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Original Paper

Predicting Future Physician Output for British Columbia, Canada

Aidan Gibbons[1] & Bosu Seo[1*]

[1] Department of Economics, University of the Fraser Valley, Canada

[*] Bosu Seo, Department of Economics, University of the Fraser Valley, 33884 King Road, Abbotsford, BC, Canada

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Abstract

This study looks at data since 2002 and estimates a prediction for the health care output by physicians for British Columbia. The measure used to capture this output is full time equivalence (FTE), developed by the Canadian Institute for Health Information to capture an aggregate level of output by physicians through the value of their billings. The paper uses past data to estimate future physician numbers for the province based on Canadian medical school graduates, interprovincial migration, as well as estimates for the number of physicians leaving the workforce and the number of foreign educated physicians entering the province every year. Taking this prediction for future number of physicians, along with data on the age and gender distribution of doctors, BC population estimates, and previous FTE data, a regression model is developed to predict the level of FTE in BC for 2018 to 2020. This research ultimately predicts a steady, but modest rise in FTE for BC in the next few years. However, whether this growth will continue beyond 2020 is unclear, and a rise alone does not necessarily mean that it will better address future demand as BC is currently experiencing a shortage in physician services, and the demand for health care is expected to rise with the increasing proportion of seniors to working age individuals in the province. This paper suggests that changes should be put in place to increase the number of seats available in Canadian medical schools to address the shortage of physicians in the long term, and that BC will have to increase the number of foreign educated doctors in order to address shortages in the short term.

Keywords

Physician services, supply of physicians, British Columbia, Full time equivalence

1. Introduction and Literature Review

For decades, research has been done looking at Canada's labour supply of physicians. As Nadeem Esmail's 2016 article on Canada's physician supply states, "most of these discussions and studies have come to the conclusion that there are too few physicians practicing in Canada" (Esmail, 2016). Esmail cites "unmet health care needs" in the country as well the comparison between other OECD countries in terms of physician to population ratio, 24th out of 28 in 2013 (Esmail, 2016). His paper goes over the history of Canada's physician to population ratio, and delves into some of the factors that have affected it over the years. The main feature of this paper is the extrapolated prediction for future physician to population ratios for Canada in the near future, using current graduation rates of Canadian medical schools as well as data collected from a 1998 paper which followed 1722 medical graduates. Esmail used data from this paper as estimates for graduation rates, the proportion of medical school graduates who remain to practice in Canada, and required replacement rates (from death, retirement, and movement out of the country) to maintain a constant physician to population ratio. Assuming a constant population growth of 3.3% (and that only Canadian educated physicians will be added to the physician supply), this paper found that "without a significant intake of foreign physicians, the physician-to-population ratio will fall in the coming years because there are not enough new doctors being trained in Canada" (Esmail, 2016).

In a similar paper by Lynda Buske, published in 2007, future physician supply was also estimated for the future, but this time using a different measure than physician to population ratio (Buske, 2007). Instead, this paper uses a measure known as full time equivalent (FTE), created by the Canadian Institute for Health Information. It is a "value based on billings for physician which can then be aggregated into average FTE values by age/sex/speciality cohorts" (Buske, 2007). Buske's paper explains that FTE is a more representative measure for physician supply. The example provided is the significant number of physicians over the age of 65, and how "obviously not all are working full-time" (Buske, 2007). This FTE measure provides information not on the sheer number of physicians in the area, but specifically on the level of output being generated by those physicians. Using this measure as well as resources and information from the Canadian Medical Association, Buske developed multiple models to look at expected FTE levels as far as 23 years into the future. The findings show that if variables and rates stay constant, FTE levels should slowly rise in the coming years. However, this paper also had "Reduced FTE Scenario" which accounted for the observed decrease in workload for certain age groups over the past decades (Buske, 2007). In this scenario, the predicted FTE levels remained relatively stable around the (at the time) current 2007 levels. With these findings, Buske noted that "various provincial reports indicate that Canada is short at least 4,000 physicians (or 6%) and 5 million Canadians say that they do not have a family physician", indicating that while the level of FTE is either slowing rising or staying stable, a constant level is not sufficient if Canada is currently at a shortage (Buske, 2007).

The paper "The Supply of Physicians in Canada" by Steven Globerman, Bacchus Barua and Sazid

Hasan (2018) offers a recent analysis on the topic of projecting the future supply of physicians. The main difference between the Globerman et al.'s paper and this one is the focus on Canada as a whole versus specifically British Columbia. The Globerman et al.'s paper (2018) first provides evidence for the persistent shortage of physicians in Canada. For decades, most papers analysing Canadian physician supply have discovered similar findings, but Globerman et al. finds that the problem still remains based on 2015. The two main indicators for a shortage of doctors in Canada is the percentage of the population unable to find a regular family physician, and the length of wait times observed in the health service sector. In addition, comparisons to other high-income OECD countries show that Canada ranks near the bottom in nearly every measure of supply of health care services. Data looking at providing medical care between Commonwealth countries arrives at the same conclusions, with Canada ranking poorly in comparison to those nations as well.

