# THE EFFECT OF THE PRIVATE SECTOR ON
# GEOGRAPHIC DISTRIBUTION OF
# PUBLIC SECTOR PHYSICIANS IN TURKEY,
# 1990-2000

Thesis submitted to

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ABSTRACT

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The availability and distribution of physicians is an important indicator of the strength of a health system and is highly associated with mortality rates and life expectancy. The purpose of this study is to determine the factors affecting the public sector physician supply in Turkey with an emphasis on the impact of private hospitals. The change in the physician supply at city-level from 1990 to 2000 is regressed on the number of private and public hospital beds, certain socio-economic variables and market area characteristics. Considering that the response to private hospitals could differ across physicians with different characteristics, the analysis is repeated using 1) specialists vs practitioners, 2) physicians working for different types of hospitals (namely Ministry of Health, SSK and university hospitals). The effect of private hospital capacity is found to be significant and positive for specialists, whereas it is negative for practitioners. There is a significant and positive correlation between the private bed numbers and the supply of specialists working in MoH and university hospitals, but it does not seem to affect the SSK hospitals. Finally, the ten year period is divided into two 5-year periods to detect the effect of the change in obligatory service law in 1995 on the distribution of physicians.

KISA ÖZET

Türkiye'de Özel Sektörün Devlet Hastanelerinde Çalışan Doktorların Bölgesel Dağılımına Etkileri, 1990-2000

Ayça Bilir

Sağlık personelinin mevcudiyeti ve dağılımı, sağlık sisteminin gücünün önemli bir göstergesidir, aynı zamanda ölüm oranları ve yaşam beklentisi ile fazlaca ilişkilidir. Bu çalışmanın amacı, başta özelhastaneler olmak üzere, doktorların çalışma yeri seçimlerini etkileyen faktörleri bularak bu alandaki bölgesel dağılım sorununa çözüm bulabilmektir. Özel ve kamu hastanelerindeki yatak sayıları, sosyoekonomik değişkenler ve bölgesel özellikleri, 1990 ve 2000 yılları arasındaki doktor sayılarının il bazında değişimini açıklamak için kullanılmıştır. Özel hastanelerin etkisinin doktor grupları için farklılık gösterebileceği düşünülerek analizler 1)uzman ve pratisyen hekim, 2)Sağlık Bakanlığı, SSK ve üniversite hatanerinde çalışan doktorlar için tekrarlanmıştır. Özel hastane kapasitesinin uzman doktorlar üzerinde pozitif etki yaparken, pratisyen hekimler üzerinde negatif etki yaptığı ortaya çıkmıştır. Sağlık Bakanlığı ve üniversitede çalışan uzman hekim sayısı ile özel yatak sayıları arasında pozitif bir ilişki bulunmaktadır. Zorunlu hizmet yasasının, doktorların dağılımına etkileri, 1990-2000 dönemi beşer yıllık iki periyoda bölünerek incelenmiştir.

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# CHAPTER 1

# INTRODUCTION

## Objective

The objective of this study is to identify the effects of the private health sector together with socio-economic development variables and certain market area characteristics on the location choice of physicians in Turkey between 1990 and 2000. Before the overall physician shortage can be understood and any public policy developed, it is necessary to understand on a macro scale the factors determining the geographic distribution of physicians across the country. An attempt is made here first to introduce the results of previous studies and then to develop a meaningful model of physician location for Turkey.

## Reasons for Studying Physician Distribution

> "Today and every day, the lives of vast numbers of people lie in the hands of health systems. From the safe delivery of a healthy baby to the care with dignity of the frail elderly, health systems have a vital and continuing responsibility to people throughout their lifespan. They are crucial for the healthy development of individuals, families and societies everywhere".
>
> (World Health Report, 2000)

At the heart of each and every health system, the workforce is central to advancing health. The availability and composition of human resources for health is an important indicator of the strength of a health system. There is ample evidence that worker numbers and quality are positively associated with immunization coverage, outreach of primary care and infant, child and maternal survival (World Health Report, 2006).

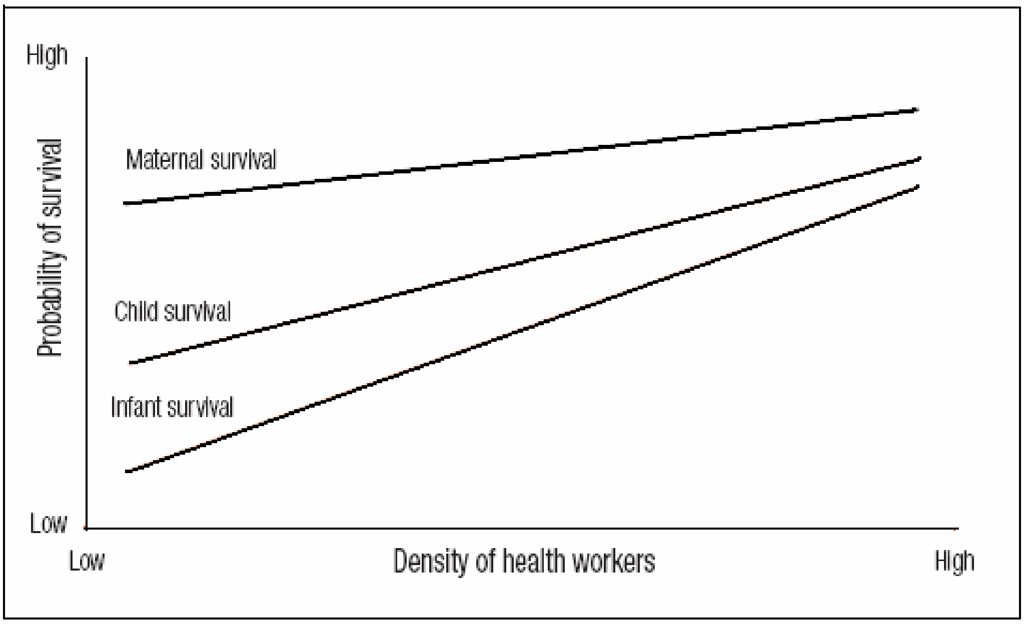



Figure 1: Health workers save lives!
Source: World Health Report, 2006

Equal distribution and prevalence of medical institutions and health personnel are the fundamental principals of The Turkish Main Law on Health Services[1]. But contrary to what is desired, physician to population ratios in Turkey vary a great deal across geographic regions. Table 1 gives the per capita and total number of all physicians, specialists and general practitioners working in the public sector for the years 1990, 1995 and 2000 in three big cities- Istanbul, Ankara and Izmir- , in other metropolises and in the remaining fifty eight cities considered in this study. In 2000, the physician supply in 12 metropolises reaches 909 and in small cities 209, with a 120% increase in ten years. The percentage increase in that period in Istanbul, Ankara and Izmir is small compared to the remaining cities. In 2000, the number of physicians working in public hospitals in the 3 big cities become 9305, 7102 and 4616, increasing by 51%, 52% and 105% respectively. In most of the cases, increase in specialist and practitioner numbers is higher in the first half of that period. After 1995, the increase in physician supply in public hospitals lessens,

[1] Sağlık Hizmetleri Temel Kanunu, 3359

which can be explained by the obligatory service law on health services that was in force until 1995.

The disproportionate distribution of physicians, both general practitioners and specialists, can also be detected from the per capita figures presented in Table 1. In 2000, there were only 0.65 physicians per 1000 persons working in public hospitals in metropolises and 0.36 in small cities compared to 1.7 in Ankara, 1.4 in Izmir and 0.9 in Istanbul. Although the number of both specialists and general practitioners per 1000 persons increased more in small metropolises and other cities in 10 years, per capita numbers of physicians are far below the numbers in big cities. The number of specialist per 1000 increased more in small cities in the second half of that period compared to big cities and per capita general practitioners and total physicians are decreased in big cities between 1995 and 2000.

Various public policies, like obligatory service for physicians are, applied to solve this problem. Also the number of physicians working in public hospitals has doubled in ten years. Neither the law on obligatory service nor the increase in physician supply lessens this maldistribution by geographic area in Turkey[2].

2 For the regional distribution of physicians, see Appendix 2.

Table 1: Distribution of total physicians, specialists and general practitioners in Turkey

| | 1990 | 1995 | 2000 | Change 00-90 | Change 95-90 | Change 00-95 |
|---|---|---|---|---|---|---|
| **Physician** | | | | | | |
| Istanbul | 6179 | 8690 | 9305 | 50,6% | 40,6% | 7,1% |
| Ankara | 4669 | 6255 | 7102 | 52,1% | 33,7% | 13,5% |
| Izmir | 2257 | 3937 | 4616 | 104,5% | 74,4% | 17,2% |
| | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | | | |
| Remaining 12 metropolises | 411 (144) | 649 (262) | 909 (285) | 121,2% | 57,9% | 40,1% |
| Remaining 58 cities | 95 (81) | 147 (143) | 209 (187) | 120,0% | 54,7% | 42,2% |
| **Specialist** | | | | | | |
| Istanbul | 3128 | 4290 | 5262 | 68,2% | 37,1% | 22,7% |
| Ankara | 2188 | 2833 | 3318 | 51,6% | 29,5% | 17,1% |
| Izmir | 1089 | 1889 | 2383 | 118,8% | 73,5% | 26,2% |
| | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | | | |
| Remaining 12 metropolises | 230 (76) | 335 (125) | 542 (244) | 135,7% | 45,7% | 61,8% |
| Remaining 58 cities | 62 (55) | 83 (73) | 129 (116) | 108,1% | 33,9% | 55,4% |
| **Practitioner** | | | | | | |
| Istanbul | 3051 | 4400 | 4043 | 32,5% | 44,2% | -8,1% |
| Ankara | 2491 | 3422 | 3784 | 51,9% | 37,4% | 10,6% |
| Izmir | 1168 | 2048 | 2233 | 91,2% | 75,3% | 9,0% |
| | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | | | |
| Remaining 12 metropolises | 181 (85) | 313 (157) | 367 (118) | 102,8% | 72,3% | 17,3% |
| Remaining 58 cities | 33 (32) | 64 (89) | 80 (79) | 142,4% | 93,9% | 25,0% |
| | | | | | | |
| **Physician per 1000** | | | | | | |
| Istanbul | 0,845 | 0,988 | 0,929 | 9,9% | 16,9% | -6,0% |
| Ankara | 1,446 | 1,774 | 1,772 | 22,6% | 22,7% | -0,1% |
| Izmir | 0,838 | 1,288 | 1,369 | 63,5% | 53,8% | 6,3% |
| | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | | | |
| Remaining 12 metropolises | 0.354 (0.12) | 0.500 (0.18) | 0.654 (0.17) | 84,7% | 41,2% | 30,8% |
| Remaining 58 cities | 0.182 (0.10) | 0.271 (0.18) | 0.362 (0.21) | 98,9% | 48,9% | 33,6% |
| **Specialist per 1000** | | | | | | |
| Istanbul | 0,428 | 0,488 | 0,525 | 22,7% | 14,0% | 7,7% |
| Ankara | 0,676 | 0,803 | 0,828 | 22,5% | 18,9% | 3,0% |
| Izmir | 0,404 | 0,618 | 0,707 | 74,9% | 53,0% | 14,4% |
| | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | | | |
| Remaining 12 metropolises | 0.195 (0.05) | 0.257 (0.08) | 0.382 (0.12) | 95,9% | 31,8% | 48,6% |
| Remaining 58 cities | 0.113 (0.07) | 0.152 (0.09) | 0.220 (0.14) | 94,7% | 34,5% | 44,7% |
| **Practitioner per 1000** | | | | | | |
| Istanbul | 0,417 | 0,500 | 0,404 | -3,3% | 19,8% | -19,3% |
| Ankara | 0,770 | 0,971 | 0,944 | 22,7% | 26,1% | -2,7% |
| Izmir | 0,433 | 0,670 | 0,662 | 52,8% | 54,6% | -1,2% |
| | **Mean (SD)** | **Mean (SD)** | **Mean (SD)** | | | |
| Remaining 12 metropolises | 0.159 (0.08) | 0.243 (0.11) | 0.272 (0.10) | 71,1% | 52,8% | 11,9% |
| Remaining 58 cities | 0.069 (0.05) | 0.119 (0.12) | 0.141 (0.10) | 104,3% | 72,5% | 18,5% |

Note: Taken from the Statistical Yearbook of Inpatient Medical Institutions. Only the physicians working in hospitals are included.

# Overview of the Health Care System in Turkey

## Organization of the Health Sector

The Turkish health care system has a highly complex structure. The actors in health care in Turkey are several public, quasi-public and private organizations but relations among them are not well structured and regulated. In Table 2, the agencies involved in the health sector are grouped according to whether they are concerned with policy formulation, provision of health care, finance of health care, or whether they have administrative jurisdiction over the delivery of health care. Health services in Turkey are supplied by a multitude of public and private providers. The three key public providers are the Ministry of Health (MoH), Social Insurance Institution (SSK) and the Universities through University hospitals.

Table 2: Organizations involved in Turkish health care classified by their function

| Provision of Health Care | Policy Formulation |
|---|---|
| **Public** | The Parliament |
| The Ministry of Health (MoH) | The State Planning Organization (SPO) |
| Social Insurance Institution (SSK) | The MoH |
| University Hospitals | The Higher Education Council |
| The Ministry of Defense | The Court of Constitution |
| **Private** | |
| Private Hospitals | **Finance of Health Care** |
| Foundations | The Ministry of Finance |
| Minority Hospitals | SSK |
| Private Practitioners / Specialists | Bağ-Kur |
| Outpatient Clinics | GERF |
| Laboratories and Diagnostic Centers | Private Insurance Companies |
| Pharmacies | Self Funded Schemes |
| | International Agencies |

Taken from Turkey Health Report 2004, The Ministry of Health of Turkey
Note: Bağ-Kur is the insurance scheme for the self-employed. GERF is the retirement fund for government employees. SSK is for private sector employees and blue-collar public sector employees

MoH is the major provider of primary and secondary health care and essentially the only provider of preventive health services. MoH operates an extensive network of health facilities providing primary, secondary and specialized inpatient and outpatient care. SSK operates a significant network of secondary in-and outpatient facilities and a more limited number of primary facilities servicing members of SSK and their dependents. University hospitals provide in-and outpatient care. Public sector health facilities are complemented by a much smaller network of private facilities providing both inpatient and outpatient care. In 2000, 56% of the total patient visits were to MoH hospitals, followed by 34% to SSK hospitals, 7% to university hospitals and 2% to private hospitals[3].

Role of the Government in Location Choice

A physician is defined as the person who has completed 6 years of higher training in medicine. Those who have had a further period of training in a special field of medicine are called specialists (specialized physician). In Turkey, the location decision of a specialist or general practitioner is not independent of the government's requirements.

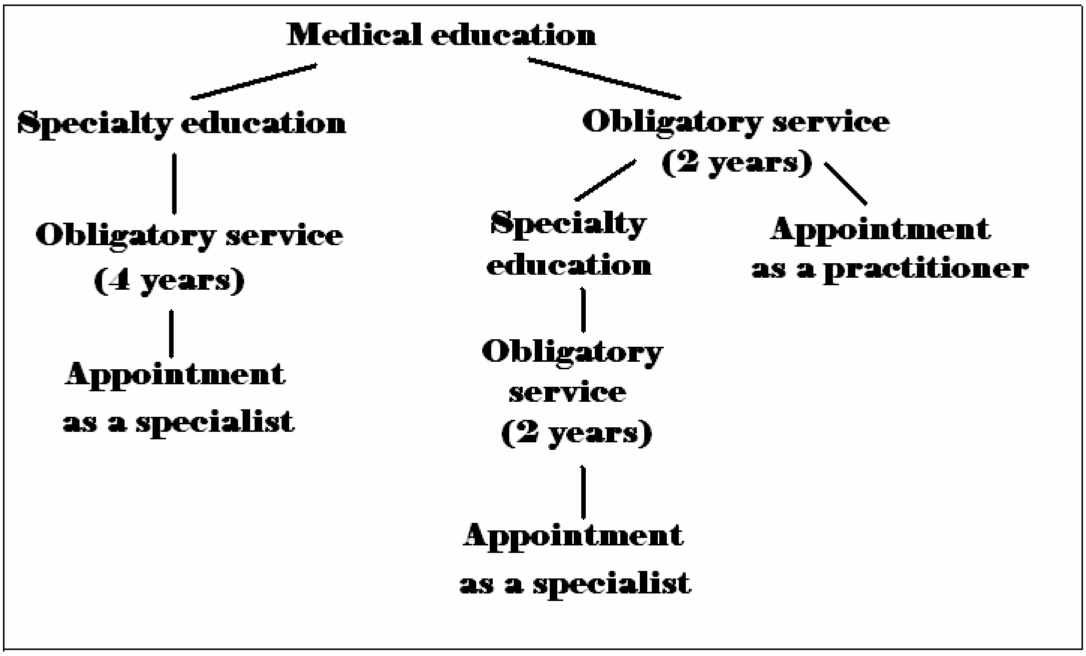



Figure 2: Role of the government in location choice of physicians[4]

[3] Calculated from Statistical Yearbook of Inpatient Medical Institutions 2000 prepared by MoH.
[4] Obligatory service was in presence from 1981 to 2003, but was not applied after 1995.

