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## **CHEPA WORKING PAPER SERIES**

### **Paper 04-03**

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Sung-Hee Jeon, PhD  
Jeremiah Hurley, PhD



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**The Relationship between Physician Labour Supply,  
Service Volume and Service Intensity**

Sung-Hee Jeon, PhD<sup>1\*</sup>  
Jeremiah Hurley, PhD<sup>1,2</sup>

<sup>1</sup>Department of Economics, McMaster University

<sup>2</sup>Centre for Health Economics and Policy Analysis, McMaster University

\* Corresponding author: Sung-Hee Jeon  
Department of Economics - KTH 424  
McMaster University  
1280 Main Street West  
Hamilton, Ontario L8S 4M4 Canada  
Tel: 905-525-9140, ext. 23218  
e-mail: [shjeon@mcmaster.ca](mailto:shjeon@mcmaster.ca)

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## Summary

Surveys of Canadian physicians show that, on average, general/family physicians have been reducing hours of direct patient care in recent years. We currently have little understanding of how changing hours of work relate to service provision. This project examines this relationship using individual-level data for a random sample of Ontario FP/GPs which contains information on fee-for-service billing and hours of direct patient care. The analysis decomposes the variation in physicians' average billing into the variation in billings per hour and variation in the average number of working hours of patient care. The empirical findings reveal that the variation across physicians in total billing is dominated by the variation in hourly billing rather than by the variation in physicians' working hours. There is also negative correlation between average billing per hour and average number of hours of patient care. This pattern is also shown in analyses of sub-groups defined by the sex of the physician, by practice location and by years of graduation. Female rather than male, rural rather than urban, and graduated in the 70's or 80's rather than in the 50's or 60's show strong negative correlations between average hourly billings and average weekly hours of direct patient care.

*JEL classifications:* I10; I11; I18

*Keywords:* Physician Labour Supply; Physician Service Volume; Physician Service Intensity.

## 1. Introduction

This study investigates the relationship between a physician's hours of direct patient care and a physician's supply of medical services using individual-level data from a random sample of Ontario general/family physicians (FP/GPs).

Canadian Medical Association physician surveys (Physician Resource Questionnaire) show that GP/FP patterns of labour supply, especially hours of direct patient care, are changing markedly.<sup>1</sup> In 2003, for instance, physicians under the age of 45 spent 20% less time providing direct patient care on average than they did in 1982. In contrast, physicians over age 65 spend 4.7 more hours per week in direct patient care in 2003 than they did in 1982 [1]. These changes have caused the difference in average hours worked between these two groups of physicians (who have historically worked the most and the least numbers of hours respectively) to shrink over this period from 14 to 4.7 hours per week, and reduced the overall average number of hours of direct patient care per physician. Similarly, a 2001 survey of physicians in Manitoba revealed that 15% of family physicians in Manitoba reduced their work hours in the previous two years, 18% planned to reduce their work hours in the subsequent two years, and only 4% expressed intent to increase their work hours [2]. In addition, a survey conducted by the College of Family Physician of Canada (CFPC) shows that a higher percentage of Canadian family doctors reduced their work hours in 1999 and 2000 than increased them, and a large majority of them planned to reduce their work hours in 2001 and 2002 [3,4]. However, despite the evidence suggesting that Canadian physicians have changed hours of direct patient care considerably in the last few decades, we currently have little understanding of how changing hours of work affect service provision.

Physician labour supply and physician service supply, although inextricably linked, are distinct [5-7]. It might seem that physicians who work fewer hours are likely to provide fewer services than those who work more hours. On the other hand, physicians who work fewer hours may practice more intensively, so that differences among physicians in service provision may be less than differences in hours worked. Similarly, physicians can organize their practices differently, using different numbers and types of non-physician staff who may perform certain office functions for the physician. Thus, although a physician's own time is the predominant input used to produce physician services in her practice, the physician can use her time in different ways, and combine it with other inputs, to produce physician services. The amounts of time a physician spends working, and how she uses that time, depend on the physician's attitudes and preferences about work, practice styles and income, as well as on the constraints and opportunities in the physician's practice environment [8-13].

As a first step in understanding the relationship between physician labour supply and services provided, this study investigates how physicians' hours of direct patient care correlate with the hourly services provided. Specifically, we focus on the relationship between hours of patient care and fee-for-service billing, which is used as a measure of the amount of physician services provided. In the first part of the analysis, we decompose the variation in physicians' average weekly billings into two components: variation in billings per hour and variation in the average number of weekly hours of patient care. We then use regression analysis to examine the relationship between intensity of service provision (billings per hour) and hours of direct patient care, controlling for other physician characteristics. We also examine how work intensity varies according to physician characteristics.

Section 2 describes the data and research methods; section 3 presents the results of the variance decomposition and reports the regression results; and section 4 concludes this study.