However, "The Supply of Physicians in Canada" (2018) points out that there is conflicting evidence against a shortage of physicians. One example is the findings by the Royal College of Physicians that "16% of new specialist and subspecialist physicians said they could not find work". Along these same lines, Globerman et al. also cites a paper by Plourde (2016) in which he argues that it may be a regional problem, with shortages mainly experiences in rural areas, not in urban areas. Other arguments included feature some who believe that the problem is more so the "lack of doctors willing to work as general practitioners and not a lack of doctors more generally" (2018). The complete opposite argument from Globerman et al.'s original discovery of evidence is the paper by Barer and Evans (2013) warning that the growth in the number of physicians in Canada will lead to a surplus of doctors.

One key problem with this issue, pointed out by Globerman et al., is that economically speaking, shortages are a mismatch between supply and demand, but medial services in Canada is not supplied normally like other market goods and services. Physicians themselves are also only one input required for the delivery of medical services, and the efficiency of Canadian doctors may not be the same as other OCED countries, which would make comparisons between them inappropriate. On the other side, demand of health care services is difficult to quantify, with age (the most common factor used to roughly estimate demand) as not the only factor relevant to the demand of health care services. That being said, physicians are still clearly a significant factor for the delivery of medical services to those who require them, and a potential shortage of physicians in Canada would pose a serious problem to the entire country. In addition, the paper "Canada's Physician Shortage: Effects, Projections, and Solutions" by Esmail (2006) points out the benefits of having an increased physician to population ratio, such as reducing mortality rates of all kinds (premature, all-cause, heart disease, infant and perinatal) as well as increased life expectancy at the age of 65.

Continuing on with the paper "The Supply of Physicians in Canada" (2018), it looks at the physician per capita growth for Canada as a whole as well as for the 3 most populous provinces (Ontario, Quebec and British Columbia). This data is one example of the differences of this issue between provinces. One example is the average annual rate of growth for physicians per capita in the years 2010-2015. Ontario

experiences a 3.0% increase in physicians per capita (doubling the growth from the 5 years prior) while BC only saw 1.4% growth (which was the same level as the 5 years prior). While it may seem obvious, dealing with a potential shortage of physicians in Canada is not simply a matter of increasing the number of physicians. It is more crucial to make sure that physicians are being supplied to provinces, and more specifically municipalities, that are experiencing a shortage. This would follow the argument made by Plourde (2016) that it is more specifically a regional issue than simply a national one. On this same topic, Globerman et al. (2018) cites that "more than 90% of physicians were registered in urban locations", but Statistics Canada (2011) shows that 19% of the population lives in rural areas as of 2011 (20% in both 2006 and 2001). Granted it is likely that patients will travel to these urban areas for medical services if the cannot receive proper treatment in their rural locations, but even so, almost 20% of the population is living in the same area as less than 10% of the working physicians. The issue of physician shortages in Canada may very well, as Plourde (2016) suggests, a regional issue. If this is the case, future policy addressing the issue of physician shortages should account for this.

The model used in the Globerman et al.'s paper (2018) is similar to the first model used in this paper. Their model predicts the number of physicians in the labour supply for the years 2016 to 2030. In this model employed by Globerman et al., residents are also included in the measure of physicians, similar to that used by the OECD. This of course makes for more appropriate comparisons between other countries. Using the total labour supply of physicians in 2015, Globerman et al. forecasts the labour supply for 2016. To do this, physicians are added into the labour supply through enrollment into residency programs, physicians returning to Canada from elsewhere, and immigrating physicians. Physicians are removed from the model by estimating the levels of retirement, death and emigration. Entry into residency programs is forecasted from the number of Canadian medical school graduates (based on the medical school enrollment from 4 years prior). This paper assumes "status quo" for most of its estimates, that statistics such as enrollment rates, Canadian physicians returning to the country, and the number of immigrating physicians will remain constant throughout the span of the prediction. These estimates are based off of the averages observed from 2011-2015 The paper discusses potential implications for if some of these factors do change in subsequent sections. For the forecasting of those leaving the labour supply, retirement is the most crucial factor. Using the 2015 physician labour supply broken down by age group, age specific exit rates (from retirement or death) are used based off of 2013-2015 data. Each physician remaining in the labour supply is then aged by 1 year (assuming a uniform distribution within each age group), and the process is repeated all the way up to the year 2030. Estimating emigration of physicians is done by taking the average emigration from 2011-2015 and applying this rate to the level or predicted physicians for the years throughout the prediction.