Figure 2 summarizes the decision process a physician will face after the six years of medical education. The process is as follows:

- After medical education, practitioners either choose to take an exam to start their specialty education or ask for their appointment for the obligatory service of two years.
- If he/she chooses to continue his/her specialty education and passes the exam, the education lasts for 4 to 6 years. After graduating as a specialist, he is required to complete his obligatory service and to work in a public hospital for 4 years.
- The newly graduated practitioner may choose to complete the first 2 years of his obligatory service just after graduation. Physicians are required to work for two years as a practitioner and then for another two years as a specialist to complete their obligatory service.
- If a physician chooses not to go to his obligatory service location, he is not allowed to work as a physician in any place.
- After the obligatory service, physicians identify three top priority areas and the selection is based on attempts to match vacancies with graduate priority preferences.
- If there are more applications to a hospital than the announced staff requirements, the physicians are chosen according to the outcomes of a draw. In case of not being appointed to any of these three places, afterwards there is a general draw.
- The physician has to work in the hospital he is appointed to at least for one year to have a right to ask for a new appointment.

- Every health personnel gets points according to the previous location of service and his occupational abilities, and these points are taken into consideration for the next draws.

Obligatory service law was put into practice between 1981 and 1995. Since 1995, graduates are immediately appointed to their place of employment. So in 1990 the law affected the distribution of physicians, but not in 2000. This change is expected to reduce the growth rate of physician supply in the less-desired cities.

## Research Questions

City-level data excluding the 3 big cities, Istanbul, Izmir and Ankara, is used in the following analyses to understand the effects of the private health sector on the change in the number of total physicians, general practitioners and specialists.

Private hospital capacity (measured by number of beds) in each city is expected to affect the location choice of public sector physicians in two ways. A study carried out by Tokat (1998) showed that physicians working full time in the public sector earned maximum $5500 per year after taxes, while physicians working part time in the private sector earned $24.000 before taxes. Since the salaries of physicians working in the public sector are very low, engagement in private practice allows them to increase their earnings significantly. In fact, the possibility of private practice by public doctors helps the public sector keep the necessary number of physicians engaged despite the low wages. But on the other hand, physicians working in MoH hospitals are allowed to see private out-patients in these facilities after 4 pm, and health personnel working at university facilities are allowed to work privately part time at university hospitals after midday. Revenues from the treatment of a private patient in public hospital are shared between the hospital's revolving funds and the treating physician. So public sector physicians will perceive the increase in private health facilities as an increase in competition.

In the analysis, the physician population is divided into two groups as specialist and general practitioners to see if location and population characteristics have different effects on them. Elesh and Schollaert (1972) state that high income areas are more important for specialists than for general practitioners as specialists are used more heavily by high income populations. Similarly, the effect of hospitals was far greater for specialists than for general practitioners. Rundall and McClain (1982) shows that specialists will not survive as well as practitioners in an environment where the level of natural resources measured by population size, availability of medical facilities and income are low, due to the fact that they only see patients with certain kinds of diseases.

To assess the impact of private hospitals on the distribution of physicians under obligatory service law and otherwise, the data is divided into two periods, 1990-1995 and 1995-2000. The effect of the private health sector on the change in physician supply in these two periods is expected to be different as the obligatory service law, which does not take into consideration the choice of physicians, was effective until 1995. When physicians are free to choose the city they want to work in, they are expected to choose the areas with higher development levels and higher hospital capacities. The availability of the private sector will affect the distribution of physicians more significantly in the absence of an obligatory law, where the true location choice of a physician can be detected.

We also analyze whether the effect of the private health sector on the number of specialists and general practitioners differ, across MoH, SSK and university hospitals.

## Outline of the Remaining Chapters

Chapter 2 provides an overview of the physician supply in Turkey with cross-national comparisons. Finally, a review of previous empirical studies that used macro and micro level analysis to study the location choice of physicians is presented.

Chapter 3 lays out the methodology for this study. The description of dependent and independent variables are presented first, followed by the explanation of data sources, sampling methods and limitations of the data. Finally, analytic methods used in the study are explained.

Chapter 4 presents the results of the analysis which include descriptive statistics, bivariate analysis, model estimation, multicollinearity diagnostics and endogeneity tests.

Chapter 5 begins with a brief summary of the study followed by the discussion of the implications for health policy makers and researchers. The chapter concludes with the limitations of the study and suggestions for further research.

# CHAPTER 2

# LITERATURE REVIEW

## Review of Physician Supply and Health Sector

### Trends in Hospital Capacity

Table 3 presents the total number of beds and per capita numbers in each hospital category[5]. Beginning with the Ministry of Health hospitals, it is seen that the16.5% increase in the total number of beds in 10 years is equal to population change, so beds per capita has not increased in that period. The capacity of SSK and university hospitals increased by 22 and 42%, respectively, resulting in 41.3 and 36.1 beds per million in 2000. The highest increase in capacity is observed in private hospitals with 124%. University and private hospitals grew more in the second half of the period with 22 and 58% compared to 16 and 42% in the first half.

Private hospitals play a significant role in many health systems, serving not only private but also public patients. In developing countries, the number of private hospitals is small compared to the number of public hospitals. According to Hanson and Berman (1998) the number of private hospital beds in selected developing countries on average accounted for 28% of all hospital beds, whereas private sector accounted for only 9% of hospital capacity in Turkey in 2000, which was 5% ten years ago. Statistics also show that there is a large variation in the number of private hospital beds between developing countries. For example, in Brazil, the number of

[5] In this table, all hospitals including the ones in Istanbul, Izmir and Ankara are considered for comparison purposes. The analysis does not cover those three big cities.

private hospital beds was 2,504 per million people compared to that in Bangladesh of 42.2 per million people.

Table 3: Increase in Bed Capacity in Turkey

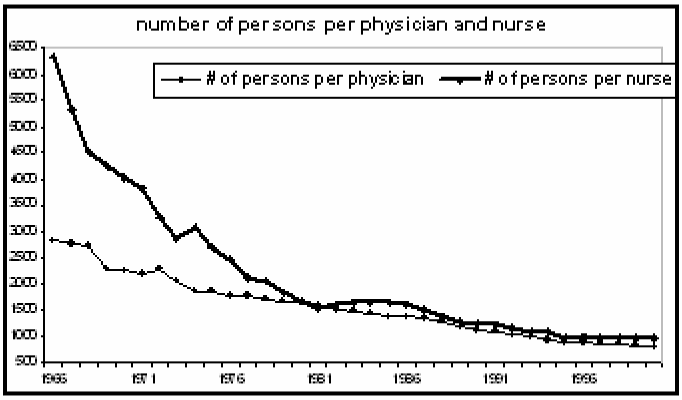
| | number of existing beds | | | existing beds per 100000 | | |
|---|---|---|---|---|---|---|
| | 1990 | 1995 | 2000 | 1990 | 1995 | 2000 |
| **MoH Hospitals** | 58,023 | 62,117 | 67,624 | 102.7 | 101.5 | 102.40 |
| **SSK Hospitals** | 22,380 | 25,119 | 27,298 | 39.6 | 45.1 | 41.34 |
| **University Hospitals** | 16,817 | 19,570 | 23,838 | 29.8 | 32.0 | 36.10 |
| **Private Hospitals** | 5,186 | 7,341 | 11,638 | 9.2 | 12.0 | 17.62 |
| **Total** | **104,396** | **116,142** | **132,398** | **181.3** | **190.6** | **197.5** |

Note: Calculated from the Statistical Yearbook on Inpatient Health Institutions.

## Trend in Total Physician Supply

Figure 3 represents the long term trends in the supply of total physicians in Turkey. In 1980 a physician needed to deal with approximately 1600 people and these decreases to 1100 and 790 in the following periods. The largest decrease (32%) in population to physician ratio took place between 1980 - 1990.

Figure 3: Number of Persons per Physician and Nurse between 1965 and 2000

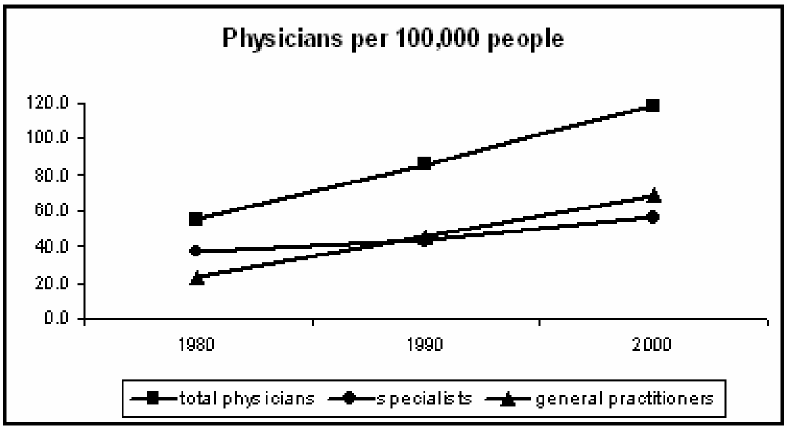



| | # of persons per physician | # of persons per nurse |
|---|---|---|
| 1970 | 2,228 | 4,016 |
| 1980 | 1,631 | 1,653 |
| 1990 | 1,109 | 1,248 |
| 2000 | 792 | 942 |

Note: Data is taken from Ministry of Health (www.saglik.gov.tr)

At the beginning of 1980, there were 37 specialists and 23 practitioners per 100,000 peoples, whereas they became 56 and 69 in 2000. The total number of specialists increased by 128% and practitioners by 346% in 20 years in Turkey.

Figure 4: Physicians per 100.000 people between 1980 and 2000




| | total physicians | specialists | general practitioners |
|---|---|---|---|
| **1980** | 55.8 | 37.3 | 23.6 |
| **1990** | 86.0 | 44.1 | 45.6 |
| **2000** | 118.1 | 56.1 | 69.4 |

Note: Data is taken from The State Institute of Statistics

## Cross-National Comparisons

### Physician Supply and Hospitals

Table 4 gives the average numbers of health personnel in certain groups of countries. Turkey has a higher amounts of physicians than the averages of the world, the upper middle income and Europe & Central Asia groups that it belongs to.

Table 4: Global Distribution of Health Workers

| | Physicians | | Nurses | |
|---|---|---|---|---|
| | Number | Density per 1000 | Number | Density per 1000 |
| **Turkey** | 96,000 | 1.35 | 121,000 | 1.70 |
| **World** | 39,862 | 1.70 | 84,954 | 4.06 |
| Low income | 19,404 | 0.45 | 33,737 | 1.21 |
| Middle inome | | | | |
| Lower middle income | 48,370 | 1.39 | 79,313 | 3.04 |
| Upper middle income | 37,672 | 1.89 | 60,266 | 3.77 |
| Low & middle income | | | | |
| East Asia & Pacific | 73,803 | 0.67 | 91,104 | 1.83 |
| Europe & Central Asia | 54,200 | 2.99 | 111,763 | 6.20 |
| Latin America & Caribbean | 25,840 | 1.45 | 34,613 | 2.19 |
| Middle East & North Africa | 16,565 | 1.11 | 37,642 | 1.91 |
| South Asia | 102,624 | 0.44 | 124,898 | 0.78 |
| Sub-Saharan Africa | 2,618 | 0.20 | 15,630 | 1.27 |
| High income | | | | |
| European Monetary Union | 82,031 | 3.47 | 187,008 | 9.07 |
| High income: OECD | 105,181 | 3.13 | 332,211 | 9.69 |
| High income: nonOECD | 5,725 | 5.34 | 12,253 | 11.17 |
| Heavily indebted poor countries | 2,075 | 0.18 | 8,244 | 0.76 |

Note. Data is taken from World Health Report 2006.

When the density per 1000 is considered, Turkey has the lowest with 1.35 physicians, whereas the average is 1.7 in the world, 1.89 in the upper middle income group and 2.99 in Europe & Central Asia .

Hospital beds per 1,000 people of selected upper middle income and OECD countries are presented in Table 5. Turkey has the least number of hospital beds per capita after Mexico compared to the other countries considered. Many high income countries have experienced a steady decline in the numbers of acute beds due to the changing pattern of care for elderly people and people with severe disabilities or mental disorders[6] (Mckee and Healy, 2002).

Table 5: Global Distribution of Hospital Beds, Density per 1,000 population

| | 1990 | 2000 |
|---|---|---|
| **Selected Upper Middle Income Countries** | | |
| Argentina | 4.6 | 4.1 |
| Poland | 5.7 | 4.9 |
| Croatia | 7.4 | 6.2 |
| Mexico | 1.0 | 1.1 |
| Latvia | 14.1 | 8.7 |
| Czech Republic | 11.3 | 8.8 |
| **Turkey** | 2.4 | 2.6 |
| **Selected OECD countries** | | |
| Canada | 6.0 | 3.8 |
| Denmark | 5.6 | 4.3 |
| Finland | 12.5 | 7.5 |
| France | 9.7 | 8.1 |
| Ireland | 6.1 | 4.6 |
| Italy | 7.2 | 4.7 |
| Norway | 4.6 | 3.8 |
| Portugal | 4.1 | 3.8 |
| Spain | 4.6 | 4.1 |
| Sweden | 12.4 | 3.6 |
| United Kingdom | 5.9 | 4.2 |
| United States | 4.9 | 3.5 |

Note: Data is taken from World Bank Health, Nutrition, and Population Statistics

## Empirical Studies on Location Choice of Physicians

Physician location studies can be regarded as a segment of the larger economic literature on population location and mostly employ the same basic determinants with population migration studies; however they differ from the

[6] The fall in hospital beds in Europe is attributed to three major movements: cost pressures, changes in treatment and care options, and restructuring of acute care (nursing homes instead of big hospitals).

population studies in terms of the emphasis they give to the variables they use. Generally, two different approaches were used in the previous studies on physician distribution at the local market level: (1) micro (individual) level models explaining the factors that determine physicians' choice of practice location, and (2) macro (aggregative) level models explaining the geographic distribution of physicians or the change in physician supply (Ernst and Yett, 1985). These two approaches should be regarded as complementary to competing explanations of physician supply.

## Micro Level Analysis

There are two theories supported empirically by the micro-level analysis of physician preferences for practice location. According to "prior-contact" theory, the more contacts (such as birth, medical school, internship or residency) a physician has with a particular area, the more likely the physician is to practice in that area and the more recent contacts have a stronger effect than the less recent ones. The second theory derives from economic models, assuming physicians' interest in maximizing both monetary and non-monetary returns (Jiang and Begun, 2000).

Previous studies mostly focus on the decisions of new physicians, who represent the most mobile component of the physician supply. Yett and Sloan (1974) used the survey data on physicians who first started a practice in 1966 to study both theories of physician location. They found that the probability of a physician locating in a state is positively related to both the number and the sequencing of contacts. The relationships still hold even after socioeconomic conditions are taken into account. Change in per capita income between 1962 and 1966 showed significant positive coefficients only in the regressions for general practitioners.

Cooper et. al. (1975) conducted a detailed survey on a sample of male general practitioners graduated from a U.S. medical school in 1965. The results of the survey showed that the majority of responding physicians made the location decision during internship, residency or other house staff training. Opportunity to join a desirable group practice, climate or geographic features of the area, availability of clinical support facilities and personnel, urban or rural preference, income potential and contact with a medical school are the highly ranked factors by the new physicians.

