AN ECONOMETRIC MODEL OF PHYSICIANS' SERVICES IN CANADA

by

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ABSTRACT

An econometric model is developed for the market for physicians' services under Canada's health care system. The model consists of three equations; the first representing the per capita demand for physicians' services, the second representing the supply of services per physician and the third representing the per capita supply of physicians. The model is a block recursive system of equations where two of the equations form a simultaneous system.

Three steps are followed in developing the model. An initial specification of the model is made based on a review of the literature on health economics and an analysis of the structure of the Canadian health care system. In the initial specification the current theory from the literature is put into context with the two dominant features of the Canadian health care system; free hospital and physicians' services for all Canadians and physicians paid on a fee for service basis by government operated insurance.

This initially specified model is then tested by applying ordinary least squares to each of the three equations.

Variables in each equation that are not statistically significant are eliminated one by one until only statistically significant variables remain in the model.

Finally from the model, containing only statistically significant variables, simultaneous equation bias is removed by applying two stage least squares to the simultaneous equation system.

The elasticities estimated in the regressions are consistent, for the most part, with our a priori reasoning and with the results reported in the literature. As is the case in most studies of physician's services the physician:population ratio is the dominant factor in determining the demand for physician's services in Canada. Real income per capita is also a significant determinant of demand even though there is universal medicare in Canada.

Physician productivity is strongly influenced by the fees paid for physician's services. The elasticity of productivity with respect to fees is negative indicating each physician provides fewer services as fees rise. This suggests physicians might have a backward bending labour supply curve.

The physician:population ratio is determined to a large extent by the per capita demand for services. Fee levels and the attractiveness of an area also influence

where physicians locate their practices. A somewhat surprising finding is that an increase in the number of hospital beds per capita results in a decrease in the physician:population ratio suggesting hospitals are a net substitute for physician's services.

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CHAPTER I

INTRODUCTION

That there are problems with the Canadian medicare system almost everyone will agree. Physicians feel that their incomes are too low for the hours they work; patients feel there is not enough access to physicians services; governments feel medicare costs are too high; and residents of rural areas feel they are underserviced compared to those in urban areas. In spite of the dissatisfaction with many aspects of medicare, very few people in Canada advocate totally abandoning the system, but many would like to see some changes.

Unfortunately the market for physicians' services is very complex. Changes which attempt to solve one group's problems will likely be felt in other ways by the other users of medicare. For instance, increasing fees to raise physicians' incomes might result in physicians working fewer hours thereby decreasing patients' access to physicians. Increasing the number of physicians should increase patient access to physicians but will likely reduce each physician's workload and in turn his income. Increasing the number of hospital beds could either increase

or decrease the overall public demand for physicians' services as hospital beds are both complements to and substitutes for physicians' services. Because of the many complex interrelationships between the determinants of the supply of and demand for physicians' services it is important that the behaviour of physicians and patients be analyzed together if we are to understand the overall influence any one variable has on the market for physicians' services.

One method for analyzing the market for physicians' services is to develop a multi-equation econometric model that mathematically represents the market. Equations for such a model are developed by identifying the individual relationship for the supply of and demand for physicians' services and fitting them to the available data. When these equations are solved simultaneously the individual relationships are specified taking into account the interactions between the variables and the equations.

The purpose of this thesis is to develop such a model for the market for physicians' services in Canada. The model is based on current theory and analysis from the literature on health economics put into the context of the unique structure of the Canadian health care system. Regression analysis is used to varify and refine the model and to fit the specified model with the observations from

the data set.

The development of the model is discussed in detail in Chapters II to V. Chapter II describes the structure of the Canadian health care system emphasizing the areas where the structure of the system affects the specification of the model. The initial specification of the model is discussed in Chapter III. It is first described in general terms followed by a detailed discussion of each equation and the variables used to make up each equation. Chapter IV contains a discussion of the data used, emphasizing how the quality of the data may affect the results of the analysis. The regression techniques used and the empirical results obtained in the analysis are discussed in Chapter V. Based on these findings, the specification of the model is derived.

Chapter VI discusses some of the implications of the empirical results with respect to the Canadian health system. The findings of our analysis of market for physicians' services are summarized in Chapter VII.

CHAPTER II

THE STRUCTURE OF THE CANADIAN HEALTH CARE SYSTEM

The Canadian health care system is actually made up of ten provincial systems. These systems are basically similar, and can thus be considered as a single system for analytical purposes. The similarities are the result of two factors: the common historical roots of medical practice in Canada and the unifying influence of the federal government's involvement in health care.

The federal government has attempted to insure that all the citizens of Canada have equal access to medical care. This has been done through various cost sharing programs with the provinces. The federal government's first major involvement in health care began in 1948 with the introduction of the National Health Grants Program. These grants were for hospital construction, health surveys, professional training, public health research, and research into the control of specific diseases. During the mid 1960's these grants amounted to $60 million per year and contributed significantly to the supply of hospitals and health professionals in all provinces. So much so that

by 1972, with the exception of public health research and professional training, all these grant programs had been phased out. At this time Canada had among the highest ratios of physicians per capita, nurses per capita and hospital beds per capita of the industrialized nations. In fact the number of hospital beds were so high that most provinces in recent years have been attempting to reduce the number from the national average of 6.5 per thousand population to 4.5 (LeClair, 1974).

During this period, the federal government also established programs that affect the demand side of health care by reducing direct costs to patients. With the passage of the Hospital Insurance and Diagnostic Services Act in 1957 the federal government agreed to share the costs for hospitalization and diagnostic services, provided the provincial plans met certain conditions. These conditions were:

(a) coverage must be comprehensive for inpatient care but was optional for outpatient care;

(b) coverage must be universal on uniform terms and conditions; and

(c) coverage must be portable.

These conditions guaranteed that virtually all Canadians would be covered for all hospital services; that any direct user fees would not act as a deterrent to

the use of hospital services; and that Canadians would be covered while migrating interprovincially or travelling abroad. The federal government agreed to contribute 25 per cent of the national per capita cost plus 25 per cent of the provincial per capita cost, less direct user fees, multiplied by the number of insured persons in the province. This formula meant that the federal government would pay a higher proportion of the total costs to those provinces which had the lower per capita costs (generally the poorer provinces). By 1961 all the provinces had joined the program and virtually all Canadians were insured for all hospital and diagnostic services.

The third step by the federal government into the field of health care was taken in 1967. The Medical Care Act was passed to encourage the provinces to introduce free medical care in addition to the existing free hospital care. Again the federal government specified certain conditions for the provincial plans before the provinces would be eligible for federal funding. These conditions, known as "the four points," were:

(a) coverage must be comprehensive for all physicians' services;

(b) coverage must be universal (covering at least 95 per cent of the population of the province);

(c) the plans must be portable; and

(d) the plans must be operated on a non profit basis and administered by an agency responsible to the provincial government.

By 1971 all the provinces had established approved medicare plans.

The cost sharing arrangements set the federal contribution at 50 per cent of the national per capita cost times the insured population of the province.[1] As is the case with hospitalization, this formula guarantees that the provinces with lower per capita expenditures on medicare have a larger proportion of these expenditures paid by the federal government.

The federal government's involvement in hospitalization and medicare has insured that the structure of the provincial plans as they relate to demand for physicians' services are for the most part identical. There are no significant direct user charges for physicians services in any province and there are no significant user charges for hospital services, the major complement to physicians' services.

On the supply side of the market for physicians' services there are also basic similarities in the structure of medical services between each province. These similarities are mainly due to the common historical roots of medical practice in all parts of Canada. The provincial medicare

plans were set up in a manner that minimized disruption to the traditional practice of medicine that physicians enjoyed.

For the most part physicians in all provinces continue to be paid on the fee for service basis as they had been before medicare was introduced.[2] The only difference is that under medicare the fees are paid by the government rather than directly by the patient. Physicians' incomes continue to be directly linked to the amount of services they provide. This is unlike government operated medicare schemes in most countries where physicians are paid a salary or are on a capitation basis.[3]

Physicians in Canada have very few restrictions on where they can locate their practices. To move inter-provincially they must, of course, meet the licencing requirements of the province in which they wish to practice but these requirements are basically the same in each province. None of the provinces regulate where physicians may locate within a province although some attempt to influence location decisions with incentives. The important point here is that, unlike the practice in many countries, physicians are free to locate anywhere they wish and still participate fully in the medicare program.

For the period under consideration, 1971 to 1977, virtually all fee for service physicians participated in medicare and very few overbilled patients even though most

had the right to do so. The fee for service payments received by the physicians from the governments can therefore be assumed to be their total income for the services they provide. Also the payment schedule can be assumed to reflect accurately the various prices physicians receive for their services in each province each year.

Because the basic structure of the provincial medicare plans are the same, it is feasible to carry out a cross section analysis using provincial data to study the supply of and demand for physicians' services in Canada.

FOOTNOTES

Chapter II

[1]The cost sharing formulas were changed in 1977. The new federal contribution was set at the 1977 level with increases in the following years tied to the growth of the gross national product.

