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Distribution Characteristics of the Medical Services in Korea

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한국 의료서비스의 분포 특징 분석

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Abstract : This study investigates the distribution characteristics of medical services in Korea. For the purpose this paper examines the spatial discordance between the provisions of the medical services and the need for them, and analyzes the spatial distribution patterns of medical service in both inter- and intra-regional levels. Disclosed is a severe regional disparity problem in the provision of medical facilities at both inter-regional and intra-regional levels. In recent years people's interest gets increased more in the social well-being of the community, and the resulting strong request makes it desirable to restructure the healthcare service system. This study has thus attempted to draw out the distribution function of the medical facilities, based on the examination of the real data. A particular attention has been paid to whether there exists any hierarchical structure in their size distribution. Quite remarkably, no appreciable hierarchical structure has been observed in the scale of the medical facilities in Korea, in sharp contrast to of the three-level hierarchical structure assumed in the three-level referral system adopted widely. Remarkably, it is revealed that medical facilities in Korea are described by scale-invariant distribution functions. Instead, scale-invariant power-law behavior has been found in the size distribution, which is expected to be rather generic and applicable to other countries as well.

Key Words : medical services, spatial disparity, distribution function, scale invariant power low

요약 : 본 연구에서는 우리나라 의료서비스의 공간분포에 나타나는 특징을 분석하였다. 이를 위하여 의료서비스의 공간적 분포 패턴을 조사하고, 의료 서비스에 대한 수요에 대한 공급의 공간적 패턴 분석을 통하여 의료서비스 공급에 나타나는 공간적 격차문제를 지역간과 지역내의 수준에서 분석하였다. 분석 결과 인구수를 고려한 상태에서도 의료 서비스의 공급이 대도시 및 경제적 중심지에 집중 분포하고, 촌락 및 경제적 주변지역은 크게 미흡한 상태여서 공간적 격차가 매우 심하다. 이러한 공간적 격차는 하나의 도시 내에서도 나타나고 있음을 확인하였다. 또한 본 연구에서는 병원시설의 규모별 분포 수의 관계를 분석하였다. 병원시설의 규모와 분포 수의 관계는 기존의 병원시설 입지계획 모형들이 일반적으로 가정하는 계층적 구조보다는 자연계 및 사회 현상의 분포에 일반적으로 나타나는 보편적 질서로 밝혀진 법칙과 유사한 분포 함수를 보인다. 즉, 병원 규모에 따른 분포에 격차가 나타나지 않는 것으로 나타나고 있다. 이는 우리나라 의료체계가 3단계로 구분되어 있음에도 불구하고 병원시설의 분포는 규모에 뚜렷한 격차를 나타내지 않는 것을 의미한다. 이러한 병원시설의 규모와 분포 수가 보이는 특징은 의료서비스의 공간적 분포가 보여 주는 특징과 함께 앞으로 바람직한 의료서비스 시설 입지계획을 위한 모형 정립에 유용한 정보로 이용될 수 있다.

주요어 : 의료서비스, 공간적 격차, 분포함수, 규모-불변이 법칙

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1. Introduction

Health is a fundamental resource necessary for both maintaining one's life and living long in the pleasant condition, and the resulting strong request makes it desirable to restructure the healthcare service system. In recent years people's interest gets increased more in the social well-being of the community. Public concerns have been focused on the improvement of the provision of healthcare service so that residents get hold of good access to the service at their localities, although healthcare comprises far more than just the provision of formal health services (Gould and Moon, 2000).

The spatial distribution pattern of the medical services describes directly the potential opportunity for the residents in a region to receive the services, thus representing the accessibility to the services. In all, the provision of healthcare services makes one of the most significant indices for evaluating the regional welfare level. Accordingly, the geographical expression of inequality in spatial accessibility to healthcare services is an important element in the welfare status of a community. Therefore, it is important to analyze the distribution pattern in the study of social well-being and healthcare planning. Indeed, many countries have planned major reforms in their national approaches to the healthcare provision to meet the increasing demand, and put increasing share of provincial and national resources into the healthcare provision (Congdon, 2000; Mustard and Frank, 1994).

