional 'ward' located ½ mile from the main hospital) their common element was a general lack of resources to meet the apparent demands of patient care.

Examples have been provided of the use of this methodology in assessing the expected resource implications of opening or closing a ward of specified characteristics and to aid future decision-making, especially concerning the reduction in the number of beds in large hospitals for the care of mentally handicapped persons. As could be expected from the original variation in ward costs, the savings to be expected from ward closures vary from approximately £10 to £48 per patient day.

Appendix 1

Regression analyses

Regression 1

Dependent variable : Total Ward Cost per Patient Day
(= N.H.S. + Educ.+ Soc. Serv. Costs)

Independent	Estimated coefficient	T Statistics
C	29.3279	*1.81
BED	-0.4017	-0.47
BEDSQ	0.0030	0.23
AGE	-0.2949	*-2.02
OCC %	0.1571	0.87
PHYSHAN %	0.0038	0.08
BEHAV %	-0.0463	-0.62
WESDEP 3%	0.1375	1.28
WESDEP 4%	0.0841	1.31

Adjusted R-squared = 0.494

Number of observations = 30

* signifies t statistic significant at 5%

Definition of variables

Bed = Number of beds on Ward

Bedsq = (Number of beds on ward)^2

AGE = Average age of residents on ward

OCC% = Average percentage bed occupancy upon each ward

PHYSHAN % = Percentage of residents with a physical handicap

BEHAV % = Percentage of residents exhibiting behaviour disturbance

WESDEP 3% = Percentage of residents classified as Wessex dependency level 3.

WESDEP 4% = Percentage of residents classified as Wessex dependency level 4.

Regression 2

Dependent Variable : Total ward cost per patient day.

Right hand variable	Estimated coefficient	T-statistic
C	28.6728	1.65
BED	-1.5280	** -2.17
BEDSQ	0.0194	* 1.72
OCC %	0.1758	0.91
PHYSHAN %	-0.0038	-0.07
BEHAV %	-0.0049	-0.06
WESDEP 3%	0.1105	0.97
WESDEP 4%	0.1309	* 2.05

Adjusted R-squared = 0.422

Number of observations = 30

* signifies significance at 5%

** signifies significance at 2½%

Definition of variables

As in regression 1.

Regression 3

Dependent variable: Total ward cost per patient day.

Right hand variable	Estimated coefficient	T-statistic
C	37.5410	*2.49
Bed	-0.5451	-0.66
Bedsq	0.0035	0.28
Age	-0.3329	*-2.50
OCC %	0.1767	1.02
PHYSHAN %	0.0111	0.23
BEHAV %	-0.0167	-0.24

Adjusted R-squared = 0.478

Number of observations = 30

* signifies significance at 2½%

Definition of variables

As in equation 1.

Regression 4

Dependent variable: Log of total ward cost per patient day

Right hand variable	Estimated coefficient	T-statistic
C	3.0191	1.54
LBED	-0.1841	-1.02
LAGE	-0.3764	* -2.36
LOCC	0.4289	0.91
LPHYSHAN %	0.0080	0.25
LBEHAV %	0.0077	0.17
LWESDEP 3%	0.0189	0.34
LWESDEP 4%	0.0638	1.53

Adjusted R-squared = 0.514

Number of observations = 30

* = significant at 2½% level of confidence

Definition of variables

LBED	=	Log of number of beds on Ward
LAGE	=	Log of average age of residents
LOCC	=	Log of average percentage bed occupancy
LPHYSHAN %	=	(Percentage +1) of residents with a physical handicap
LBEHAV %	=	Log of (percentage +1) of residents exhibiting behavioural disturbance
LWESDEP 3%	=	Log of (percentage +1) of residents classified as Wessex dependency level 3.
LWESDEP 4%	=	Log of (percentage +1) of residents classified as Wessex dependency level 4.

Regression 5

Dependent variable: Log of total ward cost per patient day

Right hand variable	Estimated coefficient	T-statistic
C	2.7541	1.29
LBED	-0.4336	*-2.70
LOCC %	0.3733	0.73
LPHYSHAN %	-0.0091	-0.27
LBEHAV %	0.0184	0.36
LWESDEP 3%	-0.0234	-0.41
LWESDEP 4%	0.0739	1.63

Adjusted R-squared = 0.418

Number of observations = 30

* signifies significance at 1%

Definition of variables

as in regression 4.

Regression 6

Dependendent variable: Log of total ward cost per patient day

Right hand variable	Estimated coefficient	T-statistic
C	2.9113	1.55
LBED	-0.3091	*-2.06
LAGE	-0.4010	**-2.70
LOCC %	0.5945	1.37
LPHYSHAN %	0.0147	0.50
LBEHAV %	0.0348	0.95

Adjusted R-squared = 0.507

Number of observations = 30

* signifies significance at 2½%

** signifies significance at 1%

Definition of variables

as in regression 4.