[2]Some physicians under medicare are paid salaries rather than on a fee for service basis. This is especially true for physicians in remote areas. The number of physicians paid in this manner is under 10 per cent in all provinces except Newfoundland where approximately 30 per cent of the physicians receive salaries.

[3]Physicians paid on a capitation basis are paid by the number of patients they have regardless of the amount of services they supply to these patients.

CHAPTER III

THE INITIAL SPECIFICATION OF THE MODEL

The model for the market for physicians services in Canada is developed from a survey of the pertinent literature in the field of health economics and an analysis of the structure of the Canadian health care system. The model, consisting of three structural equations and one identity, is summarized below:

(1) $Q/P = Q/P\ (N/P, B/P, Y/P, P65+/P, PNM/P, t, Di)$

(2) $Q/N = Q/N\ (N/P, F, B/P, PNM/P, t, Di)$

(3) $N/P = N/P\ (Q/P, F, B/P, PNM/P, HOTEL/P, MGDS/P, Y/P, t, Di)$

(4) $Q/P = (Q/N \cdot N/P)$

where the endogeneous variables are:

Q/P = physicians' services per capita,

Q/N = physicians' services per physician and

N/P = physicians per capita

and the exogeneous variables are:

Y/P = real income per capita

B/P = hospital beds per capita

P65+/P = population 65 years and older per capita

PNM/P = non metropolitan population per capita

F = fee index for physicians' services (in real terms)

HOTEL/P = hotel receipts per capita

MGDS/P = medical school graduates per capita

t = timetrend

Di = dummy variables for the provinces.

Each of the structural equations attempts to explain a particular aspect of the market for physicians' services. Equation 1 deals with the variations in the quantity of physicians' services demanded. Equations 2 and 3, the supply equations, deal with the productivity of physicians and the physician:population ratio respectively. As the identity shows, the dependent variable of the demand equation (the quantity of services demanded per capita) equals the product of the dependent variables of the supply equations (the quantity of services supplied per physician and the number of physicians per capita).[1]

Because there are endogeneous variables on the right hand side of the equations, the equations of the model make up an interdependent system. It is actually a block recursive system containing two blocks. The first is a simultaneous system, consisting of equations 1 and 3, that should be solved simultaneously. The second block contains only equation 2 and because of the recursive nature of the

system can be solved independently of equations 1 and 3.

In developing this model it is assumed that the market for physicians' services in Canada is closed. This assumption is safe for the demand equation and the equation for the supply of service per physician. Canadians rarely leave the country or their province to obtain physicians' services and the productivity of each physician should not be directly affected by factors outside the model. This assumption is not as well founded for the supply of physicians. Influences outside the model, such as changes in relative incomes of Canadian physicians to foreign physicians, immigration policy and licencing procedures could affect the supply of physicians. Over a short time period, however, marginal changes in these factors should not markedly influence the stock of physicians in Canada. Because setting up a practice is a long term investment for a physician, he is not likely to be noticeably influenced to emigrate by short term changes in any one factor. For this reason the assumption of a closed market is felt to be valid for this model.

Because the data is a cross section time series set, a timetrend and dummy variables are included in each equation to attempt to account for missing variables in the model.[2]

Each of the structural equations are now discussed separately, emphasizing the causal relationships between the dependent variables and the independent variables.

3.1 The Demand for Physicians' Services Per Capita (Equation 1)

The dependent variable (Q/P) is a measure of the quantity of physicians' services utilized per capita in each province each year.[3] In equation 1 it represents the quantity of physicians' services demanded. How each of the right hand side variables influences the demand for physicians' services is discussed in detail below.

The number of physicians per capita (N/P)

The physician:population ratio is a variable common to most analyses of the utilization of physicians' services. There have been several hypotheses given in the literature to describe the observed relationship between the demand for physicians' services and the physician:population ratio.

The first is consistent with neoclassical theory which states that prices adjust to insure that the supply of physicians' services equals the demand. In this case the time required to consume physicians' services is considered a price paid by the consumer. The more time required the higher the price therefore the lower the demand. An increase in the physician:population ratio will likely

result in a decrease in the patient's waiting time thereby lowering the price.

Phelps (1975) describes two types of waiting time. The first is the time spent in a queue waiting to see the doctor and the travelling time to the doctor's office. Acton (1975) confirmed that travel time (as measured by distance) functions as a price in determining the demand for free medical services. The second type of waiting time is the delay between making an appointment and the date of the appointment. Because many ailments are "self curing" (i.e. the common cold) long delays of this type will reduce the demand for physicians' services. In either case an increase in the number of doctors, ceteris paribus, should reduce both types of waiting time which should increase the demand for physicians' services.

Alternate explanations for the positive correlation between utilization and the physician:population ratio have been suggested by Feldstein (1970), Fuchs and Kramer (1972) and Evans (1974).

Feldstein, in his study of the market for physicians' services in the United States, found an increase in the physician:population ratio did not result in decreased monetary prices but in an increase in services utilized at the same price. He theorized that physicians set prices lower than market clearing levels to enable them to choose

the most interesting cases from the excess demand created by the low prices. This allows physicians opening new practices the opportunity to readily acquire patients from the excess demand. In Canada, where the consumer receives physicians' services without having to pay fees, the existence of an excess demand is easy to envision. Under these circumstances the supply of physicians is the major constraint on the utilization of physicians' services therefore, a positive correlation between the physician: population ratio and utilization is anticipated.

Fuchs and Kramer (1972) and Evans (1974) argue that, because the consumer is ignorant of what health services are available or necessary, he must depend upon the advice of his physician (his principal supplier of medical services) to determine what and how much to purchase. This places the physician in a position to generate demand for his services. If physicians can generate demand, then utilization of their services should rise as the physician: population rises. To make up for the demand lost from patients who go to doctors opening new practices, physicians can generate more demand from patients remaining in their practice. The ability of physicians to generate demand under medicare is higher than it would be under circumstances where the patient has to pay directly for physicians' services. This is because the patient under medicare does

not face any direct cost constraints for extra services and the doctor does not have to worry about the financial burden extra services would place on his patient.

Green (1978) demonstrates that empirical tests based on market data alone cannot distinguish between the various hypotheses used to explain the relationship between the demand for physicians' services and the physician: population ratio. It is likely that all three play a role in the demand for physician services. The time price may not adjust to create an equilibrium but could markedly decrease the measured effect the number of physicians has on demand (Monsma, 1970). It is likewise conceivable that physician induced demand could exist in some geographical areas, such as cities, and in some specialities, such as surgery (Fuchs, 1978) while excess demand exists in other areas and specialities.

Regardless of which or how many of these mechanisms operate it has been well established that the physician: population ratio plays an important role in the determination of the demand for physician services.

Income per capita (Y/P)

Even though there is no direct fee payment, a patient's income (Y/P) can still influence his demand for physicians' services. Income is generally thought of as an enabling variable; the higher one's income the more money one has

available to purchase goods and services (Phelps, 1975). If the consumer is not charged for the services he uses, the enabling component's influence on demand becomes limited. It can only be felt through the prices of the complements to physicians' services that are not covered by medicare. In Canada these include the cost of prescribed drugs and the cost of transportation to the physician's office.[4]

Income also has a predisposing influence on the demand for physician services (Phelps, 1975). Grossman (1972) views the utilization of physicians' services as an investment decision. He argues that high wage earners place a higher value on time than do low wage earners. Because time lost due to illness has a higher opportunity cost to the high wage earner, he will demand more physician services as a form of insurance against long term illness in the future. Opposing this hypothesis is the view that high wage earners experience higher opportunity costs for the time spent at the physician's office than do low wage earners and therefore may avoid seeing physicians. The net effect of these opposing views is unclear. In Canada, casual observation suggests a net positive correlation between income and utilization exists since many high wage earners work in settings that allow for time off with pay when obtaining physicians' services. As a result, their opportunity costs

are low.

If either the enabling or predisposing influences are present, a positive income elasticity of demand is expected.

Income could also show an influence on utilization of physicians' services because of its positive correlation with education levels attained. Grossman (1972) hypothesizes that increased knowledge allows people to combine medical services (of which physicians' services make up only a part) with other health promoting activities to produce a desired level of health which results in a lower utilization of medical services. With increased education, people become more aware of the availability and necessity of various medical services and therefore may choose different amounts and types of medical services. On a priori grounds it is unclear whether increased education will result in more or less utilization of physicians' services. Phelps (1975) found increased education led to more utilization of physicians' services but less utilization of hospital services.

Hospital beds per capita (B/P)

The ratio of hospital beds to population (B/P) can also influence the demand for physicians' services. Fuchs and Kramer (1972) argue that because some services offered by physicians can only be carried out in hospitals,

physicians' services and hospital services can to a limited extent be considered joint products. An increase in the number of hospital beds per capita, ceteris paribus, should therefore result in an increase in the utilization of physicians' services.