Using a nested logit specification, Hurley (1991) analyzed the physicians' decisions regarding the specialty, location size and mode of their first practices in a simultaneous decision model. Under the simultaneous specification the income coefficient is positive and statistically significantly different from zero, indicating that differentials in expected income are a significant factor in the choice among the specialty, location, and mode triplets.

Macro Level Analysis

Unlike the micro-level analyses which focus on the actions of individuals in response to the changes in demand and market characteristics, macro-level analyses attempt to understand the factors affecting the geographical distribution of physicians at the city, MSA (Metropolitan Statistical Areas) or state level. Those aggregative studies of physician location have used one or more of the five principal measures of physician supply: (1) the number of physicians working in the area; (2) the area's physician-population ratio; (3) the change in the number of physicians working in the area; (4) the change in the area's physician-population ratio; and (5) percentage change in the number of physicians working in the area. Physician numbers or ratios are also divided into two subcategories: specialists and general practitioners (Ernst and Yett, 1985).

These five measures apply to different dimensions of physician supply and to different location decisions. For example, the physician stock is determined by the decisions of all physicians working in that area so it is the result of location choices going back perhaps as much as several decades. However, the change in physician number in an area mostly captures the effects of recent location choices. Physician-population ratio is an important indicator of the population's access to physicians' services. Geographical differences in the physician-population ratio depend on both the location behavior of the general population and physicians (Ernst and Yett, 1985).

Literally dozens of different explanatory variables have been used as predictors of the geographic distribution of physicians.

One of the earliest papers in this area was by Marden (1966), who examined the effect of five demographic and ecological variables on the distribution of general practitioners and specialists across metropolitan areas in the United States. The findings clearly indicated that the five variables, population size, population composition (age, race, education) and medical environment, significantly influence the distribution of physicians' services and that there are marked differences between their influence on physicians in general practice and on specialists.

Analysis revealed that there is a linear relationship between increases in population size and the number of physicians available to aggregate. When the total physician group is divided into its two components: general practitioners and specialists, the results indicated that variables other than population size play a more important role in determining the distribution of specialists than physicians in general practice. One of the population composition variables was age structure, which was an obvious medical factor, as the youngest and the oldest parts of the population are the ones that use medical services most. So if the greatest need for medical care occurs in these segments of the population, there should be greater numbers of physicians working in those areas. Therefore, the age variable is operationalized as the percentage of the total population under five years old and sixty-five and older. The second compositional variable was the education level, as higher education levels indicate a greater awareness of illnesses and also greater usage of health insurance. Mean school years completed was used as the socioeconomic measure instead of income, with the presumption that income alone may not lead to the use of medical services unless accompanied by an understanding of the need for such services.

The analysis for the comparison of the distribution of general practitioners and specialists revealed that while specialists are found to be particularly influenced by the presence of hospital facilities measured by the number of existing hospital beds and by the education level of the population, age and race composition are relatively more important in the case of general practitioners.

Lankford (1974) groups the previous studies as the ones using income hypothesis and the ones using population size hypothesis to explain the distribution of physicians. According to income hypothesis a physician will attempt to choose a location which will maximize his total expected income so he considers several factors which affect the inflow of money paid for his services such as per capita income, population size, morbidity rates, existing medical facilities, and the propensity for health services consumption. He must also determine the demand for his services, which is the demand not satisfied by the existing physician supply. Later studies identify population size as the most important factor for the location choice of physicians and the next most influential as per capita income. The population size of an area sets a limit on the number of physicians it needs and can support. Too many physicians will yield too small a work load and income so some of the physicians will migrate out of the area. If there are too few physicians, others will migrate into the area.

In his analysis, Lankford finds a disproportionate increase in the total number of physicians with increasing population size due to the fact that general practitioners are directly proportional to the population, but a specialist needs a certain minimum population before he can be supported. So a higher degree of specialization requires a greater population increment. Other factors such as the finer medical facilities associated with large cities is an additional attractive force, and income level, although highly correlated with population size, is clearly a minor, supporting factor. Other variables such as nonwhite population, age structure, income distribution, and urbanization have negligible effects.

Nineteen independent variables grouped into four categories of (1) supportive facilities and personnel, (2) socioeconomic and demographic characteristics of an area, (3) socio-cultural considerations, and (4) need for medical services are employed in the model of physician distribution estimated by Busch and Dale (1978). In the regressions used for the estimation of physician numbers for the years 1950, 1960 and 1970, and for the estimation of change equations, six variables are identified as the main determinants of physician to population ratio for the counties in the state of Kentucky. Those variables are hospital bed to population ratio, per capita retail sales, percentage of male professionals, percentage of families with high income, presence of a medical school, and percentage of population over the age of 65. Supportive facilities measured by the presence of a medical school and hospital beds to population ratio are the most important factors effecting the geographic distribution of physicians.

The study of Krishnan (1997) examines the effects of selected demographic, socioeconomic, and environmental factors (e.g., population size, the percentage population with a of university education, and hospital bed/population ratio) on the spatial distribution of physicians. The findings indicate that the variable measuring the level of university education is the most important factor influencing physician distribution once demographic and environmental factors are controlled. The higher the educational level of the population, the higher the physician/population ratio and the higher the proportion of children under age 5, the lower the physician/population ratio.

Brasure and colleagues (1999) used the data on the number of physicians in each market area per year taken from Area Resource File and data describing the demand for health care in local markets and market area characteristics. Using an empirical framework developed by Bresnahan and Reiss (1991) to analyze the entry behavior of physicians into local markets, they estimate the probability that a particular market area has a certain level of physician supply. They found that for each of the physician types studied, the logarithm of population is a statistically significant predictor of higher supply levels of physicians. The other demand factors like the proportion of the population that is elderly and the proportion of the population with a college education have significant effects on all types of physicians' location choices, while per capita income was significant only in predicting specialist supply. Also market area characteristics were important in predicting supply across each of the physician types studied. The number of community hospital beds and the average population density were the most consistently significant market area characteristics associated with probabilities of higher supply across physician types.

In a more recent study by Jiang and Begun (2002) to identify the factors that have an impact on the change in the size and specialty mix of the local physician workforce between 1985 and 1994 within the USA an ecological framework is employed. The study tries to answer three questions: what factors in the environment support or suppress the growth of a particular physician population at the local market level; what factors in the environment have differential effects on the growth of different physician specialty populations; what is the structure of the relationship among these physician populations of different specialties (do generalist physicians compete with medical specialists or do they serve each other).

Based on the population ecology theory, they explain the growth of general practitioner and specialist populations in a local market by four mechanisms: (1)the intrinsic properties of this physician population; (2) the local market's carrying capacity determined by munificence (measured by population size, proportion of the elderly, number of hospital beds per capita, per capita income), concentration (measured by percentage of hospitals with system affiliation, percentage of physicians in group practice, percentage of large employers and Hirschman-Herfindahl index,) and diversity (measured by percentage of private hospitals, percentage of teaching hospitals, Gibbs-Martin index of differentiation) ; (3) competition within the same physician population; and (4) interdependence between different physician populations.

The results of Jiang and Begun's paper revealed that the number of both generalists and specialists increased with residential population size at a decreasing rate, the proportion of the elderly had a negative relationship with the change in the number of specialists, greater supply of hospital beds was associated with an increase in the number of specialists but a decrease in the number of generalists, and per capita income had a positive effect on the increase in the size of both physician workforce. Finally, areas with higher proportions of for-profit hospitals were more likely to exhibit an increase in the percentage of specialists but a decrease in the percentage of generalists.

In summary, studies examining physician location choice employ three major categories of variables: (1) demand for medical services determined by certain socioeconomic and demographic characteristics like population size, income and education levels, (2) market area characteristics measured by concentration and diversity indexes, the percentage of private hospitals, and (3) availability of medical services measured by the number of hospital beds and the presence of medical schools. The results of the analyses on the effects of those variables are not consistent with each other. In general, practitioners are more responsive to demographic and socio-economic factors while specialists are more concerned with the characteristics of the medical environment.

In Turkey, there are not so many researches on the distribution of physicians and the effect of private health sector. A study by Adaman and Çarkoğlu (2000) aims to understand the determinants of the ways in which public resources are allocated to different localities. To understand the discrepancies between provinces in the central government's expenditures on health, they used the number of patients per specialist and per hospital bed

# CHAPTER 3

# METHODOLOGY

## Description of Data

Definitions of the variables are presented in Table 9.

### Dependent Variables

Only the physicians working in public sector hospitals[7] are considered in the analysis and the ones that are self-employed or working in the private sector are not included. The change in the number of specialist and general practitioners are used as dependent variables.

Then, the change in physician supply in the 1990-1995 and 1995-2000 periods are estimated separately. These periods are chosen to determine the effect of the change in obligatory law in the health sector to the geographic distribution of physicians.

Finally, specialists and general practitioners are divided into three groups according to the hospital types they are working in: Ministry of Health hospitals, Social Insurance Institution hospitals and university hospitals. Hospitals belonging to the Ministry of Defense are not included in the data.

### Independent Variables

Definitions of the independent variables considered in the analysis are presented in Table 9. There are three categories of independent variables.

[7] Inpatient health institutions with more than 10 beds are classified as a hospital.

Availability of Health Facilities

The supply of hospital facilities is measured by the number of existing beds in the province to capture availability, and the access and distribution of health services delivery. All the inpatient health care institutions belonging to MoH, SSK, universities, and the private sector that have more than 10 beds are considered as variables relating to hospital capacity in the area. Bed size reflects both the current supply capacity and potential hospital output (Jiang and Begun, 2002). The number of public hospital beds sets a limit on the size of the physician population working in the public sector. Several studies have found significant relations between the supply of hospital resources and physician-population ratio (Busch and Dale, 1978; Feldman, 1979). In the analysis, private and public hospital capacities are considered separately in order to identify the effect of the private sector on the location choice of physicians.

Local Population and Other Demand Factors

Variables measuring population size, age structure, education level and income are expected to influence the number of services demanded in a market area. Brasure (1999) found that residential population size is the single most important determinant of demand. Instead of total population, urban population is used in the analysis. As most of the public hospital capacity is concentrated in city centers, urban population is expected to constitute the higher proportion of demand for health services.

Age dependency ratio, which is the number of persons at “0-14” and “65 and over” age groups per 100 people, is used as a measure of age structure. Age structure of the population is also important in determining the amount of services that will be demanded by the population as the majority of health care services are consumed by people belonging to these age groups. The percentage of university graduates in the population consisting of those aged 25 and per capita income are shown to be positively related to the demand for health care.

Market Area Characteristics

The Hirschman-Herfindahl index (HHI), which is a commonly accepted measure of market concentration, is calculated by squaring the market share of each firm competing in a market, and then summing the resulting numbers. The numbers of outpatients treated in each hospital divided by the total number are used to calculate the market share of that hospital. As the HHI increases from zero to one, so does the level of market concentration. The closer a market is to being a monopoly, the higher the market's concentration (and the lower its competition). An increase in the level hospital concentration is expected to have a negative effect of the physician population.

Distance to a university hospital is another variable that is expected to influence the distribution of physicians. If there is a university hospitals in the market the city gets zero, and if not then the distance to the nearest town center with a university hospital is used.

Also the Gibbs-Martin index of differentiation, which has been used to measure industry diversification, is calculated using hospital size. The formula is $1-\sum x^2 / (\sum x)^2$ ,with x being the number of hospitals in each bed size category (<100, 100-200, 200-400,>400) . The higher the index, the higher the diversity. Jiang and Begun describes the diversity of hospitals as the degree of dissimilarity among hospitals in size, service domain and other features. The level of hospital diversity is expected to be positively related with physician supply.

Table 6: Description of the Variables Used in the Analysis

| Variables | Definition | Data Source | Year |
|---|---|---|---|
| _90 | value of a particular variable in 1990 | | |
| _95 | value of a particular variable in 1995 | | |
| _00 | value of a particular variable in 2000 | | |
| _95/90 | change in the value of a variable in between 1990 and 1995 | | |
| _00/95 | change in the value of a variable in between 1995 and 2000 | | |
| _00/90 | change in the value of a variable in between 1990 and 2000 | | |
| pub_ | public hospitals | | |
| pri_ | private hospitals | | |
| moh_ | Ministry of Health hospitals | | |
| sii_ | Social Insurance Institution hospitals | | |
| uni_ | university hospitals | | |
| **Dependent Variables** | | | |
| _phy | number of physicians working at a particular hospital | MoH | 1990, 1995, 2000 |
| _spe | number of specialists working at a particular hospital | MoH | 1990, 1995, 2000 |
| _gp | number of practitioners working at a particular hospital | MoH | 1990, 1995, 2000 |
| **Independent Variables** | | | |
| Availibility of Medical Facilities | | | |
| _bed | number of existing beds in a particular hospital | SIS | 1990, 2000 |
| Socioeconomic Variables | | | |
| pop | provincial population | SIS | 1990, 1995, 2000 |
| urbpop | urban population | SIS | 1990, 1995, 2000 |
| income | per capita income | SIS | 1990, 1995, 2000 |
| save | per capita bank deposits | SIS | 1990, 2000 |
| unemp | unemployment ratio | SIS | 1990, 2000 |
| age | % of population at "0-14" and "65 and over" age groups | SIS | 1990, 2000 |
| uni | % of university graduates at "25 and over" age group | SIS | 1990, 2000 |
| agr | share of agricultural employees | SIS | 1990, 2000 |
| cre | per capita bank credits | SIS | 1990, 2000 |
| index | socio-economic development level index | SPO | 1990, 2000 |
| Market Area Characteristics | | | |
| hhi | Hirschman-Herfindahl index based on outpatient numbers | MoH | 1990, 1995, 2000 |
| gmi | Gibbs-Martin index of hospital concentration | MoH | 1990, 1995, 2000 |
| dist | distance of the province to nearest university hospital | MoH | 1990, 1995, 2000 |
| **Instrumental Variables** | | | |
| stu | Number of students attending private courses | SIS | 1990, 2000 |
| cour | Number of private courses for university exams | SIS | 1990, 2000 |

Note: MoH (Ministry of Health), SIS (State Institute of Statistics), SPO (State Planning Organization)

## Data Sources

For the analysis, city-level data on the number of physicians (specialist and general practitioner) working in either public or private hospitals, and the number of hospitals / hospital beds is collected from the Statistical Yearbook of Inpatient Health Institutions 1990, 1995 and 2000 published by Ministry of Health. (In-patient institutions cover hospitals and health centers). This yearbook is a unique source of information on each hospital separately.

Outpatient numbers of each hospital that are used to calculate HHI are also taken from this yearbook.

Variables related to the socio-economic development level of each city such as population size, per capita GDP, age dependency ratio, education level, unemployment ratio, share of agricultural employees in total employed population and per capita bank deposits are taken from the Provincial Indicators 1980-2003 prepared by State Institute of Statistics. The information in the provincial indicators is taken from the General Population Census for those years.

Finally, State Planning Organization prepares a socio-economic development level index for provinces using the data obtained from the census[8]. For example, in 2000, the socio-economic development level of Istanbul is calculated to be 4.8, whereas the index for Muş is -1.44. Index values for 1990 is used in the analysis, however there is not a significant difference between 1990 and 2000 values. Using this index, MoH determines the points that each health personnel is going to get when working in the city he is assigned to.

## Sampling

### Definition of Market Area

The study sample consists of 70 cities in Turkey. The cities that are not present in the classification used in the1990 Population Census (Bartın, Ardahan, Igdır, Yalova, Karabük, Kilis, Osmaniye, and Düzce) are not included in the sample. Also the three big cities, Istanbul, Ankara and Izmir are excluded from the analysis,

[8] For the variables included in the calculations of this development index, see Appendix 3.

as they are detected to be outliers, while the total numbers of physicians working in those cities are far greater than the remaining parts of the country.

Considerations Related to the Definition of Market Area

Border-crossing is a substantial issue at city-level data. This kind of market definition often includs populations that did not utilize a particular hospital while excluding patients that did use the hospital but did not reside in the city (Goody, 1993). For example, a large university hospital in a city will attract significant numbers of patients from the neighboring cities. To avoid this problem, small markets without another major market within a reasonable commuting distance should be used. Data collection at this level is expensive and time consuming, and not feasible for research at the national level.