Their predictions find that Canada should expect to increase its physician to population ratio for the years up to 2013, but this expected to be only a slight increase. If immigration of foreign educated physicians is excluded, the increase is even more minute. Globerman et al. (2018) point out that their prediction for Canada's physician to population ratio for the year 2030 is still less than 3.0 per 1000,

while the OECD average is close to 3.4 in the year 2015. The paper then goes on to discuss hours worked by physicians, touching on the idea that not every physician produces the same amount of output. The factors of gender and age are mentioned as things that can impact the average hours worked by a physician, citing that females and older physicians tend to work less hours. However, the paper does not discuss changes in hours worked by physicians overall, which is lower in 2017 than it was in 1997, both in measures of total hours and hours of direct patient care (Canadian Medical Association, 2017). Instead, Globerman et al. (2018) uses the Canadian Medical Association's estimates for both number of physicians and Full Time Equivalent physicians, using the ratio between these two figures to come up with equivalent FTE estimates based on their own predictions for number of physicians from 2016-2030.

The Globerman et al.'s paper (2018) also provides policy suggestions to address the issues brought up in their research. This includes increasing "fee-for-service payments to physicians to encourage them to work longer hours and to remain in the work force longer than they otherwise would", expanding the use and supply of "substitute health-care providers like nurse practitioners and physicians' assistants", increasing the number of seats available for Canadian medical school enrollment, and increasing "immigration of foreign-trained physicians to practice in Canada". However, in reference to this last suggestion, Esmail (2006) argues that it is "irresponsible for a wealthy, developed nation with a highly educated population to rely on international medical graduates (IMGs) to deliver health care to the population", citing that immigration of doctors from poorer nations is depriving these countries of doctors who they need much more than Canada does as a developed country. In addition, it causes a reliance on this inflow of foreign educated doctors, when there are numerous Canadian hopeful medical students who are trying to compete for the limited number of spots available to them in Canadian medical schools. It is unclear whether the policy suggestion by Globerman et al. is a long-term idea conflicting with Esmail, or if it is recognition of Canada's current inability to meet the demand of medical care services without the intake of foreign educated doctors. To this point, it would take many years for any policy relating to increasing the seats available for medical school enrollment to be felt in the labour force due to the 4 years required to complete the medical degree as well as the duration of residency. Lastly, Globerman et al. (2018) also discusses potential policy changes relating to the demand side of health services, including "the implementation of deductible and co-pays in provincial health-insurance plans", with the intended effect of reducing health care usage without any adverse health effects.

The purpose of this paper is to focus on specifically British Columbia, rather than Canada as a whole, and estimate the future output of physicians. Similar to the Buske paper, this research will look at FTE as a measure for physician output instead of just the physician to population ratio. This will provide a more accurate representation of the real supply that will be felt by the BC population rather than just physician to population ratio, capturing the aggregate workload of the physician labour supply as a whole. Much like the Esmail paper, research done in "The Class of 1989" paper will be used for the

estimates of certain data such as graduation rates and replacement rates of doctors. As stated in the paper by Buske, things can "be hidden at the national level" in terms of physician supply (Buske, 2007). Factors such as recruiting Canadian medical graduates, interprovincial migration of doctors, and differences in population growth rates. Research looking at Canada as a whole averages the data out to the point where it may not be representative of any province. By focusing on one specific province, it is able to capture the effects of these different factors.

2. Data and Methodology

The data collected for this research was primarily obtained from the Canadian Medical Association. This source was able to provide data on demographics and supply of physicians, interprovincial migration, enrolment and graduation statistics for Canadian medical school students (including postgraduate training data), and physician workload by sex and age. Many of these statistics were broken down by speciality, but for the most part, this paper focused on total physicians. Also, some of the data was broken down by province, however not all of the time series data was similarly broken down this way. As a result, some of the BC specific data was missing, and so Canada-wide data was used and it was assumed that the statistics were representative of British Columbia (this includes age and gender distribution of physicians). That being said, most of the most recent data sets included provincial breakdowns, but just for the most recent year. Therefore, the most recent data was able to be competed to see if at least the Canada data closely matched up with BC's for the most recent year.

Data for the FTE measures for BC was collected from the Canadian Institute for Health Information. Their National Physician Database data release provided FTE statistics for BC, broken down by specification, from 2002 to 2016. As a result of this timeframe, the second model (as explained later), only used data which would apply to these years to develop the regression model. These 15 years of FTE data provided the dependant variable when developing this model.

Finally, BC Stats was used for the information on the population of British Columbia. The statistics included the population numbers from 1971 to 2016, as well as predictions for future population levels up to the year 2041. In addition, this data source also included the senior dependency ratio for each year, including the future years. This ratio is calculated as the population aged 65+ divided by the age of the population aged 18-64. This senior dependency measure is used later in the paper as a way of capturing expected future health care demand.

2.1 Full-Time Equivalent Physicians

In this paper, the measure of full-time equivalent physicians (FTE) is used instead of simply the raw number of physicians. The reasoning behind this is that it offers a more comprehensive measure for the level of medical services being delivered to patients. An example would be a semi-retired physician who has a significantly reduced work schedule, compared to a doctor working more hours than the average physician. If looking at just the number of physicians in the countries, both of these doctors would be counted equally. However, using FTE, it adjusts for the semi-retired worker to count as less

than a "full-time equivalent physician", and would similarly adjust the physician working longer hours to count as more than his/her full-time equivalent.

