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An Economic Analysis of Regional Demand for Hospital Care: A Case Study of Public Hospitals of Malaysia

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ABSTRACT

This paper attempts to examine the demand for health services and to determine the effect of variables included in the demand functions. The study also analyses the interstate differences in providing public health care facilities such as hospital beds. Cross-sectional data for 1984 and 1989 have been used. Mathematical equations to measure the responsiveness of bed availability and to demonstrate the linear relationship of bed availability and beds used and admissions have been estimated. There exists a functional relationship between number of beds available and number of beds used. States with high number of beds available per 1000 population tend to have higher number of beds used but lower percentage of utilization. The bed availability is found to be responsive to the number of admissions and beds used. A criterion for the supply of hospital care facilities is also suggested.

ABSTRAK

Kertas ini cuba meneliti permintaan perkhidmatan kesihatan dan menentukan kesan pembolehubah fungsi permintaan. Kajian ini juga cuba menganalisis perbezaan antara negeri dalam pembekalan kemudahan perkhidmatan kesihatan seperti kemudahan katil di hospital. Kajian ini menggunakan data keratan rentas tahun 1984 dan 1989. Persamaan matematik untuk mengukur hubungan kesediaadaan kemudahan katil di hospital dan hubungan linear kesediaadaan katil dan penggunaan katil terhadap kemasukan pesakit telah dianggarkan. Kajian telah menunjukkan wujudnya hubungan antara bilangan katil yang sedia ada dan katil yang digunakan. Negeri yang mempunyai kesediaadaan katil yang banyak

kepada setiap 1000 penduduk cenderung mengguna lebih banyak katil tetapi kadar penggunaan menurun. Kesediaadaan katil didapati lebih responsif kepada jumlah kemasukan dan katil yang diguna. Kriteria untuk mengkaji penawaran kemudahan perkhidmatan hospital juga dicadangkan.

INTRODUCTION

The wider concept of development has necessitated indicators of health as one of the signposts of development. Successive five year plans of Malaysia emphasized "Health For All" as one of the major objectives. This means that a certain standard of health is planned to be achieved so that every citizen could lead a socially and economically productive life. Public allocations in the health sector of Malaysia reflect an inherent growing interest and concern with the nation's health and an awareness to raise the health status of Malaysian citizens. Figures 1 and 2 (Figures in appendix B) show by states in Malaysia the number of doctors and the bed supply for 1984 and 1989.

There have been numerous studies where economic analysis is considered as a powerful technique for efficient administration of public programs in the field of health economics. The thrust of these studies was to examine the demand for health services and also to determine the effects of variables included in the demand functions. An example of such a study is that of Feldstein (1963) who used British National Health Service data to analyze the effects of interregional differences in hospital bed scarcity.

This paper is another example of the use of economic analysis in studying the interstate differences in the operation of the Malaysian health system. An attempt is made in this paper to examine the issue of hospital beds, their use and illustrate the way in which analysis of this kind can improve understanding of the Malaysian health system. For the purpose of this paper, the data for 1984 and 1989 have been used. The choice of these years of observation was dictated mainly by the availability of data and also that these two years provide the health care system which existed during the end of the Fourth and the Fifth Malaysian Plans respectively.

Pioneering study of the health care system was undertaken by Feldstein (1965) who looked at the effect of area differences in the scarcity of hospital beds and the way these beds were used. He found that the number of cases treated per thousand population

was more responsive to the bed scarcity than the average duration of stay per case. In the United Kingdom, according to his studies, there were variations in the number of beds available per thousand population in different regions due to government policy on health care. Feldstein also found that the correlation between bed used and beds available was very high, while the correlation between percentage utilization and beds available was very low. He also indicated that supply created its own demand and within the current range of beds available, and the intensity of bed utilization was not affected by the relative scarcity of beds.