The degree of urbanization (PNM/P)

The degree of urbanization of a province is measured by the fraction of the population not living in Census Metropolitan Areas. The elasticity of the demand for physicians' services with respect to this fraction is expected to be negative. The less urbanized an area, ceteris paribus, the greater the distance a consumer must travel to see a physician. Increased distances mean higher costs to the consumer, therefore, all other things equal, should cause a decrease in demand. A negative elasticity of distance with respect to the utilization of physicians' services has been established by other researchers (Acton, 1975 and Russell, 1975).

The fraction of the population aged 65 years and older (P65+/P)

Statistics show that the utilization of medical services is markedly different for different age groups (Denton and Spencer, 1975). Those over sixty-five use twice as many medical services per capita as those thirty years old. To determine the effect the age composition

of the population has on the utilization of physicians' services the fraction of the population over sixty-five (P65+/P) is used as an independent variable. A positive elasticity of demand is expected.

3.2 The Supply of Services Per Physician (Equation 2)

The dependent variable (Q/N) represents the quantity of services provided per physician in each province. This variable can be interpreted as the productivity of physicians in each province.

Fuchs and Kramer (1972) consider three factors important in explaining the variations in the productivity of physicians. These are the fees paid for the services, the availability of complementary services and the physician:population ratio.

Fees for service (F)

The sign of the price elasticity of the supply of services per physician is indeterminate on a priori grounds. This price elasticity should not be confused with the price elasticity of the supply of physicians' labour as the services supplied by physicians and the hours they work are not necessarily correlated. For example, in terms of services supplied, an hour spent carrying out heart surgery is not equivalent to an hour spent carrying out a simple physical examination. Because physicians can

increase the services they supply and decrease their hours of work by providing higher quality[5] services it is possible to have a positive price (F) elasticity with respect to the physicians' supply of services and a backward bending supply of labour curve for physicians.

Likewise a negative price (F) elasticity of the supply of services could be consistent with a positively sloped supply of labour for physicians. According to Sloan (1975) this could happen if the other categories of labour present in supplying physicians' services (i.e. nurses) have a backward bending supply of labour that overrides the effect of the positive elasticity of the supply of physicians' labour.[6] Also, if as Reinhardt (1972) suggests, physicians incur "psychic costs" as they employ and supervise more personnel, an increase in fees could enable doctors to reduce their staff size to reduce these "psychic costs." This could reduce the overall services provided even if the physician increases his working hours.

From the above arguments it is clear that it is not possible to draw any definite conclusions from this study about the effect changes in fees will have on the hours worked by physicians. The results will only indicate the effect fee changes will have on the supply of services.

The number of physicians per capita (N/P)

The services provided per physician (Q/N) are expected to increase as the physician:population ratio (N/P) decreases. Fuchs and Kramer (1972) hypothesize that a physician "because of the nature of his professional training feels under some ethical and social compulsion to supply additional services even at the same rate of remuneration, when he is in an area poorly endowed with physicians" (Fuchs and Kramer, 1972, p. 26). Sloan (1975) found a negative relationship between hours/day worked and weeks/year worked by physicians and the physician: population ratio. His reasoning parallels Fuchs'.

Beds per capita (B/P)

An increase in the number of hospital beds per capita (B/P), ceteris paribus, should result in an increase in the output per physician (Q/N) for two reasons. First, as Fuchs and Kramer (1972) explain, there are certain services provided by physicians that can only be carried out in a hospital, such as most surgical procedures. An increase in the number of hospital beds should therefore result in more surgery, especially elective surgery. The second reason is that the efficiency of a physician's practice can be improved by allowing the physician to place more non ambulatory patients in one place thereby reducing his travelling time to see these patients. This

will increase the amount of time he has available to provide services.

The degree of urbanization (PNM/P)

The elasticity of the supply of services per physician with respect to fraction of the population living in non metropolitan areas is expected to be negative. This is because physicians located in rural areas will spend more time travelling to see their non ambulatory patients who are not hospitalized than would physicians in urban areas. It is also likely that there is a higher proportion of general practitioners in the rural areas. They provide less sophisticated (less expensive) services which will be reflected as a lower quantity of services provided.

The attractiveness of a province (HOTEL/P)

It is expected that physicians living in a more attractive area will provide fewer services because they will want to take advantage of the area's recreation potential. The variable HOTEL/P, a measure of the total receipts for lodgings for transients is used as a proxy for attractiveness. A negative elasticity is expected.

3.3 The Supply of Physicians Per Capita (Equation 3)

Because physicians are high income earners wherever they locate, it is expected that the living and working conditions in the various provinces play an important

role in their decisions concerning where to set up practice. In addition to the fees physicians receive for their services, several variables acting as proxies for living and working conditions are used to attempt to explain the variation in the physician:population ratios observed among the Canadian provinces.

Fees for service (F)

On a priori grounds the price elasticity, as measured by the fee index (F), of the supply of physicians per capita (N/P) is expected to be positive. An increase in fees should, ceteris paribus, result in an increase in the number of physicians practicing. The fee differentials between provinces might help to explain the differences in their physician:population ratios.

Fuchs and Kramer (1972), in their study on the market for physicians' services in the United States, considered the fees an endogeneous variable set within the framework of the model. This is justified where the consumer must pay for the services directly. In Canada, with universal medicare, the fees can be considered predetermined because they are set in advance through bilateral negotiations between the provincial governments and their respective medical associations. Ruderman (1974) describes the process as a bilateral monopoly with the provincial government the monopsonist.

The "attractiveness" variables (Y/P and HOTEL/P)

Fuchs and Kramer (1972) include income per capita (Y/P) as a proxy to measure the availability of "cultural, educational, social and recreational opportunities" (Fuchs and Kramer, 1972, p. 25). They reason that the higher the income per capita of an area the more likely these amenities will be present. Fuchs (1978) uses hotel receipts per capita as a proxy for the "attractiveness" of an area in determining the surgeon:population ratio for an area. A similar variable, HOTEL/P, measuring the total receipts per capita for lodgings from all facilities serving transients (hotels, motels, campgrounds and cabins) is used in this study. It is expected that doctors will locate in areas that most people find desirable to visit or vacation.

The degree of urbanization (PNM/P)

The physician:population ratio is generally higher in metropolitan areas not only for the amenity reasons mentioned earlier but also because medical support systems necessary for sophisticated medical procedures are more readily available. It is expected that the physician:population ratio will be higher in provinces where there is a higher percentage of people living in metropolitan areas. In this study the ratio of persons living in non metropolitan areas (population less than 100,000) to the total population

in the province (PNM/P) is used to test this hypothesis; a negative elasticity is expected. Fuchs (1978) in his study on the supply of surgeons in northeastern United States used similar variables to represent the effect of community size on the surgeon:population ratio. Benham et al (1968) used the number of persons living in centres with populations over 2,500 as a variable in their equation for the supply of physicians.

Beds per capita B/P

Fuchs argues that physicians prefer to locate in areas where more complementary services are available than in areas where fewer such services exist. The number of hospital beds per capita (B/P) is used as a proxy for the presence of complementary services, thus its elasticity is expected to be positive.

Medical school graduates per capita (MGDS/P)

The number of medical school graduates per capita (MGDS/P) could also serve as a proxy for the availability of complementary services since medical schools provide technical support for doctors as well as supplying new graduates. Although medical graduates are quite mobile upon graduation most stay in the province they trained in (Roos, 1976). For both reasons the coefficient of this variable is expected to be positive.

The utilization of physicians' services (Q/P)[7]

In his study of the market for surgery, Fuchs (1978) includes a variable measuring "potential demand" as a determinant of the surgeon:population ratio. He uses the predicted utilization of surgery, an endogeneous variable, as his measure of potential demand. The predicted utilization of physicians' services (Q/P) is used in this study to test the hypothesis that potential demand for services influence physicians location decisions. Areas that have a high per capita utilization of services should be more attractive to physicians because physicians may have fewer patients and still maintain a relatively high income. This will also enable physicians to spend more time with each patient thereby providing more thorough care lessening the chance of misdiagnosis.

Table 1 summarizes the model giving the signs expected for the coefficients to be estimated for each of the variables in the structural equations.

TABLE 1: SIGNS EXPECTED FOR THE ESTIMATED COEFFICIENTS OF THE STRUCTURAL EQUATIONS

dependent variables	explanatory variables	B/P	PNM/P	Y/P	P65+/P	F	HOTEL/P	N/P	Q/P
Q/P		+	-	+	+			+	
Q/N		+	-			?	-	-	
N/P		+	-	+		+	+		+

FOOTNOTES

Chapter III

[1]This model is similar to the model developed by Fuchs and Kramer (1972) to describe the market for physicians' services in the United States. The model could be reduced to two equations, one representing the demand for physicians' services and the other the supply of physicians' services, but valuable supply information would be lost concerning the productivity of physicians and how physicians decide where they locate their practices.

[2]Dummy variables are introduced to allow the intercept term of the regressions to vary over the cross section units (see Pindyck and Rubinfeld, 1976, pp. 202-211). The timetrend was included to pick up progressive changes over time, such as technological change.