As mentioned before, urban population is used in the analysis, which can be a partial solution to the border-crossing problem. The population living close to the borders is not considered as affecting the demand for health services in the cities. Also the distance from a university hospital is controlled by adding a variable measuring the distance between a city center and the nearest university hospital. While no significant effect of distance is detected, the analyses are not presented in the results.

## Analytic Methods

### Univariate Analysis

Descriptive statistics will be computed for each variable measured in 1990, 1995 and 2000 as well as the changes between these three points of time. Descriptive statistics involve mean and standard deviation. Two-tailed t-tests are performed to assess the statistical significance of changes in individual variables between 1990-2000, 1990-1995 and 1995-2000.

## Collinearity Diagnostics

Multicollinearity is the extent to which a variable can be explained by the other variables in the analysis (Hair, Anderson, Tatham and Black, 1995). Existence of multicollinearity will result in unstable estimates for regression coefficients and also limit the size of the $R^2$, so several procedures to detect multicollinearity are performed. These include calculating tolerance, variance inflation factor (VIF) and condition index.

Tolerance is the amount of variability of the selected independent variable not explained by the other independent variables. Thus a tolerance close to 1 means there is little multicollinearity, whereas a value close to 0 suggests that multicollinearity may be a threat. The reciprocal of tolerance is known as the variance inflation factor. VIF shows how much of the variance of the coefficient estimate is being inflated by multicollinearity. A commonly given rule of thumb is that VIFs of 10 or higher may be reason for concern.

Condition index is a measure of the relative amount of variance associated with an eigenvalue so that a large condition index indicates a high degree of collinearity. The procedure used to detect multicollinearity by condition index is described with the results.

## Tests for Endogeneity

Endogeneity refers to the fact that an independent variable included in the model is potentially a choice variable, correlated with unobservables relegated to the error term. There is a strong probability that there will be a correlation between the "availability of private health care" variable measured by the number of beds and the residuals in the model, due to the fact that the location choice of a physician and the investment decision of the private sector to a region are both determined by the general characteristics of the environment. So, the variation in private beds can be explained by the other exogenous variables like population size, per capita income or the availability of public health facilities.

There are studies which try to explain what factors affect the size of the private health sector. Previous analysis shows that health care is a "superior" or "luxury" good, which takes a steadily larger share of income as income rises. Hanson and Berman (1998) show that a 10% increase in income leads to an 11% increase in the number of for-profit beds. Berman and Rannan-Eliya (1993) reviewed a number of supply and demand factors which are believed to affect the development of the private health sector. They found that per capita income, literacy, public health expenditures and public hospital beds are the main factors affecting the level of private provision of hospital beds.

Davidson and McKinnon (1993) suggest an augmented regression test (Durbin-Wu-Hausman test), which can easily be formed by including the residuals of each endogenous right-hand side variable, as a function of all exogenous variables, in a regression of the original model.

# CHAPTER 4

# RESULTS

This chapter presents the results of the analysis. Descriptive statistics of the dependent and independent variables are examined first, followed by bivariate analysis, regressions, collinearity diagnostics and endogeneity tests. A summary of the findings is provided at the end of the chapter.

## Descriptive Statistics

### Distribution of Physician Supply

Table 10 presents the descriptive statistics of the dependent variables. As mentioned before, the study examines the physician supply in three groups.

Increase in the supply of physicians from 1990 to 2000 is statistically significant both for specialists and general practitioners. On the average a 121% increase is observed for specialists and 119% for general practitioners.

When the1990-2000 period is divided into two periods of five years, it is found that specialist supply increases significantly in both periods but the increase in practitioner supply is only significant for the 1990-1995 period. On the average, the specialist supply increases by 40% and 58% in the first and second period, and practitioners increase by 80% and 21%.

In the last group, specialists and practitioners are divided according to the hospital they are working for. MoH hospitals have the highest number of specialists on average compared to SSK and university hospitals. In ten years a 97% increase is observed for specialists in MoH hospitals, 75% for specialists in SSK hospitals and

290% for specialists in university hospitals. On the average MoH and university hospitals have more practitioners than SSK hospitals and the supply of general practitioners in these hospitals has increased by 120%, 123% and 106%, respectively.

Demand Factors and Market Area Characteristics

Table 11 presents the descriptive statistics for the independent variables used to predict the change in physician supply. Changes in most of the variables are statistically significant for 1990-2000. The total number of existing beds in all types of hospitals increased by 36% in that period and when they are examined separately, it is found that there is a 25% increase in MoH, 33% in SSK, 131% in university and 85% in private hospital beds. The increase in average hospital capacity is 5% higher in the second half of that period compared to a 14% increase between 1990 and 2000.

In general, the average population size increases, but only the urban population growth in ten years is significant. Average per capita income and bank deposits are around US$ 2000 and US$230 in 1990 and they increased by 17% and 103% respectively. Age dependency ratio of the population (ratio of 1-14 and 65 and over age groups in total population) decreased from 42 to 38%. Only 3.4% of the population over 25 has a university degree in 1990 and this increases to 5.4% in 2000. Nearly 60% of the employed population is working in the agricultural sector and 7.7% is unemployed in 2000.

The Hirschman-Herfindahl index of concentration is 0.37 in 1990 and decreased to 0.27 in 2000, indicating an average increase in competition in each market. The Gibbs-Martin index is 0.39 in 1990 and industry diversification did not change significantly in ten years.

Table 7: Descriptive statistics for dependent variables [9]

| | 1990 Mean (SD) | 1995 Mean (SD) | 2000 Mean (SD) | Change (95-90) Mean (SD) | T-test (p value) | Change (00-95) Mean (SD) | T-test (p value) | Change (00-90) Mean (SD) | T-test (p value) |
|---|---|---|---|---|---|---|---|---|---|
| **Physician Population** | | | | | | | | | |
| Specialists working at public hospitals | 90.5 (86.4) | 126.6 (126.5) | 199.6 (212.5) | 36.1 (45.6) | 0.026 | 73.0 (68.5) | 0.007 | 109.1 (134.9) | 0.000 |
| Practitioners working at public hospitals | 59.01 (71.7) | 106.5 (139.3) | 129.3 (138.5) | 47.4 (83.8) | 0.006 | 22.9 (27.8) | 0.166 | 70.3 (82.2) | 0.000 |
| **Physician population by agencies** | | | | | | | | | |
| Physicians working at MoH hospitals | | | | | | | | | |
| Specialists | 54.8 (44.1) | 73.1 (63.03) | 108.1 (94.5) | 18.4 (23.2) | 0.024 | 35 (35.9) | 0.006 | 53.4 (54.2) | 0.000 |
| Practitioners | 26.01 (16.3) | 50.2 (42.2) | 57.2 (39.5) | 24.2 (29.6) | 0.000 | 6.9 (18.01) | 0.158 | 31.2 (26.2) | 0.000 |
| Physicians working at SSK hospitals | | | | | | | | | |
| Specialists | 21.4 (24.4) | 27.5 (32.2) | 37.5 (42.9) | 6.1 (10.9) | 0.104 | 10 (13.3) | 0.061 | 16.1 (21.9) | 0.004 |
| Practitioners | 6.8 (7.2) | 9.5 (10.2) | 14.03 (24.02) | 2.7 (5.8) | 0.035 | 4.5 (22.4) | 0.077 | 7.2 (23.1) | 0.009 |
| Physicians working at university hospitals | | | | | | | | | |
| Specialists | 13.7 (30.2) | 25.5 (49.2) | 53.4 (95.8) | 11.9 (22.7) | 0.044 | 27.8 (62.02) | 0.016 | 39.7 (75.6) | 0.001 |
| Practitioners | 26.01 (58.3) | 46.5 (102.9) | 58 (100.8) | 20.5 (67.8) | 0.075 | 11.5 (65.9) | 0.253 | 32.0 (66.6) | 0.012 |

[9] Appendix 4 provides detailed information on dependent variables.

Table 8: Descriptive statistics for independent variables[10]

| | 1990 Mean (SD) | 1995 Mean (SD) | 2000 Mean (SD) | Change(00-90) Mean (SD) | T-test (p value) | Change(95-90) Mean (SD) | T-test (p value) | Change(00-95) Mean (SD) | T-test (p value) |
|---|---|---|---|---|---|---|---|---|---|
| **Availability of health facilities** | | | | | | | | | |
| Number of public beds | 858.7 (82.5) | 982.4 (93.9) | 1166.8 (110.3) | 308.1 (322.7) | 0.013 | 123.7 (163.7) | 0.162 | 184.4 (225.9) | 0.103 |
| Number of MoH beds | 587.1 (49.3) | 650.9 (53.3) | 732.1 (59.1) | 145 (169.8) | 0.031 | 63.8 (116.1) | 0.191 | 81.2 (107.1) | 0.155 |
| Number of SSK beds | 183.8 (25.1) | 216.4 (28.6) | 244.2 (29.5) | 60.4 (116.8) | 0.061 | 32.6 (68.8) | 0.197 | 27.8 (80.2) | 0.250 |
| Number of university beds | 80.3 (22.4) | 109.7 (27.9) | 185.4 (38.5) | 105.1 (166.1) | 0.010 | 29.3 (69.9) | 0.207 | 75.7 (123.02) | 0.057 |
| Number of private beds | 26.5 (5.4) | 30.8 (6.4) | 49.1 (9.5) | 22.5 (57.3) | 0.021 | 4.2 (29.8) | 0.307 | 18.3 (43.6) | 0.056 |
| **Demand for health care** | | | | | | | | | |
| Population size | 617,606 (392,214) | 654,297 (447,822) | 694,834 (481 534) | 77,228 (158,120) | 0.150 | 40,538 (96,538) | 0.303 | 36,690 (71,151) | 0.304 |
| Urban population size | 308 584 (257 256) | 353,643 (305,113) | 395,773 (323,799) | 87,189 (93,392) | 0.040 | 42,131 (59,806) | 0.215 | 45,059 (47,701) | 0.173 |
| Per capita income ($) | 1,995 (131) | 2,092 (125) | 2,334 (139) | 339 (190) | 0.040 | 242 (187) | 0.090 | 97 (181) | 0.298 |
| Per capita savings ($) | 234 (127) | | 475 (316) | 241 (207) | 0.000 | | | | |
| Age-dependency ratio | 0.42 (0.06) | | 0.38 (0.06) | 0.04 (0.017) | 0.000 | | | | |
| % of university graduates | 3.38 (0.94) | | 5.58 (1.43) | 2.20 (0.67) | 0.000 | | | | |
| Unemployment ratio | 4.98 (2.1) | | 7.73 (3.07) | 2.74 (1.79) | 0.000 | | | | |
| % of agricultural employees | 65.8 (10.3) | | 60.9 (10.9) | 4.91 (5.54) | 0.004 | | | | |
| Number of bank branches | 57.6 (40.2) | | 59.2 (48.7) | 1.57 (15.9) | 0.418 | | | | |
| Development index | -0.12 (0.71) | | | | | | | | |
| **Market area characteristics** | | | | | | | | | |
| Hirschman-Herfindahl index | 0.37 (0.21) | 0.32 (0.17) | 0.27 (0.16) | 0.097 (0.133) | 0.001 | 0.043 (0.028) | 0.126 | 0.054 (0.032) | 0.090 |
| Gibbs-Martin index | 0.39 (0.19) | 0.38 (0.18) | 0.40 (0.17) | | | | | | |
| Distance to university hospital (km) | 132 (93.3) | | | | | | | | |

[10] Appendix 4 provides detailed information on independent variables.

## Bivariate Analysis

Appendix 5 reports the bivariate correlations between the dependent and independent variables. There are three groups of dependent variables which are (1) change in the total number of physicians, specialists and general practitioners between 1990 and 2000, (2) change in the number of specialists and practitioners working in MoH, SSK and university hospitals between 1990 - 2000 and (3) change in the number of specialist and practitioners in the1990-1995 and 1995-2000 periods.

Public bed capacity, and total and urban population size in 1990 have the highest correlation with the change in the number of physicians (r>.80), followed by private bed capacity and education level (r>.60), income, HHI and GMI (r>.40).

The change in specialist supply is found to have a higher correlation with all dependent variables, especially with population size, private and public bed capacity, than the change in practitioner supply.

Private bed capacity and population size have a higher correlation with the change in specialist supply for the 1995-2000 period, whereas public bed capacity has a higher correlation for 1990-1995.

## Regression Results

Residual plots and tests both indicate that heteroscedasticity may be a problem when the change in physician numbers are used, so all dependent variables are transformed in order to avoid heteroscedasticity as proposed by Hair, Anderson, Tatham and Black, 1995. The square roots of the absolute value of the dependent variables are taken and then the sign is put back. With square root transformation, the distribution of the residuals is much improved.

Results of the first group OLS estimation, which estimate the change in total physician, specialist and practitioner supply in 1990 - 2000, are presented in Table 9.

Change in public bed capacity is statistically significant ($p<0.001$) for both specialist and general practitioner supply and the magnitudes of coefficients are 0.806 and 1.039 respectively. Initial public bed capacity in 1990 has a positive correlation ($p<0.10$) with the change in numbers of both types of physicians. Availability of private sector in the market has significant and different effects on specialists ($p<0.01$) and general practitioners ($p<0.10$). An increase in the amount of private beds increase specialist supply (with a coefficient of 2.5), whereas decrease practitioner supply (with a coefficient of -2.2).

Change in urban population size ($p<0.01$) and per capita income ($p<0.01$) have a higher effect on the growth in the number of specialists and their effects on general practitioners are not significant. As the proportion of people with university degrees increase ($p<0.05$), the number of specialists working in that area increase. Neither the age dependency rate nor the ratio of agricultural employees has a statistically significant relationship with the change in physician supply.

Hospital diversity measured by the Gibbs-Martin index ($p<0.05$) seems to favor growth in the number of specialists, as indicated by the positive coefficient of 3.91, but it is not significant for general practitioners. The effect of concentration measured by the Hirschman-Herfindahl index is not significant but has a negative sign for both types of physicians as expected.

In the second regression, instead of population, income, age , education and employment variables, a socio-economic development level index, which is expected to cover all the other variables, is used. The index variable is statistically significant ($p<0.05$) for only specialists, which indicates that an increase in the development level of the area increases the supply of specialists, but not the practitioners.

Table 9: Estimates of Models of Change in Total Physicians, Specialists and General Practitioners from 1990 to 2000

| | pubphy00/90 | | | pubspe00/90 | | | pubgp00/90 | | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value | coefficient | SE | p value |
| pubbed90 / 100 | 0.188[b] | 0.084 | 0.029 | 0.123[c] | 0.067 | 0.071 | 0.176[c] | 0.091 | 0.057 |
| pubbed00/90 / 100 | 1.244[a] | 0.187 | 0.000 | 0.806[a] | 0.148 | 0.000 | 1.039[a] | 0.202 | 0.000 |
| pribed90 / 100 | 0.987 | 1.043 | 0.348 | 2.481[a] | 0.824 | 0.004 | -2.152[c] | 1.124 | 0.060 |
| urbpop00/90 / 10,000 | 0.197[a] | 0.056 | 0.001 | 0.145[a] | 0.044 | 0.002 | 0.093 | 0.060 | 0.129 |
| income00/90 / 100 | 0.210[b] | 0.084 | 0.015 | 0.177[a] | 0.066 | 0.010 | 0.045 | 0.091 | 0.621 |
| agr00/90 | 0.115 | 0.072 | 0.115 | 0.085 | 0.057 | 0.141 | 0.077 | 0.077 | 0.327 |
| uni00/90 | 0.800 | 0.502 | 0.116 | 0.820[b] | 0.396 | 0.043 | 0.413 | 0.541 | 0.448 |
| age00/90 | 0.020 | 0.053 | 0.704 | 0.042 | 0.042 | 0.316 | -0.027 | 0.057 | 0.632 |
| hhi00/90 | -4.194 | 2.690 | 0.124 | -3.143 | 2.124 | 0.144 | -2.094 | 2.899 | 0.473 |
| gmi90 | 4.539[b] | 2.041 | 0.030 | 3.912[b] | 1.612 | 0.018 | 1.349 | 2.199 | 0.542 |
| $R^2$ (Adjusted $R^2$) | 0.964 | (0.959) | | 0.963 | (0.957) | | 0.896 | (0.878) | |
| F-ratio (P-value) | 162.7 | 0.000 | | 157.8 | 0.000 | | 51.6 | 0.000 | |

| | pubphy00/90 | | | pubspe00/90 | | | pubgp00/90 | | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value | coefficient | SE | p value |
| pubbed90 / 100 | 0.341[a] | 0.086 | 0.000 | 0.230[a] | 0.070 | 0.002 | 0.251[a] | 0.085 | 0.004 |
| pubbed00/90 / 100 | 1.091[a] | 0.192 | 0.000 | 0.761[a] | 0.156 | 0.000 | 0.910[a] | 0.189 | 0.000 |
| pribed90 / 100 | 0.282 | 1.150 | 0.807 | 1.777[c] | 0.930 | 0.061 | -2.307[b] | 1.132 | 0.046 |
| urbpop00/90 / 10,000 | 0.109[a] | 0.035 | 0.003 | 0.064[b] | 0.028 | 0.026 | 0.079[b] | 0.034 | 0.024 |
| index90 | 0.721 | 0.585 | 0.222 | 1.013[b] | 0.473 | 0.036 | -0.185 | 0.575 | 0.749 |
| hhi00/90 | -6.964[b] | 2.737 | 0.013 | -6.199[a] | 2.212 | 0.007 | -2.584 | 2.692 | 0.341 |
| gmi90 | 8.042[a] | 1.751 | 0.000 | 6.897[a] | 1.415 | 0.000 | 3.388[c] | 1.723 | 0.054 |
| $R^2$ (Adjusted $R^2$) | 0.958 | (0.953) | | 0.954 | (0.949) | | 0.896 | (0.885) | |
| F-ratio (P-value) | 203.2 | 0.000 | | 187.7 | 0.000 | | 77.9 | 0.000 | |

Note: a, b and c are for 0.01, 0.05 and 0.10 confidence intervals respectively.

