FAMILY PHYSICIAN WORK FORCE PROJECTIONS

IN SASKATCHEWAN

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By

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ABSTRACT

This thesis applies the econometric projection approach to forecast the numbers of general practitioners (GPs) in Saskatchewan for the next 15 years at both provincial and the Regional Health Authorities (RHAs) levels. The projection results will provide the estimated level of GPs up to 2021 for policy makers to adjust their decision on health professionals' planning.

Three hypothesized scenarios, which include the changes in population proportion, average income for GPs and a combination of both, are used for projections based on the regression results. The projections suggest a 4.34% expected annual increase of GPs if the proportions of children and seniors increase or decrease according to prediction for the next 15 years for Saskatchewan. At the RHAs level, 4.5% to 10.7% expected annual rate of increase for numbers of GPs is projected for the northern RHAs and Saskatoon RHA, while the expected increase for other urban RHAs will experience less than 1.5% increases.

The predicted changes in average income for GPs show insignificant effect for the expected changes in numbers of GPs. However, the second and third scenarios are not extended to the RHAs level due to lack of information, which requires additional data for both Saskatchewan physicians and population for further projection analysis.

DEDICATION

Without my parents, Mr. Kai Yin Lam and Mrs. Wei Kau Yu, and all my family members' actuation, I would not be able to finish this thesis. I would like to gratefully appreciate the supports and encouragements, both mentally and financially, from all of them.

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CHAPTER 1

INTRODUCTION

Perceived physician shortage creates significant public concerns in different

communities across Canada. These worries come not only from the patients, but also

from the physicians, policy makers and even researchers with their different arguments

on the physician shortage. Some researchers argued that there is an over-supply of

physicians in Canada (Hall, 1980). However, the College of Family Physicians of Canada

(CFPC) and the Canadian Institute for Health Information (CIHI) warned with their

investigations and survey data that number of practicing physicians are largely below the

actual needs of the population. Moreover, the self-reported unmet health care needs in

2000-2001 reached 12.5 %, which is doubled in Canada within two years and was three

times higher than the 1994-1995 number for Saskatchewan (HSURC, 2002; Statistic

Canada, 2002). These investigations and survey data influence not only the perception of

the public but also the decision of policy markers and thus, there is a need for further

investigation for the balance between physician demand and supply at all levels. This

thesis is an attempt to provide further information on human resource need in

Saskatchewan physician market.

1.1 Overall Trend in Canada and Saskatchewan

Healthcare expenditures in Saskatchewan for all sources have continued to increase

since 1990. By increasing $37.7 million over the last year, Medical Service Plan (MSP)

payments reached to $534 million in 2005-2006. On average, payment per general

practitioner (GP) increased from $191,300 in 2000-2001 to $ 234,200 in 2005-2006, an

average of 4.16 % change annually (Saskatchewan Health, 2002; 2006). The same trend

was also observed for the number of general practitioners (GPs) in Saskatchewan. There was an overall 6.1 % increase for the ratio of family physicians per 100,000 populations in Saskatchewan between 1996 and 2000 (CIHI, 2001). Total number of GPs increased from 693 in 2000-2001 to 767 in 2005-2006. Except for the period of 2004-2005, more than 60 % of this increase was contributed by international medical graduates (IMGs) (Saskatchewan Health, 2006).

Although there was an increase in the number of GPs in healthcare markets, significant number of Canadians reported that they do not have family physicians. According to the survey conducted by the CFPC in October 2005, 15 %, almost 4.8 million adult Canadians reported not having a family physician. This is a 0.6 million increase compared to the 2004 survey (CFPC, 2004; 2005). This significant number of unmet health care needs suggests that it is important for policy makers to have a projection for the need for family physicians in Saskatchewan.

However, studies on health human research made limited progress on developing the model for forecasting and they are not as accurate as proved (O'Brien-Pallas et al., 2001). Likewise, not many of them are focusing on the prairie, which is characterized with low population growth, short life span, large scale of health personnel, aging and numerous amounts of aboriginal residents (HSURC, 2002).

According to the Health Services Utilization and Research Commission (2002), Saskatchewan is characterized by large scale of senior population where 14.6 % of the Saskatchewan residents aged 65 or older compared to 12.6 % on average of Canadians, and in 2004, number of seniors rise up to 14.8 % of the Saskatchewan population (Saskatchewan Health, 2006). At the same time, the smoking rate and obesity rate are higher than the Canadian average and the obesity rate has increased at a faster rate than that of the other provinces. A large population of aboriginals also creates the unique feature in Saskatchewan. Aboriginals accounted for 11.4 % of the Saskatchewan

population in 1996 and 13.6% in 2001 (Statistic Canada 2001) compared to 2.8 % across

Canada. The life expectancy of aboriginals are about 5 to 6 years shorter than the

Canadian average, which lower the Saskatchewan life span to the below Canada average

level (HSURC, 2002). These factors create pressure for the medical resources and

indicate a foreseeable growth in needs for health care resources. With these particular

prairie health features, attention should be drawn on how health resources, especially

health personnel should be allocated in Saskatchewan.

However, with the lack of human resource studies on the prairie and the need for

clarifying the balance between the unmet health care needs and the resources invested,

there is an urge for the human resource study on the Saskatchewan health care market.

Therefore, in order to provide an insight for human resource planning for Saskatchewan

healthcare market, this thesis concentrates on regional health authorities (RHAs) with

similar nature and attempts to predict the number of family physicians required for each

health regions in Saskatchewan

1.2   Recent Changes in the Saskatchewan Health Care System

Before the year 1993, Saskatchewan health care services were managed by more

than 400 boards, of which, each was responsible for a single health facility such as a

hospital, nursing home, home care or ambulance service. Subsequently, inefficiency of

medical service delivery and lack of service co-ordination across service providers, led to

a decision of integration of these health boards. As a result, 32 district health boards and

one health authority, the Athabasca regional health authority, were created in 1993.

Due to persistence of these issues, the new health action plan, released in December

2001 and the Regional Health Services Act, proclaimed on August 1, 2002 provided a

new wave of health care reform in Saskatchewan. The new health action plan launched

the 24-hour toll-free health advice telephone line, established the Health Quality Council

and introduced the new 12 RHAs with their responsibilities outlined (see Figure A1 in Appendix for the map of the 12 RHAs in Saskatchewan). These 12 new RHAs replaced the previous 32 health districts of Saskatchewan to reduce duplication of health services delivery and to strengthen the provincial network between communities and health service providers (Saskatchewan Health, 2007).

Despite the continuation of the health structure reform, there are assertions of physician shortages across Canada and Saskatchewan. According to the 2002 report from the CIHI, the overall 5% decrease in physician supply since 1993 was caused mainly by longer duration of postgraduate training required for physicians who want to do family practice. The decrease in number of international medical graduates (IMGs) in Canada and the high retirements account for a significant proportion of the decrease in physician supply. Meanwhile, the reduction of medical school admission was not crucial for the decline but was believed to take place in the near future (CIHI, 2002).

Furthermore, results of the 2004 National Physician Survey (NPS) concluded two major impacts of the changes on overall Canadian health care sector as reported by the CFPC (CFPC, Oct 2004). The survey found out that retirement rate would be more than twice to the current rate with approximately 3,800 physicians reaching their retirement age and that they are planning to retire within two years. The survey also showed that more female than male medical students are graduated from the medical school and entered the health care market. Despite their domination in health industry, the survey pointed out that female physicians work about seven hours less in a week than their male counterparts due to additional family responsibilities. Moreover, more attractive immigration and residency program offering in the U.S. worsen the physician shortage situation. There are more overseas physicians leaving to the U.S. for practice because of the relatively shorter waiting period required for credential assessment and plainer immigration processes (Phillips et al., 2007). All these changes also support the need for

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GP study in Saskatchewan health care market.

CHAPTER 2

CONCEPTUAL FRAMEWORK AND LITERATURE

Following the rising public concerns of health resource issue, researchers carried out numerous studies that are focusing on health care industry. Some of these studies are descriptive, which provide general ideas on the topic, review what have been done previously and assess their results generated. These predictive studies investigate the health resource problem by developing and improving the projection models and proposing policy suggestions.

O'Brien-Pallas (2001) and her colleagues reviewed numerous studies between 1996 and 1999 with a focus on the topic of health resource forecasting. They concluded that most of these studies are accurate when focusing on particular health human resources, but, none of those methods are proven useful on long-range forecast or for a large geographical area. Besides the inappropriate size and area being considered, where results might be affected by regional differences, O'Brien-Pallas et al. (2001) blamed these differences on the lack of comprehensive database and the insufficiency of forecasting methods.

2.1   Different Types of Forecasting Approaches

Based on the review of models and definition of O'Brien-Pallas et al. (2001), types of projection method are separated into three broad categories with their assorted assessment for health care resources. These methods include supply or utilization-based approach, demand-based approach and econometrics approach. These approaches will be reviewed below.

2.1.1   Supply / Utilization-based Trend Approach

One of the most commonly used projection methods is the supply-based analysis. It includes estimation of personnel-to-population ratio as well as the projection model with consideration to factors that influencing labour participation (O'Brien-Pallas et al., 2001). The health human resource requirement projected under this approach is usually determined based on data collected from current workforce. These data, for example, include current resource level, graduation rate, attrition rate, demographic characteristics such as average age and gender of different health professionals.

Researches under this approach merely involve historical supply side information of physician or resources that are already been collected from one or more sources. Therefore, despite its low coverage of health market information and ignorance of demand side information from the general population, this approach was still widely adapted for researchers in analyzing health resource level in the early 1980s and 1990s (O'Brien-Pallas et al., 2001).

Trend analysis is one of the supply-based techniques for projecting the level of physicians for health workforce planning. It examines the long-term relationship between two factors and establishes their linear trend using historical information. Then, it projects the physician number based on the average growth rate of per capita gross domestic product (GDP).

Cooper et al. (2002) proposed a strong relationship between economic expansion and the use of health care services as well as the demand for health human resources based on the fact that wage is the major component of health care expenditure. By applying data obtained from the Bureau of Economic Analysis, the American Medical Association and the Bureau of Census, Cooper et al. (2002) examined the historical relationship between GDP per capita and number of active physicians per 100,000 population for 1929- 2000 in the U.S. They estimated a long-term linear relationship

between these two variables. With this fixed ratio of change in physician supply with respect to the average GDP growth, they established three separate trends for future physician supply that took into account population growth rate, relative work effort and substitution effect of non-physician providers (NPCs). They also projected a decrease in per capita physician supply with faster population growth rate compared to the growth of physicians. They calculated a 10 % and 20 % reduction in physician supply based on the increased number of aging physicians and female physicians, respectively. They also concluded that 15 % of physician works to be substituted by the NPCs effort in their analysis. On the demand side, they projected that real GDP growth continues at 1.5- 2% annually. Based on their estimation that physician supply changed on average by 0.75% for each 1% change in GDP or personal income, they projected that physician demand will grow 1.1% to 1.5% annually. Therefore, by comparing the projected demand and supply trend, they concluded that physician shortage will occur in 2000 to 2021.

Freed et al. (2003) projected the number of active pediatric physicians at overall U.S level to the year 2020 using similar trend analysis. Using data from the AMA Physician Masterfile and the U.S. Census Bureau, they modified the trend analysis by predicting the number of physicians in multiple procedures. For each procedure, Freed and his colleagues used only the information from the previous 20 years (1963- 1980) to project the trend for the next 10 years (1981-1990) as a testing period and repeated the procedure for every 5 year increments through 2001. They believed that information that is too early in the past may not be relevant and effective for the projection model. Therefore, instead of predicting the trend of physician supply using all available historical information, they used only information at the latest 20 years. By repeating the procedures, number of active pediatric physicians was forecasted to the year 2020. Then, using the high correlation over 37 year periods between per capita GDP and number of active pediatricians per 100,000 children that they estimated before, they projected the

demand of physicians with the assumption that future demand will follow the historical linear trend of per capita GDP growth untill 2020. By comparing the projected demand and supply, they predicted a shortage of physicians will occur for the period 1996- 2015 and 2001- 2020. They concluded that this shortage is due to the increase of woman participation, altogether with diminishing working hours in the pediatric workforce.

Zurn et al. (2002) assessed the unbalance in the registered U.S. nurse market. Similar to trend analysis, they compared the trend of vacancy rate, real wage rate changes, unemployment rate and turnover rate with respect to time for registered nurses in the U.S. from 1996 to 2000. They proposed a future shortage of registered nurses by comparing the observed growth pattern for the above four factors. But in their analysis, they ignored other health resources and demographic factors that might alter the demand and the substitution between human resources.

Another type of methods for forecasting the physician numbers is the utilization-based model. This model implicitly examines the impact of health service provision changes on the physician requirement with the expected demographic changes (O'Brien Pallas et al., 2001). Based on the proposition of an over-supply of specialists and a shortage of GPs, Greenberg and Cultice (1997) demonstrated a requirement model to examine different types of physician requirement in the future. Greenberg and Cultice (1997) first determined the base year per capita utilization from the service volume information experienced for each population group provided by different surveys. The future utilization was then calculated by the base year per capita utilization in each population group. These numbers varied with time and population growth, and then were converted to the productivities of physician using the initially determined productivity by the AMA Socioeconomic Monitoring System survey. Under different scenarios of analysis in the managed care penetration, they estimated the physician requirement in the year 2020 and concluded that a decrease in number of required physician would occur

while the percentage of primary care specialists would rise. These projected changes might due to the growth of managed care, which reduced the utilization while raising productivities for physicians.

2.1.2   Demand-based Trend Approach

The demand-based approach projection analysis is another method that is widely used in health care resource planning. This approach includes projection methods that take the demographic characteristics and market factors into account, thus affecting the demand of health services such as access to services and preference of patients. The demand-based approach is relatively normative, which involves expert opinions for the relationship between services and human resources needed for each task (O'Brien-Pallas et al., 2001; Prescott, 1991).

Under the demand-based approach, the health human resource is projected based on qualitative analysis. Researchers calculate the adjusted service needs by combining the information obtained from surveys, the experts' point of view for society's true needs and quantitative information, such as morbidity, to obtain the total service requirement. The total number of physicians required is then calculated according to time, number of physicians needed for medical operation and non-direct patient care, then subtracted by the number of NPCs (McNutt, 1981; O'Brien Pallas et al., 2001).