[3]The method used to determine this variable from data is described in detail in Chapter IV. It measures the quantity of services such that the sophistication of the services provided is taken into account.

[4]The costs of prescribed drugs should be included in the model but unfortunately an adequate price could not be found. Some drug usage is covered by insurance while other drug usage is not. All drugs used in hospitals are covered by hospitalization. Drugs used by outpatients are only partially covered by medicare and this coverage varies from province to province and year to year. It is felt that because most prescription drugs are covered or subsidized the absence of this variable will not have a major effect on the regression results.

[5]Here quality relates to the sophistication of the services provided and not to how well a procedure is performed. In this context a full medical examination is considered a higher quality service than a partial exam.

[6]It is highly unlikely that the other sources of labour used in the provision of physicians' services have a backward bending supply of labour (see Sloan, 1975).

[7]Fuchs and Kramer (1972) and Evans (1972) argue that workload (Q/N) is a determinant of the supply of physicians. Regressions were run using this variable instead of the potential demand (Q/P) but were abandoned because much of the a priori reasoning was contradicted.

CHAPTER IV

THE DATA

The data used in this study are from Statistics Canada and the Department of National Health and Welfare (NHW). They are annual data for each of the provinces covering the medicare years 1971 to 1977. In some cases the data can be used directly as variables and in other cases several sets of data have to be combined to construct the desired variable. This chapter describes the variables and the data used, noting the assumptions made. The sources for the data are given in Appendix I.

4.1 The Fee Index

The fee index is a Laspeyres price index constructed by NHW from the prices paid for physicians' services by the provinces. The index has the form: $\Sigma P_t Q_{78} / \Sigma P_{71} Q_{78}$ where Q_{78} are the weights based on the services provided in 1978 and the base for the index number are the fees, P_{71}, charged in Ontario in 1971. The fee index can therefore be used to compare the fees over time and across provinces. The fee index when used in the regressions is divided by the consumer price index to obtain the fee

index in real terms.

4.2 The Quantity of Physicians' Services (Q)

The quantity of medical services (Q) is determined by dividing the total expenditures on medicare in each province by the nominal fee index for services provided by physicians.

The expenditures reported by the provinces are adjusted by NHW because some provinces charge the costs of radiology and laboratory services to medicare while others charge it to the hospitalization program. To make the data compatible interprovincially, NHW has removed the cost of radiology and laboratory services from all the expense data.

A potential problem with this expense data is that it includes the administration costs for the medicare plans as well as the payments made to doctors. Ideally, only the payments to doctors should be used to calculate the quantity of services. Fortunately the administration costs have made up a relatively constant portion of the total expenses over time and across the provinces.[1] If this is the case there should be no bias introduced in the elasticity estimates.

Dividing each province's total expenditure on physicians' services by the fee index provides an excellent

proxy for the quantity of physicians' services utilized each year in each province. The use of the fee index as the divisor adjusts the estimate of the quantity of physicians' services upwards if the quality of physicians' services increases. That is, the quantity will increase if the higher quality (complete physical examinations) services are substituted for lower quality (partial physical examinations) ones as years progress.

4.3 The Number of Physicians

The estimates of the number of physicians (N) in each province are assembled by NHW. Their estimates are based on the number of physicians who receive fee for service payments from the provincial medicare plans. Radiologists and pathologists, paid through medicare in only some of the provinces, are excluded from the estimates to insure interprovincial compatibility.

NHW further adjusted this data to obtain an estimate of the number of "full time equivalent" physicians. This is done to account for the number of part time fee for service physicians practicing.[2]

Counting only fee for service physicians creates a problem with respect to Newfoundland. In Newfoundland approximately one third of the physicians paid through medicare are paid salaries and thus are not included in

the NHW estimates. This will distort the relationships between expenses, population and the number of physicians for Newfoundland compared to other provinces where no more than ten per cent of physicians paid by medicare are salaried. For this reason the data for the province of Newfoundland are excluded from the set.

4.4 Income Per Capita

The income per capita (Y/P) variable used is the before tax income per capita for each province divided by the consumer price index.

In the supply equation income per capita is used as a proxy for the amenities available in the province. Since many amenities are paid by governments (museums, art galleries and civic centres) before tax income per capita is the appropriate proxy.

The before tax income variable is also used in the demand equation although it is not clear that this is the most appropriate income variable. If income is considered a proxy for time costs incurred obtaining physicians' services wage income should be used. If the income effect on the purchase of services complementary to physicians' services (drugs and transportation costs) is felt to be of primary importance disposable income is the appropriate variable. Any of the income variables can

serve as a proxy for education. The before tax income variable, used in the supply equation, serves as an adequate proxy for any of these income variables because either disposable income or wage income makes up the largest portion of before tax income.

4.5 The Attractiveness Variable (HOTEL/P)

The variable used to represent the attractiveness of an area is made up of the receipts for lodgings from hotels, motels, tourist homes, tourist courts, cabins, campgrounds, trailer parks and fishing and hunting camps divided by the provincial population. This is divided by the consumer price index to adjust for inflation.

The receipts are for lodgings only, they do not include food and beverage receipts because a large proportion of these receipts would come from local residents who do not live in the area for its attractiveness alone.

Receipts are superior to occupancy as a proxy for attractiveness. If there is a "shortage" of rooms the attractiveness of an area would be biased downward if occupancy is used as a proxy. Total receipts would tend to compensate for a "shortage" of rooms through higher prices resulting from the shortage.

4.6 The Consumer Price Index

The consumer price index used to adjust the nominal monetary values to real constant dollar values is the national index. It would be preferable to use price indices for each province since each province experiences different rates of inflation. Unfortunately the price indices that are available for each province are not comparable interprovincially and therefore cannot be used in a cross section analysis.

4.7 The Degree of Urbanization (PNM/P)

The fraction of the provincial population that does not live in metropolitan areas (cities of over 100,000 population) is used to measure the degree of urbanization in a province. This variable is used to indicate differences in travel times and costs for patients to see doctors in the demand equation and for doctors to visit their non ambulatory patients in the supply equations. It is a better proxy for these purposes than the population density (persons per square mile) used by Russell (1975). In Canada the travel time experienced by most patients and doctors of each province would not be reflected by density measurements as well as they would be by the degree of urbanization. This is because the large virtually uninhabited areas of

the larger provinces like Quebec, Ontario and British Columbia would obliterate the fact that over one half the population of these provinces is concentrated in large cities and therefore live very close to their physicians.

4.8 Other Variables

The number of hospital beds per capita (B/P) includes general care beds. All beds under federal jurisdiction (military, and veterans hospitals) are excluded since they are not serviced by physicians receiving medicare funds.

The other variables, the fraction of the population over 65 years of age (P65+/P) and the number of medical school graduates per capita (MGDS/P) are self explanatory.

FOOTNOTES

Chapter IV

[1]Personal communication, Mr. L.W. Rehmer, Director, Health Information Division, Policy, Planning and Information Branch, Information Systems Directorate, Health and Welfare Canada, Ottawa, Ontario.

[2]To test the effect that using the adjusted number of physicians might have on the estimates, regressions are run using both the actual number of physicians and the adjusted number of physicians for the years 1971 to 1974, a period when both sets of data are available. The estimates are very similar.

CHAPTER V

EMPIRICAL RESULTS

5.1 Estimation Procedures

Each equation of the model is estimated with all the variables (except the timetrend and dummy variables) in logarithmic form. There are several reasons for using a logarithmic model. First, many researchers in health economics use this form. Second, the estimated coefficients for the variables are elasticities and are therefore easy to interrupt. Third, the double logarithmic form allows for interaction among the explanatory variables. This is important because the impact of many of the factors that determine the utilization of physicians' services are interrelated. For instance, if physicians per capita increase one would expect a larger impact on the demand for physicians' services if income per capita is high than if it is low. The double logarithmic form will pick this up whereas the linear form will not.

The formal model as initially specified is presented below:

$$(1)\quad \ln Q/P = \ln a_o + a_1 \ln(N/P) + a_2 \ln(B/P) + a_3 \ln(Y/P) + a_4 \ln(P65+/P) + a_5 \ln(PNM/P) + a_6 gT + a_{7i} Di$$

$$(2)\quad \ln Q/N = \ln b_o + b_1 \ln(N/P) + b_2 \ln(F) + b_3 \ln(B/P) + b_4 \ln(PNM/P) + b_5 \ln(HOTEL/P)\ b_6 T + b_{7i} Di$$

$$(3)\quad \ln N/P = \ln C_o + C_1 \ln(Q/P) + C_2 \ln(F) + C_3 \ln(B/P) + C_4 \ln(PNM/P) + C_5 \ln(HOTEL/P) + C_6 \ln(MGDS/P) + C_7 \ln(Y/P) + C_8 T + C_{9i} Di$$

$$(4)\quad \ln\ Q/P = \ln(Q/N) + \ln(N/P)$$

The final model is selected from the specified model by sequentially eliminating the variables that are not statistically significant at the 5 per cent level from the ordinary least squares regressions.[1] That the OLS results are biased should not affect the selection process as the bias is mainly associated with the endogeneous variables which are not dropped from the equations.