Table 10 presents the results of second group regressions, where the period is divided into two 5-year periods to determine the effect of the obligatory service law on physicians, which was in force until 1995.

Private bed capacity ($p<0.01$), change in urban population size ($p<0.10$) and per capita income ($p<0.10$) have statistically significant effects on the specialist supply in 1995-200, but, for the previous period, they do not seem to have any effect on the location choice of specialists. The availability of public hospitals ($p<0.05$) and change in public hospital beds ($p<0.01$) display similar and significant effects on the change in the number of specialists for both periods, with change in first period bed capacity having a higher effect. In addition to hospital capacities, in the first period, specialist supply is related to the ratio of agricultural employees, whereas, in the second period, it is related to the age-dependency ratio and hospital diversity.

When the development index is used instead of other socio-economic variables, similar results are obtained for specialists. Public hospital capacity variables have significantly positive effects and private hospital capacity is only significant ($p<0.10$) in the 1995-2000 period, however the development index ($p<0.05$) is only significant in the 1990-1995 period. Finally change in specialist supply increases with market diversity.

The results of the same regressions for the general practitioner population are presented in Appendix 6. For practitioners, change in public bed capacity ($p<0.05$) has significant effects on all groups of regressions and increases in private bed capacity ($p<0.10$) significantly decrease the change in practitioner supply in the second period. However, the explanatory power of the model for practitioners decreases, when it is divided into two periods compared to specialists, with R-square ranging from 0.39 to 0.78.

Table 10: Estimates of Models of Change in Specialists Supply in1990-1995 and 1995-2000

| | pubspe00/95 | | | pubspe95/90 | | |
|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value |
| pubbed95 / 100 | 0.166[b] | 0.068 | 0.017 | | | |
| pubbed90 / 100 | | | | 0.164[b] | 0.065 | 0.015 |
| pubbed00/95 / 100 | 0.651[a] | 0.208 | 0.003 | | | |
| pubbed95/90 / 100 | | | | 1.002[a] | 0.252 | 0.000 |
| pribed95 / 100 | 2.356[a] | 0.851 | 0.007 | | | |
| pribed90 / 100 | | | | 0.367 | 0.911 | 0.688 |
| urbpop00/95 / 10,000 | 0.114[c] | 0.062 | 0.071 | | | |
| urbpop95/90 / 10,000 | | | | 0.057 | 0.079 | 0.478 |
| income95 / 100 | 0.074[c] | 0.038 | 0.057 | | | |
| income90 / 100 | | | | 0.039 | 0.032 | 0.224 |
| agr00/90 | -11.709 | 19.660 | 0.554 | 26.657[c] | 15.125 | 0.083 |
| uni00/90 | -0.139 | 0.610 | 0.820 | 0.648 | 0.438 | 0.144 |
| age00/90 | 0.167[b] | 0.077 | 0.036 | -0.040 | 0.060 | 0.504 |
| hhi00/95 | -8.540 | 6.588 | 0.200 | | | |
| hhi95/90 | | | | -2.609 | 2.610 | 0.321 |
| gmi95 | 4.477[b] | 2.227 | 0.049 | | | |
| gmi90 | | | | 0.907 | 1.924 | 0.639 |
| $R^2$ (Adjusted $R^2$) | 0.913 | (0.898) | | 0.881 | (0.861) | |
| F-ratio (P-value) | 62.8 | 0.000 | | 44.5 | 0.000 | |

| | pubspe00/95 | | | pubspe95/90 | | |
|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value |
| pubbed95 / 100 | 0.186[a] | 0.069 | 0.009 | | | |
| pubbed90 / 100 | | | | 0.171[a] | 0.062 | 0.007 |
| pubbed00/95 / 100 | 0.594[a] | 0.212 | 0.007 | | | |
| pubbed95/90 / 100 | | | | 0.951[a] | 0.246 | 0.000 |
| pribed95 / 100 | 1.564[c] | 0.928 | 0.097 | | | |
| pribed90 / 100 | | | | -0.006 | 0.883 | 0.994 |
| urbpop00/95 / 10,000 | 0.083[c] | 0.043 | 0.061 | | | |
| urbpop95/90 / 10,000 | | | | 0.077[c] | 0.043 | 0.079 |
| index90 | 0.978 | 0.589 | 0.102 | 1.087[b] | 0.449 | 0.018 |
| hhi00/95 | -7.735 | 6.043 | 0.205 | | | |
| hhi95/90 | | | | -4.273 | 2.664 | 0.114 |
| gmi95 | 7.662[a] | 1.793 | 0.000 | | | |
| gmi90 | | | | 3.839[a] | 1.317 | 0.005 |
| $R^2$ (Adjusted $R^2$) | 0.901 | (0.890) | | 0.881 | (0.868) | |
| F-ratio (P-value) | 82.1 | 0.000 | | 66.6 | 0.000 | |

Note: a, b and c are for 0.01, 0.05 and 0.10 confidence intervals, respectively.

In the third group regressions, change in each period of specialist supply is divided into three categories according to the hospitals they are working for. Because the estimates of similar models for practitioners produce insignificant results, they are not presented here.

Table 11 presents the results for specialists for the 1995-2000 and 1990-1995 periods. In the second period, the change in bed capacity of a particular hospital type significantly increases the specialist supply in that hospital, with a magnitude of 0.99 in MoH hospitals ($p<0.001$), 0.67 in SSK hospitals ($p<0.10$) and 2.4 in university hospitals ($p<0.001$). The effect of the private sector is positive and significant ($p<0.05$) on specialists in MoH and university hospitals, but it does not seem to affect the SSK hospitals.

In the first period, change in public bed capacity produces similar results, with a magnitude of 1.22 in MoH hospitals ($p<0.001$), 1.49 in SSK hospitals ($p<0.001$) and 1.76 in university hospitals ($p<0.001$), however, private bed capacity affects the SSK and university hospitals significantly ($p<0.10$), without affecting the specialist supply in MoH hospitals.

The socio-economic development level index has statistically significant coefficients for the different types of specialists in each period. A higher level of development is more likely to lead to an increase in the number of specialists in MoH ($p<0.001$) and SSK ($p<0.05$) hospitals in the first period and only the ones in SSK hospitals ($p<0.05$) in the second period. In most of the regressions, if private bed capacity has significant effects, then development level is not significant. and vice versa.

Estimation of the models, with population, income, employment, education level and age structure used as independent variables, are given in Appendix 7.

Table 11: Estimates of Models of Change in Specialist Supply in MoH, SSK and University Hospitals from 1990 to 1995 and 1995 to 2000

| | mohspe00/95 | | | sskspe00/95 | | | unispe00/95 | | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value | coefficient | SE | p value |
| **mohbed95 / 100** | 0.113 | 0.069 | 0.104 | | | | | | |
| **sskbed95 / 100** | | | | 0.454$^{a}$ | 0.139 | 0.002 | | | |
| **unibed95 / 100** | | | | | | | -0.336 | 0.223 | 0.137 |
| **mohbed00/95/100** | 0.987$^{a}$ | 0.239 | 0.000 | | | | | | |
| **sskbed00/95 /100** | | | | 0.668$^{c}$ | 0.338 | 0.053 | | | |
| **unibed00/95 /100** | | | | | | | 2.440$^{a}$ | 0.438 | 0.000 |
| **pribed95 / 100** | 2.007$^{a}$ | 0.577 | 0.001 | -0.093 | 0.587 | 0.875 | 2.417$^{b}$ | 0.980 | 0.016 |
| **urbpop00/95 / 10,000** | 0.104$^{a}$ | 0.025 | 0.000 | 0.022 | 0.024 | 0.347 | 0.016 | 0.045 | 0.732 |
| **index90** | -0.249 | 0.368 | 0.946 | 0.764$^{b}$ | 0.380 | 0.049 | 0.874 | 0.691 | 0.211 |
| **hhi00/95** | -2.029 | 3.681 | 0.584 | -3.719 | 3.619 | 0.308 | 0.394 | 6.946 | 0.955 |
| **gmi95** | 6.041$^{a}$ | 1.092 | 0.000 | 2.470$^{b}$ | 1.035 | 0.020 | 1.637 | 1.472 | 0.271 |
| **$R^2$ (Adjusted $R^2$)** | 0.923 | (0.914) | | 0.753 | (0.726) | | 0.676 | (0.640) | |
| **F-ratio (P-value)** | 107.6 | 0.000 | | 27.5 | 0.000 | | 18.7 | 0.000 | |

| | mohspe95/90 | | | sskspe95/90 | | | unispe95/90 | | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value | coefficient | SE | p value |
| **mohbed90 / 100** | 0.290$^{a}$ | 0.073 | 0.000 | | | | | | |
| **sskbed90 / 100** | | | | -0.015 | 0.116 | 0.896 | | | |
| **unibed90 / 100** | | | | | | | 0.638$^{a}$ | 0.150 | 0.000 |
| **mohbed95/90 /100** | 1.219$^{a}$ | 0.240 | 0.000 | | | | | | |
| **sskbed95/90 /100** | | | | 1.488$^{a}$ | 0.301 | 0.000 | | | |
| **unibed95/90 / 100** | | | | | | | 1.761$^{a}$ | 0.379 | 0.000 |
| **pribed90 / 100** | -1.179 | 0.709 | 0.101 | 0.951$^{c}$ | 0.553 | 0.090 | 1.065$^{c}$ | 0.652 | 0.094 |
| **urbpop95/90 / 10,000** | 0.069$^{c}$ | 0.035 | 0.054 | 0.025 | 0.026 | 0.338 | 0.015 | 0.030 | 0.611 |
| **index90** | 1.261$^{a}$ | 0.371 | 0.001 | 0.646$^{b}$ | 0.306 | 0.039 | 0.246 | 0.355 | 0.492 |
| **hhi95/90** | -2.779 | 2.163 | 0.204 | -1.191 | 1.728 | 0.493 | -0.229 | 2.045 | 0.911 |
| **gmi90** | 1.863$^{c}$ | 1.105 | 0.097 | 1.868$^{a}$ | 0.704 | 0.010 | 0.717 | 0.680 | 0.296 |
| **$R^2$ (Adjusted $R^2$)** | 0.846 | (0.829) | | 0.727 | (0.697) | | 0.757 | (0.730) | |
| **F-ratio (P-value)** | 49.4 | 0.000 | | 24.0 | 0.000 | | 30.0 | 0.000 | |

Note: a, b and c are for 0.01, 0.05 and 0.10 confidence intervals respectively.

## Collinearity Analysis

The variance inflation factor and tolerance values for the first group regressions are given in Table 12. As mentioned before, large VIF values (a usual threshold is 10) and tolerance values approaching zero indicate that the variable is highly predicted with the other predictor variables. So multicollinearity is not detected as a problem for this group of regressions.

Table 12: VIF and Tolerance for the Variables Used in First Group Regression

| | VIF | Tolerance |
|---|---|---|
| pubbed90 | 3.12 | 0.32 |
| pubbed00/90 | 3.37 | 0.30 |
| pribed90 | 2.03 | 0.49 |
| urbpop00/90 | 2.56 | 0.39 |
| income00/90 | 1.65 | 0.61 |
| agr00/90 | 1.46 | 0.68 |
| uni00/90 | 1.52 | 0.66 |
| age00/90 | 1.27 | 0.79 |
| hhi00/90 | 1.27 | 0.79 |
| gmi90 | 1.76 | 0.57 |

Hair, Anderson, Tatham and Black (1995) describe another method to detect multicollinearity in which the condition index that represents the collinearity of combinations of variables in the data set and the regression coefficient variance-decomposition matrix that shows the proportion of variance for each regression coefficient is attributable to each condition index is used. In the first step, all condition indices above a threshold value are identified. The threshold value is in a range of 15 to 30, with 30 the most commonly used one. In the second step, for all the condition indices exceeding the threshold, variables with variance proportions above 90 percent are identified. A collinearity problem is indicated when a condition index identified in step 1 as above the threshold value accounts for a substantial proportion of variance (.90 or above) for two or more coefficients.

The results are given in Table 13 again for the variables in first group regressions. Even if the threshold value in the first step is taken as 15, there are no variables in the last condition index that are with variance proportions above 90 percent. As a result, multicollinearity is not detected for the first group regressions by the usage of VIF, tolerance and condition index.

Table 13: Coefficient Variance-Decomposition Analysis with Condition Indices

| condition index | proportion of variance of coefficients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | pubbed90 | pubbed00/90 | pribed90 | urbpop00/90 | income00/90 | agr00/90 | uni00/90 | age00/90 | hhi00/90 | gmi90 |
| 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2.17 | 0.00 | 0.01 | 0.05 | 0.02 | 0.07 | 0.03 | 0.00 | 0.01 | 0.01 | 0.00 |
| 2.81 | 0.01 | 0.00 | 0.00 | 0.01 | 0.12 | 0.01 | 0.00 | 0.00 | 0.29 | 0.00 |
| 3.71 | 0.00 | 0.00 | 0.12 | 0.00 | 0.00 | 0.44 | 0.00 | 0.00 | 0.07 | 0.03 |
| 4.18 | 0.00 | 0.01 | 0.27 | 0.00 | 0.23 | 0.04 | 0.00 | 0.03 | 0.34 | 0.01 |
| 5.38 | 0.00 | 0.15 | 0.31 | 0.11 | 0.22 | 0.04 | 0.00 | 0.13 | 0.01 | 0.02 |
| 5.99 | 0.03 | 0.01 | 0.00 | 0.32 | 0.13 | 0.17 | 0.00 | 0.21 | 0.13 | 0.09 |
| 7.59 | 0.00 | 0.45 | 0.03 | 0.52 | 0.01 | 0.07 | 0.01 | 0.12 | 0.02 | 0.18 |
| 7.65 | 0.54 | 0.01 | 0.11 | 0.00 | 0.00 | 0.06 | 0.11 | 0.11 | 0.05 | 0.01 |
| 11.49 | 0.40 | 0.30 | 0.10 | 0.00 | 0.20 | 0.12 | 0.33 | 0.17 | 0.01 | 0.50 |
| 16.81 | 0.00 | 0.04 | 0.00 | 0.02 | 0.00 | 0.03 | 0.55 | 0.21 | 0.06 | 0.16 |

The above analyses have been done on all the other regression groups where different sets of variables are employed and similarly multicollinearity is not detected[11].

Endogeneity

In the first regression, change in the supply of total physicians, specialists and practitioners are tried to be explained by the availability of public and private hospitals, some socio-demographic variables and market area characteristics. But there is a probability that availability of private hospitals (measured by the number of hospital beds) can also be explained by some right- hand side variables.