Since this method uses self-assessed data from population survey and the time required for specific diseases from expert opinions, the projection result is believed to be more representative for the population's true needs with its relatively direct assessment and first-hand information from service users. However, the demand-based approach requires numerous amount of information from the population health condition to establish the analysis model. Also, this information is self-reported so they may not be available from the same source for every analysis year. These create certain difficulties

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for researchers to carry out their analysis based on this approach because the data accuracy and sufficiency are in doubt (O'Brien-Pallas et al., 2001; Prescott, 1991).

2.1.3   Econometrics Approach

Econometrics approach is another method used for health resource projection. This method uses health resource determinants as a function of health resources to explain the relationship between determinants and needs. Then, the requirement of health service providers is projected based on the estimated relationship obtained from the econometric model. The econometric model estimates the historical relationship between dependent variables, such as the physician level, and independent variables such as factors that affect the health services demand and supply. Under this approach, the labour market and the economic determinants will be examined together (O'Brien-Pallas et al., 2001).

Benham (1971) used the econometrics model to examine the impact of factors, such as wages, marital status and husbands' income, to the female nurses' employment level and their earnings. He established a 3-stage least square model to examine the gross impact between factors that influence the employment level and the earning of registered female nurses for the year 1950 and 1960 in the U.S. This includes a demand equation which uses the nurses' wage rate as a dependent variable; median earning of other health personal and per capita personal income as dependent variables; and labour participation rate and stock of registered nurses as instruments. The demand equation is;

$$RNWAGE = f(RNLFPR*, RNSTOCK*, ATWAGE, PCY) \qquad (1)$$

Moreover, a second equation is used for examining the labour force participation (Equation 2) and a third equation for geographical location (Equation 3) is used by choosing stock of registered nurses per capita as endogenous variable and wage rate of registered nurses as instrument.

$$RNLFPR = f(RNWAGE*, MHY, CHILD) \qquad (2)$$

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$$RNSTOCK = f(RNWAGE*, MHY, RNG) \qquad (3)$$

He also developed three separate reduced-form equations to examine the net impact of husband's wage rate, number of children under 5 years old, per capita personal income and total graduations from nursing school in the U.S., on wage rates of female nurses, participation and total registered female nurses. His study suggested a negative effect of husband's income on the number of female nurse labour market participation rate for the year 1950 to 1960. Also, during the same period, the influence of registered nurses' own wage rate and location of training facilities on the nurses' participation rate decreased.

Smith et al. (2000) adopted a combined approach to provide assessment of whether there is a future shortage of physicians in Memphis and Shelby County, Tennessee in the U.S. using combined data in 1997. To assess the existence of future shortage of physician in the U.S., Smith and his colleagues (2000) performed separate projection analysis of the demand and supply for physicians using calculated provider-specific use ratio and linear regression model, respectively. For physician demand projection, they assumed that the use of health services would proportionally change with demand for health professionals and used population size as a proxy for utilization measurement. They first calculated the expected utilization levels by multiplying the projected population and future utilization rate for each insurance group. Then, they obtained the provider-specific use ratio by dividing the professional ratios with the utilization levels. Next, they multiplied the provider-specific use ratio with the utilization ratio and, by varying the projected population and utilization rate in different scenarios, they obtained the projected future health professional demand. These scenarios included changes in different services utilization and changes in managed care penetration.

On the other hand, Smith et al. (2000) applied a simple autoregressive model for assessing the future physician supply. They estimated the current physician supply as a function of last year's supply, with some exception for health professionals that

experienced temporary shocks, such as nurse practitioners. They estimated the

professionals' supply as a function of time to obtain the projected supply, where

physician supply at time t for state j (N_{tj}) is estimated as a function of last year's supply

($N_{(t-1)j}$).

$$N_{tj} = \beta_0 + \beta_1 N_{(t-1)j} + \varepsilon \tag{4}$$

They then compared the projected supply and projected demand of the health

professionals to examine their forecasted future trend and determine whether there would

be a projected imbalance in the market. After that, they used five indicators, including

practitioner-to-population ratio, human vacancy rates in hospital, relative wage trend and

expert reports, to assess the current situation in the professionals' market combined with

the projected future imbalance to assess the evidence of future shortage. Their results

showed that there is a strong evidence of future shortage for certified nursing aids and

some evidence of future shortage of medical technologists for the 17 analyzed specialists.

While there is only a limited evidence of future shortage for the rest, including nurse

practitioners and physician assistants. Their results also suggested that there would be a

lower health provider demand for a faster managed care penetration rate and lower

utilization rate for a higher population health insurance coverage (Smith et al., 2000).

2.2   Major Factors Considered For Health Human Resource Planning

As suggested by earlier studies, work participation pattern for any kind of health

personnel such as entry, re-entry, attrition rate and work habit should not be assumed

stable over time as they will change across age cohorts (Lomas et al. 1985). Moreover, as

researches revealed that the health services provided by nurse practitioners are

comparable to that by the GPs (O'Brien-Pallas et al., 2001). Thus, analysis should take

into account factors such as substitution between health human resources, payment

methods, practice organization and style, mobility patterns and place of graduation when

developing their projection models to avoid the misleading result.

Cooper et al. (2002) suggested the examination of four major indicators that influence the level of physician on health resources planning analysis, including economic growth rate, population growth rate, work effort of physicians and services provided by non- physician clinician. While economic growth rate captures the influence of economic factors, population growth rate reflects the health care service requirement. Work effort suggests the labour characteristics that caused different labour supply, and the services provided by other professionals exhibit the substitution among health resources.

The influence of population growth rate on health provider requirement are affirmed by the research from Denton et al. (2001) with a focus on the impact of population change on health personnel and requirement projection to the year 2020. They examined the pure effect of population change, a combination of population growth and aging, and found that the population growth is much more crucial for the increase in the physician utilization rate when compared to the aging problem. However, they suggested that these kinds of studies should undergo further investigation since they focused mainly on the aging population. Overall speaking, in their study, even though they took the quantity needed and the timeframe question into account, still, the conditions that would change the physicians' requirement were not carefully examined.

The services provided by GPs are sometimes interrelated with those provided by specialists because some health services require patients to obtain referrals when ordering more targeted and specific treatments. This is also a reason when considering specialists' work level for the human resource planning analysis.

For more accurate calculation towards physician supply and unit of services provided, researchers suggested using full-time equivalent physicians (FTE) instead of head count for physician as the unit of measurement. The Physician Resource Planning Committee (PRPC, 2000) adopted the Health Canada FTE methodology for calculating

the FTE for the Alberta's physicians. PRPC ranked physicians in Alberta based on aggregate annual payments and computed the FTEs. It established two different formulas for those above 60th percentile and below the 40th percentile to compute the FTEs for physicians. Meanwhile, the FTEs for those physicians between 40th and 60th percentile were assigned a FTEs value equals to one. Greenberg and Cultice (1997) even took into account the percentage of time contributed by physicians to the indirect patient care as a measurement of workload and true needs of physicians. These indirect patient care include consulting with other physicians, patients, patients' families on phone and analyzing laboratory results. The method of FTEs calculation illustrates the average self-reported hours but the estimated results using self-reported information may be misleading.

However, insufficient health resource database might cause diverse and inaccurate forecasting results. (Smith et al. , 2000; Cooper et al. , 2002; O'Brien-Pallas et al. , 2001). Denton et al. (2001) concluded in their analysis that:

"… there are many factors that affect the requirements for

physician services, and those factors vary over time. While

population change is obviously important, so too (and equally

obviously) are changes in medical knowledge, technology, and

delivery practices."

Obviously, more efforts are required on building up more complete medical database for health information collection with various indicators, especially information like medical needs and health condition on population in order to establish more all-rounded projection models for society as a whole.

CHAPTER 3

METHODOLOGY

This chapter illustrates the empirical projection model used in this thesis by introducing three different hypothesized scenarios for the changes of population profile, average payment to general practitioners (GPs) and a combination of both.

3.1 Empirical Model

This thesis projects the future level of GPs in each regional health authority (RHA) in Saskatchewan and uses health regions as unit of analysis. While focusing on the econometric approach, this thesis depends on supply-side physician information and demand-side information. In this econometric model, the equilibrium of physician market is assumed with base year 2006, which is the latest available year of data that could be obtained.

This thesis applies the econometric model for projecting the level of GPs to the year 2021. The relationships are obtained between the number of GPs and the demand-, supply- side factors using regression analysis. In previous research performed by Benham (1971), he demonstrated separate reduced form regression for physician numbers and income to obtain the estimated changes for factors between two years. Using a similar approach of Benham's analysis, the following reduced form physician equation, with both demand and supply side factors, are estimated using data from health regions from 1998 to 2006 to obtain the estimated relationship between variables:

$$Ln(GP_{it}) = \alpha + \beta Ln(D_{it}) + \gamma Ln(W_{it}) + \delta S_{it} + r_i + \varepsilon_{it} \qquad (5)$$

It is believed that region specific time invariant differences would also affect the physician supply. In equation (5) above, this impact is shown by r_i, which stands for factors specific to region i that is observable or unobservable. The rural and urban nature, weather and travel differences between health regions would be examples for these factors. These effects are unobservable and time invariant, but are believed to be correlated with other variables in the model, such as demographic population components and density of population, which should not be omitted from the model. Therefore, the panel data regression analysis with fixed effect approach will be applied to the analysis to capture these region specific factors.

The model being used with the fixed effect approach is the least squares dummy variable (LSDV) model. In this model, the differences between health regions are included in the constant terms. In equation (5), the dependent variable, number of GPs ($Ln(GP_{it})$) for region i at time t, is defined as function of both supply side factors, demand side factors and health region specific factors. On the right hand side of the equation, the independent variable, D_{it}, includes demand side shifters for region i at time t, such as demographic characteristics at the region and number of people in different age and gender groups. According to Denton et al. (2001) and Greenberg and Cultice (1997), female population were found to have a higher requirement of GP services. Besides, different age groups demand different levels of physician services, and therefore, the female population and age proportions are going to influence the requirement level of GPs and should be considered in the model. W_{it} stands for average payment per active GPs in region i at time t, which is a index for showing the GP labour participation influence in the healthcare market (Cooper et al., 2002). S_{it} shows supply side shifters for region i at time t, such as number of specialists and female GP proportion, to determine the degree of input substitutions between area of practices and between gender.

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The model also includes the international medical graduate proportion to determine the cultural difference between GPs and how it affects the GP levels. Different GP age groups and experience groups are considered in the model to identify the influence of GP's seniorities in practice on their labour supply (Greenberg and Cultice, 1997; Smith et al., 2000; Cooper et al., 2002; Zurn et al., 2002).

With the fact that only physician level at equilibrium could be observed from the historical data, ratios estimated from the model provide both demand and supply side information of human resources for the regional population. The relationship between independent factors and level of physicians is obtained from regression estimation.

3.2   Econometric Projection Model

The marginal effects of these variables are analyzed with three different hypothetical scenarios.

The first projection model starts by applying the historical data for independent variables at the 2006 base year value into the regression model to obtain the estimated level of GPs. Then, this level is changed by substituting the projected proportion for those two age groups to the estimated equation for year 2011, 2016 and 2021, with the rest of the other independent variables held constant at 2006 base year level. Next, by converting the dependent variable into number of GPs and dividing that by the corresponding projected total population for 2011, 2016 and 2021, the number of GPs per 1000 capita is projected into year 2021 based on the first hypothesis that only child and senior proportion change. The projected total population information for year 2011, 2016 and 2021 are obtained from the report of CITB, Saskatchewan Health (2002). Then, the projection analysis is extended to the RHA level to obtain the projected GPs number for each RHA up to year 2021, by repeating the above procedures with the corresponding

observed and projected RHA information.

In scenario 2, changes in average payment per GP and its effect on physician level are analyzed for Saskatchewan overall in 2006 to 2021. This analysis is based on the Average Payment per Physician (APP) Report (CIHI, 2001-2006), which includes average payment per fee-for-service physician who received at least $60,000 in payments by type of practice from the period 1996-1997 to 2004-2005. Scenario 2 based on the percent change in average payment per fee-for-service physician, specifically for family medicine type of practice, from 1996-1997 to 2004-2005 to analyze the influence of average payment per GPs changes on the GPs level. The percentage change of the average payment per GPs is first projected for period 2005-2006 to 2020-2021, using its trend from 1996-1997 to 2004-2005. Then, the average payment per GPs is projected for 2006-2021 by multiplying the projected percentage change of average payment per GPs in the same time period. After this, the projected average payments per GPs are converted to natural logarithm format, used as a variable in the analysis. Meanwhile, the GP level for 2006-2021 is estimated by substituting the projected average payment with their growth while the rest of other independent variables are kept at the 2006 base year level. The estimated GP level is then converted into number of GPs. By dividing the GP level with the corresponding projected total population at the year 2011, 2016 and 2021, the number of GPs per 1000 capita is projected to the year 2021 bases on the second assumption that only the average payment per GP changes among all other variables in the model. This projection model is not extended to the RHA level in scenario 2 due to the lack of detail average payment per GP information at the RHA level.

In scenario 3, changes in both scenario 1 and 2 are considered together with similar calculation of scenario 1 and 2 for the GP level. In this projection, three independent variables vary at the same time according to their projected level from year 2006 to 2021. These variations are then substituted into the estimated equation with their projected

values for the corresponding year discussed previously. Again, the estimated GP level is then converted and GPs per 1000 capita are projected up to year 2021. Based on the same information limitation for the average payment per GP variable, this scenario is also restricted from extending into the RHA level for the projection.

CHAPTER 4

DATA SOURCE AND VARIABLE DESCRIPTION

This thesis projects the level of general practitioners (GPs) at each regional health authorities (RHAs) and uses demographic and socio-economic information for the 12 RHAs in Saskatchewan for 1999-2006. There are some challenges in obtaining the regional level data in Saskatchewan because most micro-data provided for public uses are only available at the overall provincial, territorial level or country level. Therefore, the acquisition of data has to be done through a combination of different databases, though, the data for some of the variables are not available for all years included in the model.