The statistically insignificant dummy variables are eliminated first as they are a major source of the multicollinearity[2] in the model. This increases the reliability of the remaining variables without losing explanatory information. The presence of dummy variables merely confirms differences exist between the utilization of physicians' services in the provinces that are not explained by the other variables but does not explain what causes the differences.

Next the timetrend is eliminated, if it is not statistically significant. Again little explanatory information is lost by eliminating this variable.

The remaining variables that are not statistically significant are eliminated on a step by step basis by dropping the least statistically significant variable and rerunning the regression. This procedure is repeated until only variables that are statistically significant at the 5 per cent level of confidence remain.

Although the final model is selected primarily on the basis of the statistical significance of the variables, attention is also paid to multicollinearity, the $\bar{R}^2$ and to the signs of the estimated coefficients.

5.2 The Demand for Physicians' Services Per Capita

The ordinary least squares estimates for the demand equation are presented in Table 2. Equation 2A gives the estimated elasticities for the regression of the demand equation as initially specified. All the dummy variables except for Ontario's are dropped because they are not statistically significant and the regression is rerun. The result is equation 2B. The timetrend is dropped because it is not statistically significant and the regression rerun resulting in 2C. The elimination of these variables causes large shifts in

TABLE 2: REGRESSION ANALYSIS (OLS) OF THE DEMAND FOR PHYSICIANS SERVICES PER CAPITA (Q/P)

	N/P	Y/P	BED/P	PNM/P	P65+/P	t	Di	$\bar{R}^2$	HAIT
2A	0.97 (5.23)[1]	0.023 (0.26)	0.14 (1.30)	0.22 (0.85)	0.47 (1.18)	0.0026 (0.32)	Only Ont Sig	.9630	0.001 (105)[2]
2B	0.58 (6.61)	0.15 (1.50)	0.22 (3.00)	-0.15 (-2.64)	0.085 (1.35)	0.12 (1.90)	i=Ont	.9434	0.21 (28)
2C	0.60 (6.78)	0.31 (5.48)	0.15 (2.31)	-0.070 (-1.79)	0.080 (1.25)		i=Ont	.9407	1.30 (21)
2D	0.67 (9.86)	0.29 (5.33)	0.18 (3.27)	-0.038 (-1.28)			i=Ont	.9405	3.66 (15)
2E	0.70 (10.39)	0.31 (6.12)	0.16 (3.00)				i=Ont	.9395	13.14 (10)

[1] t statistics

[2] Degrees of freedom.

the estimated coefficients of the remaining variables. This is common in regression analysis where there is multicollinearity present.

The variables, the fraction of the population sixty-five and over (P65+/P) and the fraction of the population living in non metropolitan areas (PNM/P) are not statistically significant in Equation 2C. The variable, P65+/P, is dropped from 2C and the variable PNM/P is dropped from 2D. The elimination of these variables causes an increase in the estimated elasticity with respect to the physician: population from 0.60 to 0.70 level but causes only marginal shifts in the estimated elasticities of the other variables.

Equation 2E contains only statistically significant variables. With an $\bar{R}^2$ of 0.9395 this equation gives a good explanation of the variation in the demand for physicians' services. It is selected to represent the demand equation in the final model. Although the Haitovsky Statistic[3] indicates multicollinearity is present this should not be a major problem as the t ratios are high and multicollinearity does not bias the coefficients.

Each of the independent variables are now discussed comparing the elasticities estimated here with those from the literature.

The physician:population ratio (N/P)

The elasticity of demand with respect to the physician: population ratio has a positive sign for all the regressions, as was expected. The elasticities vary from 0.58 to 0.70 and are all statistically significant at the 1 per cent level for the equations that contain only statistically significant dummy variables.

Fuchs and Kramer (1972) find similar results for the physicians' services market in the United States. The elasticities they report range from 0.36 to 0.51. These results support our hypothesis that the elasticity of demand with respect to the physician:population ratio should be higher for Canada where there is universal medical coverage than the United States where there is not.

Income per capita (Y/P)

The income elasticity of demand for physicians' services is found to be positive in all the regressions run. The values range from 0.15 to 0.39 which is between the 0.04 to 0.57 range found by Fuchs and Kramer (1972). Feldstein (1971) found income elasticities ranging from -0.14 to 0.65. Phelps (1975), in a study of the effect of co-insurance on the total expenses paid for physicians' services, found an income elasticity of 0.11.

The positive income elasticities estimated in the demand equation are consistent with the a priori

specification of the model. However it is interesting to note that the estimated elasticities found for Canada are generally higher than those found by other researchers for the United States. This is not what one might expect since there is no direct income constraints on physicians' services in Canada whereas there is in the United States where universal medicare does not exist.

Hospital beds per capita (B/P)

The supply of hospital beds per capita (B/P) is found to be a statistically significant determinant of demand at the 5 per cent confidence level with an elasticity of demand ranging from 0.14 to 0.22. Fuchs and Kramer (1972) find similar results in their analysis of the physicians' services market in the United States. They report two elasticities; 0.19 and 0.25 but downplay these results in spite of the fact that their R^2 is greatly improved by the inclusion of beds per capita. Their concern is that the presence of this variable greatly reduces the magnitude and statistical significance of their price elasticity of demand. Their rationale for deleting the variable is that hospital days per capita is one of the three components they use to calculate their data set for the quantity of physicians' services variable (the dependent variable). Since there is little interstate

variation in the occupancy rates of hospital beds, hospital days per capita and hospital beds per capita are almost entirely proportional. Thus they conclude that the relationship between the number of beds and the quantity of physicians' services measured in the regressions is more statistical than causal. Excluding the variable, beds per capita, from the regression implies there is no causal relationship between quantity of services and hospital facilities available which counters their a priori arguments.

The data problem that concerned Fuchs and Kramer is not present in our data because the beds per capita variable is not used to calculate the quantity of services variable (Q/P). The beds per capita variable is therefore retained as a determinant of demand for this analysis.

The degree of urbanization (PNM/P)

The fraction of the population living in non metropolitan areas (PNM/P), introduced as a variable to act as a proxy for search and travel time to acquire physicians' services, is statistically significant in only one of the four regressions containing the variable. The high degree of correlation between the physician:population ratio (N/P) and the fraction of the population living in non metropolitan areas (PNM/P) (see Appendix B) is a

source of multicollinearity. Because both of these variables are at least in part proxies for the time price paid by consumers of physicians' services the loss of one from the final equation is not considered serious.

The fraction of the population over 65 (P65+/P)

The fraction of the population over 65 years of age (P65+/P) was not found to be a statistically significant determinant of demand in any of the regressions run. Fuchs and Kramer report similar results in their study.

Most micro studies, however, have established beyond doubt that the elderly consume more health services than the rest of the population. It is possible that the effect of this variable is lost because of a lack of variation in data for this variable. Its elimination from the regressions does not markedly affect the magnitude of any of the other elasticity estimates.

5.3 The Supply of Services Per Physician (Equation 2)

The ordinary least squares results for the regressions of this equation are given in Table 3. The statistically insignificant dummy variables are eliminated in two steps as can be seen from Equations 3A and 3B. The timetrend is not statistically significant in Equation 3C and is dropped. As was the case with Equation 1 the removal of these variables has a considerable impact on the estimates

TABLE 3: REGRESSION ANALYSIS (OLS) OF THE SUPPLY OF SERVICES PER PHYSICIAN (Q/N)

	N/P	F	B/P	PNM/P	HOTEL/P	t	Di	$\bar{R}^2$	HAIT
3A	-0.24 (-1.62)[1]	-0.41 (.80)	0.21 (2.48)	0.43 (2.06)	-0.078 (-1.22)	0.016 (1.53)	Only NS,NB PEI, ONT, SASK Sig	.8710	0.0000 (105)[2]
3B	-0.12 (-1.41)	-0.30 (-3.85)	0.10 (1.62)	0.23 (1.14)	0.0097 (0.32)	0.0028 (0.56)	i=NS, NB,PEI, ONT, SASK Only NS&ONT Sig	.8559	0.0002 (66)
3C	-0.11 (-1.56)	-0.30 (-3.64)	0.30 (7.43)	-0.14 (-3.93)	-0.037 (-1.49)	0.0086 (1.56)	i=NS &ONT	.8169	0.3927 (36)
3D	-0.10 (-1.44)	-0.42 (-8.61)	0.29 (7.20)	-0.16 (-4.42)	-0.010 (-0.55)		i=NS& ONT	.8333	2.63 (28)
3E	-0.14 (-3.19)	-0.42 (-8.87)	0.29 (7.22)	-0.16 (-6.39)			i=NS& ONT	.8144	7.9322 (21)

[1] t statistics
[2] Degrees of freedom.

of the remaining elasticities. In Equation 3D the only estimate that is not statistically significant is for the variable representing the "attractiveness" of a province (HOTEL/P). It is dropped with little effect on the remaining coefficients. Equation 3E has only statistically significant variables remaining. It does a "fair job" of explaining the variation in physician productivity with an $\bar{R}^2$ of 0.8144. Again it is likely multicollinearity exists but because the t ratios for the coefficients in 3E are high, it is not felt to be a major problem. All the signs of the estimated coefficients concur with our a priori reasoning. Equation 3E is therefore selected for the final model.