Regression 7

Dependent variable: Total ward cost per patient day in Adult units.

Right hand variable	Estimated coefficient	T-statistic
C	34.9233	1.08
Bed	-0.1540	-0.14
Bedsq	0.0009	0.06
Age	-0.4487	-1.84*
OCC %	0.1040	0.30
PHYSAN %	-0.0059	-0.09
BEHAV %	-0.0571	-0.60
WESDEP 3%	0.1285	0.90
WESDEP 4%	0.1100	1.36

Adjusted R-squared = 0.266

Number of observations = 22

* signifies significance at 5%

Definition of variables

As in regression 1 but with data restricted to 'Adult' units.

Regression 8

Dependent variable: LTWCPD

Right hand variable	Estimated coefficient	T-statistic
C	2.8985	0.59
LBed	-0.1656	-0.67
LAGE	-0.4266	-1.35
LOCC	0.5000	0.46
LPHYSHAN %	0.0136	0.35
LBEHAV %	-0.0035	-0.06
LWESDEP 3%	-0.0022	-0.03
LWESDEP 4%	0.0663	1.35

Adjusted R-squared = 0.323

Number of observations = 22

Definition of variables

- As in Table 7 but with data restricted to adult units.

Regression 9

Dependent variable: Total Ward cost per patient day.

Right hand variable	Estimated coefficient	T-statistic
C	23.3009	1.13
BED	0.0128	0.02
BEDSQ	-0.0018	-0.13
AGE	-0.3985	*-1.90
OCC %	0.1673	0.88
PHYSHAN %	0.0008	0.01
BEHAV %	-0.0422	-0.53
WESDEP 3%	0.1922	1.63
WESDEP 4%	0.0983	1.43
DUM 1	3.0751	0.37
DUM 2	5.9162	1.01

Adjusted R-squared = 0.483

Number of observations = 30

* signifies significance at 5%

Definition of variables

As in regression 1 plus .....

DUM 1 = Dummy variable 'on' in the case of the three childrens wards.

DUM 2 = Dummy variable 'on' in the case of the five wards with average residents ages of over 60.

Regression 10

Dependent variable : Total Ward cost per patient day

Right hand variable	Estimated coefficient	T-statistic
C	39.7512	2.60*
BED	0.4920	0.57
BEDSQ	-0.0094	-0.72
AGE	-1.5353	-2.88*
AGESQ	0.0135	2.40*
OCC%	0.1715	1.05
PHYSHAN%	-0.0351	-0.72
BEHAV%	-0.0329	-0.49
WESDEP 3%	0.1729	1.76
WESDEP 4%	0.0941	1.62

Adjusted R-squared = 0.587

Number of observations = 30

* = significant at 1% level of confidence

Definition of variables

As in regression 1 plus .....

AGESQ = Average Age of residents upon ward - squared.

Appendix 2

Spearmans rank correlation coefficients

Spearmans rank correlation coefficient

related regressions		spearmans coefficient	0.2% critical region
* 1 and 2)		0.868	0.549
1 and 3)	unlogged	0.923	0.549
2 and 3)		0.699	0.549
** 4 and 5)		0.876	0.549
4 and 6)	logged	0.949	0.549
5 and 6)		0.834	0.549
*** 7 and 8 Adult		0.878	0.633
1 and 4)	comparing	0.893	0.549
2 and 5)	logged with	0.900	0.549
3 and 6)	unlogged	0.897	0.549

The Spearmans rank correlation between the ranking of absolute cost levels and the ranking of 'costliness' derived from regression 1 is only 0.538. This is outside the 0.2% critical region and thus appears to indicate a significant difference between the rankings of absolute costs and the rankings of ward 'costliness'.

* The results presented in table 6 are here designated as regression 1.

** The results presented in table 7 are here designated as regression 4.

*** The results presented in table 8 are here designated as regression 8.

APPENDIX 3

CORRELATION MATRIX BETWEEN INDIVIDUAL INPUTS

	BED	AGE	WESDEP 3%	WESDEP 4%	BEHAV %	PHYSHAN %	OCC %
BED	1.000	0.544	-0.092	-0.556	0.038	-0.290	0.193
AGE	0.544	1.000	0.039	-0.573	-0.145	-0.224	0.274
WESDEP 3%	-0.092	0.039	1.000	-0.225	0.182	-0.172	0.275
WESDEP 4%	-0.556	-0.573	-0.225	1.000	0.121	0.399	-0.254
BEHAV %	0.038	-0.145	0.182	0.121	1.000	-0.024	0.276
PHYSHAN %	-0.290	-0.224	-0.172	0.399	-0.024	1.000	-0.092
OCC %	0.193	0.274	0.275	-0.254	0.276	-0.092	1.000

Weight : None

Number of observations : 30.