Number of physicians therefore was not a complete measure for a physician's output. In fact, it is more of an input into the health care service sector. Hours worked was also considered, but then again, much like physicians, not all hours put into the medical field are equivalent. If a physician arrives to their practice an hour early to do administrative work, that is not exactly equal to spending an hour of overtime to treat half a dozen more patients. Again, hours worked is an input factor, not a complete measure of output. Services provided is certainly a measure of output, but it does not give any measurable value as to the difference between say treating a cold or performing heart surgery. Therefore, what was landed on was expenditure. Expenditure measures output while also giving a value and weight to specific services provided (weighted by the fees of each service). For this reason, the CMA uses gross income per physician as a measure of their output. Rather than choose a single point to be considered exactly one full-time equivalent, a range was determined, in this case anywhere between the 40th and 60th percentiles of gross income are measured as 1 full-time equivalent physician (research shows that any symmetric benchmarks would provide similar results if they were also symmetric around the midpoint, such as 30th and 70th percentiles). By using percent thresholds (instead of dollar figures), it prevents altering the data from purely nominal changes to the billings, and it also adjusts itself for any changes to the average or standard deviation of physician incomes.

Using this method, if a physician is below the 40th percentile in terms of gross income, they are counted as a fraction of a full-time equivalent, whereas if they earn more than the 60th percentile mark, they are counted as more than one full-time equivalent physician. However, the measure for FTE is not linear for those earning above the 60th percentile mark, instead it is logarithmic (as shown in Figure 1). The Canadian Medical Association states that the reasoning for this is "to prevent high-income physicians from having a very large FTE" (2017). Instead, with using a logarithmic scale, a physician earning 3 times the 60th percentile benchmark is counted as an FTE of 2.1 instead of 3.

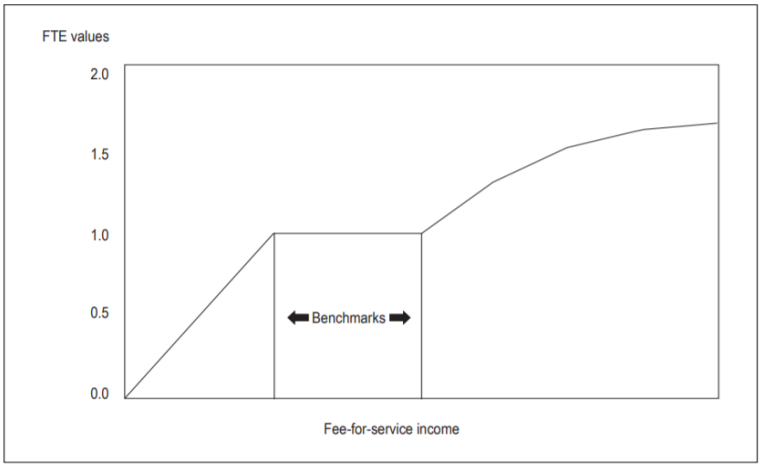

Figure 1. Defining FTE Using Logarithmic Function

In order for the measure to be comparable across provinces, the CMA adjusts for fee differences between provinces, and the benchmarks are then set at a national level and adjusted back to give the provincial benchmarks for the 40th and 60th percentiles.

The process of calculating FTE for a physician is as follows. If the physician falls below the lower (40th percentile) threshold of gross earnings, then you simply take their level of annual earnings divided by the lower threshold amount. If the physician falls between the 40th and 60th percentile benchmarks, then their FTE is considered to be 1. If the physician's gross income is higher than the upper (60th percentile) threshold, then their FTE is 1 + ln(their income ÷ upper benchmark amount) where ln is the natural log. This calculation in pictorial form as provided by the Canadian Medical Association (2017) is shown in Figure 2.

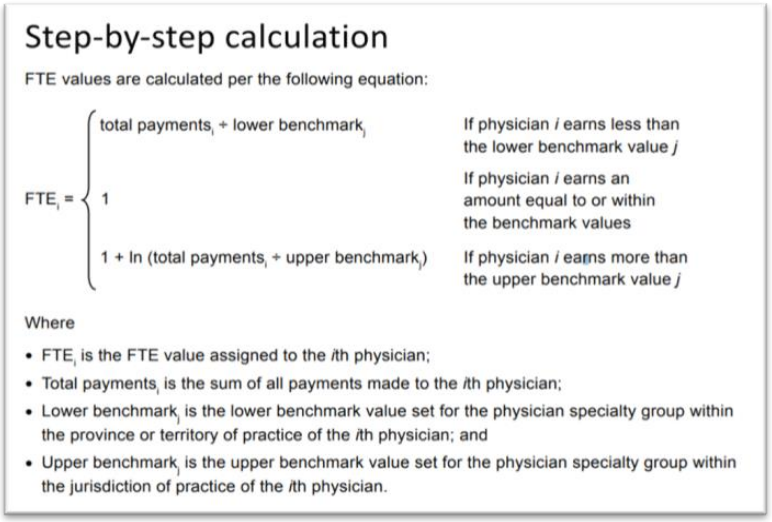

Figure 2. Canadian Medical Association Definition of FTE

3. Mathematical Models

The first model predicts the number of physicians in BC for a given year using the factors affecting the inflows and outflows of working physicians.