4.1 Data Source

In the analysis, data are obtained from two sources from 1999 to 2005. Some physician supply data are obtained from the annual statistical report prepared by the Medical Services Branch (MSB) from Saskatchewan Health. These data are collected each fiscal year (April to March) and I used the starting year of the fiscal period as a representation to that year of analysis. For instance, a variable is included in the estimation for 2004 if it was collected for the fiscal year 2004-2005.

The data obtained from these statistical reports include number of GPs, average payment per GPs, number of specialists and the demographic component of population such as gender and age groups (see Section 4.2 for further details).

Noted that for the number of GPs and specialists, the MSB, Saskatchewan Health, collected these data four times a year (March, June, September and December), but the data included in this research only contain those that are collected at the end of the fiscal year (March) and are in discrete total count, which means that physician will only be

counted once in total but will be counted in each community or health region if he practiced in more than one region in Saskatchewan from the definition of data obtained from the MSB.

In the MSB database, the physician data are kept in 32 health districts before 2002. After the major health reform of the health delivery system in Saskatchewan in 2002, which combined the 32 district health boards into 12 RHAs (see Chapter 1 for further details), the MSB database changed accordingly and physician data are kept in 12 RHAs after 2002. To make the regression analysis consistent, all information obtained from the MSB in 2001 or before will regroup all component health districts according to their corresponding RHAs as defined at 2002 onwards. These component health districts are included into their RHAs according to their geographic location as defined by the Regional Health Services Act proclaimed in 2002, with the assumption that they shared equal work loads within the RHA. For example, the Saskatoon regional health authority (Saskatoon RHA) proclaimed in 2002 is composed of Living Sky Health District, Central Plains Health District, Saskatoon Health District and Gabriel Springs Health District as defined from 1993 to 2001.

The second data source is the Scott's Medical Database (SMDB), previously known as the Southam Medical Database, provided by the Canadian Institute for Health Information (CIHI). The data is collected and maintained by the Business Information Group, a division of Hollinger Canadian Newspaper Publications Company (formerly Southam Medical Group, Southam Inc.) of Scarborough, Ontario (CIHI, 2005). These data were extracted in August 2007 and the data obtained from this source contains mainly demographic information of GPs, which includes active physicians in all practice, excluding those who are unregistered, the specialists[1] from 1992 (the earliest available

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[1] Specialty allocation is by latest acquired certified specialty. Specialists include certificants of the Royal College of Physicians and Surgeons of Canada (RCPSC) or the College des Medecins du Quebec (CMQ).

year) to 2005, and only the information from 1999 to 2005 are used for the comparison with the data obtained from the MSB.

The SMDB data are collected at the end of each year and is slightly different from that provided by the MSB, which is collected as of the fiscal year. Moreover, before the year 2004, GPs who are not certified in Canada, foreign-certified specialists and other non-certified specialists are included in the family medicine counts. Starting from 2004 and later, non-certified specialists are assigned to their associated specialty designations.

The SMDB database includes information such as physician gender, their places of graduation, age groups and years since graduation (see Section 4.2 for further details).

In order to protect the privacy of reported physicians, data for some variables obtained from the SMDB are grouped together according to the rules of compression from the SMDB to ensure that no information will be released in raw form or in tables with cells counts of less than 4. Physicians' age are compressed into groups with a 10-year interval starting from the group aged 30-39 to the group aged 80 or above. Years since graduation are obtained in a group of 5-year interval starting with the first group of 1 to 5 years, to the last group of 36 years or above. Furthermore, the information obtained from the SMDB are received in grouped format for the 12 RHAs, therefore, it is assumed that the data collected at 2001 or before is compressed just as the new boundaries defined in the Regional Health Services Act.

The definition for the categories of physician is slightly different between Saskatchewan Health and the CIHI and it should be clarified prior to the analysis. According to the definition of the MSB, specialist is defined as "a Canadian certified physician listed by the College of Physicians and Surgeons of Saskatchewan as eligible to receive the MSB payments at specialist rates. If a physician becomes a certified specialist during the year, only those services provided after certification are included with specialist services" while a GP is "a physician registered with the College of Physicians

and Surgeons of Saskatchewan whose names does not appear on the specialist listing", which is the listing of specialist mentioned above. By the CIHI definition, they used the term "family medicine physician" and defined it as GPs, physician in family medicine and emergency family medicine specialists with exception to interns and residents, and those who without a current medical specialty certified in Canada. However, due to their similarity in practicing nature, the terms "Family Medicine Physician", "Family Physician" and "General Practitioner" are all referred to the same family physician practice in this analysis.

4.2   Variable Descriptions

This chapter provides the general description and sources for variables used in the analysis. The dependent variable is the total number of registered GPs in natural logarithm form and the independent variables are the combination of both demand-side factors with population characteristics, supply-side factors with physician characteristics, and average payment per active GP as proxy for their income. These data are collected from 1999 to 2005 for each RHA and are described in Table 4.1 with only the average of the RHA numbers over the years shown.

In the analysis, the dependant variable is the natural logarithm of the total number of GPs identifying the percentage changes of level of GPs with the percentage changes of the demand or supply side factors. Since different age groups are going to demand different levels of GP services (Denton et al., 2001), therefore, in order to test the population age cohort influences to the physician market, 5 different age groups are defined in the model using the data obtained from the covered population reports prepared by the MSB instead of using average population age.

Table 4.1: Description of Variables

Variable names	Description	Mean	Source
Dependent Variables:			
Ln (General Practitioner)	The natural logarithm of number of registered GPs	3.87 (0.90)	MSB
Independent Variables:			
Demand-side Variables:			
Ln (Female)	The natural logarithm of the total number of female population	10.30 (0.86)	MSB
Ln (Age <10)	The natural logarithm of total number of children aged 0 – 9	8.99 (0.74)	MSB
Ln (Age 35 – 64)	The natural logarithm of total number of people aged 35 – 64	10.00 (0.92)	MSB
Ln (Age 65+)	The natural logarithm of total number of seniors aged 65 – 74	8.98 (1.15)	MSB
Supply-side Variables:			
Ln (Physician Income)	The natural logarithm of the average payment per active GP	12.24 (0.29)	MSB
Ln (Specialist)	The natural logarithm of total number of specialist	-0.70 (8.51)	MSB
Female Physicians (%)	Percentage of female physician that is specialized in general practice.	21.5 (9.8)	SMDB
IMG (%)	Percentage of GP that is graduated from medical school outside Canada	65.2 (22.4)	SMDB
Physicians Age 50-64 (%)	Percentage of GP aged between 50-64	45.9 (15.5)	SMDB
Physicians Age 65+ (%)	Percentage of GP aged 65 or above	16.2 (8.4)	SMDB
Years of experience 16-25(%)	Percentage of GP graduated within 16-25 years	28.0 (11.8)	SMDB
Years of experience 26+ (%)	Percentage of GP graduated more than 26 years	39.7 (15.8)	SMDB

Note: Standard derivations are in parentheses. MSB stands for the Medical Service Branch, Saskatchewan Health, and SMBD is the abbreviation for the Scott's Medical Database from the Canadian Institute for Health Information

The range of each age group is separated accordingly: children (age 0-9); teenager (age 10-19); parent (age 20-34); middle age (age 35-64) and seniors (age 65 or above).

These groups are separated according to their difference in health care service utilization. Their differences in utilization are believed to be U-shaped with more services consumed by children and teenagers, then reduce gradually and increase again from the later middle age (Denton et al., 2001). The population group aged between 10 to 19 years and 20 to 34 years are used as base group for comparing the physician requirement for children, middle age and the senior age group. Again, the natural logarithm form of these data is used to obtain their variations over the year.

In the regression analysis, the income of physician should be considered in order to identify the physician activity in the labour force. However, since information is not available, I used the average payment to each active GP as proxy for income by assuming the payment that each GP received is her main source of income.

The total number of specialists is included to analyze the degree of substitution between physicians that specialized in family medicine and those who specialized in the fields outside general practice. Furthermore, the percentage of female physicians is considered in the analysis to obtain the gender difference within the physician group that specialized in general practice.

For the supply side variables, the years of experience data are grouped according to the physicians' seniorities in practice. These include the group of GP that graduated for 1 to 15 years, the group that graduated for 16 to 25 years and the one for 26 years or more. To obtain the seniority influence on the level of physician supply, the group with less than 16 years of experience is used as a base group for comparing the physician supply to those with higher seniority. As observed, the sample contains 28% of GPs with 16 to 25 years of experience, while almost 40 % of GPs having 26 years or more of experience in Saskatchewan. This means that less than 27% of physicians are graduated within 1-15

years, with the unreported statistic more than 6%. By the definition of the CIHI, the "years of experience" variable is calculated as the "number of years between the year of graduation and the current year", which is not necessarily equals to the actual time that a physician spent in the labour force. Thus, it only indicates the number of years a physician could have been remained in the labor force while not taken into account the time she spent for continuing education or temporary leave. Therefore, the years of experience of the physicians, as defined in this analysis, do not necessarily relate to their productivity.

The physicians' place of graduation is compressed into three main groups, which are Saskatchewan, other Canada jurisdictions and international medical institutes outside Canada. In this sample, the international medication graduates (IMGs) compose of more that 65 % of the total number of GPs over time in Saskatchewan and thus, the other two groups are used as the comparison group in the regression.

Two physician age groups over age 50 are included in the analysis to examine the influence of physician work efforts and retirement norms between age groups on the level of physician supply. As shown in the variable description in Table 4.1, on average, almost 62 % of the GPs in Saskatchewan over time were at the age of 50 years or older.

4.3 Descriptive Analysis

This section provides general description of the observed information from 1999 to 2006 and compares the regions.

Figure 4.1.1 and 4.1.2 below separate the 12 RHAs into 2 groups according to their trends for GP density. These are also an observation of physician spatial disparity and a comparison of different level of health services provided between rural and urban communities. The GP density is the total number of GPs divided by the total land area of the corresponding RHA, not the total area of Saskatchewan, in order to illustrate the

regional difference of spatial disparity.

Figure 4.1.1: RHAs with higher GPs per 1000 square kilometer
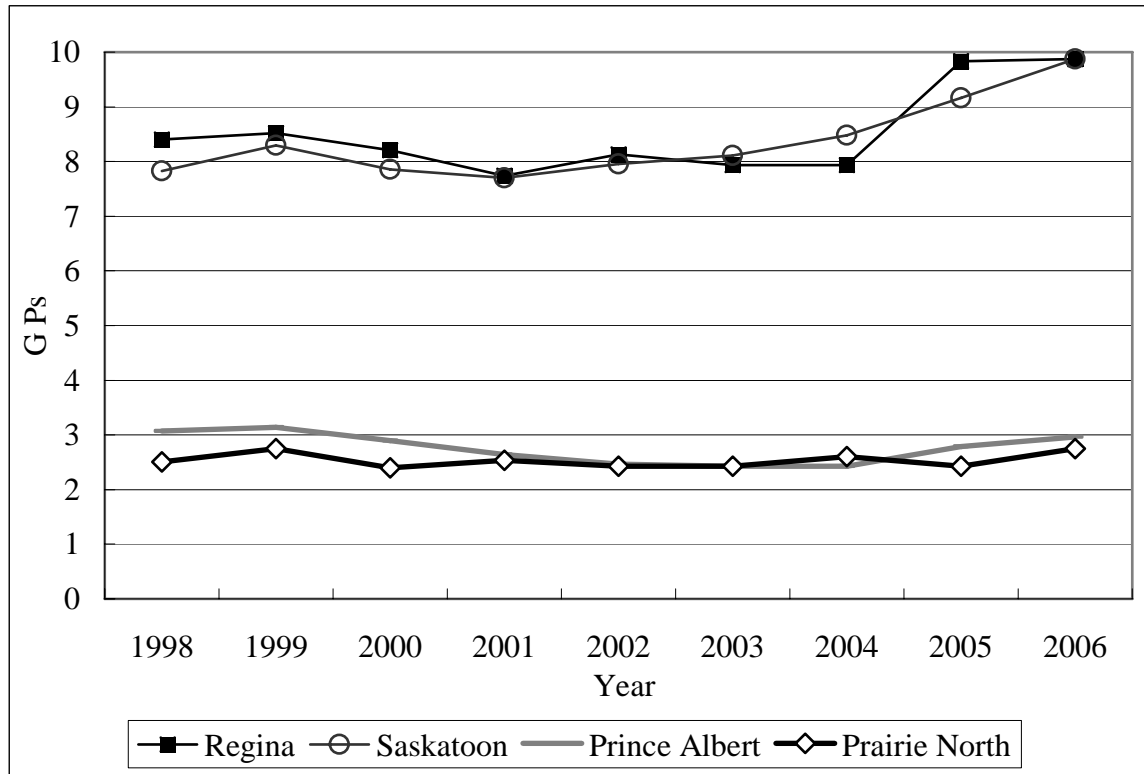
Figure 4.1.1 contains RHAs that show upward trends of physician density. It indicates that for each 1000 square kilometer, there are more and more GPs practicing in these RHAs from 1998 to 2006. These RHAs also maintain high GP density at above 2 GPs per 1000 square kilometer compared to the rest of the RHAs.

These density trends also show an increasing number of physicians, regardless of race, gender or place of graduation, practicing in Regina Qu'Appelle, Saskatoon, Prince Albert and Prairie North RHA from 1998 to 2006. Contrarily, the rest of the RHAs maintain below low GP density at below 2 GPs per 1000 square kilometer. Moreover, the rest of the RHAs either show a decreasing or constant density for the number of physicians per 1000 square kilometer in Figure 4.1.2.