The spatial variations of the need, provision, and accessibility of healthcare resources have been studied actively since late 1960s in various disciplines. In particular, the spatial relationship between the need and provision of healthcare services has been examined in many studies (Noyce, *et al.*, 1974; West and Lowe, 1976; Knox, 1982; Joseph and Phillips, 1984; Powell, 1990; Haynes, 1991; Jones and Moon, 1993; Mohan, 1998). A number of studies have examined the spatial disparity problem in the need for health care facilities and the provision of them at the inter- and intra-area levels (Morrill and Rees, 1967; Morrill and Erickson, 1969; Coates and Rawstron, 1971; Hart, 1971; Shannon and Dever, 1974; Buxton and Klein, 1975; Gober and Gordon, 1980; Powell, 1990; Townsend, *et al.*, 1992). Most of these studies raised the spatial disparity problem in the distribution of health care services in their study regions.

This study analyzes the distribution patterns of medical services in Korea, and examines the spatial discordance in the distributions of the supply and demand at both the inter- and intra-regional levels. In particular this study focuses on the comparisons between urban and rural areas in the provision of medical services. Furthermore, this study analyzes the distribution function of medical facilities in Korea, and obtains real distribution functions of the medical facilities in Korea, paying particular attention to whether there exists a hierarchical structure in their distributions.

2. The Spatial Distribution Patterns of Medical Services in Korea

1) Changes in the Provision of Medical Services

As the living standard has raised, the demand

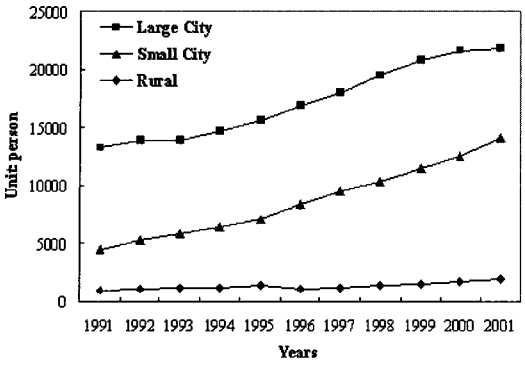

Figure 1. Growth Trends of the Numbers of Medical Doctors in the Urban and the Rural Areas

Source: Author reworks the data from Survey Reports for the Memberships, 1991, 2001, The Korean Medical Doctors Association,

for and supply of medical services have been rapidly increasing during the last decades throughout the world. The demand for healthcare services has increased rapidly in Korea since 1970's, and the provision of medical services has also increased rapidly following the increase in the demand for healthcare services both in quantity and in quality.

Table 1 shows the changes in the numbers of hospital facilities and of medical doctors during the last three decades in Korea. Both numbers are observed to have grown up tremendously. In particular, medical doctors show the highest rate of increase; hospital facilities of larger sizes show higher increase rates. The number of general hospitals as well as that of medical doctors has increased almost eight times, while the number of clinics has increased only a little over three times during the time period. In particular the numbers of hospitals and medical doctors have increased dramatically during the later part of 1990's.

Table 1. Changes in the Provision of Medical Services

Years	General Hospital	Hospital	Clinic Doctors	Medical
1975a	37	133	6,087	5,854
1980	82	240	6,344	8,415
1985	183	317	8,069	14,797
1990	228	328	10,935	23,222
1995	266	398	15,002	32,030
2000b	278	663	20,820	45,870
b/a	7.51	4.98	3.42	7.84

Source: Author reworks the data from Annual Statistics of the Ministry of Health and Welfare, (1976, 1981, 1986, 1991, 1996, 2001, Health Resources Policy Division.

Also shown in Figure 1 are the different growth trends of medical services between urban areas and rural areas during last ten years. The numbers of medical doctors are shown to have increased rapidly in urban areas, both large and small cities, since 1995, while those in rural areas remained almost the same during the last decade. These trends results in the spatial disparity problem of the medical service distribution in Korea, and the situation has been getting worse and worse. Here the spatial disparity problem associated with the fact that the provision of medical services has grown mostly in the urban areas should be pointed out.