In his other paper, Feldstein (1963) concluded that the demand for bed days increased proportionately with supply. The demand for bed days and admissions appeared to rise linearly with the bed supply and there was adequate evidence to estimate an upper limit of potential demand. It was rather difficult to use the waiting list as a criterion for policy determination. He further mentioned that in the health care system, the appropriate standards of provisions could not be determined by reference to the level of "need" inherent in or manifested by the community. He reiterated that the number of hospital beds to be provided must be ascertained by weighing the costs and benefits of additional (or reduced) hospital care against the alternative uses to which those health care resources could be deployed.

MALAYSIAN HEALTH CARE SYSTEM: A STATISTICAL PROFILE

Table 1 shows the Ministry of Health Financial Appropriations for 1970-1990 which indicates that the total expenditure exhibits an increasing trend but as a percentage of National Budget it shows a decline. In 1970, the Development and Operating Expenditure was 5.64% of the National Budget but decreased to 5.27% in 1980 and increased to 5.5% in 1990. The percentage Total Expenditure of the Health Financial Appropriation was 4.3% of the National Budget.

The number of hospitals during 1984 and 1989, shows that they remain the same between those years except for Kedah and Kelantan. In some states particularly in the states of Perlis, Negeri Sembilan, Melaka and Johor the number of beds has declined. While in other states, especially in Pulau Pinang and Trengganu it has risen. For the state of Kelantan, there has been an increase in the number of hospitals as well as the number of beds.

TABLE 1. Ministry of Health Financial Appropriation (million RM)

Years	Development Expenditure	Operating Expenditure	Total Expenditure	Percentage to National Budget	Percentage to GNP
1970	26	157	183	5.64	1.51
1975	71	334	405	5.78	2.39
1980	136	759	896	5.27	3.53
1985	165	1094	1256	4.30	2.23
1990	505	1335	1840	5.50	1.68

Source: Federal Budget; various reports (1980 – 1990)
Treasury Economic Report; various issues from 1981 – 1988
Information and Documentation Systems Unit, Ministry of Health

Table 2 also shows interstate variations in the number of doctors. The number of doctors in all states increased except in the case of Melaka where it showed a decrease of about 4%. Nationally, the number of doctors increased from 2071 in 1984 to 2781 in 1989. The highest percent of increase in the number of doctors was Kelantan (100.90%). This may be due to the increase in the number of new hospitals from 1984 to 1989.

As for the number of beds during the years under observation, the states of Perlis, Negeri Sembilan, Melaka and Johor have showed a decline of 3.34%, 7.22% , 5.30% and 5.18% respectively. Meanwhile, the number of beds has increased in the states of Trengganu (30.28%), Kelantan (26.77%) and Pulau Pinang (21.46%).

DATA

All data required for this study were obtained from the Department of Statistics, the Information and Documentation System Unit of Ministry of Health and the other Departments of Health of different states. The data used for our study are presented in Appendix A. The data covers only the general and district hospitals in different states of Malaysia for the years 1984 and 1989, excluding those patients seeking treatment in hospitals attached to medical schools, army hospitals, mental and psychiatric hospitals.

TABLE 2. Number of Hospitals, Doctors and Beds for 1984 and 1989

	Number of Hospitals		Number of Doctors		(% Changes)	Number of Beds		(% Changes)
	1984	1989	1984	1989		1984	1989	
Perlis	1	1	27	31	(14.8)	418	404	(– 3.34)
Kedah	5	6	94	155	(64.89)	1689	1773	(4.97)
P. Pinang	5	5	151	190	(25.82)	2013	2445	(21.46)
Perak	12	12	199	264	(32.66)	3546	3704	(4.45)
Selangor	5	5	122	168	(37.70)	1225	1429	(16.65)
W. Persekutuan	1	1	669	923	(37.96)	2436	2458	(0.90)
N. Sembilan	5	5	87	119	(36.78)	1826	1694	(– 7.22)
Melaka	2	2	79	76	(– 3.79)	961	910	(– 5.30)
Johor	9	9	171	194	(13.45)	2932	2780	(–5.18)
Pahang	8	8	101	130	(28.71)	1451	1496	(3.10)
Trengganu	4	4	66	80	(21.20)	852	1110	(30.28)
Kelantan	3	6	103	207	(100.9)	986	1250	(26.77)
Sabah	15	15	77	108	(40.25)	2232	2497	(11.87)
Sarawak	15	15	115	136	(18.26)	2394	2493	(4.13)
Total	90	94	2061	2781	(34.93)	24961	26443	(5.94)