We now turn to a discussion of each of the independent variables in this equation.

The physician:population ratio (N/P)

The elasticity of the supply of services per physician (Q/N) with respect to the physician:population ratio (N/P) has the expected negative sign for all the regressions run. The elasticity is statistically significant at the 5 per cent level in only one of the five regressions. It is however quite stable ranging from -0.14 to -0.10, when considering only those equations containing statistically significant dummy variables.

Fuchs and Kramer's results for the United States have somewhat larger elasticities in absolute terms, ranging from -0.67 to -0.49. All other things equal, it is not surprising that the results for Canada show a lower elasticity (in absolute terms) than those found for the United States. Because of medicare, physician induced demand should be more prevalent in Canada thus the workload per physician should on a priori grounds be reduced less by an increase in the physician:population ratio.

The fee index (F)

The price (F) elasticity of the supply of services per physician is negative and statistically significant at the 5 per cent level in all the equations tested. The elasticities measured are very stable varying from -0.42 to -0.30. This indicates fee increases, ceteris paribus, result in decreased output of services per physician.

Fuchs and Kramer (1972) and Feldstein (1971) also find negative price elasticities in their studies on the market for physicians' services in the United States. Both studies use the average price per service consumed as their price variable and not a fee index as used in this study. Sloan (1975), finds a positive price elasticity for the hours a physician worked in the United States. He attempts to reconcile these different findings but cannot resolve the differences to his satisfaction.

He concludes the calculated average price used by Feldstein and Fuchs are incorrect.

Although the negative elasticities obtained for Canada lend support to Fuchs and Kramer's and Feldstein's findings, the support is not conclusive. This is because the fee index used represents the price paid for a specific bundle of services in each province each year not the average price paid per service consumed. This difference can be illustrated with evidence from Quebec. In Quebec between 1971 and 1975 there was a 1.5 per cent increase per year in the average price per service consumed. During this period, however, the fee index did not change. The increase in average price per service consumed was caused by physicians substituting more expensive services for the less expensive ones as the years progressed. Similar results were found for British Columbia, Alberta, Saskatchewan, Manitoba and Nova Scotia (Soderstrom L., 1978, p. 249). While the fee index, in real terms, was decreasing in Canada from 1971 to 1977 it is likely the real average price received per service consumed increased. It is therefore conceivable to obtain positive price elasticities using the average price per service consumed while observing negative elasticities when the fee index is used as the price. For this reason the negative elasticity obtained in this study using the fee index does

not give conclusive support to the Feldstein and Fuchs and Kramer findings.

Hospital beds per capita (B/P)

The elasticity of the supply of services per physician with respect to the number of hospital beds per capita (B/P) is found to be positive and statistically significant in all the regressions run. The estimated elasticities are between 0.29 and 0.31 for the equations where the insignificant dummy variables are removed. Fuchs and Kramer find this variable not to be statistically significant at the 5 per cent level for their analysis of the United States market, but their elasticities, 0.25 and 0.26, are near those found for Canada. These consistent results support the hypothesis that hospitals supply services that improve the productivity of physicians.

The degree of urbanization (PNM/P)

The elasticity of the supply of services per physician with respect to the fraction of the population living in non metropolitan areas (PNM/P) is negative as expected for all of the regressions from which the statistically insignificant dummy variables have been removed. These estimates range from -0.16 to -0.11 and are all statistically significant at the 5 per cent level. The significance of this variable lends support to the

hypothesis that physicians spend more time travelling and hence are less productive in rural areas.

The attractiveness variable (HOTEL/P)

The attractiveness of an area, measured by the hotel receipts per capita (HOTEL/P), does not seem to affect the productivity (Q/N) of physicians. Most of the elasticities have the predicted negative sign that indicate physicians choose to work less in areas that have high recreational potential but none of these elasticities are statistically significant at the 5 per cent level.

5.4 The Supply of Physicians Per Capita (Equation 3)

The ordinary least squares results for the regressions of the equation representing the supply of physicians are presented in Table 4. In regression 4A all of the dummy variables are statistically insignificant at the 5 per cent level except those for Ontario and Alberta. With the statistically insignificant dummy variables dropped, the timetrend remains statistically significant in regression 4B. The least significant of the remaining variables, income per capita (Y/P) is dropped. In 4C the timetrend has become statistically insignificant therefore it is dropped. In regression 4D , the fraction of the population living in non metropolitan areas, remains statistically insignificant and is eliminated leaving

TABLE 4: REGRESSION ANALYSIS (OLS) OF THE SUPPLY OF PHYSICIANS PER CAPITA (N/P)

	Q/P	F	B/P	HOTEL/P	MDGD/P	PNM/P	Y/P	t	Di	$\bar{R}^2$	HAIT
4A	0.42 (4.32)[1]	0.017 (0.20)	-0.006 (-1.37)	0.00086 (0.015)	-0.017 (-0.99)	-0.24 (-1.38)	0.052 (0.77)	-.014 (2.74)	ONT& ALT Sig	.9824	0.0000 (136)[2]
4B	0.60 (7.64)	0.16 (2.24)	-0.14 (-2.70)	0.14 (6.20)	0.030 (6.88)	-0.078 (-1.69)	-0.11 (-1.61)	0.011 (2.02)	i=ALT &ONT	.9730	0.0076 (85)
4C	0.57 (7.36)	0.14 (2.01)	-0.19 (-4.31)	0.15 (6.29)	0.929 (6.59)	-0.044 (-1.06)		0.0045 (1.22)	i=ALT &ONT	.9722	0.1195 (45)
4D	0.61 (8.69)	0.10 (1.59)	-0.21 (-5.04)	0.16 (6.70)	0.028 (6.45)	-0.034 (-0.85)			i=ALTA &ONT	.9720	0.5340 (36)
4E	0.66[2] (20.3)	0.14 (3.66)	-0.23 (-7.28)	0.14 (9.45)	0.026 (6.51)				i=ALTA &ONT	.9721	8.86 (28)

[1] t statistics

[2] Degrees of Freedom.

regression 4E containing only statistically significant variables.

The Haitivosky Statistic for equation 4E indicates the presence of multicollinearity but again the high t ratios for all the coefficients in the equation indicate multicollinearity is not a major problem. Regression 4E has an $\bar{R}^2$ of 0.9721 indicating it does an excellent job of explaining the variation in the physician:population ratio. All the estimated coefficients have the signs anticipated by a priori reasoning except for the variable beds per capita (B/P). Despite this, the variable has a high statistical significance in all the regressions run except in 4A. It does not have a strong simple correlation (see Appendix B) with any of the other variables thus is not likely acting as a proxy for one of the eliminated variables. Equation 4E, which includes the variable beds per capita is selected for the final model; our a priori reasoning for the sign of this variable is reconsidered in the following discussion of the variables.

The potential demand (Q/P)

The elasticities of the supply of physicians with respect to the demand for services ranged from 0.57 to 0.66 and are statistically significant at the one per cent level when the regressions include only statistically

significant dummy variables. This indicates per capita demand plays an important role in determining where physicians locate in Canada.

Fuchs (1978) used a similar variable for his analysis of the distribution of surgeons in the United States but did not find it to be statistically significant. The reason for this may be that most surgeons provide services other than surgery, thus the "potential demand" for surgery alone may be too restrictive a demand variable for surgeons to base location decisions upon.

The fee index (F)

The estimated elasticities of the supply of physicians per capita (N/P) with respect to fees (F) are positive for all the regressions. For the regressions containing only statistically significant dummies, the elasticities vary from 0.18 to 0.24, indicating higher fees attract physicians. These elasticities are much lower than those found by Fuchs and Kramer (1972) for physicians in the United States. Their price elasticities ranged from 0.75 to 1.14 with only the largest being statistically significant. It should be noted that Fuchs and Kramer used the calculated average price per service in his estimate while this study uses the fee index. As noted earlier the average price per service consumed in Canada rose faster than the fee index, therefore the elasticity

associated with the average price of services consumed would be even smaller for Canada, all other things being equal.

Beds per capita (B/P)

The elasticity estimated for the number of physicians per capita with respect to hospital beds per capita is negative, the opposite of that expected. Hospital beds are considered complements to supplying physicians' services thus their presence is expected to attract physicians. This view is supported by the result described in section 5.3 that suggests physician productivity increases with an increase in the number of hospital beds per capita.