2) The Spatial Distribution Pattern of Medical Provision

The spatial distribution pattern of the medical services describes directly the potential opportunity for the residents in a region to receive the services, thus representing the accessibility to the services. Therefore, it is important to analyze the distribution pattern in the study of social well-being and healthcare planning. However, there is argument for the difficulty in measuring precisely the need (or demand) for health care services (Powell, 1990).

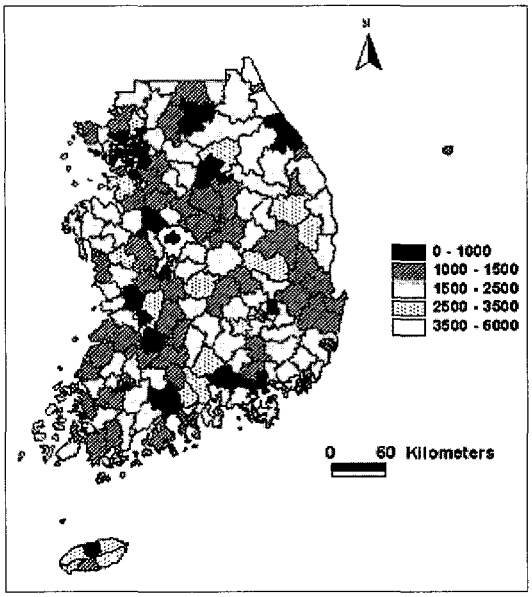

Figure 2. Distribution of Medical Resources: population per medical doctor in 2001

Source: Author reworks the data form Survey Reports fof the Memberships, 2001, The Korean Medical Doctors Association

Figure 2 exhibits the spatial distribution of medical services provision across Korea in the year of 2001 with the number representing the population per medical doctor, which represents medical service provisions, concerned both the demand for and supply of the medical services.

It is clear that the distribution of medical resources displays an extremely uneven pattern. In the year of 2001, the medical resources are concentrated mostly at urban centers of large cities. Rural areas located at the eastern and southern parts of country, in particular in the Province Gangwon, Juengbuk, Chungbuk, and Juennam, show the very low level of medical service provision.

3. Spatial Disparity in the Provision of Medical Services in Korea

1) Inter-Regional Disparity Problems

The equity consideration has continued to have important bearing on policy formulation for the healthcare provision, so that the resources are allocated to meet the overall need of the society. Here the spatial disparity problem associated with the fact that the provisions of medical services has grown mostly in the urban areas should be pointed out. Also shown in Figure 1 are the different growth trends of medical services between urban areas and rural areas during last ten years. In particular, manifested is severe disparity between urban and rural areas (see Table 2).

The medical resources are concentrated mostly

Table 2. Disparity in the Medical Resources between the Urban and the Rural Areas in 2001

Years / Regions	Medical Doctors(%)	Hospitals (%)			Hospital Beds(%)	Population(%)
		General hospitals	Hospitals	Clinics		
Urban (Metropolitan Seoul Area)	94.7 (50.8)	93.3 (41.1)	82.8 (35.6)	91.8 (47.0)	88.8 (37.3)	79.7 (42.0)
Rural	5.3	6.7	17.2	8.2	11.2	20.3
Total	100	100	100	100	100	100

Source: Author reworks the data from Survey Reports for the Memberships, 2001, The Korean Medical Doctors Association,

at urban centers of large cities: About 95% of medical doctors, 93% of general hospitals, 83% of hospitals, and 92% of clinics provide their services in urban areas. Namely, the medical resources are concentrated heavily in urban areas, which imply that rural regions are relatively disadvantaged with regard to the accessibility to medical services.

Medical resources are especially concentrated in the Metropolitan Seoul area. Although this high concentration has relaxed slightly during the last ten years, still more than 50% of the total medical doctors render services in the Metropolitan Seoul area. In view of the fact that the population of the Metropolitan Seoul area takes up 42% of the total population, the medical services accounting over 50% indicate a marked trend toward concentration. The centralization of healthcare services in the Metropolitan Seoul is expected to generate profound effects on inequality in the healthcare delivery system.