To test for endogeneity, first instrumental variable(s) that are correlated with private bed capacity but not correlated with public sector physician supply are found. The number of private courses for university exams and the number of students

[11] The results are presented in Appendix 8.

attending these courses are taken as IVs as they may be regarded as proxies for private expenditures in the area.

First private bed in 1990 is regressed on the all right-hand side variables and an instrumental variable. Then the original model is run again with the residuals taken from the previous regression. Table 14 summarizes the results of the regressions.

Table 14: Endogeneity Test with Students used as Instrumental Variable

| | pribed90 | | | | pubspe00/90 | | |
|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | | coefficient | SE | p value |
| pubbed90 / 100 | -0.335 | 0.789 | 0.673 | pubbed90 / 100 | 0.140 | 0.073 | 0.061 |
| pubbed00/90 / 100 | -0.486 | 1.608 | 0.004 | pubbed00/90 / 100 | 0.814 | 0.148 | 0.000 |
| stu90 / 100 | 2.950 | 0.344 | 0.000 | pribed90 / 100 | 2.420 | 1.114 | 0.034 |
| urbpop00/90 /10,000 | 1.858 | 0.448 | 0.000 | urbpop00/90 /10,000 | 0.140 | 0.046 | 0.003 |
| income00/90 / 100 | -0.881 | 0.694 | 0.209 | income00/90 / 100 | 0.188 | 0.067 | 0.007 |
| agr00/90 | -1.457 | 0.647 | 0.028 | agr00/90 | 0.052 | 0.062 | 0.061 |
| uni00/90 | 2.132 | 4.153 | 0.610 | uni00/90 | 0.765 | 0.400 | 0.173 |
| age00/90 | 1.023 | 0.451 | 0.027 | age00/90 | 0.062 | 0.045 | 0.407 |
| hhi00/90 | -26.230 | 30.643 | 0.395 | hhi00/90 | -6.021 | 2.954 | 0.046 |
| gmi90 | -20.568 | 16.984 | 0.231 | gmi90 | 3.490 | 1.667 | 0.041 |
| | | | | resid | -0.002 | 0.017 | 0.910 |
| $R^2$ (Adjusted $R^2$) | 0.840 | (0.813) | | | 0.965 | (0.958) | |
| F-ratio (P-value) | 31.1 | 0.000 | | | 143.9 | 0.000 | |

For a good instrument individual and joint significance is checked. An F statistic greater that 10 is required as a rule of thumb. The statistical significance of the instrumental variable (student number) in the first stage and F-statistic of 31 show that student numbers can be used. In the second regression, the great p-value for the residuals taken from the first regression indicates that if the instrumental variable used is appropriate, then endogeneity is not a problem in the original regression.

Similar results are obtained when the number of private courses are employed as an instrumental variable[12].

[12] For the results of these regressions, see Appendix 9.

# CHAPTER 5

# SUMMARY AND CONCLUSIONS

The purpose of this study is to estimate the effects of the private sector together with socio-economic development variables and certain market area characteristics on the location choice of public sector physicians. The number of physicians working full time in public hospitals is identified and grouped according to specialty and type of hospital. Major findings of the analysis as well as the limitations of the study are discussed below.

## Major Findings

The results of this study provide several important findings which are relevant for health policies. It is found that the private sector promotes the disproportionate distribution of physicians across cities, as physicians choose to work in the cities with high private hospital capacities and the private sector prefers to operate in more developed parts of the country. The earnings of a physician working full-time in a public hospital is far below the average earnings of a private sector physician and the possibility of part-time private practice by public physicians affects their decision to locate in areas with higher private capacities.

In order to deal with the inequality problem between east-west and urban-rural Turkey, new policies may directly focus on the requirements of the public sector physician. Instead of forcing the newly graduated physicians to work in rural areas and in less developed parts of the country, several wage policies can be considered. The distribution of physician supply is found to be highly correlated with the per capita income of an area. Differentiated wages, with higher promotions to physicians who agree to work in areas with physician shortages, will in return correct the distributional problems and decrease the unequal distribution of health services.

## Limitations and Further Research

Several limitations of this study should be acknowledged. The data on physician supply is taken from the statistical yearbook prepared by the Ministry of Health and only covers the physicians working full-time in hospitals. The total number of public physicians included in the analyses on average constitute half of the total physician supply (self-employed or working in private and public hospitals). Specialty type cannot be detected from this data, whereas a lot of studies on physician location choice divide physicians not only as specialists and practitioners but also according to their field of specialty. If data on total physician supply and each specialty type can be obtained, the results on the models of location choice will be more realistic and general. Individual level data can be collected through surveys applied to public sector physicians. The location choice of a newly graduated physician differs from an older one, which can only be grasped by micro-level data.

Recently, a Health Transformation Program has been launched by the Ministry of Health. The program's main objectives are to organize, provide financing to, and deliver the health services in an effective, productive and equal way. One of the components of this transformation program enables all people under a social security scheme to demand service from private hospitals. This program will change the distribution of the private sector as well as the physician supply, while the demand for health services will be affected. So the analysis on location choice needs to be considered again after the launch of this transformation program.

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APPENDIX 1

| | Infant Mortality Rates | | | Child Mortality Rates | | |
|---|---|---|---|---|---|---|
| | 1980 | 1990 | 2000 | 1980 | 1990 | 2000 |
| Istanbul | 106 | 57 | 39 | 36 | 12 | 6 |
| East Black Sea | 114 | 56 | 36 | 40 | 12 | 6 |
| Mediterrenean | 110 | 59 | 37 | 38 | 13 | 6 |
| West Marmara | 111 | 59 | 37 | 39 | 13 | 6 |
| Aegean | 124 | 66 | 40 | 46 | 16 | 7 |
| West Anatolia | 123 | 63 | 40 | 45 | 15 | 7 |
| East Marmara | 121 | 64 | 42 | 44 | 15 | 8 |
| Central Anatolia | 144 | 71 | 43 | 57 | 18 | 8 |
| West Black Sea | 160 | 82 | 46 | 66 | 24 | 8 |
| South East Anatolia | 123 | 65 | 48 | 45 | 15 | 9 |
| Central East Anatolia | 138 | 77 | 49 | 53 | 21 | 9 |
| North East Anatolia | 166 | 78 | 57 | 70 | 27 | 12 |

Classification of Statistical Regions provided by the State Institute of Statistics:

- Istanbul
- West Marmara : Tekirdag, Edirne , Kırklareli, Balıkesir, Canakkale
- Aegean : Izmir, Aydın, Denizli, Mugla, Manisa, Afyon, Kütahya, Uşak
- East Marmara : Bursa, Eskisehir, Bilecik, Kocaeli, Sakarya, Düzce, Bolu, Yalova
- West Anatolia : Ankara, Konya, Karaman
- Mediterrenean : Antalya, Isparta, Burdur, Adana, Mersin, Hatay, Kahramanmaras, Osmaniye
- Central Anatolia : Kırıkkale, Aksaray, Nigde, Nevsehir, Kırsehir, Kayseri, Sivas, Yozgat
- West Black Sea : Zonguldak, Karabük, Bartın, Kastamonu, Cankırı, Sinop, Samsun, Tokat, Corum, Amasya
- East Black Sea : Trabzon, Ordu, Giresun, Rize, Artvin, Gumushane
- North East Anatolia : Erzurum, Erzincan, Bayburt, Agrı, Kars, Igdır, Ardahan
- Central East Anatolia : Malatya, Elazığ, Bingöl, Tunceli, Van, Mus, Bitlis, Hakkari
- South East Anatolia : Gaziantep, Adıyaman, Kilis, Sanlıurfa, Diyarbakır, Mardin, Batman, Şırnak, Siirt

# APPENDIX 2

| | physicians per 1000 | | specialists per 1000 | | practitioners per 1000 | | total # of physicians | | total # of SSK physicians | | total # of MoH physicians | | total # of University physicians | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1990 | 2000 | 1990 | 2000 | 1990 | 2000 | 1990 | 2000 | 1990 | 2000 | 1990 | 2000 | 1990 | 2000 |
| **Istanbul** | 0.845 | 0.929 | 0.428 | 0.525 | 0.417 | 0.404 | 6179 | 9305 | 1221 | 2013 | 2658 | 4241 | 2054 | 2570 |
| **East Black Sea** | 0.223 | 0.354 | 0.123 | 0.202 | 0.100 | 0.152 | 114 | 206 | 23 | 32 | 63 | 118 | 28 | 56 |
| **Mediterrenean** | 0.235 | 0.467 | 0.150 | 0.283 | 0.085 | 0.184 | 229 | 497 | 42 | 79 | 125 | 258 | 61 | 159 |
| **West Marmara** | 0.336 | 0.540 | 0.217 | 0.407 | 0.118 | 0.133 | 169 | 301 | 34 | 89 | 102 | 211 | 33 | 1 |
| **Aegean** | 0.303 | 0.601 | 0.190 | 0.368 | 0.112 | 0.234 | 421 | 942 | 95 | 158 | 227 | 458 | 91 | 313 |
| **West Anatolia** | 0.624 | 0.863 | 0.312 | 0.427 | 0.312 | 0.436 | 1732 | 2772 | 182 | 381 | 825 | 1288 | 698 | 1055 |
| **East Marmara** | 0.293 | 0.594 | 0.174 | 0.418 | 0.118 | 0.175 | 244 | 495 | 50 | 78 | 109 | 190 | 81 | 159 |
| **Central Anatolia** | 0.226 | 0.390 | 0.125 | 0.225 | 0.101 | 0.165 | 133 | 244 | 18 | 26 | 58 | 122 | 55 | 96 |
| **West Black Sea** | 0.195 | 0.400 | 0.119 | 0.246 | 0.076 | 0.154 | 139 | 218 | 34 | 46 | 82 | 133 | 21 | 39 |
| **South East Anatolia** | 0.139 | 0.243 | 0.074 | 0.139 | 0.066 | 0.103 | 116 | 225 | 20 | 24 | 55 | 113 | 41 | 88 |
| **Central East Anatolia** | 0.133 | 0.333 | 0.067 | 0.144 | 0.066 | 0.188 | 59 | 200 | 10 | 26 | 36 | 76 | 14 | 97 |
| **North East Anatolia** | 0.173 | 0.256 | 0.092 | 0.140 | 0.080 | 0.116 | 99 | 130 | 7 | 7 | 45 | 62 | 46 | 61 |

# APPENDIX 3

| Variables | Weights |
|---|---|
| Share of salaried women in total employed population | 0.035 |
| Share of financial employees in total employed population | 0.034 |
| Income and corporate tax per capita | 0.034 |
| Rate of employees to total employed population | 0.033 |
| Bank deposits per capita | 0.033 |
| Share of commercial employees in total employed population | 0.032 |
| Number of counters per capita | 0.032 |
| Number of dentists per 10,000 people | 0.031 |
| Amount of industrial, commercial and tourism credits per capita | 0.031 |
| Municipality expenditures per capita | 0.031 |
| Number of private automobiles per 10,000 people | 0.031 |
| Share of industrial employees in total employed population | 0.030 |
| Share of salaried employees in total employed population | 0.030 |
| Rate of university graduates in 25 years old and over population | 0.030 |
| Number of physicians per 10,000 people | 0.030 |
| Average of employees in manufacturing industry in a year | 0.030 |
| Share in gross domestic product | 0.030 |
| Number of businesses in manufacturing industry | 0.029 |
| Gross domestic product per capita | 0.029 |
| Amount of built capacity in manufacturing industry | 0.029 |
| Number of residential buildings | 0.029 |
| Number of bank branches | 0.028 |
| Population | 0.028 |
| Number of pharmacies per capita | 0.027 |
| Share in total bank deposits | 0.027 |
| Share in total bank credits | 0.027 |
| Number of overland vehicles per 10.000 people | 0.026 |
| Ratio of population by literacy | 0.025 |
| Ratio of female population by literacy | 0.025 |
| Ratio of high schools | 0.025 |
| Population density | 0.024 |
| Budget revenues per capita | 0.023 |
| City population growth rate | 0.023 |
| Exports per capita | 0.023 |
| Ratio of asphalt roads in villages | 0.022 |
| Number of businesses in small industrial estate | 0.021 |
| Imports per capita | 0.021 |
| Ratio of technical high schools | 0.021 |
| Manufacturing industry value added per capita | 0.020 |
| Electricity consumption per capita | 0.020 |
| Industrial electricity consumption per capita | 0.019 |
| Ratio of residential buildings with plumbing | 0.018 |
| Ratio of primary schools | 0.018 |
| Number of hospital beds per 10,000 people | 0.018 |
| State highways and provincial roads in provinces area | 0.017 |
| Area of industrial zone | 0.017 |
| Share of value added in agriculture in Turkey total | 0.016 |
| Amount of investment incentive certificates per capita | 0.016 |
| Population growth rate | 0.009 |
| Agriculture sector value added per capita in rural population | 0.008 |
| Ratio of population by sufficient freshwater | 0.006 |
| Agricultural credit per capita in rural population | 0.005 |
| Public investments per capita | 0.000 |
| Infant mortality rate | -0.016 |
| Total fertility rate | -0.022 |
| Average household size | -0.025 |
| Ratio of population with green card | -0.026 |
| Share of agricultural employees in total employed population | -0.031 |

# APPENDIX 4

| | 1990 | 1995 | 2000 |
|---|---|---|---|
| **Dependent variables** | | | |
| Specialists in public hospitals | 1 < - < 367 | 5 < - < 591 | 4 < - < 1162 |
| Practitioners in public hospitals | 6 < - < 288 | 5 < - < 606 | 7 < - < 581 |
| Specialists in MoH hospitals | 1 < - < 171 | 5 < - < 272 | 4 < - < 437 |
| Practitioners in MoH hospitals | 6 < - < 73 | 5 < - < 208 | 7 < - < 181 |
| Specialists in SSK hospitals | 0 < - < 102 | 0 < - < 129 | 0 < - < 159 |
| Practitioners in SSK hospitals | 0 < - < 34 | 0 < - < 52 | 0 < - < 141 |
| Specialists in university hospitals | 0 < - < 105 | 0 < - < 190 | 0 < - < 566 |
| Practitioners in university hospitals | 0 < - < 223 | 0 < - < 534 | 0 < - < 388 |
| **Independent variables** | | | |
| Number of public beds | 75 < - < 2676 | 75 < - < 3242 | 100 < - < 3688 |
| Number of MoH beds | 75 < - < 1633 | 75 < - < 1784 | 100 < - < 2103 |
| Number of SSK beds | 0 < - < 1102 | 0 < - < 1083 | 0 < - < 1012 |
| Number of university beds | 0 < - < 702 | 0 < - < 850 | 0 < - < 1081 |
| Number of private beds | 0 < - < 217 | 0 < - < 222 | 0 < - < 372 |
| Population size | 107,330 < - < 1,934,907 | 102,324 < - <2,123,458 | 93,584 < - < 2,192,166 |
| Urban population size | 41,295 < - < 1,350,339 | 48,000 < - < 1,544,000 | 41,356 < - < 1,630,940 |
| Per capita income ($) | 171 < - < 6,992 | 660 < - < 7,349 | 725 < - < 7,556 |
| Per capita savings ($) | 27 < - < 482 | | 66 < - < 1,595 |
| Age-dependency ratio | 45 < - < 117 | | 41 < - < 99 |
| % of university graduates | 1.53 < - < 6.18 | | 3.05 < - < 11.48 |
| Unemployment ratio | 1.8 < - < 11.5 | | 0.6 < - < 17.4 |
| % of agricultural employees | 32.7 < - < 84.6 | | 33.6 < - < 83.4 |
| Number of bank branches | 8 < - < 238 | | 3 < - < 286 |
| Development index | -1.440 < - < 1.943 | | -1.245 < - < 1.746 |
| Hirschman-Herfindahl index | 0.107 < - < 1 | 0.100 < - < 1 | 0.080 < - < 1 |
| Gibbs-Martin index | 0 < - < 0.719 | 0 < - < 0.735 | 0 < - < 0.700 |
| Distance to university hospital (km) | 0 < - < 474 | | |
| **Instrumental variables** | | | |
| Number of students | 23 < - < 7,257 | | 16 < - < 12,912 |
| Number of courses | 1 < - < 204 | | 1 < - < 657 |