## 2. Data and Methods

### 2.1 Data

The Canadian Medical Association has regularly conducted national physician surveys (including in the survey both members and non-members of Medical Associations) on physician workforce issues since 1982. We use the 1990 Physician Resource Questionnaire (PRQ)<sup>2</sup> for a random sample of Ontario GP/FPs, linked to administrative data on fee-for-service billings for services provided through the Ontario Health Insurance Plan.<sup>3</sup> For each physician in the sample, the Physician Resource Questionnaire provides information on weekly working hours for direct patient care,<sup>4</sup> working weeks in a year, and physician characteristics; the OHIP data include monthly fee-for-service billings. We calculate the annual average weekly billings by dividing weeks of work per year into total annual billings. The analysis focuses on those physicians working near or at full-time. We therefore exclude from our sample fee-for-service physicians working fewer than 46 weeks a year or billing for fewer than 12 months in a year. This approach has the advantage of focusing the analysis on that group of physicians who provide the bulk of primary care physician services, and of reducing measurement errors in computing average weekly billing for physicians who have highly unusual work patterns.<sup>5</sup> The sample includes 1219 physicians, of whom 974 are male; 1078 practice in urban areas; 594 work in solo practices. Of those, 221 graduated in the 1950's, 280 in the 1960's, 439 in the 1970's and 279 in the 1980's.

## 2.2. Methods

### *A. Relationship between Total Annual Billings and Average Weekly Hours of Direct Patient Care.*

Before examining the relationship between hourly billings and hours of direct patient care, we take a look at the average annual billings by groups of deciles of weekly hours of direct patient care. We then estimate the elasticity of total annual billings with respect to weekly hours of direct patient care; the log of total annual billings is regressed on the log of weekly hours of direct patient care. This elasticity shows the overall relationship between total annual billing and hours of direct patient care.

### *B. Decomposing Variation in Total Billings.*

A physician's total billings ( $B$ ) equals the average hourly billing rate ( $B/h$ ) multiplied by the number of working hours ( $h$ ):

$$B = (B/h) \cdot h . \quad (1)$$

Taking the logarithm of both sides (1), we get:

$$\log(B) = \log(B/h) + \log(h) \quad (2)$$

Using the properties of variance and covariance, the variance of log total billings ( $\sigma_{\log(B)}^2$ ) can be decomposed into the sum of the variance of log hourly billings ( $\sigma_{\log(B/h)}^2$ ), the variance of log number of working hours ( $\sigma_{\log(h)}^2$ ) and twice covariance of the log hourly billings and the log number of working hours ( $\text{cov}(\log(B/h), \log(h))$ ):

$$\sigma_{\log(B)}^2 = \sigma_{\log(B/h)}^2 + \sigma_{\log(h)}^2 + 2 \text{cov}(\log(B/h), \log(h)) \quad (3a)$$

$$\sigma_{\log(B)}^2 = \sigma_{\log(B/h)}^2 + \sigma_{\log(h)}^2 + 2\rho_{B/h,h} \sigma_{\log(B/h)} \sigma_{\log(h)} \quad (3b)$$

where  $\rho_{B/h,h} = \frac{\text{cov}(B/h, h)}{\sigma_{\log(B/h)} \sigma_{\log(h)}}$ .  $\rho_{B/h,h}$  is a correlation coefficient, which is a measure of linear association between  $\log(B/h)$  and  $\log(h)$ . This decomposition reveals the extent to which variation in total billings is caused by variation in hourly billings or by variation in working hours. The sign of the covariance will indicate the type of the correlation between hourly billings and average working hours. A negative covariance, for instance, means that a decrease in working hours is associated with an increase in average hourly billing.<sup>6</sup>

*C. Estimating the elasticities of hourly billing with respect to hours of direct patient care.*

We then extend the analysis by estimating the elasticity of hourly billing with respect to hours of direct patient care while controlling for physician characteristics. Let  $B_w(h)$  denote weekly billings when hours of work per week equal  $h$ , and  $B_h(h)$  denotes the average hourly billing rate for  $h$  hours per week. It follows that  $B_w(h) = B_h(h) \cdot h$ . Suppose weekly billing is an increasing function of working hours, so that

$$\frac{dB_w(h)}{dh} = \frac{d(h \cdot B_h(h))}{dh} = B_h(h) + h \cdot \frac{dB_h(h)}{dh} = B_h(h)[1 + \theta] > 0 \quad (4)$$

where  $\theta$  is the elasticity of hourly billings with respect to hours of direct patient care [14].