$$L_t = (1+\alpha-\beta)L_{t-1} + \gamma G_{t-5} + NIPM \quad \text{(Equation 1.1)}$$

L_t = Physician labour supply for year t

α = Annual rate at which foreign trained doctors enter the province

β = Percentage of the labour supply that leaves every year (from death, retirement, emigration)

L_{t-1} = Physician labour supply for the previous year

γ = Percentage of Canadian medical school graduates that are added to the BC physician labour supply

G_{t-5} = Number of Canadian medical school graduates 5 years prior (to account for length of residency)

NIPM = Annual Net Interprovincial Migration

The second model is a regression model to predict the level of FTE for a given year in BC. This equation includes several factors that may affect the level of FTE. In the next section, after backwards

elimination is performed, the updated regression model is presented (Equation 2.2) which includes only the significant factors (significance level of 0.10).

$$FTE_t = a + bL_t + cL_{female} + dL_{<35} + eL_{35\text{-}44} + fL_{45\text{-}54} + gL_{55\text{-}64} + hL_{65+} + iPop_t \quad \text{(Equation 2.1)}$$

FTE_t = Full-Time Equivalent Physicians for year t

a = Regression intercept

b, c, d, e, f, g, h, i = Regression coefficients for their respective factors

L_t = Physician labour supply for year t

L_{female} = Percentage of physicians who are female

$L_{<35}$ = Percentage of physicians who are under the age of 35

$L_{35\text{-}44}$ = Percentage of physicians who are between the ages of 35-44

$L_{45\text{-}54}$ = Percentage of physicians who are between the ages of 45-54

$L_{55\text{-}64}$ = Percentage of physicians who are between the ages of 55-64

L_{65+} = Percentage of physicians who are 65 years and older

Pop_t = Population of BC for year t

3.1 Model 1

The first model of this research is to predict the number of physicians in BC for the future. To do this, it required gathering data on all of the factors affecting this number. First was the number of new physicians added to the BC workforce, specifically Canadian educated doctors. The Canadian Medical Association provided data for the number of medical degrees awarded to Canadian students every year, but the problem is estimating how many of these Canadian graduates end up working in BC. The Class of 1989 study by Ryten, Thurber and Buske showed that 13% of Canadian medical school graduates were active in BC in 1996. Using this information, this model took the number of medical school graduates, and assumed that 13% of them would be added to the BC doctor supply 5 years following graduation (to account for postgraduate training which is typically 3-5 years). Next was to estimate the number of physicians leaving the workforce. This includes those physicians who die, retire, or move out of the country. Again, using data found in the Class of 1989 study, it found that about 2% of the physician supply needed to be replaced every year due to these factors. Additionally, the number of physicians moving from one province to another (specifically the net change in physicians from interprovincial migration for BC) needs to be taken into account. The Canadian Medical Association data showed that from 2007 to 2015, British Columbia gained an average of 40 physicians per year, with only one year (2011) of the province having a net loss of physicians. Therefore, the model assumes a constant increase of 40 physician per year from interprovincial migration. The last factor affecting the number of physicians in BC is the number entering the province who have been educated outside of Canada. Data specifically on the intake of foreign educated doctors was difficult to find. Instead, what was done was taking the actual observed data of physicians in BC since 2000, as well as the previous factors discussed above, and tried to solve for what constant rate is the BC physician population increasing that isn't being accounted for by these previously discussed factors. This was

found to be a 1.5% increase in the physician population each year, and this was assumed to be the rate at which the number of physicians increases due to foreign educated doctors entering the workforce. Using all of this data and assumptions, the number of physicians in BC was predicted for the years 2018 to 2020 (as seen in Figure 3).

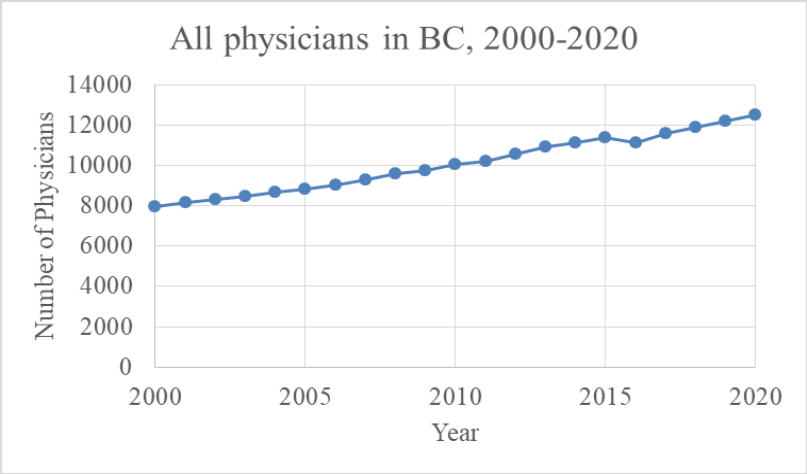

Figure 3. Prediction of Number of Physicians in BC, Canada

This model predicts a steady increase in the number of physicians over the next 3 years. Figure 4 then shows these results in the form of the predicted physician to population ratio. Similar results are observed, the expected increase in physicians is not outdone by the population growth in the next few years, with the ratio predicted to rise over this span.