Figure 4.1.2: RHAs with lower GPs per 1000 square kilometer
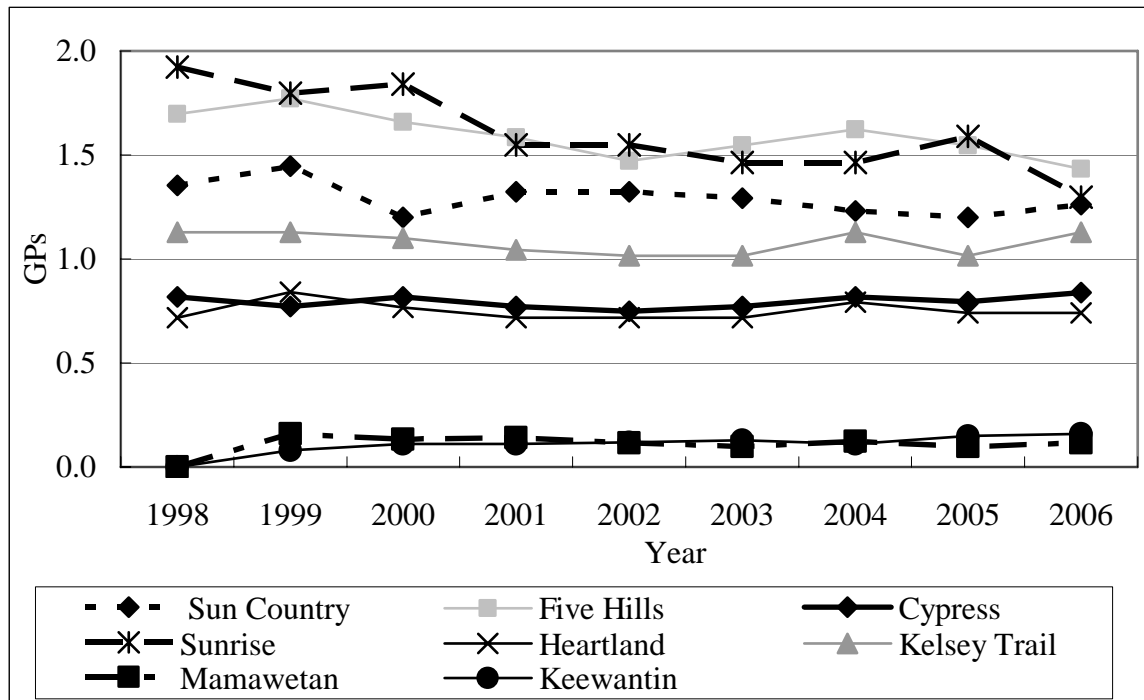
These two figures reveal that fewer GPs are located in rural and urban communities than in metropolitan areas such as Saskatoon and Regina. From the graphs, the number of GPs per 1000 square kilometer of Saskatoon and Regina are almost 5 to 10 times of the others indicating a significant difference in physician density between the metropolitan areas and the rest of Saskatchewan.

Figure 4.2.1, Figure 4.2.2 and Figure 4.2.3 provide the trend for GPs per 1000 capita in each RHA. Figure 4.2.1 includes RHAs that shows an increasing number of GPs per 1000 capita, while Figure 4.2.2 and Figure 4.2.3 show a relatively stable trend and decreasing trend respectively.

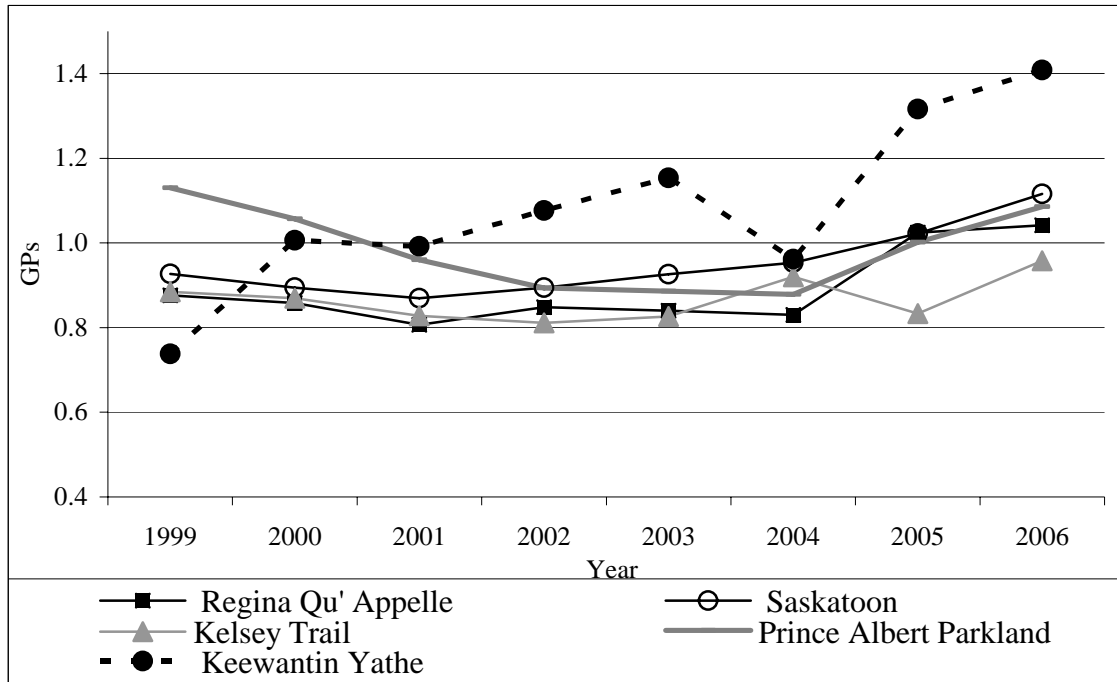**Figure 4.2.1**: RHAs with increasing number of GPs per 1000 Capita

Figure 4.2.2: RHAs with stable number of GPs per 1000 Capita
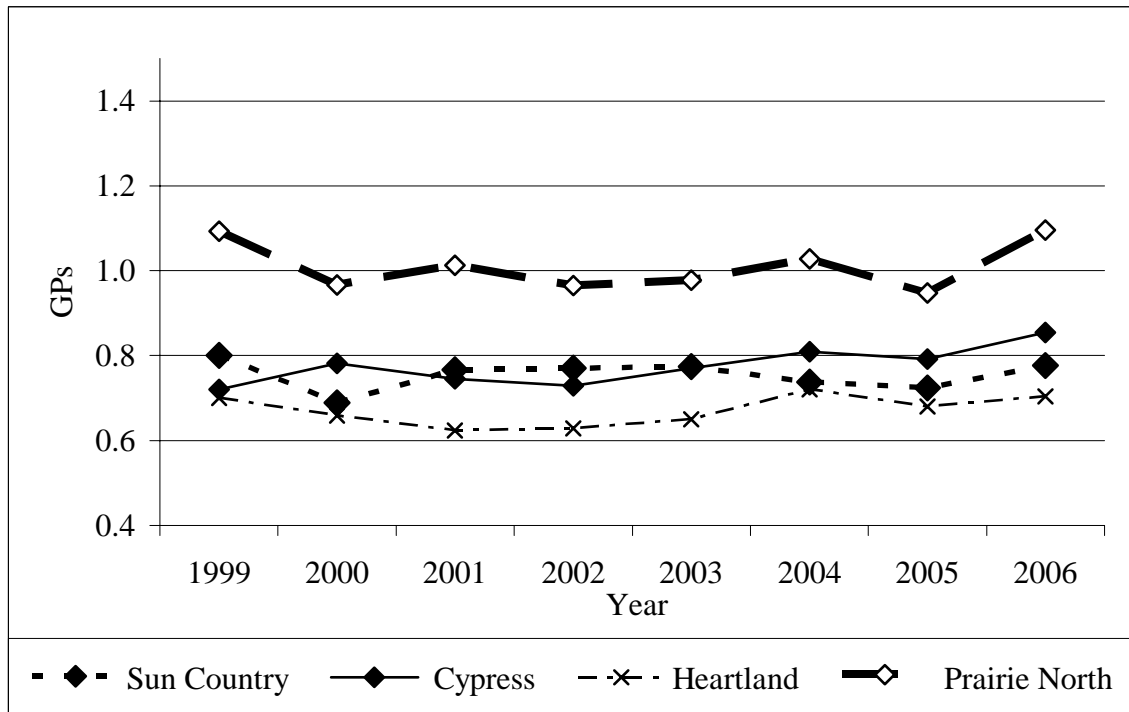
Figure 4.2.3: RHAs with decreasing number of GPs per 1000 Capita
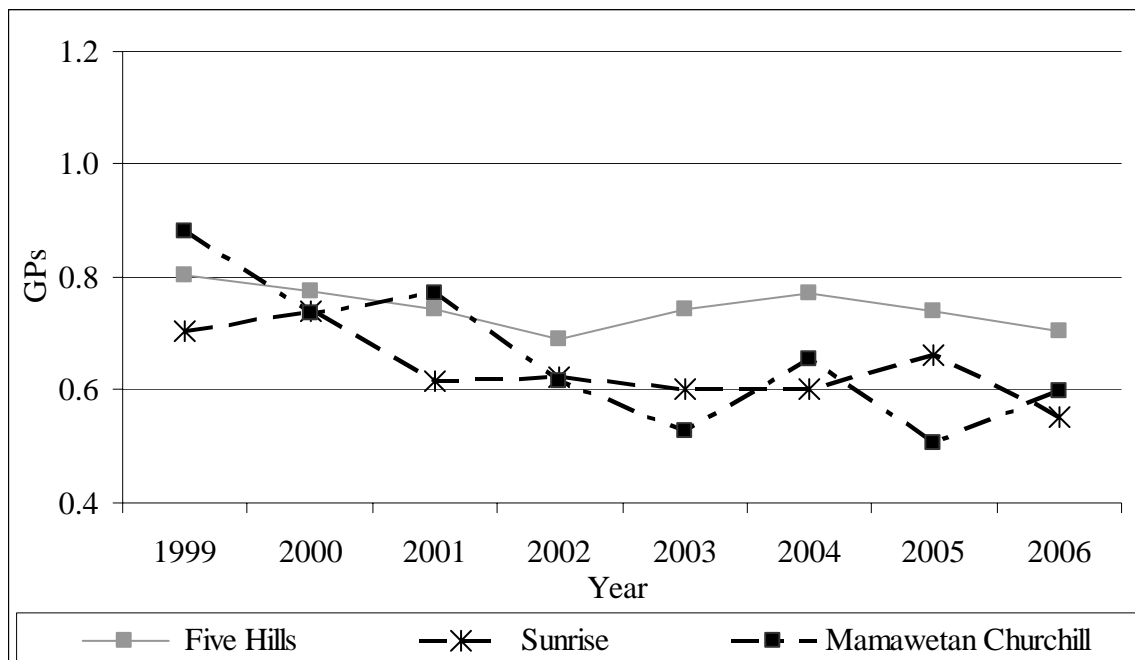
The northwest health region, Keewatin Yatthe RHA, had the most GPs per 1000

capita increases during 1999-2006 as shown in Figure 4.2.1. The reason for this trend

may due to the attractive northern relocation subsidies provided by Saskatchewan Health

and other policies that encourage physician to relocate to the northern part of

Saskatchewan, where unfavorable weather and dispersed health facilities are located.

Figure 4.3 is a scattered graph that shows the relationship between number of GPs

and per capita payment in real terms for all 12 RHAs. The real per capita payments for

each RHA are converted with the consumer price index (CPI) for Saskatchewan. The CPI

information is located in the Saskatchewan Consumer Price Index, a report prepared by

Saskatchewan Bureau of Statistics, Ministry of Finance (Saskatchewan Bureau of

Statistics, 2008), with reference year at 2002. Since this CPI information is not available

at the RHA level. I use Saskatchewan level CPIs to convert the nominal per capita

payment into the real term.

The time frame of the points started from the right hand side (1999) to the left hand

side (2005) in Figure 4.3. Those scattered points concentrated on the left hand side in the figure are the real per capita payment after 2002, when the most recent health reform took place and combined the health districts into 12 RHAs. As shown in Figure 4.3, the real payment per 1000 capita remained low for the Mamawetan Churchill RHA and Keewantin Yathe RHA even though the number of GPs per 1000 capita increased overtime.

Figure 4.3: Number of GPs by Real Payment per 1000 Capita in each RHA
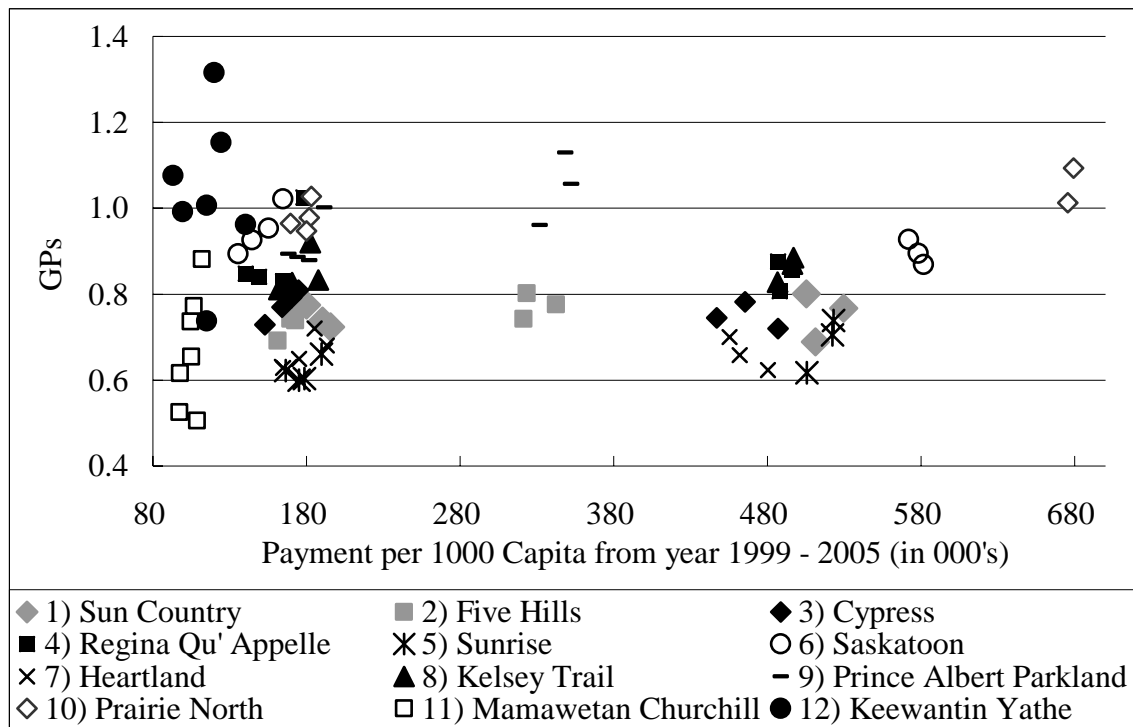
Unlike the RHAs located in the northern part of Saskatchewan, the rest of the RHAs experienced significant decrease in real payment per 1000 capita after the health reform in 2002, with their fluctuation in GPs per 1000 capita remained at small ranges.