Source: Information and Documentation Systems Unit, Ministry of Health
Malaysia Medical Council
Hospital Division, Ministry of Health

DEMAND FOR HEALTH CARE

The demand for health care in Malaysia can be measured by:

1. the number of beds used,
2. the number of admissions and
3. the percentage of utilization.

Table 3 shows the variation in hospital demand for both the years 1984 and 1989. It is observed that for both these years, there is not much difference in the range.

TABLE 3. Variation in Hospital Demand

Demand Measure	Mean		Standard Deviation		Coefficient of Variation		Range	
	1984	1989	1984	1989	1984	1989	1984	1989
Beds Used	1.10	1.01	0.36	0.31	32.66	30.90	0.38 1.82	0.39 1.63
Number of Admissions	67.03	73.05	19.37	18.41	28.90	25.20	28.30 105.70	36.24 109.87
% of Utilisation	63.67	62.77	10.77	9.55	16.92	15.22	42.12 85.21	43.66 81.88

Table 4 shows that the bed demand and the availability are highly correlated. This indicates that a large percentage of the differences among the states in Malaysia can be explained by the differences in bed availability. As presented in Table 4, if demand is measured as the number of beds used, the squared correlation coefficient is 0.66. This signifies that about 66% of the differences is explained by beds used. If instead, we use the number of admissions as the demand measure, the squared correlation coefficient is estimated at 0.69. Eventhough the number of admissions is highly correlated than the number of beds used, both measures could indicate the appropriate supply of beds for all states.

VARIATION IN SCARCITY AND USE OF HOSPITAL BEDS

In states where there are more beds available, they might be expected to make less intense use of these beds because of lower occupancy rates and longer turnover intervals between patients.

TABLE 4. Correlation Coefficients of Bed Demand and Availability

		Number of Admissions	Beds Used	Percentage of Utilization
Bed Complements	1984	0.8289 (0.0002)	0.8093 (0.0005)	– 0.1399 (0.6334)
	1989	0.8388 (0.0002)	0.8170 (0.0004)	– 0.2649 (0.3600)

Note: Figures in parentheses are probabilities.

Tables in Appendix A show otherwise. With the exception of Wilayah Persekutuan, the number of beds used per 1000 population reflects the number of beds available. For instance, Negeri Sembilan which has the highest number of beds per 1000 population (2.84 for 1984 and 2.39 for 1989) uses relatively higher number of beds (1.43 and 1.19 respectively). While Selangor with the lowest supply (0.73 for 1984 and 0.74 for 1989) uses the lowest number of beds per 1000 population (0.44 and 0.48 respectively).

It is expected that there exists a functional relationship between number of beds available and number of beds used, and the utilization rate (refer to Appendix A for the calculation of percentage of utilization). It appears that in both 1984 and 1989, states with relatively high number of beds have low utilization rates. Wilayah Persekutuan is an exception to this. Negeri Sembilan which has the highest number of beds at 2.89 utilizes only 1.43 beds at a low utilization rate of 49.3%. Selangor has 0.44 beds used out of 0.73 beds per 1000 population at a relatively higher utilization rate of 60.7%. The level of utilization rate indicates the intensity of beds used. In Malaysia, the intensity of beds used signifies that the pattern of bed availability reflects the population distribution in all states and does not imply the needs of each state for additional beds.