However it is also likely that hospital beds or hospitals with their emergency care units, residents and interns also act as a substitute for some physicians' services especially those of general practitioners. Hospital beds can thus be complements for some services, such as the more complex ones provided by specialists while being substitutes for other services, such as those provided by general practitioners. With the highly aggregaged data used in this analysis it is possible for hospital beds per capita to be a net complement for services provided per capita and per physician while being a net substitute for physicians. In Canada ten years of free hospital

services in the pre medicare years may have trained Canadians to seek hospital services as a substitute for the then non free service of general practitioners.

If this is the case then most physicians may well avoid areas, ceteris paribus, that have an abundance of hospital services.

The attractiveness variable (HOTEL/P)

The elasticity with respect to the hotel receipts per capita (HOTEL/P) indicates that physicians prefer to live in attractive areas. The elasticities measured are very stable when the statistically insignificant dummy variables are removed. The values range from 0.09 to 0.12. Fuchs' (1978) results for surgeons were very similar ranging from 0.12 to 0.27.

The number of medical school graduates per capita (MGDS/P)

The elasticity of the supply of physicians per capita with respect to the number of medical school graduates per capita is positive for all the regressions that include only statistically significant dummy variables. The values of these elasticities range from 0.025 to 0.029. Benham et al. (1968), using a similar variable found elasticities for the supply of self employed physicians with respect to the number of places for medical students to range from 0.04 to 0.05. The positive elasticities could be

attributed to the hypothesis that graduates tend to remain in the province they trained in and/or the hypothesis that medical teaching facilities provide complementary services for physicians. Using the number of medical schools as a variable Fuchs and Kramer (1972) take the latter view and find that the coefficients for this variable range from 0.027 to 0.059.

The urbanization variable (PNM/P)

The estimated elasticities for the physician: population ratio (N/P) with respect to the fraction of the population living in non metropolitan areas (PNM/P), although consistently having the anticipated sign, are not statistically significant. Benham et al (1968) however, did find the fraction of people living in metropolitan areas to be statistically significant in his study of the market for physician services in the United States.

The statistical insignificance of this variable in our analysis could be a result of multicollinearity as the fraction of persons living in non metropolitan areas is highly correlated with the utilization of physicians' services (Q/P) (see Appendix B). It is possible that the utilization of physicians' services (Q/P) is "picking up" the information that should be supplied by the urbanization variable. This could result in an inflated estimate for the "potential demand" variable. Even though the

urbanization variable is eliminated from the final form of this equation it is possible that it is an important determinant of the supply of physicians.

Income per capita (Y/P)

Fuchs and Kramer (1972) find statistically significant elasticities for the physician:population ratio (N/P) with respect to the income per capita (Y/P), varying from 0.49 to 0.76. Their study confirms that income per capita plays a significant role in the location decisions of physicians in the United States.

The same cannot be said for Canada judging from the results of this study. The elasticities for Canada are, for the most part, negative, and are never statistically significant, even at the 10 per cent level.

One explanation for this difference in results is that income per capita has more influence on the location decisions of physicians who depend on their patients for payment of fees than it does on the location decisions of physicians who do not. In Canada, under medicare, payments are paid by the government therefore the patient's ability to pay is of little consequence to the physician; in the United States without universal medicare the physician is more dependent upon the patient's ability to pay.

5.5 The Final Specification of the Model

The final specification of the model, drawn from the ordinary least squares regressions of Tables 2, 3, and 4 is presented below.

(1) $\ln(Q/P) = \ln a_o + a_1(N/P) + a_2\ln(Q/P) + a_3\ln(Y/P) + a_4 Dont$

(2) $\ln(Q/N) = \ln b_o + b_1\ln(N/P) + b_2\ln(B/P) + b_3\ln(F) + b_4\ln(PNM/P) + b_5 Dont + b_6 Dns$

(3) $\ln(N/P) = \ln c_o + c_1\ln(Q/P) + c_2\ln(B/P) + c_3\ln(F) + c_4\ln(HOTEL/P) + c_5\ln(MGDS/P) + c_6 Dont + c_7 Dalta$

(4) $\ln(Q/P) = \ln(N/P) + \ln(Q/N)$

Because equations 1 and 3 are a simultaneous system two stage least squares is used to eliminate any simultaneous equation bias present in the ordinary least squares estimates. The recursive nature of the model guarantees that ordinary least squares is an unbiased estimator of equation 2. The estimated coefficients for the final model are presented in Table 5. Note that the two stage least squares results are very similar to the ordinary least squares results.

There is therefore no need to discuss the parameter estimates of the final model.

TABLE 5: THE FINAL MODEL

dependent variables	explanatory variables	F	PNM/P	Y/P	HOTEL/P	MGDS/P	B/P	N/P	Q/P	$\bar{R}^2$
Q/P[1]		-	-	0.35 (0.055)[3]	-	-	0.13 (0.057)	0.64 (0.07)	-	.9388
Q/N[2]		-0.42 (0.048)	-0.16 (0.027)	-	-	-	0.29 (0.041)	-0.14 (0.046)	-	.8143
N/P[1]		0.14 (0.039)	-	-	0.14 (0.015)	0.026 (0.0042)	-0.28 0.032	-	0.67 (0.036)	.9720

[1] 2SLS estimator.

[2] OLS estimator.

[3] Bracketed terms are standard errors.

5.6 The Reduced Form Equations

It is possible to obtain reduced form equations from the structural equations. The reduced form coefficients, calculated from the estimated coefficients of the structural equations,[5] take into account the interactions of the endogeneous variables in the structural model. This results in coefficients that give the ultimate impact a change in an exogeneous variable has on each of the endogeneous variables.

Caution must always be taken when making use of reduced form coefficients. Unlike structural equations where each equation, for the most part, stands on its own, the reduced form equations are highly dependent on the soundness of the model as a whole. If the model is misspecified or there is a flaw in any of the structural equations the error will likely be transmitted to all the reduced form coefficients.

Table 6 gives the reduced form coefficients, which are elasticities, as calculated from the final model of Section 5.5. The elasticities can be read as follows. For example, if there is a 1 per cent change in medical graduates per capita (MGDS/P) the utilization of physicians' services (Q/P) will rise by 0.028 per cent, the productivity of

TABLE 6: REDUCED FORM EQUATIONS (COEFFICIENTS ARE ELASTICITIES)

dependent variables	exogeneous variables	F	PNM/P	Y/P	HOTEL/P	MGDS/P	B/P
Q/P		0.16	0	0.61	0.16	0.028	-0.03
Q/N		-0.45	-0.16	-0.056	-0.04	-0.006	0.33
N/P		0.25	0	0.41	0.25	0.040	-0.24

physicians (Q/N) will decrease by 0.006 per cent and the physician:population ratio (N/P) will increase by 0.040 per cent.

The structural equations in section 5.5 explain why an increase in medical school graduates has these effects on demand (Q/P), productivity (Q/N) and the physician population ratio (N/P). An increase in the number of medical school graduates will directly increase the physician: population ratio (see equation 4E) but will not directly affect the productivity of physicians or the demand for their services. The resulting increase in the physician: population ratio does however affect both the productivity of physicians and the demand for their services. The increase in demand in turn increases the supply of physicians. These interactions continue until an equilibrium is reached. The reduced form coefficients measure the effect a change in any exogeneous variable will have on each endogeneous variable when equilibrium is reached.

The dependent or endogeneous variables of the reduced form equations trace out the paths of the equilibrium points of these variables. This leads to a rather unique situation in the case of our model as the dependent variables are related to each other by an identity. The sum of the logarithims of physician productivity (Q/N) and the physician:population ratio (N/P) equals the logarithim of

the utilization per capita (Q/P) at equilibrium. This being the case the sum of the reduced form elasticities for each exogeneous variable in the productivity (Q/N) and physician:population ratio (N/P) equations should equal the elasticity for like variables in the utilization per capita (Q/P) equation.

This is not the case for most of the elasticities in Table 6. For example, if there was a one per cent increase in the ratio of the population living in non metropolitan areas (PNM/P) the elasticities given in Table 6 show there is no change in the utilization per capita (Q/P), a 0.16 per cent decrease in physician productivity and no change in the physician:population ratio (N/P). Of the six exogeneous variables only two (HOTEL/P and MGDS/P) have elasticities in the productivity equation (Q/N) and physician:population ratio (N/P) that sum close to the elasticities for these variables in the utilization (Q/P) equation. The elasticities for the reduced form equations indicate that there is room for improvement in the model. Unfortunately they cannot point to the source of the problems in the structural model.

FOOTNOTES

Chapter V

[1]Ordinary least squares estimates are biased in Equations 1 and 3 because the endogeneous variables are used as regressors. However, it is felt the bias is not great enough to affect the selection process. The advantage of using ordinary least squares is that the Haitovsky Statistic and the t-statistics are available in the computer package program used (SHAZAM). These statistics are important in selecting the final equation.