Figure 4.4 shows the trend of proportion of IMGs practicing in the Regina Qu'Appelle and Saskatoon RHAs overtime. IMGs contributed to an average of 65.2% in the overall physician population over the year 1999 to 2005 in Saskatchewan. Figure 4.4 illustrates an increasing trend of IMGs practicing in Regina Qu'Appelle and Saskatoon

RHAs from 1999 to 2005.

Figure 4.4: Percentage of International Medical Graduate (IMG)
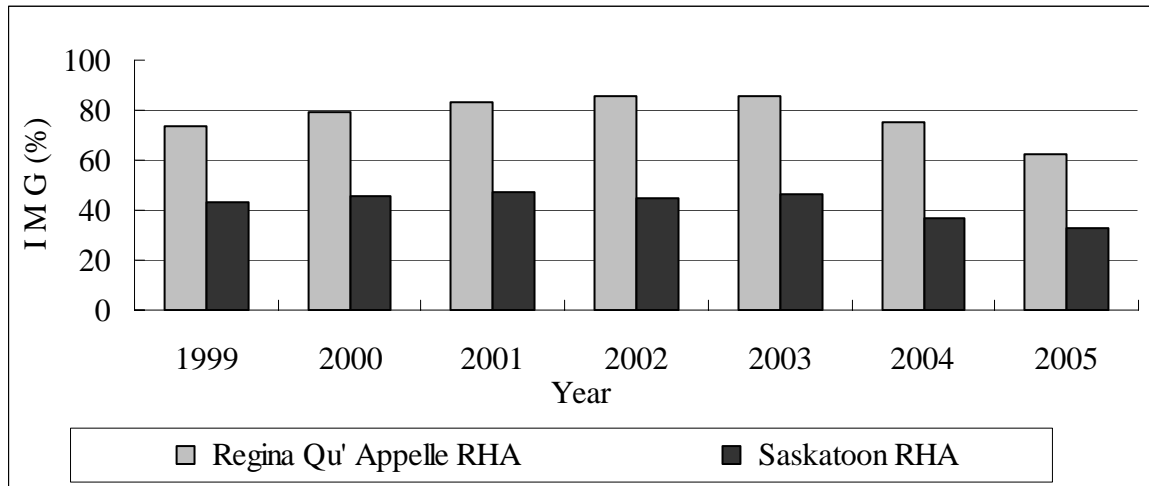
The number of the IMGs practicing in these two health regions decrease

overtime since 2001. Figure 4.4 also shows a significant difference between these two

RHAs overtime.

Figure 4.5.1: Female Physicians in South Western Saskatchewan (%)
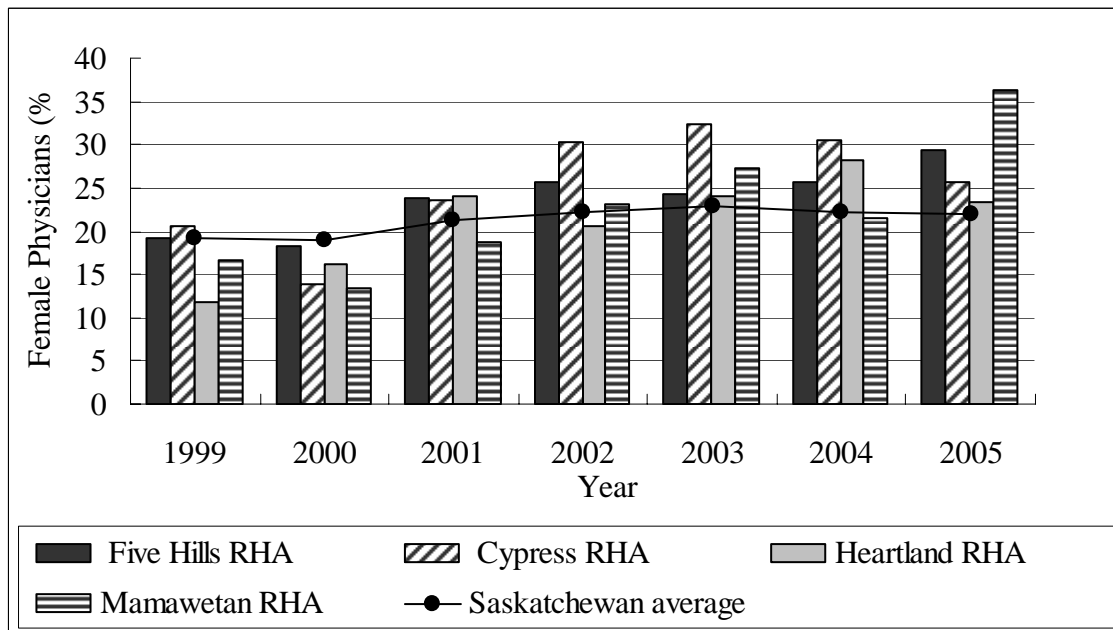
Figure 4.5.1 and Figure 4.5.2 present the number of female physicians in the RHAs located in the south western part and northern central part of Saskatchewan, respectively. As shown from Figure 4.5.1, there are more and more female GPs willing to participate in the labour force in the RHAs located in the south western part of Saskatchewan from 1999 to 2005. These include Five Hills, Cypress, Heartland and Mamawetan RHAs.

On the other hand, Figure 4.5.2 shows that there are fewer female GPs practicing in the Sun Country RHA and the northern central part of Saskatchewan such as Saskatoon and Prince Albert Parkland RHAs from 2000 to 2005.

Figure 4.5.2: Female Physicians in Northern Central Saskatchewan (%)
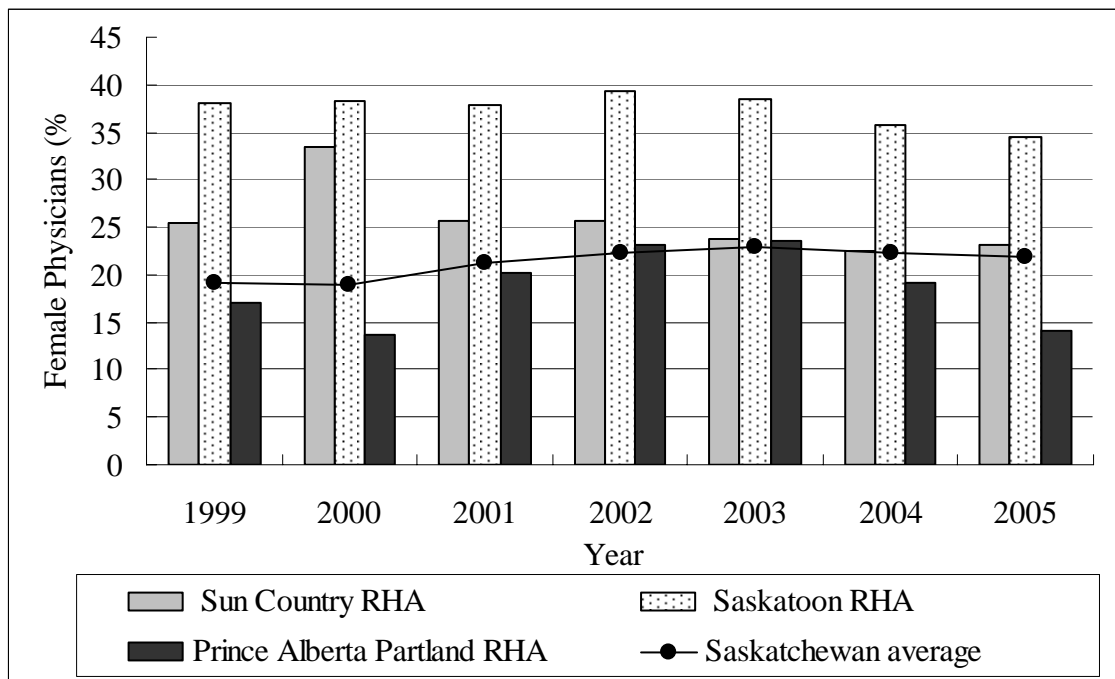
Furthermore, the average percentage of the Saskatchewan female GPs is about 20 % overtime. When comparing this provincial average to the RHA averages, we could observe from Figure 4.5.1 and 4.5.2 that all those south western RHAs have an above average female physician level after 2001. Saskatoon RHA also presents a highly above average female physician level, even though its trend is decreasing overtime; while

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Prince Alberta Parkland RHA shows a decreasing and below average level from 1999 to 2005.

The annual income for GPs is also significant to the future physician supply since it alters her decision for whether or not to continue her practice. This information for Saskatchewan over the year 1999 to 2005 is presented in Figure 4.6 below.

Figure 4.6: GPs Average Annual Income in Saskatchewan (in 000's)
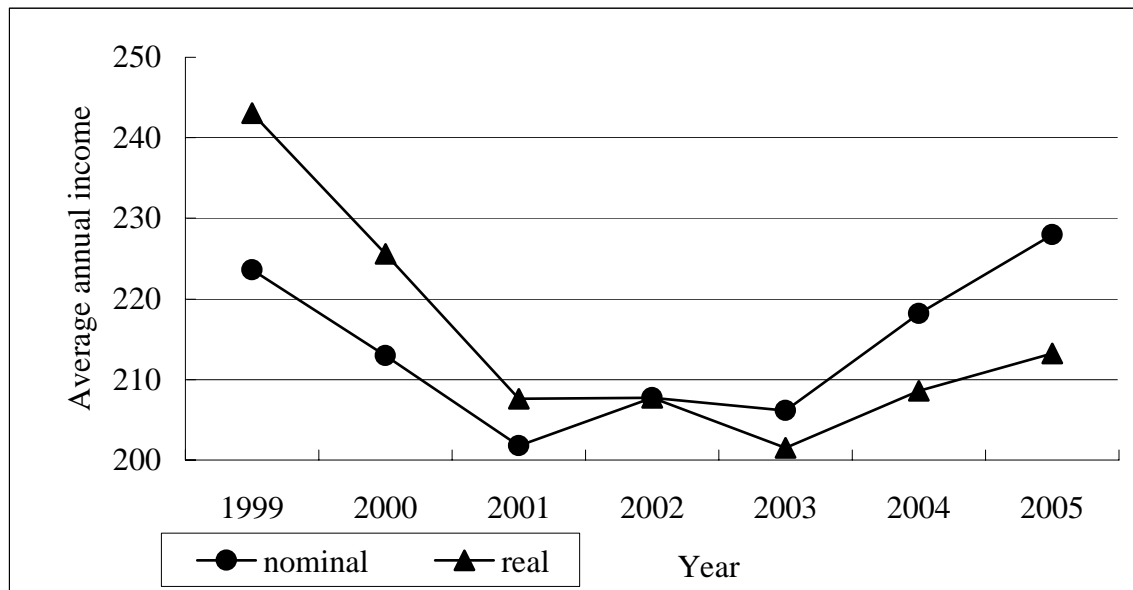
Figure 4.6 shows the annual average payment per active GP in both nominal and real terms, which is used as proxy to the annual physician income in the analysis. The average annual incomes in real term are converted using the nominal annual income and the CPI at the corresponding year (Saskatchewan Bureau of Statistics, 2008), with reference year at 2002. As shown from the figure, the annual income in nominal term decreased from $223,580 in 1999 to the lowest as $201,779 in 2001 then increased back to $227,972 in 2005. There was an increasing trend in physician income from 2001 to 2002 and fell slightly from 2002 to 2003. While in real terms, the difference of annual physician income widen between the year 1999 and 2003 as it dropped from $243,025 in 1999 to

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$201,500 in 2003. The real annual physician income increased to $213,257 in 2005 which was still lower than the annual physician income in nominal terms for the same year.

CHAPTER 5

EMPIRICAL RESULTS AND INTERPRETATION

This chapter presents the estimated results from the regression model under three different scenarios. The first scenario analyzes the influence of the projected population profile changes to the level of GPs. The second scenario interprets the hypothesized average payment per GP changes and its effects to the GPs level. The third scenario discusses the effects of the combination under both first and second scenario changes.

5.1 Estimation Results

In the analysis, the independent variables are added separately to the least squares dummy variable (LSDV) model in the regressions to compare their effects to the level of general practitioners (GPs). The complete results of seven estimated panel data models (Model I – Model VI) are presented in Table A2 in Appendix to compare the marginal effects of selected factors on the GP level.

Model I contains only the demand side determinants. These variables include elderly, children and female population that are believed to be the highest health user groups with higher demands for physician services.

The supply side variables, such as physician income and number of specialists are added to the model to analyze their own income effect as well as the substitution effect from specialists in model II and III respectively.

Model IV includes also the female physician level and the IMG level to determine the gender difference and the educational credential difference from other countries. The physician age and years of experience variables are examined in two separate models

because the interpretation of these two variables may overlap in the analysis. This problem arises because years of experience of physicians accumulate with ages, the inclusion of years of experience variable may not be necessary if physician age variables already existed in the model, or vice versa. Therefore, they may be correlated with each other in the analysis if they were both included.

Model V includes factors that capture the physician age as well as other previous determinants such as demand side and supply side variables. The supply side variables include physician income, number of specialists and IMGs proportion, which consists more than 65% of the total Saskatchewan physicians.

Model VI contains similar variables compared to Model V, but with the years of experience variables imposed instead of age variables. Years of experience variable, which is actually the years since graduation data, is examined as a proxy for the physicians' experience. This factor is believed to affect the retirement decision of physicians and have an important influence on the level of physicians.

Unlike the population composition information, most of the physician information is not available for the year 2006. Despite this fact, the regression analysis is performed by the maximum number of observed data available, that is, data in year 2006 are included in some but not all variables.

With these six regression results, it is suggested that the more the variables are added to the model, the more significant the estimated coefficients are and the higher the R-square statistic. Within those models, the last two provide more significant results and higher R-square statistic compared to the rest. These imply that more variation of the dependent variable is explained by the independent variables in model V and VI. Moreover, the years of experience in Model VI would better reflect the labour supply of the physician because wages, number of patients, sense of belonging in the industry and the patients' loyalty are mostly cumulated and determined by experience. Therefore, the

results from model VI are used for further projection analysis. The regression results are reported in Table 5.1 below. The physician income data for Keewantin RHA at 2002 is missing and therefore, the total number of observations is 83 for the 12 RHAs from 1999 to 2005.