# APPENDIX 5

Correlation between dependent (change between 1990 and 2000) and independent variables

| | pubdoc 00/90 | pubspe 00/90 | pubgp 00/90 | mohspe 00/90 | mohgp 00/90 | sskspe 00/90 | sskgp 00/90 | unispe 00/90 | unigp 00/90 |
|---|---|---|---|---|---|---|---|---|---|
| pubbed90 | 0.828 | 0.821 | 0.701 | | | | | | |
| pubbed00/90 | 0.867 | 0.836 | 0.801 | | | | | | |
| mohbed90 | | | | 0.599 | 0.518 | | | | |
| mohbed00/90 | | | | 0.769 | 0.743 | | | | |
| sskbed90 | | | | | | 0.566 | 0.140 | | |
| sskbed00/90 | | | | | | 0.554 | 0.382 | | |
| unibed90 | | | | | | | | 0.655 | 0.340 |
| unibed00/90 | | | | | | | | 0.711 | 0.586 |
| pribed90 | 0.625 | 0.696 | 0.398 | | | | | | |
| pribed00/90 | 0.440 | 0.446 | 0.410 | | | | | | |
| pop90 | 0.827 | 0.837 | 0.698 | 0.669 | 0.538 | 0.687 | 0.353 | 0.657 | 0.488 |
| pop00/90 | 0.642 | 0.610 | 0.580 | 0.714 | 0.609 | 0.361 | 0.266 | 0.473 | 0.368 |
| urbpop90 | 0.825 | 0.845 | 0.670 | 0.697 | 0.556 | 0.693 | 0.371 | 0.705 | 0.454 |
| urbpop00/90 | 0.697 | 0.691 | 0.580 | 0.714 | 0.625 | 0.389 | 0.247 | 0.594 | 0.367 |
| urban90 | 0.616 | 0.623 | 0.516 | 0.533 | 0.395 | 0.508 | 0.367 | 0.556 | 0.346 |
| urban00/90 | -0.564 | -0.552 | -0.526 | -0.506 | -0.361 | -0.581 | -0.354 | -0.327 | -0.306 |
| income90 | 0.470 | 0.528 | 0.296 | 0.415 | 0.106 | 0.598 | 0.335 | 0.323 | 0.174 |
| income00/90 | -0.173 | -0.150 | -0.225 | -0.495 | -0.410 | -0.099 | -0.132 | -0.034 | -0.069 |
| totinc90 | 0.798 | 0.845 | 0.598 | 0.664 | 0.420 | 0.759 | 0.400 | 0.655 | 0.385 |
| totinc00/90 | 0.696 | 0.697 | 0.595 | 0.615 | 0.395 | 0.593 | 0.355 | 0.574 | 0.476 |
| save90 | 0.426 | 0.479 | 0.265 | 0.372 | 0.139 | 0.511 | 0.368 | 0.255 | 0.089 |
| save00/90 | 0.502 | 0.563 | 0.327 | 0.325 | 0.070 | 0.598 | 0.337 | 0.402 | 0.229 |
| agedep90 | -0.346 | -0.396 | -0.203 | -0.345 | -0.124 | -0.460 | -0.413 | -0.174 | -0.041 |
| agedep00/90 | 0.226 | 0.225 | 0.194 | 0.300 | 0.262 | 0.279 | 0.295 | 0.097 | 0.044 |
| uni90 | 0.648 | 0.663 | 0.535 | 0.553 | 0.382 | 0.594 | 0.483 | 0.493 | 0.345 |
| uni00/90 | 0.327 | 0.354 | 0.250 | 0.250 | 0.133 | 0.235 | 0.278 | 0.326 | 0.197 |
| unemp90 | 0.240 | 0.192 | 0.294 | 0.153 | 0.203 | 0.025 | -0.065 | 0.270 | 0.304 |
| unemp00/90 | -0.113 | -0.112 | -0.110 | -0.056 | 0.034 | -0.190 | -0.133 | 0.023 | -0.074 |
| bank90 | 0.845 | 0.887 | 0.651 | 0.799 | 0.576 | 0.762 | 0.483 | 0.657 | 0.389 |
| bank00/90 | 0.597 | 0.618 | 0.496 | 0.644 | 0.482 | 0.525 | 0.341 | 0.504 | 0.294 |
| cre90 | 0.487 | 0.510 | 0.384 | 0.497 | 0.389 | 0.477 | 0.481 | 0.357 | 0.124 |
| cre00/90 | 0.345 | 0.382 | 0.229 | 0.239 | 0.086 | 0.318 | -0.048 | 0.404 | 0.261 |
| agr90 | -0.577 | -0.612 | -0.425 | -0.432 | -0.208 | -0.592 | -0.377 | -0.503 | -0.285 |
| agr00/90 | 0.267 | 0.240 | 0.261 | 0.199 | 0.167 | 0.280 | 0.081 | 0.151 | 0.210 |
| elc90 | 0.337 | 0.383 | 0.204 | 0.222 | -0.079 | 0.435 | 0.183 | 0.209 | 0.116 |
| elc00/90 | 0.089 | 0.158 | -0.052 | -0.015 | -0.282 | 0.267 | 0.117 | 0.060 | -0.046 |
| gmi90 | 0.498 | 0.496 | 0.406 | 0.369 | 0.303 | 0.393 | 0.132 | 0.430 | 0.417 |
| gmi00/90 | 0.004 | 0.002 | 0.051 | -0.007 | 0.032 | 0.148 | 0.101 | 0.057 | -0.003 |
| hhi90 | -0.499 | -0.494 | -0.442 | -0.368 | -0.347 | -0.479 | -0.192 | -0.327 | -0.292 |
| hhi00/90 | 0.140 | 0.142 | 0.134 | 0.019 | -0.020 | 0.153 | 0.009 | 0.135 | 0.170 |
| score00 | -0.590 | -0.648 | -0.395 | -0.482 | -0.184 | -0.648 | -0.440 | -0.418 | -0.241 |
| index90 | 0.621 | 0.689 | 0.407 | 0.507 | 0.205 | 0.677 | 0.432 | 0.474 | 0.233 |
| index00/90 | -0.063 | -0.129 | 0.056 | 0.049 | 0.162 | -0.129 | -0.075 | -0.075 | 0.091 |
| dist00 | -0.453 | -0.455 | -0.356 | -0.461 | -0.305 | -0.341 | -0.311 | -0.390 | -0.272 |

Correlation between dependent (change between 1990 and 2000) and independent variables

| | pubdoc 95/90 | pubspe 95/90 | pubgp 95/90 | | pubdoc 00/95 | pubspe 00/95 | pubgp 00/95 |
|---|---|---|---|---|---|---|---|
| pribed90 | 0.578 | 0.587 | 0.493 | pribed95 | 0.522 | 0.619 | -0.047 |
| pribed95/90 | 0.241 | 0.342 | 0.147 | pribed00/95 | 0.385 | 0.405 | 0.118 |
| pubbed90 | 0.808 | 0.776 | 0.707 | pubbed95 | 0.572 | 0.720 | 0.091 |
| pubbed95/90 | 0.685 | 0.704 | 0.521 | pubbed00/95 | 0.701 | 0.637 | 0.343 |
| pop90 | 0.737 | 0.693 | 0.659 | pop95 | 0.692 | 0.804 | 0.166 |
| pop95/90 | 0.536 | 0.577 | 0.393 | pop00/95 | 0.326 | 0.367 | 0.026 |
| urbpop90 | 0.716 | 0.699 | 0.622 | urbpop95 | 0.682 | 0.797 | 0.147 |
| urbpop95/90 | 0.629 | 0.634 | 0.512 | urbpop00/95 | 0.341 | 0.361 | 0.027 |
| urban90 | 0.476 | 0.488 | 0.396 | urban95 | 0.446 | 0.506 | 0.164 |
| urban95/90 | -0.328 | -0.410 | -0.241 | urban00/95 | -0.228 | -0.311 | -0.081 |
| income90 | 0.376 | 0.543 | 0.186 | income95 | 0.405 | 0.412 | 0.102 |
| income95/90 | -0.198 | -0.234 | -0.093 | income00/95 | 0.059 | 0.123 | 0.019 |
| totinc90 | 0.662 | 0.729 | 0.509 | totinc95 | 0.683 | 0.765 | 0.140 |
| totinc95/90 | 0.415 | 0.457 | 0.325 | totinc00/95 | 0.583 | 0.578 | 0.252 |
| save90 | 0.403 | 0.521 | 0.242 | save90 | 0.310 | 0.362 | -0.009 |
| save00/90 | 0.431 | 0.586 | 0.259 | save00/90 | 0.426 | 0.450 | 0.078 |
| age90 | -0.381 | -0.505 | -0.214 | age90 | -0.227 | -0.273 | 0.026 |
| age00/90 | 0.273 | 0.340 | 0.178 | age00/90 | 0.270 | 0.290 | 0.068 |
| uni90 | 0.626 | 0.661 | 0.498 | uni90 | 0.479 | 0.544 | 0.063 |
| uni00/90 | 0.371 | 0.414 | 0.280 | uni00/90 | 0.207 | 0.257 | -0.095 |
| unemp90 | 0.127 | 0.039 | 0.196 | unemp90 | 0.231 | 0.257 | 0.211 |
| unemp00/90 | -0.207 | -0.257 | -0.107 | unemp00/90 | 0.003 | -0.033 | -0.051 |
| bank90 | 0.764 | 0.796 | 0.623 | bank90 | 0.671 | 0.788 | 0.057 |
| bank00/90 | 0.442 | 0.487 | 0.351 | bank00/90 | 0.589 | 0.575 | 0.130 |
| cre90 | 0.432 | 0.523 | 0.281 | cre90 | 0.407 | 0.380 | 0.081 |
| cre00/90 | 0.227 | 0.232 | 0.216 | cre00/90 | 0.341 | 0.452 | 0.074 |
| agr90 | -0.460 | -0.544 | -0.328 | agr90 | -0.530 | -0.547 | -0.155 |
| agr00/90 | 0.160 | 0.086 | 0.184 | agr00/90 | 0.270 | 0.318 | 0.156 |
| elc90 | 0.246 | 0.357 | 0.129 | elc90 | 0.335 | 0.342 | 0.058 |
| elc00/90 | 0.092 | 0.187 | 0.022 | elc00/90 | 0.102 | 0.135 | -0.081 |
| gmi90 | 0.487 | 0.502 | 0.400 | gmi95 | 0.476 | 0.582 | 0.155 |
| gmi95/90 | -0.082 | -0.128 | 0.006 | gmi00/95 | -0.082 | -0.166 | 0.013 |
| hhi90 | -0.470 | -0.474 | -0.382 | hhi95 | -0.396 | -0.429 | -0.141 |
| hhi95/90 | 0.028 | 0.001 | 0.072 | hhi00/95 | 0.110 | 0.124 | 0.039 |
| score00 | -0.544 | -0.687 | -0.367 | score00 | -0.488 | -0.521 | -0.081 |
| index90 | 0.553 | 0.699 | 0.366 | index90 | 0.523 | 0.567 | 0.075 |
| index00/90 | 0.052 | -0.239 | 0.213 | index00/90 | -0.335 | -0.036 | -0.262 |
| dist00 | -0.512 | -0.481 | -0.448 | dist00 | -0.226 | -0.384 | 0.094 |

# APPENDIX 6

Estimates of models of change in general practitioner supply from 1990 to 1995 and from 1995 to 2000

| | pubgp00/95 | | | pubgp95/90 | | |
|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value |
| pubbed95 / 100 | -0.085 | 0.130 | 0.513 | | | |
| pubbed90 / 100 | | | | 0.249 | 0.103 | 0.018 |
| pubbed00/95 / 100 | 1.664 | 0.397 | 0.000 | | | |
| pubbed95/90 / 100 | | | | 0.839 | 0.396 | 0.038 |
| pribed95 / 100 | -2.736 | 1.627 | 0.098 | | | |
| pribed90 / 100 | | | | 0.935 | 1.432 | 0.516 |
| urbpop00/95 /10,000 | -0.093 | 0.119 | 0.438 | | | |
| urbpop95/90 / 10,000 | | | | 0.079 | 0.126 | 0.530 |
| income95 / 100 | 0.159 | 0.072 | 0.031 | | | |
| income90 / 100 | | | | -0.112 | 0.050 | 0.030 |
| agr00/90 | -0.093 | 0.148 | 0.532 | 0.120 | 0.094 | 0.207 |
| uni00/90 | -2.028 | 1.166 | 0.087 | 1.610 | 0.689 | 0.023 |
| age00/90 | -26.478 | 37.565 | 0.484 | 12.711 | 23.782 | 0.595 |
| hhi00/95 | -7.497 | 12.585 | 0.554 | | | |
| hhi00/90 | | | | -0.971 | 4.103 | 0.814 |
| gmi95 | 3.607 | 4.256 | 0.400 | | | |
| gmi90 | | | | 2.690 | 3.025 | 0.377 |
| $R^2$ (Adjusted $R^2$) | 0.440 | (0.347) | | 0.775 | (0.737) | |
| F-ratio (P-value) | 4.7 | 0.000 | | 20.7 | 0.000 | |

| | pubgp00/95 | | | pubgp95/90 | | |
|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value |
| pubbed95 / 100 | -0.076 | 0.128 | 0.555 | | | |
| pubbed90 / 100 | | | | 0.315 | 0.101 | 0.003 |
| pubbed00/95 / 100 | 1.531 | 0.395 | 0.000 | | | |
| pubbed95/90 / 100 | | | | 0.710 | 0.404 | 0.084 |
| pribed95 / 100 | -2.745 | 1.720 | 0.116 | | | |
| pribed90 / 100 | | | | 1.447 | 1.452 | 0.433 |
| urbpop00/95 /10,000 | -0.106 | 0.080 | 0.192 | | | |
| urbpop95/90 / 10,000 | | | | 0.064 | 0.071 | 0.367 |
| index90 | 0.346 | 1.092 | 0.752 | -0.928 | 0.737 | 0.213 |
| hhi00/95 | -9.555 | 11.198 | 0.397 | | | |
| hhi00/90 | | | | -0.082 | 4.383 | 0.985 |
| gmi95 | 4.968 | 3.322 | 0.140 | | | |
| gmi90 | | | | 2.176 | 2.166 | 0.319 |
| $R^2$ (Adjusted $R^2$) | 0.403 | (0.337) | | 0.752 | (0.725) | |
| F-ratio (P-value) | 6.1 | 0.000 | | 27.3 | 0.000 | |