MEASURE OF RESPONSIVENESS

Monitoring information permits assessing individual aspects of the current position of the health system. More specifically, this could answer the question; how do differences in a certain policy variable

affect some other variables concerning the health system? Generally, associated with each possible government health care policy are:

1. a set of available facilities for example, hospital beds and nurses
2. the pattern of utilization facilities such as hospital admission and duration of stay by diagnosis

If the ultimate impact cannot be assessed, it is at least possible to use estimated behavioral relations to predict its overall effects on the pattern of availability and the use of health care services. We can indicate however how the hospital beds are used and how the health system has responded to bed availability and the number of doctors.

According to Feldstein (1965), one of the measures to examine the way in which the hospital beds are used is the "measure of responsivenes". The measure of responsiveness is given by the regression coefficient of the beds available in a double logarithmic equation:

$$\text{Log(BEDUS)} = \text{Log a} + \text{b1 Log(BED)} + \text{U} \quad \text{.....[1]}$$

where U is the error term satisfying standard assumptions.

The coefficient b1 in the specified regression equation gives us the"measure of responsiveness". These sets of values are presented in Table 5 for the years 1984 and 1989 respectively. It may be noted here that although much can be learned by calculating the regional responses of different health variables, it is convenient to have a single measure at the national level.

At the national level, the bed availability is more responsive to the number of admissions and beds used. However, the responsiveness of the number of doctors to the number of admissions and beds used is relatively low. These estimates of responsiveness are given in Table 6.

In our estimation of the measure of responsiveness we have not taken into account diagnostic categories, patients age and sex group. Measures of responsiveness by these categories can be calculated if the data on these categories are available.

TABLE 5. Estimated Result For 1984 and 1989

Equation	Dependent Variable	Intercept 1988	Intercept 1989	Coefficient 1984	Coefficient 1989	Independent Variable	R-Square 1984	R-Square 1989	N
1	LOGBEDUS	– 0.407 (0.078)	– 0.440 (0.069)	0.886 (0.127)	0.918 (0.130)	LOGBED	0.8015	0.8057	14
2	BEDUS	0.203 (0.192)	0.097 (0.917)	0.512 (0.104)	0.564 (0.186)	BED	0.6675	0.6549	14
3	ADD	17.44 (9.791)	17.896 (11.029)	28.247 (5.318)	34.199 (6.606)	BED	0.7016	0.6907	14

Notes:

1. Figures in parentheses are standard errors.
2. N is number of observations.
3. Definition of variable:
   ADD = Number of admissions
   BED = Bed Complements
   BEDUS = Number of beds used

TABLE 6. Estimates of Responsiveness 1984 and 1989

	Responsiveness Values			
	Admissions		Bed Used	
Measure of Supply	1984	1989	1984	1989
Bed Availability	0.805	0.760	0.886	0.918
	(0.104)	(0.118)	(0.127)	(0.130)
Doctors	0.303	0.2092	0.399	0.319
	(0.139)	(0.122)	(0.146)	(0.131)

Note: Figures in parentheses are the standard errors

THE DEMAND FOR BEDS USED AND ADMISSION

Equation 2 demonstrates a proportional linear relationship between number of beds used per 1000 population (BEDUS) and beds available per 1000 population (BED):

$$BEDUS = a + b1\ BED + U \quad \text{.....[2]}$$

The equation exhibits a positive relationship (which it should) between beds used and beds available, with $R^2 = 0.67$ for 1984 and 0.66 for 1989.

Other forms of the functions have been tested but the estimated results as shown in Appendix C are not satisfactory.

Equation 3 shows a linear relationship between demand for admissions (ADD) and beds available per 1000 population:

$$ADD = a + b1\ BED + U \quad \text{.....[3]}$$

We have observed that the number of admissions increased proportionately with beds available. The logarithmic form gives better result based on economic and statistical criteria.

The causal relationship between supply and demand for beds have been uncertain. We have tried both the causal relationships that is supply on demand and demand on supply and both results are similar. Therefore, as a demand measure, number of admissions increases proportionately with the supply of beds.