Table 5.1: Fixed effect results

Model VI		
Dependent variable: Ln (General Practitioner)		
	coefficient	t-statistics
Constant	14.081 **	2.22
Demand-side variables:		
Ln (Female)	-3.871 **	-3.29
Ln (Age <10)	0.457	1.27
Ln (Age 35 – 64)	0.095	0.46
Ln (Age 65+)	2.827 **	4.25
Supply-side variables:		
Ln (Physician Income)	-0.029	-1.03
Ln (Specialist)	-0.004	-1.21
Female Physicians (%)	-0.009 **	-4.00
IMG (%)	-0.004 **	-2.41
Years of experience 16-25 (%)	0.004 *	1.86
Years of experience 26+ (%)	-0.002	-0.77
Number of observation		83
R-squared		0.995
Prob(F-statistic)		<0.001**

Note: Coefficients that are significant at the 10% level and 5% level are marked with * and ** respectively. Model includes RHAs fixed effects.

Table 5.1 shows that the regression results for most of the coefficients are estimated significantly at the 10% or 5% significant level. However, these estimated coefficients reflect only the relationship observed between the GP level and the independent variables based on their historical values and co-variation overtime. They do not represent the

causality.

For the demand side variables, the coefficient for total female population variable is estimated negative, meaning that 1 % increase in the female population lowers the level of GPs for more than 3.8 %.

The children age group coefficient is estimated to be positive at 0.457 with respect to the natural log of GPs in the analysis. It is expected that 1 % decrease in the children population leads to a less than half percent decrease in the level of GPs. On the other hand, the marginal effect of senior age group is estimated to be positive as well at 2.827, meaning that if there is 1 % increase in the senior population, there would be an increase of 2.8 % of the level of GPs.

From the supply side variables, the coefficient for the natural logarithm of physician income is estimated negatively at -0.029. This negative estimate shows the inverse relationship between the physician number and their income level. Therefore, if there is 1 % increase in the average payment per active GP (a proxy for the physician's own income), the level of GPs will fall by 0.03 % according the estimated relationship.

In the analysis, the estimated substitution effect between GPs and specialists is not significant. While the gender difference for GPs is estimated negatively at -0.009 meaning that if there is 1% female GPs increase, the level of GPs in the market will fall by 0.9%. On the other hand, the place of graduation difference for GPs is estimated negatively at -0.004, which also shows an inverse relationship between the level of GPs and the proportion of IMGs in the market.

The relationship between the level of GPs and their years since graduation is estimated to be positively related in the regression analysis for GPs with lower seniority. The estimated coefficient is not significant for physician with 26 years of experience or more. Alternatively, if the physicians graduated in between 16 to 25 years, the estimated coefficients show that there will be a 0.4 % GPs increase if 1 % GPs increase in that

group. This observed increase in the group with lower seniority might reveal their higher career desires compared to their colleagues with higher seniority.

5.2 Within- and Between-groups estimation

To learn more about the least squares dummy variable (LSDV) model under the fixed effect approach, the total variation of the variables are decomposed in this panel data set to analyze the between- groups variation and the within- groups variation.

Table 5.2 shows the decomposition of the total variation for each variable of the LSDV model. The first column is the variables included in the analysis. The second column is the proportion of the within-group variation of the variable. This is the statistic that shows how much this fixed effect panel data set is different from the cross section.

Table 5.2: Analysis of Variance

	Within-Groups Variation (%)	Between-Groups Variation (%)
Demand-side variables:		
Ln (Female)	69.31	30.69
Ln (Age <10)	6.45	93.55
Ln (Age 35 – 64)	2.12	97.88
Ln (Age 65+)	22.08	77.92
Supply-side variables:		
Ln (Physician Income)	0.04	99.96
Ln (Specialist)	0.00	100.00
Female Physicians (%)	0.00	100.00
IMG (%)	0.00	100.00
Years of experience 16-25 (%)	0.00	100.00
Years of experience 26+ (%)	0.00	100.00

The third column shows the heterogeneity of the variables (Greene, 2008). The results of the variance analysis suggest that most of the variations in the supply-side data are

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between groups, meaning that cross-sectional variations remain strong among the supply-side data. On the other hand, the data from demand-side variables show much higher within-groups variations compare to that in the supply-side. This reveals that the time variation for the demand-side estimators are significant and distinguish this panel data set from the cross sectional one. Therefore, the fixed effect LSDV model in this analysis is still worth performing to identify the degree of variation within health regions.

5.3 Group Effects Significance Test

In this fixed effect regression, the significance of the group effects is tested to determine the degree of difference across groups. This is done by testing the hypothesis that all the individual specific dummies are equal, means that group effects are zero, with the F-test.

$$F(n-1, \ nT-n-K) = \frac{(R^2_{LSDV} - R^2_{Pooled})/(n-1)}{(1 - R^2_{LSDV})/(nT-n-K)}$$

(6)

The F ratio used for the test is shown in equation 6. The efficient estimator is pooled least squares (Pooled) under the null hypothesis of equality, while the alternative estimator is the least squares dummy variable model (LSDV) under the alternative hypothesis that the individual specific dummies are not equal (Greene, 2008). The results of the fixed effect and the pooled least squares model are shown in Table A3.

As shown in Table A3, the LSDV model indicates the model under fixed effect approach where each RHA are assigned with one specific coefficient other than the constant term. On the other hand, the pooled least square model indicates the restricted model with only one single constant term.

From the regression results shown in Table A3, the R-square is estimated as 0.995 and 0.985 respectively for the LSDV model and the pooled least squares model. The *F*

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ratio for the group effects significance test would be:

$$F(12\text{-}1, 996\text{-}12\text{-}11)=\frac{(0.995\text{-}0.985)/(12\text{-}1)}{(1\text{-} 0.995)/(996\text{-}12\text{-}11)}$$

$$F(11, 973)=187.13$$

The critical value for the F statistic with 11 and 973 degrees of freedom at 5%

significance level is 1.79. Therefore, the null hypothesis that group effects are zero is

rejected. This means that the group effects in this analysis are significant which support

the results of the LSDV model and the projections based on it.

5.4   Projection for Saskatchewan GP level based on Scenario 1

In scenario 1, the influence of the projected proportional changes for senior and

child age groups are examined according to the 'Saskatchewan Health Population

Projections 2006-2021' (Saskatchewan Health, 2002). This scenario is analyzed at the

provincial level first and is then extended to the RHA level with the corresponding RHA

population proportion projections.

5.4.1   Projections at Provincial level

This scenario is performed based on the projected proportion of senior and child

age groups for Saskatchewan in the next 15 years. As observed in Figure 5.1, the

population aged 0 to 9 increases from 12.4% to 12.5 % and number of people aged 65

and above increases by 24.3 % from 2006 to 2021 in Saskatchewan.

Besides the projected population levels, the GP projection requires also the

estimated marginal effects from the regression result under the econometrics approach.

The least squares dummy variable (LSDV) regression model is performed previously in

chapter 5.1 to capture the variation of other factors in the market and provide the

estimated marginal effects to the GP level. With this estimated coefficients, next, the GP

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projection is performed based on the regression function evaluated and on the latest available data at 2006.

Projection begins with the observed historical information at year 2006 for all variables being applied to the estimated equation (5).

Figure 5.1: Population Projection in Saskatchewan (2006-2021)
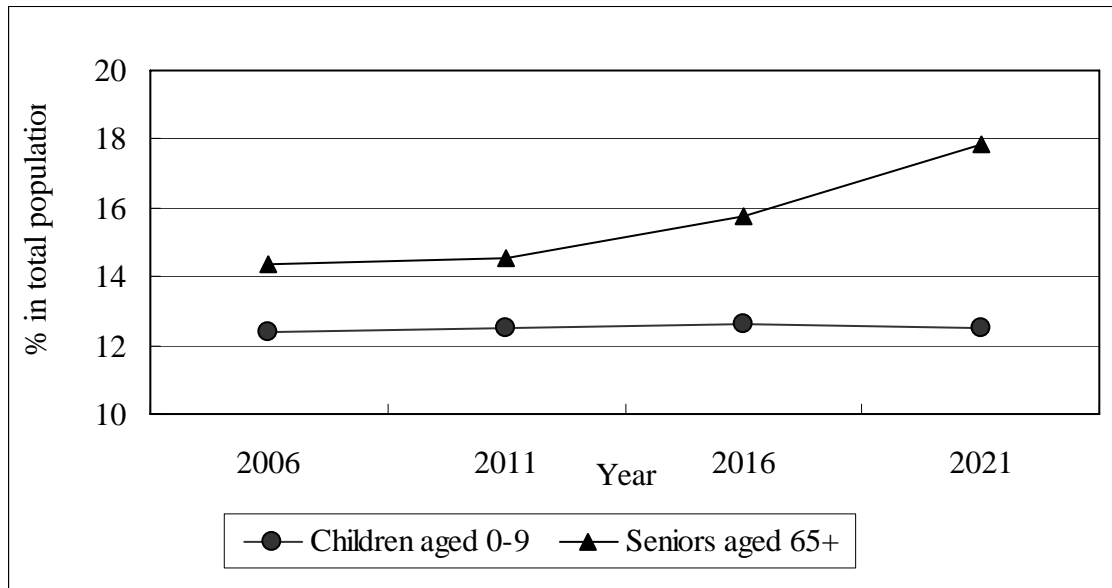
Source: Saskatchewan Health (2002)

As shown in Figure 5.1, the children and seniors age group in total population are observed at 12.4% and 14.3% respectively in 2006 and are projected to increase to 12.5% and 17.8% respectively in 2021.

Then, to project the GP level, the projected level of child and senior age group in 2011, 2016 and 2021 are applied to the equation with the rest of the variables remain constant at the year 2006 level. The GP level (in natural logarithm format) at 2011, 2016 and 2021 are thereby estimated to be 6.93, 7.17 and 7.51 respectively.

Figure 5.2: Projection in Saskatchewan under Scenario 1
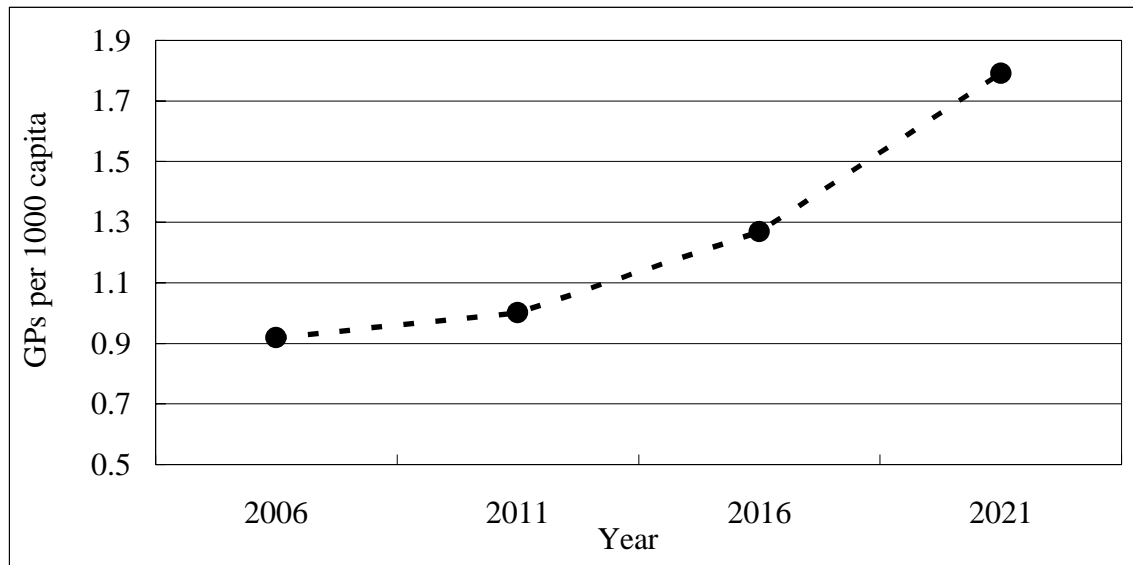
Using the projected population from Saskatchewan Health at each corresponding projection year, the GP level from natural logarithm format is then converted in terms of numbers of thousand capita for 2011, 2016 and 2021. Figure 5.2 shows the projected number of GPs per 1000 capita for the next 15 years based on the panel data regression analysis. It shows that Saskatchewan overall GP level reaches 1.0, 1.27 and 1.79 GPs per 1000 capita respectively in the year 2011, 2016 and 2021 under the assumption that only child and senior age group vary at the corresponding years.

According to the observed information in year 2006, Saskatchewan contains 1,000,926 total population and 0.92 GPs per 1000 capita. Under these observed values and the projected GPs level, it estimates that an increase of 0.08 GPs per 1000 capita from 2006 to 2011, which equivalent to an expected increase of 80 GPs from 2006 to 2011. For a longer range projection, the expected increase of GP level reaches 350 GPs for the period 2006 to 2016 and the highest expected increase occurs in 2006 to 2021 at a level of 870 GPs according to the projection for overall RHAs in Saskatchewan.

The projections above show that projected number of GPs in 5 years interval. In

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order to calculate the projected number of GPs for each year, I assume that the expected change will be the same for each year within the corresponding 5-year interval. Hence, I use the following formula to calculate the expected annual rate of change in the number of GPs:

(number of GPs observed at 2006)*(1+ expected annual rate of increase) $^{\text{(number of years)}}$ = total GP estimated at the projection year

Using the formula above, I estimated that the annual rate of change equals to 1.7% in the period of 2006-2011. This suggests that if we want to achieve the projected number of GPs in 2011, we need to increase number of GPs by 1.7% annually. If the projection targets set at 2016 or 2021 GP numbers, the projection suggests that 3.0% and 4.34% annual increase for the number of GPs should be prompted by policies to accomplish the targets respectively for those two target years.

5.4.2   Projections at Regional Health Authorities level

For further analysis, the GPs projection is decomposed into 12 RHAs based on the population projections for each RHA from 2006 to 2021 at a 5-year interval. The population projection and the total population for year 2006 for each RHA are presented in Table A4 in Appendix for further reference in the individual RHA projection model.