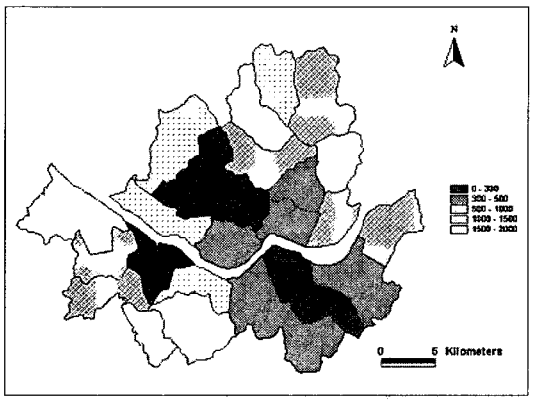

Figure 3. Distribution of Medical Services in the City of Seoul: population per medical doctor in 2001

Source: Author reworks the data form Survey Reports fof the Memberships, 2001, The Korean Medical Doctors Association

2) Intra-urban Disparity Problems

The spatial disparity appears at the intra-urban level as well. Figure 3 shows the distribution of medical services in the City of Seoul. The higher-level medical services tend to concentrate in the economic core areas, which is consistent with the results of the previous study by Kim and Lee (1998). That study analyzed the major location criteria of the Hospital facilities in Seoul: The daytime population, taken as a measure for the centrality level, was ascertained as the major location factor for general hospitals. In consequence, general hospitals tend to be concentrated at the central business districts (C.B.D.s) and sub-centers of the city, and potential opportunities to receive higher-level medical services are far poorer in socially less advantaged areas. Even clinics, which take the lowest level of the three level referral systems and thus expected to be located near the patients, tend to be located the economic core areas. Especially, higher-level medical services, such as general hospitals and medical specialists, show more concentration in the economic core areas than the lower-level services.

Hospital facilities have been invested and managed by both private and public sectors in Korea, whose location mechanisms differ vastly from each other (Lee, 1998). Their proportions have changed with time, and this proportion of private sector has been getting higher in recent years. Recently most hospital facilities have been invested by the private sector. In the year of 2001, for example, almost 90% of the hospitals and over 80% of the beds in the hospitals were provided by the private sector (see Table 3).

This trend produces the spatial discordance between the provisions of the medical services

Table 3. Private Sector and Public Sector in the Provision of Hospital Facilities in the year of 2003

	Hospitals	Ratio (%)	Hospital beds	Ratio (%)
Public sector	103	10.95	35745	17.85
Private sector	838	89.05	164469	82.15
Total	941	100.00	200214	100.00

Source: Author reworks the data from Survey Reports for the Memberships, 2001, The Korean Medical Doctors Association

and the need for them. It reflects that hospital facilities are located according to the market mechanism rather than to the social welfare. The spatial disparity problem in the provision of medical facilities in Korea is closely related with the fact that most medical facilities have been invested and managed by the private sector.

Namely, the healthcare system has not evolved appropriately for the social need, leading to the high potentiality for spatial discordance between the provision of and the need for medical services. As shown by Hart (1971), the operation of market forces tends to cause "unjust and irrational" distributions of healthcare facilities, so that rich people get too much while the poor too little. There has been major growth in private hospitals throughout Korea, and the proportion of the private sector has become much higher in the Metropolitan Seoul area in particular. As the result, this region exhibits more severe intra-regional spatial disparity in the healthcare provision.

4. Distribution Function of Medical Service Facilities in Korea

Most previous studies on the medical service facility location problem have assumed that medical services are distributed in the hierarchical manner according to the facility size as well as the service level and the catchments area, and the locations and numbers of medical services are largely affected by their hierarchy levels. Therefore, to identify the hierarchical structure of the healthcare system is a pre-requisite procedure for developing the location model.

It has been in general expected that the distribution function of the medical facilities in Korea may be cast into the hierarchical structure, since the three-level referral system has been in force for the Korean medical system: Clinics are at the lowest level, hospitals at the middle, and general hospitals (mostly university hospitals) at the highest. In order to investigate the distribution structure of medical facilities, we plot the frequency of each hospital size category in Figure 4. Surprisingly, the distribution function is observed not to possess any appreciable hierarchical structure in the size of the medical facilities, contrary to the conventional expectation and assumption in most of the healthcare facility location-allocation models.