SUMMARY AND CONCLUSION

This paper has indicated that the demand and supply of hospital inpatient care such as provision of beds, doctors, etc., could be used to provide monitoring and explanatory information and to make conditional predictions of the effects of alternative policies. The model presented requires further modification to make use of state-by-state data which for most of the variables are at present not available in published form.

For the purpose of planning the supply of hospital facilities there is a need to know the criterion of the adequacy of supply. In this connection, the Hill-Burton Act (Feldstein 1967) gave the following criteria:

1. 4.5 beds per 1000 population in states more than 12 persons per square mile
2. 5.0 beds per 1000 population in states with 6-12 persons per square mile
3. 5.5 beds in states with fewer than 6 persons per square mile.

Many planners have criticized the use of Hill-Burton criterion. They have however put forward an alternative approach that measures local demand for hospital admissions by the number of cases admitted to hospitals together with those to be admitted.

In Malaysia, at the moment we are not aware of any specific criterion for the supply of hospital facilities. Our analysis shows that the average number of beds available per 1000 population for 1984 and 1989 was 1.75 and 1.61 respectively. Based on these averages as shown in Table 7 and other results of our analysis in this paper, we could conclude that the criteria suitable for the national level is about 2 beds per 1000 population for area with density of about 500 persons per square kilometres. But under the Sixth Malaysian Plan, the government has targeted a doctor population ratio of 1:1500 by the year 2000. Besides this expected doctor population ratio, we feel that planners should also consider average beds per 1000 population for planning the health care services in Malaysia.

Finally, this paper has recognised the usefulness of including in the study the state wise variations in the following: (1) bed class (2) ethnic groups (3) types of diseases (4) age structure (5) patients's income. Our economic analysis did not however take into account these variations as statistics relating to most of the variables were not available in published form.

TABLE 7. Bed Complement and Population Density 1984 and 1989

	Bed Complements ('000 population)		Population Density (Square km)	
States	1984	1989	1984	1989
Perlis	2.56	2.19	205	231
Kedah	1.36	1.28	131	147
Penang	1.96	1.99	998	1091
Perak	1.79	1.69	94	104
Selangor	0.73	0.74	212	243
W. Persekutuan	2.26	2.04	4428	4966
N. Sembilan	2.89	2.39	95	107
Melaka	1.88	1.58	310	347
Johor	1.61	1.35	96	109
Pahang	1.62	1.45	25	29
Trengganu	1.38	1.52	48	56
Kelantan	0.97	1.05	68	79
Sabah	1.89	1.76	16	19
Sarawak	1.66	1.52	12	13
Mean	1.756	1.611	481.286	538.643
Std Dev	0.575	0.447	1163.40	1303.51
C.V.	32.714	27.726	241.728	241.99

Source: Department of Statistics, Kuala Lumpur
Ministry of Health

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APPENDIX A

Availability and Use of Hospital Beds, Number of Patients and Number of doctors 1984 ('000 populations)

State	Bed Complements	Number of Admissions	Total Patients	No. of Discharges	Bed Used	Mean Stay	% of Utilization	No. of Doctors
Perlis	2.57	79.22	837.41	78.91	1.36	6.21	52.88	0.17
Kedah	1.37	61.57	638.94	61.57	0.96	5.68	69.71	0.08
Penang	1.96	77.65	1216.24	76.83	1.37	6.46	70.05	0.15
Perak	1.79	64.54	760.80	64.40	1.01	5.73	56.30	0.10
Selangor	0.73	31.85	396.60	31.81	0.44	5.09	60.72	0.07
W. Persekutuan	2.26	105.18	1499.09	104.70	1.87	6.49	82.38	0.62
N. Sembilan	2.89	84.92	1029.90	84.89	1.43	6.15	49.32	0.14
Melaka	1.88	66.20	932.21	66.31	1.08	5.98	57.53	0.15
Johor	1.61	65.04	547.30	65.02	0.92	5.20	57.32	0.09
Pahang	1.62	52.21	593.16	52.10	0.87	6.12	53.85	0.11
Terengganu	1.38	54.32	634.28	53.99	0.80	5.37	57.70	0.11
Kelantan	0.97	38.71	413.99	38.70	0.74	6.98	76.09	0.10
Sabah	1.90	86.10	1192.54	na	1.25	5.30	65.74	0.07
Sarawak	1.66	70.97	700.18	69.51	1.36	7.00	81.76	0.08
Total	1.63	64.98	774.70	–	1.07	6.02	65.43	0.13