Next, for GP level projection, the latest available information at each RHA is applied to the marginal effects in equation (5) for projecting its own level of GPs up to the year 2021, with the child and senior age group proportion varying at the year 2011, 2016 and 2021 projected rates.

Figure 5.3 presents the projection of GPs per 1000 capita for the 12 RHAs from 2006 to 2021 using the estimated marginal effects and the projected population proportion for each RHA.

Figure 5.3: Projections in Regional Health Authorities under Scenario 1
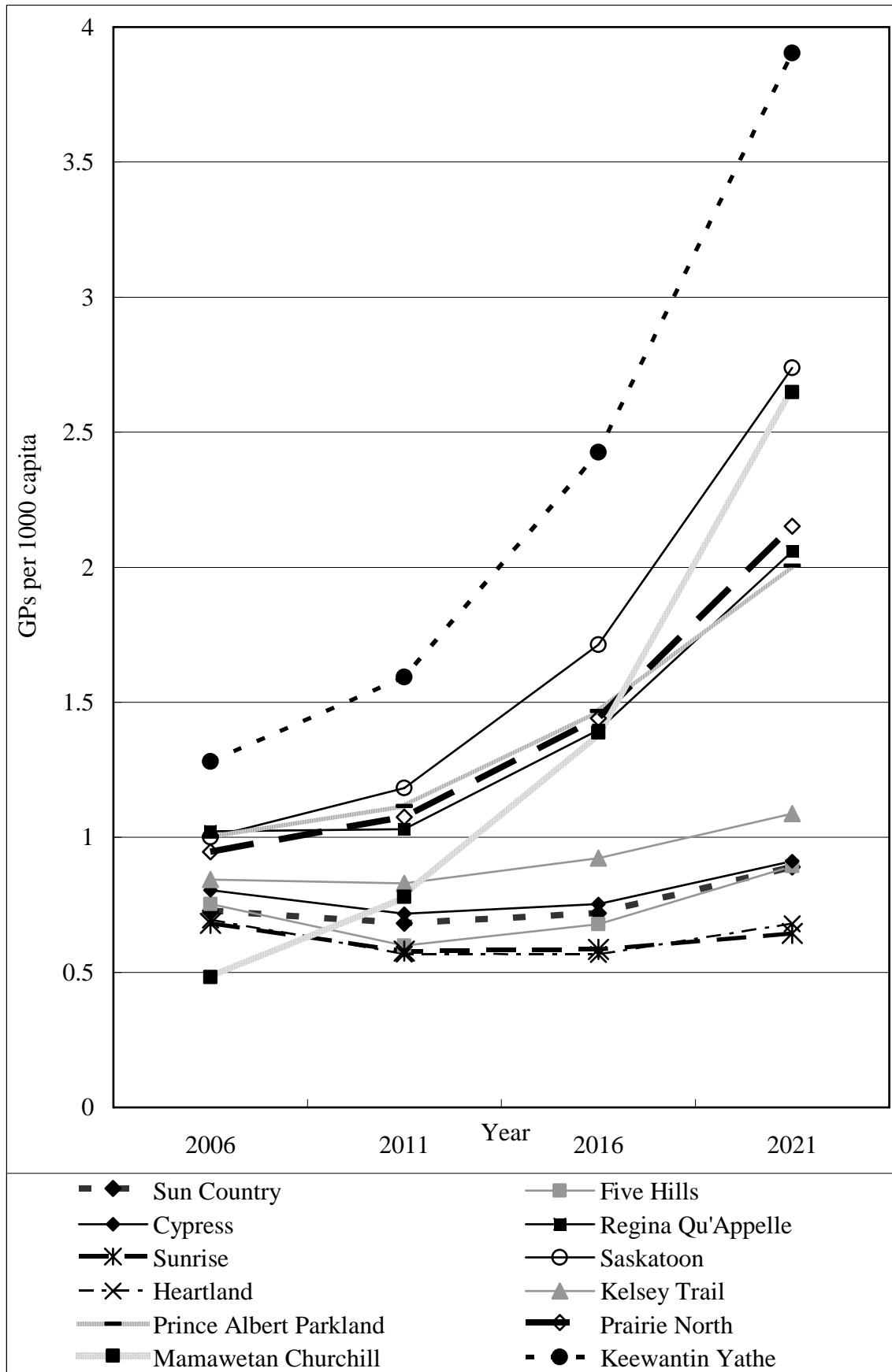
Among all 12 RHAs, Saskatoon RHA and the rural area, Mamawetan Churchill and Keewantin Yatthe RHA, show the highest estimated expected increase in GPs per 1000 capita from 2006 to 2021. The GPs per 1000 capita for these three RHAs are expected to rise from 1.02, 0.51 and 1.32 in year 2006, to 2.74, 2.65 and 3.9 in year 2021 for Saskatoon, Mamawetan Churchill and Keewantin Yatthe RHA respectively if the child and senior proportion will change according to projection. Using the 2006 total population from these three RHAs, which are 285,763, 21,738 and 11,359, the changes are equivalent to an expected increase of 490, 47 and 29 GPs at year 2021 for these three RHAs respectively. This also represents an expected increase in GPs at an annual rate of 6.4%, 10.7% and 7.2% for Saskatoon, Mamawetan Churchill and Keewantin Yatthe RHA for the next 15 years respectively.

From Figure 5.3, there are two other groups that show similar projected GPs per 1000 capita from year 2006 to 2021. The first group is RHAs that contain metropolitan areas such as Regina Qu'Appelle, Prince Albert Parkland and Prairie North RHA. The GPs per 1000 capita for these RHAs are projected to rise from 1 to an average of 2.07 from year 2006 to 2021. This means that for Regina Qu'Appelle, Prince Albert Parkland and Prairie North RHA, 252, 77 and 86 more GPs are expected respectively from year 2006 to 2021 under the total 2006 population for the corresponding RHA. Taking into consideration of the expected annual rate of GP increase, 4.7 %, 4.5% and 5.1% respectively for these three RHAs are expected to increase for each year until 2021 to achieve the projected level under the assumption that projected population will change.

Another group of RHAs that show similar projected GPs per 1000 capita contains the urban communities, which includes Sun Country, Five Hills, Cypress and Kelsey Trail RHA. These RHAs are projected to have expected increase in GPs for the next 15 years with 0.77 GPs per 1000 capita in year 2006 on average, increase to an average of 0.95 GPs per 1000 capita in year 2021. Using the average observed population in 2006

for these four RHAs, which is 47,950 capita, around 8 GPs increase are projected on average from 2006 to 2021 under the projected RHA population changes. These expected number of GPs increases in total for the next 15 years implying that, on average, these RHAs require a 1.3% annual rate of GPs increase to achieve the projected level until 2021.

From Figure 5.3, Sunrise and Heartland RHA show a slight decrease in the expected GPs per 1000 capita for year 2011 but an increase afterward. Under the projected analysis, the change in expected number of GPs closes to zero for these two RHAs. This reveals that the projected population changes have almost no effect on the expected GPs level for the next 15 years.

5.5 Projection for Saskatchewan GP level based on Scenario 2

Scenario 2 presents results for the influence of average physician payment variation on the expected level of GPs. This average payment per GP variable is used as proxy to the average GPs income in the analysis. Based on the Average Payment per Physician (APP) Report (CIHI, 2001-2006), the percentage change in average payment per fee-for-service GP from period 1996 to 2005 for Saskatchewan are used to perform a trend of percentage change. Next, the average payments per GP from 2006 to 2021 are projected by applying this percentage change trend to the observed value at 2006. Figure 5.4 shows the historical trend for the percentage changes of the average GP payment from 1997 to 2005.

Figure 5.4: Percentage change in payment for GPs (1997-2005)
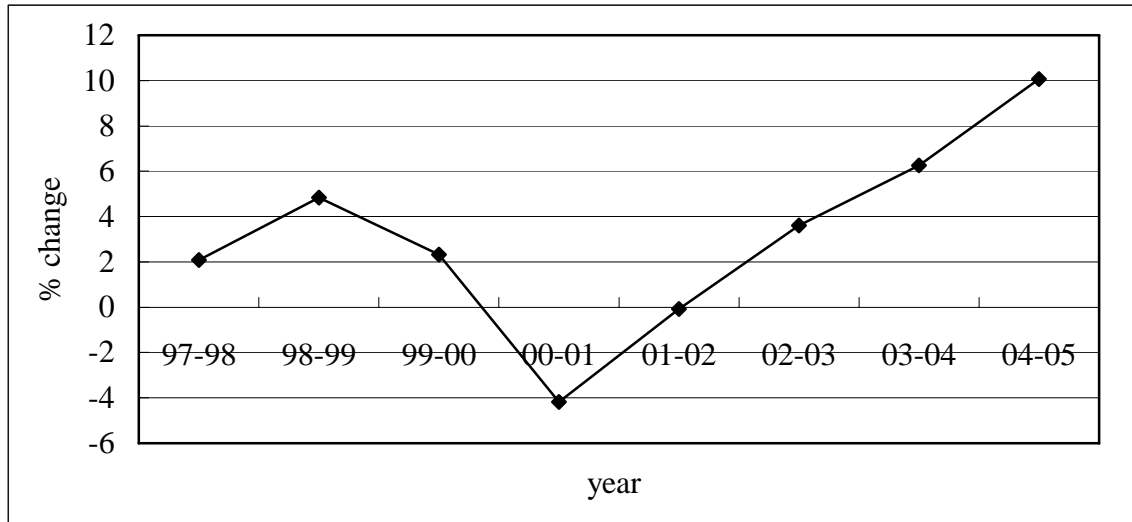
In the second scenario, the average GP payments for 2006-2021 are assumed to change according to the historical trend and the rest of the variables remain at 2006 observed level. Then, the GP levels are projected for the next 15 years based on the above assumption.

Figure 5.5 presents the projection results based on the hypothesis that only average GP payment changes with the rest of the factors remain unchanged at year 2006.

Figure 5.5: Projection in Saskatchewan under Scenario 2
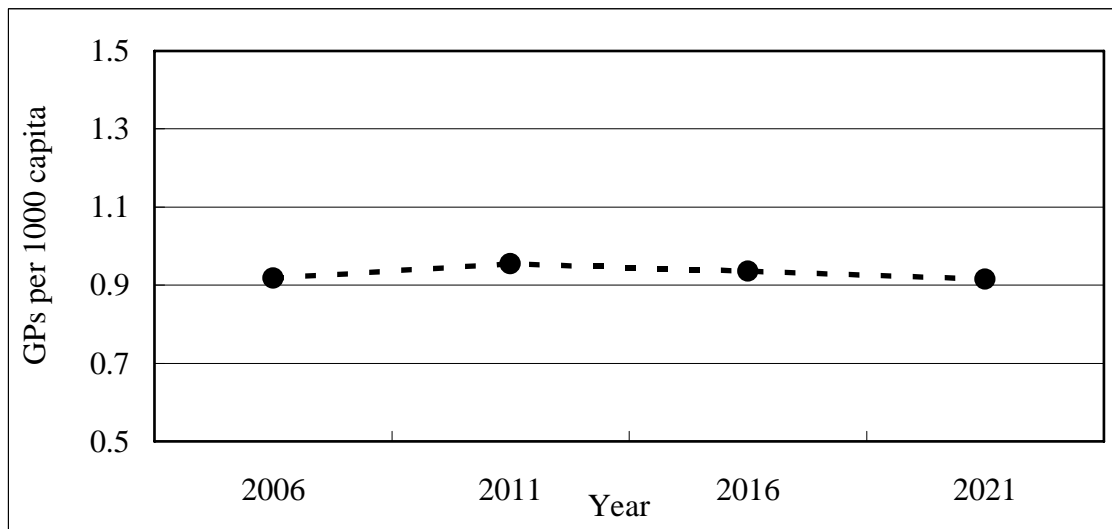
Unlike scenario 1, the projection under scenario 2 predicted a decrease of GPs per 1000 capita from 0.918 at 2006 to 0.915 at 2021 for Saskatchewan. Using the year 2006 total population of Saskatchewan, the result implies that an expected decrease of 3 GPs at 2021 is seek if the average GPs payment grows according to the historical trend for the next 15 years. The projection model under this scenario is not extended to the RHA level due to the lack of information for the average GPs payment variable at the RHA level.

5.6 Projection for Saskatchewan GP level based on Scenario 3

This scenario takes into account both the population profile and the average payment per GP variation for projecting the level of GPs at 2011, 2016 and 2021. In this scenario, only child population, senior population and average payment per GP variables vary in the model at the corresponding years, with the rest of the factors remain constant at the base year 2006 level. Figure 5.6 shows the GPs per 1000 capita projection for Saskatchewan under both population proportion and average GPs payment changes.

Figure 5.6: Projection in Saskatchewan under Scenario 3
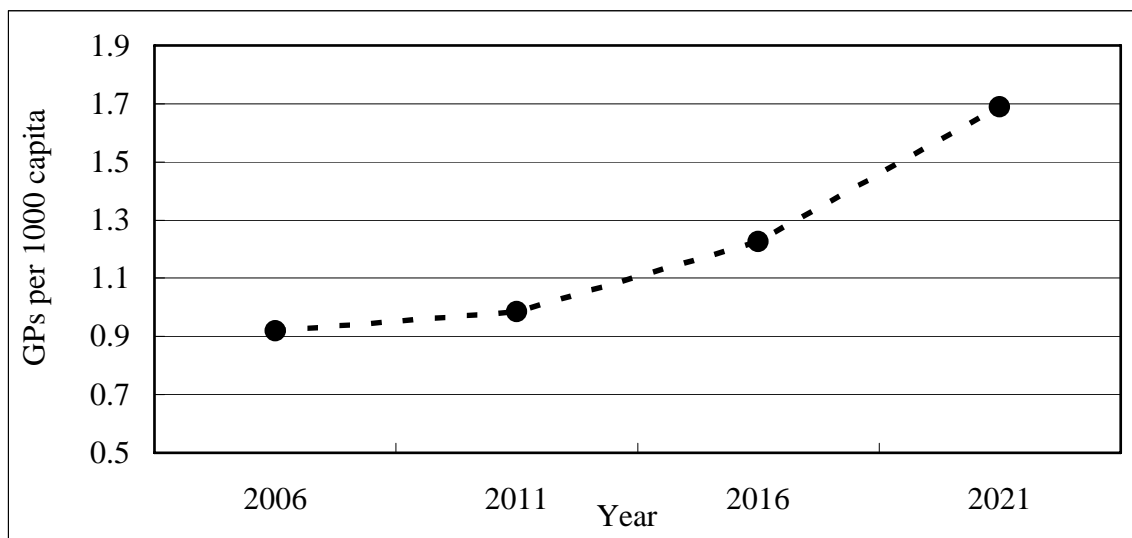
The projection under scenario 3 predicts a lower GP level increase from 0.92 GPs

per 1000 capita in 2006 to 1.69 GPs per 1000 capita in 2021 for Saskatchewan compared

to that in scenario 1. This projection represents an expected increase of 772 GPs for the

next 15 years in Saskatchewan, with the total numbers of GP at 1752 are expected at

2021, based on the 2006 total population. The results imply that if the projection target is

set at 2021, 3.9 % annual growth of GPs are estimated for the next 15 years under both

projected population profile and average payment per GP changes.