This may be related with the fact that the referral system in the Korean healthcare system apparently does not function well at the actual operational level: People tend to visit directly the

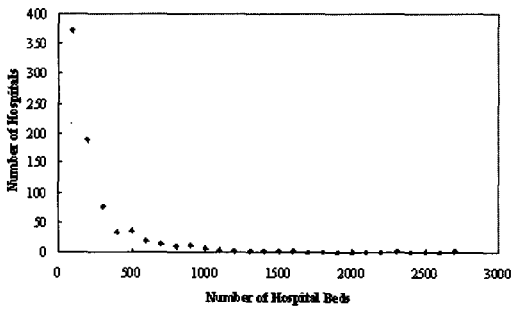

Figure 4. Hospital Size Distribution in Korea

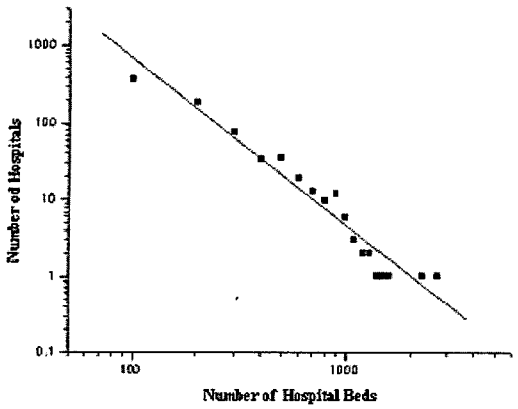

Figure 5. Log-Log Plot of the Hospital Size Distribution

highest-level hospitals, rather than to follow the referral order. Among the various reasons why the referral system does not work well in Korea, the severe disparity problem in the medical facility distribution is undoubtedly one of the major reasons.

The structure of the distribution *f(s) is* conveniently probed by the log-log plot as a function of the facility size s, i.e. the number of beds in a hospital. Fitting the log-log plot of the distribution in Figure 5 to a straight line, we obtain

$$\log f(s) = -a \log s + b \tag{1}$$

where the least-square fit yields the exponent . a=2.170.+14.0 Namely, the value of the exponent a is approxi-mately given by two: $a \approx 2$. It is thus observed in Figure 5 that the size distribution exhibits power-law behavior with the exponent close to two:

$$f(s) = Cs^{-a} \approx Cs^{-2} \tag{2}$$

where the normalization constant $C=10_b$ can be computed in the following way. The total number N of medical facilities is given by

$$N = \int_{s_{min}}^{s_{max}} f(s)ds = \int_{s_{min}}^{s_{max}} Cs^{-2}ds = C\left[\frac{1}{s_{min}} - \frac{1}{s_{max}}\right] \tag{3}$$

where s_{min} and s_{max} stand for the minimum size of medical facilities and the maximum size, respectively. Noting that s_{max} is far larger than s_{min}, we obtain the normalization constant from Equation (3):

$$C \approx N s_{min} \tag{4}$$

It should be stressed that there does not exist a characteristic size in the distribution given by Equation (2), which reveals that medical facilities in Korea are described by the scale-invariant distribution function. In general such algebraic (power-law) behavior is peculiar in the sense that the characteristic scale is lacking, and widely believed to be characteristic of a complex system, appearing ubiquitously in nature (Bak, 1999). Indeed empirical data for a variety of systems in physics, biology, economy, and society have been demonstrated to follow power-law distributions. While the emergence of the power law for the city size distribution has been widely known as Zipf's rank-size law (Zipf, 1949), recent studies have disclosed power-law behavior in other social science systems as well (Blank and Solomon, 2000; Malescio, *et al.*, 2000; Kaizoji, 2003; Andersson, *et al.*, 2003). It is further of interest that the power-law distribution with the exponent close to two appears in many systems, ranging from the fossil data in biological evolution (Choi,*et al.*, 1997) to the area distribution in urban growth (Makse, et al., 1995). This may be a manifestation of intermittency in such cases as demographic evolution, cultural and technical development, and economic activity (Handerson, 1985) as well as biological

evolution (Gould and Eldredge, 1993) and urban growth (Zanette and Manrubia, 1997).