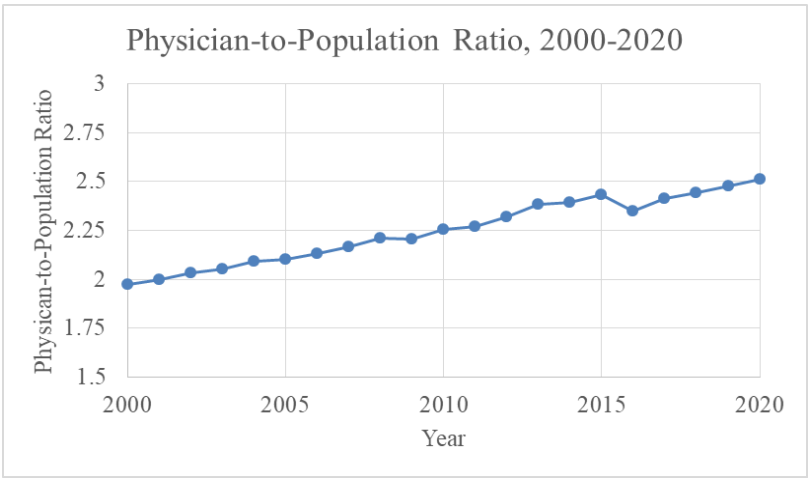

Figure 4. Prediction of Physician to Population Ratio in BC, Canada

3.2 Model 2

The second model builds upon the first to create the regression model to predict FTE. First is to figure out which variables are significant and required for the regression model of FTE. To create the

regression model, data was used that was thought to be affecting the overall output of physicians. This included the gender and age breakdowns of physicians, as well as the number of physicians and total population in BC (since FTE is measured as per 100,000 people). Using backwards elimination regression, variables were dropped from the model until each variable was significant at 90% confidence interval at the least. Through this method, 3 variables were dropped from the model: the proportion of female physicians, the proportion of physicians under the age of 35, and the proportion of physicians between the ages of 35 and 44. This left the number of total physicians, BC population, and the proportion of physicians aged 45-54, 55-64 and 65+. The results of the regression analysis are shown in Figure 5.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.998247
R Square	0.996496
Adjusted R Square	0.99455
Standard Error	0.620689
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	5	986.1327	197.2265	511.9374	9.19E-11
Residual	9	3.467297	0.385255		
Total	14	989.6			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-121.875	37.76015	-3.2276	0.010362
All physicians in BC	0.003912	0.001842	2.124073	0.062622
% 45-54	1.80679	0.553197	3.266086	0.009743
% 55-64	-2.31767	0.387529	-5.98065	0.000207
% 65+	1.209611	0.567034	2.133225	0.061697
BC population (in thousands)	0.047011	0.008136	5.778076	0.000267

Figure 5. Regression Results

The updated equation for predicting FTE (with the insignificant factors removed) is as follows:

$$FTE_t = a + bL_t + fL_{45\text{-}54} + gL_{55\text{-}64} + hL_{65+} + iPop_t \quad \text{(Equation 2.2)}$$

FTE_t = Full-Time Equivalent Physicians for year t

a = Regression intercept

b, f, g, h, i = Regression coefficients for their respective factors

L_t = Physician labour supply for year t

$L_{45\text{-}54}$ = Percentage of physicians who are between the ages of 45-54

$L_{55\text{-}64}$ = Percentage of physicians who are between the ages of 55-64

L_{65+} = Percentage of physicians who are 65 years and older

Pop_t = Population of BC for year t

This regression gives an adjusted R-square value of 0.995, meaning that 99.5% of the variation in the FTE level is accounted for in this regression model. As expected, the coefficients show that as the number of physicians increases, the FTE increases. Interestingly, the proportion of physicians aged 55-64 shows a negative relationship between FTE compared to the positive relationship of the other 2 age groups. Perhaps this is due to physicians at that age deciding to work part time or become semi-retired. More research will have to be done to analyse these results further, as well to test to see if there is any collinearity between the age variables used.

Finally, with the regression model developed, the next step was to create predictions for the significant variables. Predictions of the number of physicians was created in Model 1, and the future population for BC was already estimated by BC Stats. This left the proportion of physicians for the 3 age groups. For these, the average annual change from 2002 to 2016 was used to estimate the proportions for 2017 to 2020. For physicians aged 45-54, this was an annual decrease of 1.27%, for 55-64 is was an annual increase of 1.88%, and for physicians aged 65+, it was an annual increase of 3.12%. Using all of these estimates, as well as the BC population estimates from BC Stats, and the predicted physician numbers from Model 1, plugging this data into the regression model was able to predict the future FTE for BC in the next 3 years. Figure 6 shows a graph of the resulting data.