CHAPTER 6

CONCLUSION

This thesis illustrates the econometric projection approach and applies the model for the Saskatchewan general practitioner (GP) workforce. This is based on the factual prediction of the population profile change, average payment per GP changes and the combination of both, to analyze their influence on the level of GPs in the future. The projection of GPs is based on the provincial level as well as the regional health authorities (RHAs) level for Saskatchewan in order to find out the influences for each RHA and to provide the policy makers with regional information to adjust the policies for health professionals' deployment accordingly.

The GPs projection is performed under three hypothesized scenarios using information at year 2006 as a baseline, while the selected factor(s) vary at year 2011, 2016 and 2021. Under scenario 1 with hypothesized population proportion changes, it is estimated that the GPs per 1000 capita increase from 0.92 at 2001 to 1.79 at 2021 in Saskatchewan. This projection represents a 4.34% annual rate of increase in the number of GPs expected by 2021. The projection results at the RHA level vary from region to region. The estimated GP level increases the most for the Saskatoon RHA and the two northern RHAs. The expected increase in GPs in Saskatoon RHA and two northern RHAs are 6.4% to 10.7% for each year until 2021. On the other hand, results from scenario 1 also suggest that for RHAs that contain metropolitan areas, the estimated GPs are expected to increase at an annual rate ranges from 4.5% to 5.1% until 2021; while for RHAs that contain urban communities, the estimated annual rate of GP increase is less than 1.5%. The estimated GPs are expected to decrease for Sunrise and Heartland RHA for the next 15 years but the annual rate of decrease are estimated to be close to zero.

Under scenario 2, projection is performed with the average payment per GP change

while the rest of the factors remain constant at the year 2006 level. Based on the

projected percentage change for the average payment per GP, the GPs per 1000 capita are

predicted to be 0.915 in 2021 for Saskatchewan. Scenario 3 combines both the population

profile and average payment per GP changes: The results show that 3.9% growth of GPs

is estimated for each year until 2021 for Saskatchewan. The projection is not extended to

the RHAs level for scenario 2 and 3 since information for the predicted average payment

per GP at 2006-2021 is not available at the regional level.

Increasing the admissions to the medical schools or lowering the waiting time for

certificated IMGs to practice would be a temporary way to relieve the pressure on GP

demand. But overall, improving the physical activities and health condition by educating

population and encouraging active life style would help lowering the overall health

service utilization. Cultivating the sense of belongings of the GPs practicing in

Saskatchewan by providing a better work environment would be another way to retain or

even attract more GPs to practice in Saskatchewan.

One of the advantages for using econometrics projection approach is that it allows

the consideration of all available information including physician or population data. This

creates reliable results since many historical variations are taken into account. Moreover,

the econometrics approach leaves rooms for further analysis since it could consider the

variation of one or more factors in the projection at the same time. Since factors in the

market are not changing alone, the econometrics approach provides more factual results

with the combination of more than one factors in the model.

It should be emphasized again that the prediction is not the actual needs for the

population. People's preference when new disease detected would change, hence, cannot

be easily predictable. It is the estimated relationship between selected factors and GP

levels with observed information from the past. Therefore, the marginal effects show only

the correlation between variables, not the causality between the factors.

There are some drawbacks on this analysis and some of them are caused by the lack of data. For instance, this model did not take into account all the factors that might affect the GP levels. One of the examples will be the population mental health condition and chronic condition. These health problems have raised public concerns increasingly and might increase the physician visit. Moreover, most of the information are not available at the RHAs level and thus not allowing the analysis to be extended and took into a deep look of each RHAs based on their specific characteristics that influence the GP level. The shortcomings continue with only head count information being considered and the differences in service nature between GPs and the rest of the health service providers are ignored.

Overall, a more complete database for Saskatchewan physicians is required for further planning purposes. One suggestion to create such a database is to send out comprehensive surveys to each RHA for obtaining information such as their current and projected physician FTEs, immediate additional and total additional physician needs for both direct and indirect health care services, and other responsibilities in each physician groups. Even though information obtained in a self-reported format is rather self-assessed for each health region, it would be more accurate for reflecting their own requirements as well as obtaining information on their future plans on foreseeable changes in health resources.

Figure A1: Map for the Regional health authorities in Saskatchewan
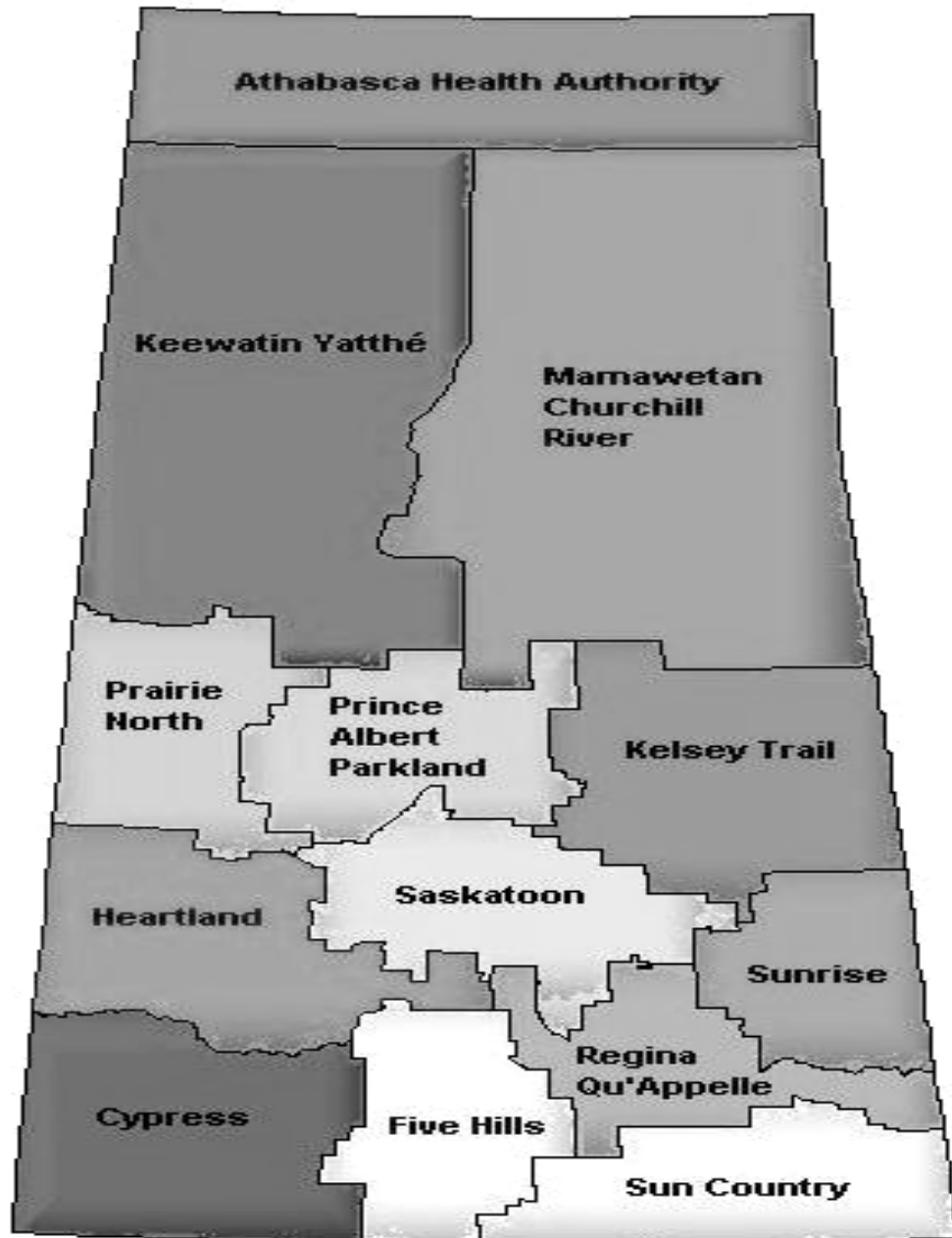
Source: Saskatchewan Health (2002)

Table A2: Fixed effect results for all models.

	(I)	(II)	(III)	(IV)	(V)	(VI)
Variables						
Dependent variable: Ln (General Practitioner)						
Constant	-1.66	-0.997	-1.152	13.835 **	13.586 **	14.081 **
	(-0.26)	(-0.13)	(-0.15)	(2.16)	(2.12)	(2.22)
Ln (Female)	-0.599	-0.920	-1.760	-3.884 **	-3.537 **	-3.871 **
	(-0.49)	(-0.65)	(-1.32)	(-3.72)	(-3.40)	(-3.29)
Ln (Age <10)	-0.403	0.013	0.866 *	1.091 **	0.931 **	0.457
	(-1.15)	(0.03)	(1.85)	(3.07)	(2.60)	(1.27)
Ln (Age 35 – 64)	0.602 **	0.587 **	0.524 **	0.013	0.056	0.095
	(2.49)	(2.38)	(2.30)	(0.07)	(0.31)	(0.46)
Ln (Age 65+)	1.039	0.977	0.421	1.943 **	1.668 **	2.827 **
	(1.57)	(1.24)	(0.57)	(3.26)	(2.77)	(4.25)
Ln (Physician Income)		-0.033	-0.337 **	-0.307 **	-0.317 **	-0.029
		(-0.92)	(-3.89)	(-4.38)	(-4.60)	(-1.03)
Ln (Specialist)			0.001	-0.003	-0.002	-0.004
			(0.19)	(-0.82)	(-0.53)	(-1.21)
Female Physicians (%)				-0.007 **	-0.006 **	-0.009 **
				(-3.12)	(-2.82)	(-4.00)

IMG (%)				-0.005 **	-0.003 **	-0.004 **
				(-4.62)	(-2.59)	(-2.41)
General Practitioner aged 50-64 (%)					-0.003 **	
					(-2.06)	
General Practitioner aged 65+ (%)					-0.001	
					(-0.34)	
Years of experience 16-25 (%)						0.004 *
						(1.86)
Years of experience 26+ (%)						-0.002
						(-0.77)
N	96	83	83	83	83	83
R-squared	0.990	0.990	0.993	0.995	0.995	0.995
Prob(F-statistic)	<0.001**	< 0.001**	< 0.001**	<0.001**	<0.001**	<0.001**

Note: Coefficients that are significant at the 10% level and 5% level are marked with * and ** respectively. t-statistics are in parentheses. All models include RHAs fixed effects.

Table A3: Comparison between LSDV model and Pooled Least Squares model

Dependent variable: Ln (General Practitioner)

	LSDV model		Pooled Least Squares	
	Estimate	**t-Statistic**	**Estimate**	**t-Statistic**
Constant	14.081	2.22	-3.721	-4.68
Demand-side variables:				
Ln (Female)	-3.871	-3.29	-0.616	-1.47
Ln (Age <10)	0.457	1.27	0.933	3.91
Ln (Age 35 – 64)	0.095	0.46	0.422	1.67
Ln (Age 65+)	2.827	4.25	0.363	2.54
Supply-side variables:				
Ln (Physician Income)	-0.029	-1.03	-0.137	-3.76
Ln (Specialist)	-0.004	-1.21	0.004	1.86
Female Physicians (%)	-0.009	-4.00	-0.008	-4.40
IMG (%)	-0.004	-2.41	-0.005	-5.01
Years of experience 16-25 (%)	0.004	1.86	0.006	4.13
Years of experience 26+ (%)	-0.001	-0.77	0.003	1.83
R-squared	0.995			0.985
F-Statistic	591.95			466.09

Note: The LSDV model includes the RHAs fixed effect.

Table A4: RHAs Population Projection for 2006- 2021

	Children (aged 0-9) (%)				Seniors (aged 65+) (%)				Total Population
	2006	2011	2016	2021	2006	2011	2016	2021	2006
Sun Country RHA	11.48	11.59	11.61	11.28	17.44	17.38	18.35	20.65	52,804
Five Hills RHA	10.46	10.84	11.08	10.79	18.03	17.87	19.15	21.83	53,921
Cypress RHA	10.99	10.76	10.95	10.8	17.97	18.07	19.02	21.17	43,303
Regina Qu'Appelle RHA	11.64	11.67	11.69	11.55	13.32	13.73	15.31	17.70	243,767
Sunrise RHA	9.65	9.83	9.79	9.37	22.44	22.75	24.18	26.70	56,199
Saskatoon RHA	12.08	12.02	12.05	11.96	12.92	13.31	14.81	17.14	285,763
Heartland RHA	10.94	11.45	11.85	11.60	18.22	18.33	19.28	21.86	42,657
Kelsey Trail RHA	12.02	11.87	11.76	11.34	18.34	18.83	20.37	22.64	41,770
Prince Albert Parkland RHA	13.95	13.73	13.74	13.60	13.51	13.9	15.21	16.93	76,459
Prairie North RHA	15.36	15.48	15.63	15.40	11.37	11.44	12.39	14.04	71,185
Mamawetan Churchill RHA	22.82	23.57	23.79	23.55	4.63	4.78	5.42	6.34	21,738
Keewantin Yatthe RHA	20.92	21.94	22.46	22.19	5.08	5.43	5.99	6.82	11,359

Source: Saskatchewan Health (2002)

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