Such characteristic scale-invariant behavior appears essentially independent of the details of the microscopic dynamics of the system (Schroeder, 1991), indicating that it may be a universal and fundamental property of the complex system viewed as a network of interacting constituents. In particular, its ubiquity suggests that there may exist a generic and universal mechanism common to a variety of systems (Bak, 1999; Choi, *et al.*, 2005). Accordingly, the scale invariance of the hospital size distribution is expected to be the case in other countries as well.

5. Conclusion

This study has considered the provision of the medical facilities in Korea, and investigated the disparity problem between the demand for and the provision of medical resources. The spatial distribution pattern of the medical services describes directly the potential opportunity for the residents in a region to receive the services, thus representing the accessibility to the services. Therefore this study has analyzed the distribution pattern of medical facilities at first, and then examined the spatial disparity problem in terms of the inter- and intra-regional levels.

The medical resources have been found concentrated at the economic core regions, especially at the Metropolitan Seoul area. In particular, higher-level healthcare resources, such as the general hospitals and medical specialists, show marked concentration at the economic core areas. Such centralization of medical facilities may have profound effects on inequality in the healthcare delivery system, intensifying the relative disadvantage of the non-metropolitan region. It has turned out that the spatial disparity appears at the intra-regional level as well as at the inter-regional level.

This feature is presumably related with the fact that most healthcare facilities in Korea are invested and managed by the private sector, whose interest is to maximize the profit rather than social welfare. Their proportions have changed with time, and this proportion of private sector has been getting higher in recent years. As the result, the medical services have been concentrated on large cities, especially in the Metropolitan Seoul area, giving rise to the severe spatial disparity problem in the provision of medical resources.

In recent years people's interest gets increased more in the social well-being of the community, and the resulting strong request makes it desirable to restructure the healthcare service system. For the construction of a rational location-planning model for the healthcare facilities, it is prerequisite to investigate the location characteristics of the healthcare facilities in reality. This study has thus attempted to draw out the distribution function of the medical facilities, based on the examination of the real data. A particular attention has been paid to whether there exists any hierarchical structure in their size distribution.

Quite remarkably, no appreciable hierarchical structure has been observed in the scale of the medical facilities in Korea, in sharp contrast to of the three-level hierarchical structure assumed in the three-level referral system adopted widely. Remarkably, it is revealed that medical facilities in Korea are described by scale-invariant distribution functions. Instead, scale-invariant

power-law behavior has been found in the size distribution, which is expected to be rather generic and applicable to other countries as well.

Findings of this paper provide a preliminary contribution to the planning for desirable healthcare delivery systems to ameliorate the inequality problem in the distribution of healthcare facilities, and eventually to improve the public health. Manifested accordingly are the gap between the optimal distribution of medical facilities and the existing distribution, which needs to be reduced for achieving a desirable healthcare service system.

Detailed investigations and applications as well as dynamic extensions to the development of a medical facility location-planning model for the desirable healthcare distribution systems are left for further study.

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References

Anderson, C., Hellervik A., Lindgren, K., Hagson, A., and Tornberg, J., 2003, The urban economy as a scale-free network, *e-print cond-mat* /03035352.

Bak, P., 1999, *How Nature Works: The Structure of Self-Organized Criticality*, Springer-Verlag, New York.

Blank, A. and Solomon, S., 2000, Power laws in cities population, financial markets and internet sites (scaling in systems with a variable number of components), *Physica A*, 287, 279-288.

Buxton, M. and Klein, R., 1975, Distribution of hospital provision: Policy themes and resource variations, *British Medical Journal*, 1, 345-349.

Choi, M.Y., Lee, H.Y., Kim, D., and Park, S.H., 1997, Entropic sampling and natural selection in biological evolution, *Journal of Physics A*, 30, L749-L755.