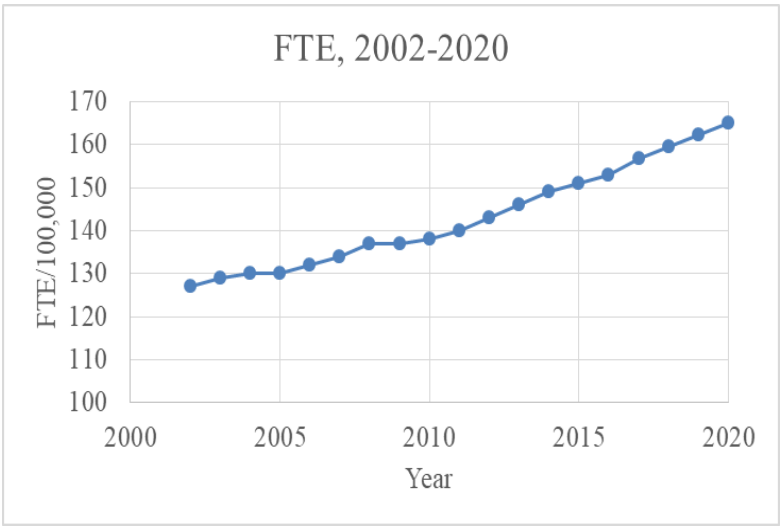

Figure 6. Future FTE from Regression Model

4. Results and Discussion

The final model as seen in Figure 6 shows that the FTE for 2018 to 2020 is expected to rise steadily. From the 2016 FTE of 153, this model predicts a rise to 156.6 in 2017, 159.4 in 2018, 162.2 in 2019, and 165.0 in 2020. While this increase in expected FTE is encouraging, there are some other factors to consider. According to the population estimates by BC Stats, there is a significant expected increase in the senior dependency of the BC population (as seen in the appendix, Figure A1). This would suggest that the future population would require a higher level of overall physician output, as the level of care demanded by older individuals are, on average, higher than younger people. It is unclear whether the predicted increase in FTE supply would be sufficient to cover the expected future increase in the demand for healthcare services. However, it is worth noting that BC, as well as Canada as a whole, is reporting a current shortage in healthcare services. This means that the predicted increase in FTE would have to be sufficient enough to not only cover the expected future increase in demand, but also make up for the current lack of supply already observed in the health care sector. Lastly, the current supply of physicians is getting older. Since 2002, the proportion of physicians aged 55 or older has increased from under 30% to over 41% in 2016 (as seen in the appendix, Figure A2). This suggests that the required rate of replacement to maintain just a stable level of FTE through the transition of older to younger physicians will likely increase in the coming years. This may also suggest that the predicted increase in future FTE may not continue to increase for long.

5. Conclusions and Future Research

It is likely that BC, much like Canada as a whole, still requires more physicians for the near future, and this problem will likely have to be addressed using an intake of foreign educated physicians. This is because of the significant amount of time it takes for changes involving Canadian educated physicians to take effect in the physician supply. For instance, the effect on the labour supply of increasing the number of entrants into Canadian medical schools would not be felt until about a decade later due to the length of time required to complete the medical school education as well as the post-graduate training. As a result, for dealing with a shortage of physicians in the short term, this requires a more immediate increase in the physician supply, meaning taking in more foreign educated doctors into the province.

For future research and expansion of this paper, we will focus on primarily reducing the assumptions, making the models and findings more accurate. First would be to find BC specific data for information in which BC being representative of all of Canada is simply assumed. Second would be to find data on the number of foreign educated physicians that enter the province every year. This give a far more accurate estimate for predictions of the future physician supply rather than extrapolating the rough estimate of the number of foreign educated doctors coming into the country by looking at the difference between the other factors affecting physician supply. Third would be to take the figures and rates that are assumed off of the averages of the last 15 or so years, and use conservative and optimistic numbers

based on these stats, not just using the average. The Buske paper for example, included a status quo scenario where rates and absolute figures of data was assumed to remain stable into the near future in which the model predicted. However, the paper also included a reduced FTE scenario, citing the reason for this inclusion being the downward trend of workload that are being observed in the younger physician population, that the same age group is not working at the same level as was observed a decade before (Buske, 2007). In the same way, this research could be expanded to include a reduced estimate of FTE that may be more representative of the levels of output that can be expected in the future. The inclusion of multiple estimates will provide a better representation of the expected future output levels and better illustrate the data in general. Due to the high level of uncertainty in predicting something as complicated as future health care production output, the inclusion of a different estimate may better capture some of that uncertainty. Lastly, if Canadian medical school enrolment numbers along with graduation rates were used to predict future increase in the physician supply, (while adding another level of uncertainty) would allow the model to predict further into the future, from 3 years to 7 or 8 years (depending on if the latest enrollment statistics have been released).