[2]Multicollinearity results from a near linear relationship between two or more of the independent variables. The estimates of the coefficients remain unbiased but are unreliable. Intriligator states, "if the model reflects only ad hoc and causal reasoning as to which variables might be considered relevant then it might be appropriate to change the specification" (Intiligator, 1978, p. 155) to remove the multicollinearity. This procedure was followed. For an excellent discussion of the problem of multicollinearity see Farrer D.E. and P.R. Glauber (1967).

[3]The Haitovsky Statistic was developed to test for the presence of multicollinearity. It has a chi squared distribution where values less than the critical value indicate multicollinearity is present (see Haitovsky, 1969).

[4]Simultaneous equation bias occurs when endogeneous variables are used as regressors. The endogeneous regressors are correlated with the error term. This bias is removed from the final equation by using two stage least squares. This procedure is described in Pindyck and Rubinfeld (1976, pp. 276-278).

[5]In matrix form the structural equations are:

$By + Gx = u$

where B = matrix of cofficients for the endogeneous variables

G = matrix of coefficients for the exogeneous

y = vector of endogeneous variables

x = vector of exogeneous variables

u = vector of random error terms

The structural equations are transformed to the reduced form equations as follows:

$y = B^{-1}Gx + B^{-1}u$

where $B^{-1}G$ = matrix of reduced form coefficients.

CHAPTER VI

POLICY IMPLICATION

This study provides some insight into the market for physicians' services in Canada under the medicare system by suggesting the important parameters that determine the supply of and demand for physicians' services. The results of the study also suggest what the possible consequences of policy actions of governments, such as adjusting for fee schedules, might be.

The aging of the population in Canada is considered a major source of the observed increase in the use of physicians' services. There is statistical evidence to confirm that the elderly use more physicians' services than the general population. Surprisingly this study does not find this variable to be statistically significant in the demand equation. One possible reason for this is the high degree of correlation between the age variable and the beds per capita variable ($r=0.44$). If the beds per capita variable is picking up some of the effect of the age variable one would expect the coefficient of the beds per capita variable to increase when the age variable is removed. This is in fact what happens (see equations 2C and 2D).

The physician:population ratio has long been considered an important determinant of the demand for physicians' services; this study shows it to be the major determinant of demand under Canada's medicare system. From 1971 to 1977 the per capita utilization of physicians' services has risen by 24 per cent while the physician:population ratio has risen by 25 per cent. By multiplying the estimated elasticity of demand with respect to the physician:population ratio (0.64) by the per cent change in the physician:population ratio for the period 1971 to 1977 (25 per cent) the rise in utilization resulting from the increase in the physician:population ratio can be estimated to be 16 per cent. This implies the rise in the physician:population ratio alone accounts for two thirds of the total observed rise in utilization of physicians' services in Canada between 1971 and 1977. The model cannot determine whether this increase is desirable or not but it does indicate that the growth in the number of physicians has been the major source of the increase in the per capita utilization of physicians' services. This suggests the most straightforward way to control the growth in physicians' services is to control the number of physicians.

The fee for service variable is of considerable interest because fees play an important role in determining

the amount of services provided by physicians. Under medicare fee rates are directly under the control of governments. It is therefore important that governments understand what impact a change in fees has on the market for physicians' services. This study provides some of this information. From the structural equations the elasticity of physician productivity with respect to fees is -0.42. This indicates that for every 10 per cent increase in fees there will be approximately a 4 per cent decrease in productivity per physician. The elasticity of the physician:population ratio with respect to fees indicate a 10 per cent rise in fees will increase the physician:population ratio by about 1.5 per cent. These results suggest that fee increases could actually reduce the total supply of services. The reduced form equations however suggest the ultimate outcome of a 10 per cent fee increase is a 1.6 per cent increase in per capita utilization.

These results allow us to speculate on two areas of concern. The first deals with an often stated goal of physicians, that they wish to maintain their relative income position with respect to the rest of the population. If, as this study indicates, physicians reduce their work-loads as real fees rise then it is clear that their fees will have to increase faster than the pay rates of the general population if they are to maintain their relative

income level.

These results also warn about the possible success of increasing the services available in underserviced rural areas by having higher fee schedules in these areas relative to the better serviced urban areas. The increase in services due to the increased number of physicians attracted by the higher fees may be counterbalanced by the decrease in output of each physician. Unfortunately the results of this study are not directly applicable to the problem of servicing remote areas because the data used are too highly aggregated. Nevertheless, the results do point out a potential problem in attempting to achieve the goal of equal access to physicians' services by applying higher fee schedules to physicians in rural areas.

CHAPTER VII

SUMMARY AND CONCLUSIONS

In this thesis a simple three equation model of the market for physicians' services in Canada is developed and estimated using two stage least squares and cross section time series data for nine of the ten Canadian provinces for the period 1971 to 1977. It is found that 94 per cent of the variation in the demand for physicians services can be explained by regressing demand on three variables; the physician population ratio, the number of hospital beds per capita and the personal income per capita. Of these three variables a change in the number of physicians per capita has the greatest impact on per capita demand and a change in beds per capita has the smallest effect.

With respect to the services supplied per physician 81 per cent of the observed variation can be explained by regressing this variable on four variables; the physician: population ratio, the fee index, the fraction of the population living in non metroplitan areas and the number of hospital beds per capita. An increase in the number of beds per capita is found to increase the productivity

of physicians whereas increases in the other three variables decrease physician productivity. Of these three an increase in fees has the largest (negative) impact on the productivity of physicians.

In the third equation of the model five variables explain 97 per cent of the variation in the physician: population ratio observed in the Canadian provinces from 1971 to 1977. Increases in the potential demand per capita, the fee index, the "attractiveness" of a province and the number of medical school graduates per capita all result in increases in the physician:population ratio with the potential demand by far having the greatest impact. An increase in the number of hospital beds per capita is found to result in a decrease in the number of physicians per capita.

Of the six exogeneous variables in the model three can be considered policy variables under the control of the government health authorities. These are the fees, the number of beds per capita and the number of medical school graduates per capita. The model indicates an increase in fees will result in a substantial decrease in the amount of services supplied per physician while increasing the per capita supply of physicians. The reduced form equations further indicate increased fees will indirectly result in an increase in per capita

demand for physicians' services.

The model predicts an increase in the number of medical school graduates per capita results in an increase in the number of physicians per capita. The reduced form equations indicate an increase in the number of medical school graduates ultimately and indirectly results in a slight decrease in physician productivity while increasing per capita demand.

If the number of beds per capita are increased the physician:population ratio will likely decline while physician productivity increases. The direct impact of an increase in the number of beds on the per capita demand for physicians services is found to be positive but the reduced form equations indicate a slight negative impact ultimately occurs indirectly through the decline in physician productivity.

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APPENDIX A

Sources of Data

Number of physicians	Unpublished data, Policy, Planning and Information Systems Directorate, Health and Welfare Canada, Ottawa, Ontario, K1A 1B4
Expenditure for Medicare	Unpublished data, Policy, Planning and Information Systems Directorate, Health and Welfare Canada, Ottawa, Ontario, K1A 1B4
Fee index	Unpublished data, Policy, Planning and Information Systems Directorate, Health and Welfare Canada, Ottawa, Ontario, K1A 1B4
Population	Estimates of Population by Age and Sex, Statistics Canada, Cat. 91-202
Personal income	National Income and Expenditure Accounts, Statistics Canada, Cat. 13-201
Medical doctor graduates	Education in Canada, Statistics Canada, Cat. 81-229
Hospital beds	List of Canadian Hospitals, Statistics Canada, Cat. 83-201
Receipts for Rooms	Traveller Accommodation Statistics, Statistics Canada, Cat. 63-204
Consumer price index	Economic Review, 1978 Department of Finance
Urbanization variable	Estimates of Population for the Census Metropolitan Areas of Canada, Statistics Canada, Cat 91-207

APPENDIX B

Simple Correlation Coefficient Matrix

SIMPLE CORRELATION COEFFICIENT MATRIX

	Q/P	Q/N	N/P	Y/P	B/P	F	PNM/P	HOTEL/P	MGDS/P	P65+/P
Q/P	1.00									
Q/N	0.37	1.00								
N/P	0.90	-0.08	1.00							
Y/P	0.90	0.44	0.75	1.00						
B/P	-0.30	0.41	-0.52	-0.15	1.00					
F	0.02	-0.48	0.25	-0.06	-0.29	1.00				
PNM/P	-0.77	-0.15	-0.75	-0.59	0.53	-0.44	1.00			
HOTEL/P	0.25	-0.30	0.41	0.24	0.02	0.26	-0.01	1.00		
MGDS/P	0.58	-0.11	0.68	0.52	-0.40	0.26	-0.65	-0.03	1.00	
P65+/P	-0.12	-0.01	-0.13	-0.21	0.44	-0.40	0.55	0.11	-0.25	1.00

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AN ECONOMETRIC MODEL OF PHYSICIANS' SERVICES IN CANADA

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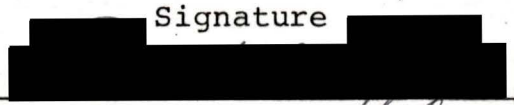

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