Availability and Use of Hospital Beds, Number of Patients and Number of doctors 1989 ('000 populations)

State	Bed Complements	Number of Admissions	Total Patients	No. of Discharges	Bed Used	Mean Stay	% of Utilization	No. of Doctors
Perlis	2.20	87.22	1138.47	87.22	1.29	5.40	58.50	0.17
Kedah	1.28	63.04	654.64	63.01	0.79	4.60	61.83	0.11
Penang	2.00	74.30	1103.89	74.03	1.16	5.70	57.96	0.17
Perak	1.70	73.59	887.31	72.91	0.94	4.70	55.73	0.12
Selangor	0.74	41.06	526.56	40.87	0.48	4.30	65.07	0.09
W. Persekutuan	2.04	111.02	1339.23	110.93	1.76	5.80	86.37	0.76
N. Sembilan	2.39	90.72	1036.68	90.44	1.19	4.80	49.79	0.17
Melaka	1.59	60.16	824.28	60.08	0.90	5.50	56.86	0.13
Johor	1.35	75.42	665.96	75.26	0.82	4.00	61.07	0.09
Pahang	1.45	62.89	755.99	62.43	0.86	5.00	59.12	0.13
Terengganu	1.52	69.36	768.60	69.31	0.95	5.00	62.23	0.11
Kelantan	1.05	46.26	479.29	45.62	0.67	5.30	63.55	0.17
Sabah	1.76	90.39	1161.71	89.41	1.86	4.30	60.41	0.08
Sarawak	1.53	77.34	772.71	77.20	1.23	5.80	80.28	0.08
Total	1.51	71.44	825.51	71.11	0.97	4.90	64.01	0.16

Bed Used = (No. of Admission x Mean Stay)/366
% of Utilization = (Bed Used/Bed Complement) x 100
Total Patient = No of Adm. + No. of Outpatient

APPENDIX B

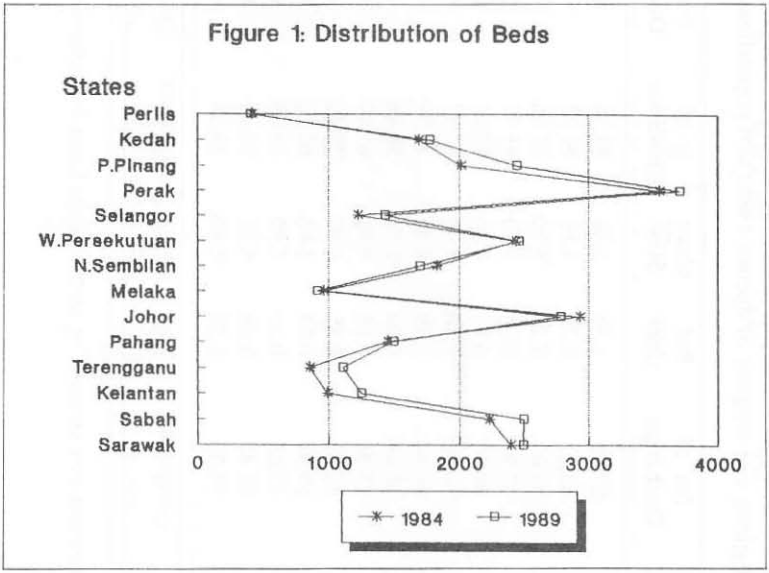
Figure 1: Distribution of Beds
States
Perlis
Kedah
P.Pinang
Perak
Selangor
W.Persekutuan
N.Sembilan
Melaka
Johor
Pahang
Terengganu
Kelantan
Sabah
Sarawak
0
1000
2000
3000
4000
1984
1989