# APPENDIX 7

Estimates of Models of Change in Specialist Supply in MoH, SSK and University Hospitals from 1990 to 1995 and 1995 to 2000

| | mohspe00/95 | | | sskspe00/95 | | | unispe00/95 | | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value | coefficient | SE | p value |
| mohbed95 / 100 | 0.149 | 0.072 | 0.041 | | | | | | |
| sskbed95 / 100 | | | | 0.497 | 0.138 | 0.001 | | | |
| unibed95 / 100 | | | | | | | -0.323 | 0.226 | 0.158 |
| mohbed00/95 /100 | 0.819 | 0.242 | 0.001 | | | | | | |
| sskbed00/95 /100 | | | | 0.586 | 0.347 | 0.097 | | | |
| unibed00/95 /100 | | | | | | | 2.317 | 0.436 | 0.000 |
| pribed95 / 100 | 1.627 | 0.534 | 0.003 | 0.181 | 0.593 | 0.761 | 3.484 | 0.930 | 0.000 |
| urbpop00/95 /10,000 | 0.055 | 0.044 | 0.212 | -0.023 | 0.004 | 0.584 | 0.112 | 0.084 | 0.188 |
| income00/95 / 100 | -0.248 | 0.067 | 0.001 | -0.019 | 0.067 | 0.782 | 0.169 | 0.123 | 0.175 |
| agr00/90 | 0.058 | 0.048 | 0.225 | 0.058 | 0.049 | 0.246 | 0.121 | 0.092 | 0.192 |
| uni00/90 | 0.544 | 0.301 | 0.076 | 0.533 | 0.301 | 0.073 | -0.154 | 0.550 | 0.780 |
| age00/90 | 0.001 | 0.033 | 0.979 | 0.052 | 0.035 | 0.148 | -0.014 | 0.066 | 0.837 |
| hhi00/95 | -2.587 | 3.990 | 0.519 | -5.191 | 4.079 | 0.208 | -0.880 | 7.893 | 0.911 |
| gmi95 | 5.785 | 1.315 | 0.000 | 1.583 | 1.382 | 0.257 | 0.420 | 2.289 | 0.855 |
| $R^2$ (Adjusted $R^2$) | 0.933 | (0.922) | | 0.756 | (0.715) | | 0.690 | (0.639) | |
| F-ratio (P-value) | 83.6 | 0.000 | | 18.6 | 0.000 | | 13.4 | 0.000 | |

| | mohspe95/90 | | | sskspe95/90 | | | unispe95/90 | | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | coefficient | SE | p value | coefficient | SE | p value |
| mohbed90 / 100 | 0.249 | 0.083 | 0.004 | | | | | | |
| sskbed90 / 100 | | | | 0.017 | 0.120 | 0.892 | | | |
| unibed90 / 100 | | | | | | | 0.623 | 0.153 | 0.000 |
| mohbed95/90 / 100 | 1.266 | 0.262 | 0.000 | | | | | | |
| sskbed95/90 / 100 | | | | 1.487 | 0.317 | 0.000 | | | |
| unibed95/90 / 100 | | | | | | | 1.743 | 0.377 | 0.000 |
| pribed90 / 100 | -0.373 | 0.775 | 0.632 | 0.791 | 0.600 | 0.193 | 0.737 | 0.658 | 0.267 |
| urbpop95/90/10,000 | 0.034 | 0.068 | 0.561 | 0.067 | 0.048 | 0.166 | 0.045 | 0.055 | 0.421 |
| income95/90 / 100 | -0.030 | 0.086 | 0.728 | -0.039 | 0.065 | 0.550 | -0.034 | 0.075 | 0.650 |
| agr00/90 | -0.011 | 0.053 | 0.832 | -0.009 | 0.040 | 0.827 | 0.002 | 0.046 | 0.965 |
| uni00/90 | 0.693 | 0.334 | 0.042 | 0.242 | 0.249 | 0.335 | 0.516 | 0.292 | 0.082 |
| age00/90 | 0.069 | 0.037 | 0.069 | 0.057 | 0.028 | 0.044 | 0.043 | 0.033 | 0.192 |
| hhi95/90 | -1.786 | 2.257 | 0.432 | -0.780 | 1.700 | 0.648 | 0.255 | 1.911 | 0.894 |
| gmi90 | 0.505 | 1.481 | 0.734 | 1.513 | 1.041 | 0.151 | -0.655 | 1.144 | 0.569 |
| $R^2$ (Adjusted $R^2$) | 0.827 | (0.798) | | 0.731 | (0.686) | | 0.773 | (0.735) | |
| F-ratio (P-value) | 28.6 | 0.000 | | 16.3 | 0.000 | | 20.4 | 0.000 | |

# APPENDIX 8

Multicollinearity tests for the first group regressions

| | VIF | Tolerance |
|---|---|---|
| **pubbed90** | 2.91 | 0.34 |
| **pubbed00/90** | 3.15 | 0.32 |
| **pribed90** | 2.23 | 0.45 |
| **urbpop00/90** | 2.43 | 0.41 |
| **index90** | 1.81 | 0.55 |
| **hhi00/90** | 1.25 | 0.80 |
| **gmi90** | 1.64 | 0.61 |

| condition index | proportion of variance of coefficients | | | | | | |
|---|---|---|---|---|---|---|---|
| | **index90** | **pubbed90** | **pubbed00/90** | **pribed90** | **urbpop00/90** | **hhi00/90** | **gmi90** |
| 1.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 |
| 1.76 | 0.19 | 0.00 | 0.00 | 0.02 | 0.00 | 0.08 | 0.00 |
| 2.41 | 0.00 | 0.02 | 0.00 | 0.01 | 0.21 | 0.07 | 0.02 |
| 3.04 | 0.28 | 0.00 | 0.03 | 0.02 | 0.06 | 0.54 | 0.00 |
| 3.82 | 0.28 | 0.00 | 0.02 | 0.68 | 0.06 | 0.00 | 0.03 |
| 5.53 | 0.01 | 0.13 | 0.40 | 0.05 | 0.34 | 0.22 | 0.09 |
| 7.13 | 0.03 | 0.71 | 0.50 | 0.07 | 0.29 | 0.05 | 0.00 |
| 8.60 | 0.20 | 0.14 | 0.04 | 0.13 | 0.03 | 0.03 | 0.85 |

Multicollinearity tests for the second group regressions

| | VIF | Tolerance |
|---|---|---|
| **pubbed95** | 2.59 | 0.39 |
| **pribed95** | 2.03 | 0.49 |
| **pubbed00/95** | 1.99 | 0.50 |
| **urbpop00/95** | 1.29 | 0.78 |
| **income95** | 1.62 | 0.62 |
| **agr00/90** | 1.67 | 0.60 |
| **uni00/90** | 1.84 | 0.54 |
| **age00/90** | 1.30 | 0.77 |
| **hhi00/95** | 1.33 | 0.75 |
| **gmi95** | 1.68 | 0.60 |

| condition index | proportion of variance of coefficients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **pubbed95** | **pribed95** | **pubbed 00/95** | **urbpop 00/95** | **income95** | **agr 00/90** | **uni 00/90** | **age 00/90** | **hhi 00/95** | **gmi95** |
| 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2.47 | 0.01 | 0.05 | 0.04 | 0.01 | 0.00 | 0.05 | 0.00 | 0.01 | 0.11 | 0.00 |
| 3.25 | 0.01 | 0.04 | 0.03 | 0.50 | 0.01 | 0.00 | 0.00 | 0.00 | 0.04 | 0.00 |
| 3.57 | 0.00 | 0.32 | 0.00 | 0.00 | 0.01 | 0.09 | 0.00 | 0.01 | 0.10 | 0.01 |
| 4.08 | 0.00 | 0.01 | 0.03 | 0.00 | 0.01 | 0.31 | 0.00 | 0.00 | 0.43 | 0.01 |
| 5.17 | 0.00 | 0.05 | 0.62 | 0.43 | 0.03 | 0.01 | 0.00 | 0.00 | 0.14 | 0.00 |
| 6.40 | 0.26 | 0.00 | 0.06 | 0.00 | 0.28 | 0.00 | 0.02 | 0.07 | 0.00 | 0.03 |
| 6.94 | 0.18 | 0.33 | 0.01 | 0.01 | 0.04 | 0.27 | 0.01 | 0.30 | 0.04 | 0.03 |
| 9.43 | 0.45 | 0.08 | 0.00 | 0.00 | 0.12 | 0.07 | 0.00 | 0.06 | 0.08 | 0.77 |
| 13.20 | 0.07 | 0.01 | 0.18 | 0.01 | 0.49 | 0.18 | 0.49 | 0.46 | 0.02 | 0.06 |
| 16.73 | 0.01 | 0.11 | 0.02 | 0.02 | 0.02 | 0.02 | 0.48 | 0.09 | 0.04 | 0.06 |

| | VIF | Tolerance |
|---|---|---|
| **pubbed90** | 2.64 | 0.38 |
| **pribed90** | 2.19 | 0.46 |
| **pubbed95/90** | 2.20 | 0.45 |
| **urbpop95/90** | 2.51 | 0.40 |
| **income90** | 1.68 | 0.60 |
| **agr00/90** | 1.43 | 0.70 |
| **uni00/90** | 1.38 | 0.72 |
| **age00/90** | 1.22 | 0.82 |
| **hhi95/90** | 1.22 | 0.82 |
| **gmi90** | 1.89 | 0.53 |

| | proportion of variance of coefficients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| condition index | pubbed90 | pribed90 | pubbed 95/90 | urbpop 95/90 | income90 | agr 00/90 | uni 00/90 | age 00/90 | hhi 95/90 | gmi90 |
| 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2.42 | 0.01 | 0.06 | 0.03 | 0.03 | 0.00 | 0.06 | 0.00 | 0.01 | 0.03 | 0.00 |
| 2.90 | 0.01 | 0.00 | 0.02 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.64 | 0.00 |
| 3.62 | 0.01 | 0.07 | 0.01 | 0.01 | 0.02 | 0.38 | 0.00 | 0.00 | 0.00 | 0.03 |
| 5.10 | 0.00 | 0.53 | 0.45 | 0.02 | 0.00 | 0.03 | 0.00 | 0.01 | 0.12 | 0.00 |
| 6.03 | 0.07 | 0.10 | 0.03 | 0.25 | 0.25 | 0.05 | 0.00 | 0.12 | 0.00 | 0.00 |
| 6.26 | 0.25 | 0.01 | 0.11 | 0.42 | 0.10 | 0.06 | 0.01 | 0.00 | 0.05 | 0.03 |
| 6.93 | 0.12 | 0.14 | 0.34 | 0.21 | 0.01 | 0.22 | 0.00 | 0.25 | 0.05 | 0.04 |
| 10.16 | 0.51 | 0.08 | 0.01 | 0.05 | 0.18 | 0.05 | 0.05 | 0.00 | 0.05 | 0.78 |
| 11.16 | 0.03 | 0.01 | 0.00 | 0.01 | 0.41 | 0.14 | 0.57 | 0.36 | 0.01 | 0.00 |
| 15.85 | 0.01 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.37 | 0.25 | 0.05 | 0.12 |

Multicollinearity tests for the third group regressions

| | VIF | Tolerance |
|---|---|---|
| **mohbed95** | 2.72 | 0.37 |
| **pribed95** | 2.21 | 0.45 |
| **mohbed00/95** | 1.61 | 0.62 |
| **urbpop00/95** | 1.63 | 0.62 |
| **income00/95** | 1.79 | 0.56 |
| **agr00/90** | 1.68 | 0.60 |
| **uni00/90** | 1.71 | 0.58 |
| **age00/90** | 1.22 | 0.82 |
| **dhhi00/95** | 1.33 | 0.75 |
| **gmi95** | 1.57 | 0.64 |

| | proportion of variance of coefficients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| condition index | mohbed95 | pribed95 | mohbed 00/95 | urbpop 00/95 | income 00/95 | agr 00/90 | uni 00/90 | age 00/90 | dhhi 00/95 | gmi95 |
| 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2.23 | 0.00 | 0.02 | 0.06 | 0.06 | 0.10 | 0.02 | 0.00 | 0.00 | 0.02 | 0.00 |
| 2.63 | 0.01 | 0.04 | 0.00 | 0.05 | 0.09 | 0.03 | 0.00 | 0.01 | 0.14 | 0.00 |
| 3.26 | 0.00 | 0.30 | 0.06 | 0.02 | 0.02 | 0.06 | 0.00 | 0.01 | 0.06 | 0.00 |
| 3.92 | 0.00 | 0.00 | 0.07 | 0.02 | 0.01 | 0.33 | 0.00 | 0.00 | 0.37 | 0.02 |
| 4.18 | 0.00 | 0.00 | 0.46 | 0.40 | 0.00 | 0.02 | 0.00 | 0.00 | 0.17 | 0.00 |
| 5.03 | 0.00 | 0.00 | 0.14 | 0.24 | 0.46 | 0.04 | 0.00 | 0.15 | 0.07 | 0.03 |
| 6.79 | 0.08 | 0.29 | 0.00 | 0.12 | 0.20 | 0.22 | 0.00 | 0.38 | 0.01 | 0.18 |
| 7.80 | 0.49 | 0.03 | 0.00 | 0.03 | 0.00 | 0.02 | 0.13 | 0.20 | 0.02 | 0.04 |
| 10.10 | 0.24 | 0.08 | 0.16 | 0.05 | 0.07 | 0.21 | 0.14 | 0.10 | 0.05 | 0.68 |
| 17.30 | 0.16 | 0.22 | 0.05 | 0.01 | 0.04 | 0.06 | 0.72 | 0.15 | 0.08 | 0.03 |

# APPENDIX 9

## Endogeneity Test with Students Used as Instrumental Variable

| | pribed90 | | | | pubspe00/90 | | |
|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | | coefficient | SE | p value |
| pubbed90 / 100 | 0.361 | 0.823 | 0.663 | pubbed90 / 100 | 0.274 | 0.081 | 0.001 |
| pubbed00/90 /100 | -3.456 | 1.754 | 0.053 | pubbed00/90 /100 | 0.768 | 0.156 | 0.000 |
| stu90 / 100 | 2.661 | 0.420 | 0.000 | pribed / 100 | 0.822 | 1.489 | 0.583 |
| urbpop00/90 /10,000 | 0.093 | 0.292 | 0.002 | urbpop00/90 /10,000 | 0.066 | 0.029 | 0.030 |
| index90 | 3.959 | 5.232 | 0.452 | index90 | 1.212 | 0.523 | 0.024 |
| hhi00/90 | -21.529 | 31.046 | 0.491 | hhi00/90 | -8.871 | 2.995 | 0.004 |
| gmi90 | -23.206 | 15.784 | 0.147 | gmi90 | 5.996 | 1.561 | 0.000 |
| | | | | resid | 0.014 | 0.019 | 0.458 |
| $R^2$ (Adjusted $R^2$) | 0.795 | (0.772) | | | 0.956 | (0.949) | |
| F-ratio (P-value) | 34.3 | 0.000 | | | 164.0 | 0.000 | |

## Endogeneity Test with Courses Used as Instrumental Variable

| | pribed90 | | | | pubspe00/90 | | |
|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | | coefficient | SE | p value |
| pubbed90 / 100 | 0.098 | 0.841 | 0.907 | pubbed90 / 100 | 0.118 | 0.075 | 0.118 |
| pubbed00/90 / 100 | -2.375 | 1.678 | 0.162 | pubbed00/90 / 100 | 0.820 | 0.147 | 0.000 |
| cour90 | 0.738 | 0.100 | 0.000 | pribed90 / 100 | 3.016 | 1.191 | 0.014 |
| urbpop00/90 /10,000 | 1.417 | 0.482 | 0.005 | urbpop00/90 /10,000 | 0.131 | 0.046 | 0.006 |
| income00/90 / 100 | -1.038 | 0.749 | 0.171 | income00/90 / 100 | 0.194 | 0.067 | 0.005 |
| agr00/90 | -1.539 | 0.702 | 0.031 | agr00/90 | 0.056 | 0.062 | 0.369 |
| uni00/90 | 0.047 | 4.526 | 0.992 | uni00/90 | 0.733 | 0.398 | 0.071 |
| age00/90 | 0.783 | 0.490 | 0.116 | age00/90 | 0.055 | 0.045 | 0.229 |
| hhi00/90 | -14.857 | 33.215 | 0.656 | hhi00/90 | -5.803 | 2.943 | 0.053 |
| gmi90 | -16.723 | 18.452 | 0.368 | gmi90 | 3.721 | 1.667 | 0.029 |
| | | | | resid | -0.013 | 0.017 | 0.431 |
| $R^2$ (Adjusted $R^2$) | 0.814 | (0.782) | | | 0.965 | (0.958) | |
| F-ratio (P-value) | 25.8 | 0.000 | | | 145.2 | 0.000 | |

| | pribed90 | | | | pubspe00/90 | | |
|---|---|---|---|---|---|---|---|
| | coefficient | SE | p value | | coefficient | SE | p value |
| pubbed90 / 100 | 0.599 | 0.876 | 0.497 | pubbed90 / 100 | 0.238 | 0.085 | 0.007 |
| pubbed00/90 / 100 | -0.871 | 1.758 | 0.622 | pubbed00/90 / 100 | 0.765 | 0.157 | 0.000 |
| cour90 | 0.648 | 0.120 | 0.000 | pribed90 / 100 | 1.911 | 1.654 | 0.253 |
| urbpop00/90 /10,000 | 0.626 | 0.307 | 0.046 | urbpop00/90 /10,000 | 0.058 | 0.030 | 0.059 |
| index90 | 4.960 | 5.570 | 0.377 | index90 | 1.003 | 0.543 | 0.069 |
| hhi00/90 | -17.658 | 33.036 | 0.595 | hhi00/90 | -8.312 | 3.030 | 0.008 |
| gmi90 | -25.050 | 16.673 | 0.138 | gmi90 | 6.353 | 1.585 | 0.000 |
| | | | | resid | -0.003 | 0.020 | 0.871 |
| $R^2$ (Adjusted $R^2$) | 0.771 | (0.745) | | | 0.955 | (0.949) | |
| F-ratio (P-value) | 29.8 | 0.000 | | | 162.5 | 0.000 | |