Additionally, we will also look at another province, such as Saskatchewan. This would make it so that comparisons could be made between the BC findings and findings from another province that is significantly different from BC. This could serve as a way to better understand the impacts of the BC findings as well. Factors such as policies affecting where foreign educated doctors can first start practicing and interprovincial migration of physicians are elements that could be captured by doing this research with multiple provinces. These sorts of factors and analysing provincial differences provide different results and implications than simply looking at all of Canada as a whole. In terms of addressing what sort of policy decisions need to be made to address physician shortages in Canada, looking at individual provinces would give a better understanding and overview of the problem. Finding that Canada requires more doctors does not give any indication as to where more doctors need to be. An expansion on research such as this, focusing on the individual provinces, would be able to provide a more detailed overview of the physician supply across Canada. Expanding on this point, it seems that distribution of doctors, not just the number of output of physicians, is crucial to the issue of shortages experienced across Canada. This question about the distribution of physicians across the country has also been touched on by Globerman, et al. (2018) as well as Plourde (2016). This is another topic that should be researched further as it could have huge implications for guiding future policy regarding physician labour supply.

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Appendix

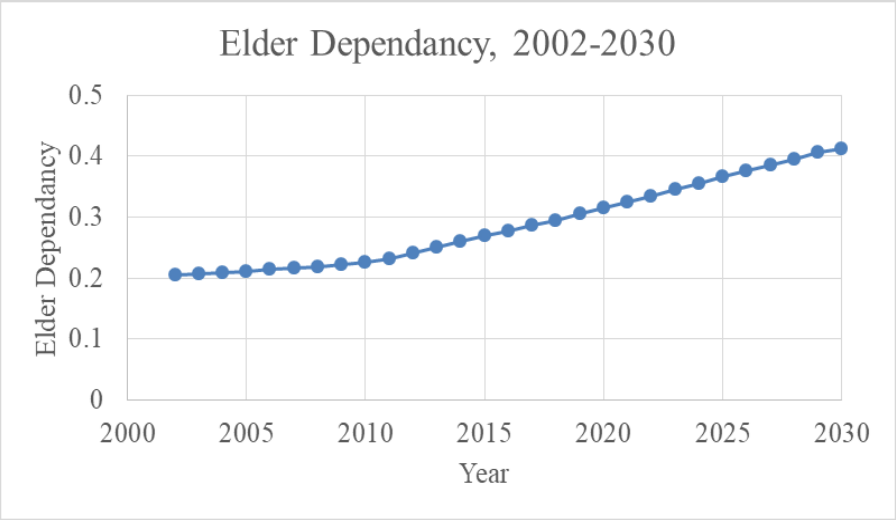

Figure A1. Prediction of Senior Dependency in BC, Canada

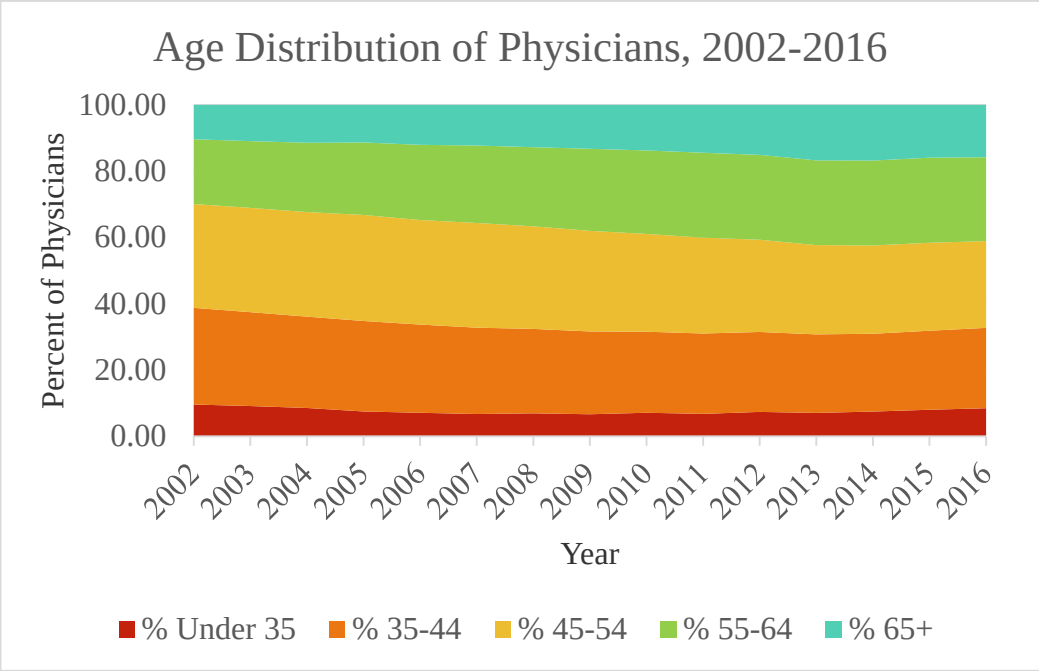

Figure A2. Age Distribution of Physicians

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