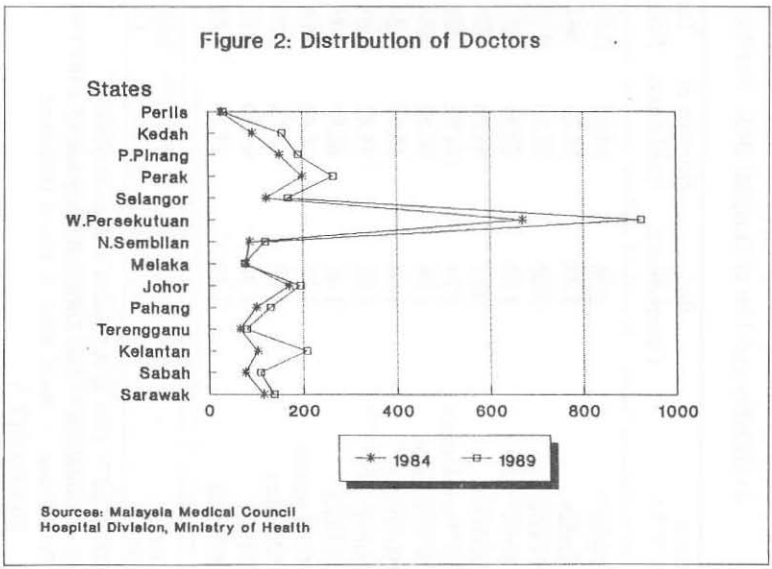
Figure 2: Distribution of Doctors
States
Perlis
Kedah
P.Pinang
Perak
Selangor
W.Persekutuan
N.Sembilan
Melaka
Johor
Pahang
Terengganu
Kelantan
Sabah
Sarawak
0
200
400
600
800
1000
1984
1989
Sources: Malaysia Medical Council
Hospital Division, Ministry of Health

APPENDIX C

Estimated Results for Other Forms of Equation: 1984

Dependent Variable	Intercept	Coeeficient	Independent Variable (s)	R-Square	N
LOGADD	3.753	0.805	LOGBED	0.8328	14
	(0.064)	(0.104)			
LOGADD	4.808	0.303	LOGDOC	0.2827	14
	(0.306)	(0.139)			
ADD	54.669	85.021	DOC	0.3814	14
	(6.215)	(31.260)			
BEDUS	– 0.343	1.179	BED	0.7147	14
	(0.445)	(0.505)			
		– 0.184	BEDSQ		
		(0.137)			
BEDUS/BED	0.724	–0.050	BED	0.07	14
	(0.096)	(0.052)			
BEDUS/BED	0.548	0.164	BED	0.12453	14
	(0.233)	(0.264)			
		–0.059	BEDSQ		
		(0.072)			
LOGBEDUS	– 0.879	0.525	BED	0.7093	14
	(0.179)	(0.097)			
ADD	–18.797	72.457	BED	0.7752	14
	(21.266)	(24.095)			
		– 12.215	BEDSQ		
		(6.528)			
LOGADD	4.858	– 1.083	RBED	0.8399	14
	(0.095)	(0.137)			
LOGBEDUS	0.811	–1.195	RBED	0.8093	14
	(0.116)	(0.167)			
BED	0.0008	0.325	DISC	0.7390	13
	(0.325)	(0.0048)			

Notes:
Figures in parentheses are standard errors.
N is number of observations
Definition of variables:
ADD = Number of admissions
BED = Bed complements
DOC = Number of doctors
RBED = Reciprocal of bed complements
BEDSQ = Square of bed complements
DISC = Number of discharges
BEDUS = Number of beds used