Choi, M.Y., Kim, B.J., Yoon, B.-G., and Park, H., 2005, Information transfer and self-organized criticality, *Europhysics Letters*, 69, 503-509

Congdon, P., 2000, A Bayesian approach to prediction using the gravity model, with an application to patient flow modeling, *Geographical Analysis*, 32(3), 205-224.

Coates, B. and Rawstron, E., 1971, *Regional Variations in Britain*, Batsford, London.

Gober, P. and Gordon, R.J., 1980, Intraurban physician location: a case study of Phoenix, *Social Science and Medicine*, 14D, 407-417.

Gould, M. and Moon, G., 2000, Problems of providing health care in British island communities, *Social Science and Medicine*, 50, 1081-1090.

Gould, S.J. and Eldredge, N., 1993, Punctuated equilibrium comes of age, *Nature*, 366, 223-227.

Handerson, J.V., 1985, *Economic Theory and the Cities*, Academic Press, San Diego.

Hart, J.T., 1971, The inverse care law, *Lancet*, 1, 405-412.

Haynes, R., 1991, Inequalities in health and health service use: evidence from the General Household Survey, *Social Science & Medicine*, 33, 361-368.

Health Resources Policy Division, 1976, 1981, 1986, 1996, 2001, *Annual Statistics of the Ministry of Health and Welfare*

Jones. K. and Moon, G., 1993, Medical geography: taking space seriously, *Progress in Human Geography*, 17, 515-524.

Joseph, A. and Phillips, D., 1984, *Accessibility and Utilization: Geographical Perspectives on Health Care Delivery*, Harper and Row, New York.

Kaizoji, T., 2003, Scaling behavior in land markets, *Physica A*, 326, 256-264.

Kim, H. and Lee, K., 1998, The relationships between hospital distribution and socio-e conomic indices in Seoul, *The Journal of Applied Geography*, 21, 17-37.

Knox P.L., 1982, The geography of medical care delivery: An historical perspective, *Geoforum*, 12, 245-250.

Lee, K., 1998, The medicare service facility location problem, *Journal of the Economic Geographical Society of Korea*, 1(2), 71-84.

Makes, H.A., Havlin, S., and Stanley, H.E., 1995, Modeling urban growth patterns, *Nature*, 377, 608-612.

Melescio, G., Dokholyan, N.V., and Stanley, H.E., 2000, Hierarchical organization of cities and nations, *e-print cond-mat*/0005178.

Mohan, J.F., 1998, Explaining geographies of health care: A critique, *Health and Place*, 4, 113-124.

Morrill, R.L. and Erickson, R.J., 1969, Location efficiency in Chicago hospitals, *Health Services Research*, 4, 127-145.

Morrill, R. and Rees, P., 1967, Physician referral and patient to hospital flows, *Chicago Regional Hospital Study Working Paper*, 1 (11), Chicago.

Mustard, J.F. and Frank, J., 1994, The determinants of health, in Hayes, M.V. et al.(eds.), *The Determinants of Population Health: A Critical Assessment*, Western Geographical Series, 29, 7-48.

Noyce, J., Snaith, A.H. and Trickey, A., 1974, Regional variations in the allocation of financial resources to the community health services, *Lanset*, 1, 554-557.

Powell, M., 1990, Need and provision in the National Health Service: an inverse care law, *Policy and Politics*, 18, 31-37.

Shannon, G.W. and Dever, G.E.A., 1974, *Health Care Delivery-Spatial Perspectives*, McGraw-Hill, New York.

The Korean Medical Doctors Association, 1991, 2001, *Survey Reports for the Memberships.*

Townsend, P. and Davidson, N. and Whitehead, M., 1992, *Inequalities in Health: the Black Report and the Health Divide*, Penguin, Harmondsworth.

West, R. and Lowe, C., 1976, Regional variations in need for and provision and use of child health services in England and Wales, *British Medical Journal*, 2, 843-846.

Zanette, D.H. and Manrubia, S.C, 1997, Role of intermittency in urban development: a model of large-scale city formation, *Physical Review Letters*, 79, 523-526.

Zipf., G.K, 1949, *Human Behavior and the Principle of Least Effort*, Addison-Wesley, Reding.

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