For (4) to be true,  $\theta$  needs to be greater than -1. To determine this elasticity ( $\theta$ ) while controlling for physician's characteristics ( $X$ 's) such as sex, practice location, practice setting, and year of graduation from medical school, we estimated the following equation:

$$\ln(B_h) = \alpha + \beta X + \theta \ln(h) + \varepsilon \quad (5)$$

where,  $\varepsilon$  is a stochastic error term. Coefficients ( $\beta$ 's) on the elements of  $X$  indicate differences in service intensity across physician characteristics groups. To test for the significance of



differences in elasticities between groups, we estimate elasticities of hourly billing with respect to hours of direct patient care by sub-groups ( $j$ 's): using the following equation:

$$\ln(B_{h,j}) = \alpha + \beta X + \theta \ln(h_j) + \varepsilon_j \quad (6)$$

where,  $j$  denotes a sub-group of physician (e.g.  $j$  = rural, urban; male, female).

### 3. Results

Table 1 displays average annual (/weekly) billings associated with deciles of hours of direct patient care provided. The data exhibit the expected positive relationship: there is a consistent gradient whereby those who report higher hours of direct patient care also have higher mean billings levels. For example, physicians whose hours of work place them in the first decile of the hours distribution provide an average of 21.28 hours per week of direct patient care and annually bill an average of \$92,872, while those whose hours of work place them in the second decile provide an average of 30.71 hours of direct patient care per week and annually bill an average of \$158,911. The systematic relationship is nearly one-to-one: the estimated elasticity between hours of direct patient care and total annual billings of physicians is 0.92, which is significant at less than 1% significant level with 95% confidence interval [0.83, 1.00]. This implies that a 1% increase in weekly hours of direct patient care is associated with a 0.92% increase in total annual billings. However, the non-systematic variation is large: there is a large range in the amounts billed by physicians who worked the same number of hours of direct patient care per week. Therefore, further investigations into this variation among total billings may provide insight into how differences in hours of work relate to service provision.

Table 2 displays the variance of weekly billings decomposed into variance of average hourly billing, variance of weekly hours of direct patient care and covariance. For both our whole sample and our sub-group analysis, the variation across physicians in average weekly

billings is dominated by the variation in hourly billings rather than by the variation in weekly hours of direct patient care: the variance in average hourly billing is greater than the variance in average weekly hour of patient care.<sup>7</sup> We also find significant negative correlations between average hourly billings and average number of hours of direct patient care. For the whole sample, the correlation coefficient is -0.065 which is significant at less than 5% significant level. This means that if physicians increase their average weekly hours of direct patient care, their average hourly billings (fee-for-services) decrease. This pattern emerges in sub-group analysis as well. Female rather than male, rural rather than urban, and having graduated in 70's and 80's rather than in 50's and 60's, all show strong negative correlations between average hourly billings and average weekly hours of direct patient care.

Table 3 reports the estimation result for equation (5). The calculated elasticity between hourly billings of physicians with respect to hours of direct patient care is -0.21. Weekly billings is an increasing function of hours of direct patients care; the estimated elasticity ( $\theta$ ) of hourly billing with respect to hours of direct patient care is significantly greater than -1 ( $\theta > -1$ ). However, the negative sign of elasticity reflects a negative correlation between weekly hours of direct patient care and hourly billings; -0.21 means that a 1% increase in weekly hours of direct patient care is associated with a 0.21% decrease in hourly billing. In addition, the coefficients on physician characteristics reveal that i) female physicians work less intensely than male physicians, ii) rural physicians work more intensely than urban physicians, iii) younger graduation cohorts work more intensely than older cohorts, and iv) group practice physicians work less intensely than solo practice physicians. Table 4 reports estimates of the elasticity ( $\theta$ ) within each sub-group. However, estimated elasticities of hourly billings with respect to hours of direct patient care are not significantly different between sub-groups of male and a female physicians, despite the fact that female physicians work less intensely than male physicians

(from Table 3). Similarly, the relationship between work intensity (hourly billings) and hours of direct patient care is not statistically significantly different between urban and rural sub-groups, or between solo practice and group practice sub-groups. Elasticities of hourly billings with respect to hours of direct patient care are significantly different only between those physicians who graduated in the 70's and 80's and those who graduated in the 50's. Estimated results suggest the negative correlation between hourly billings and hours of direct patient care is steeper among younger physicians.

#### **4. Conclusions**

In spite of the importance of the question, relatively little is known about the relationship between physician hours of direct patient care and service supply. This study examines the relationship between self-reported hours of direct patient care and OHIP fee-for-service billings for a random sample of Ontario GP/FPs, who worked more than 45 weeks in 1990.

We find a number of striking aspects to the relationship between physician hours of direct patient care and average hourly billing. Although the systematic relationship between weekly hours of direct patient care and total annual billings is nearly one-to-one linear, there is a large variation in total annual billings among physicians who worked the same number of hours of direct patient care per week. Furthermore, there is a negative correlation between the average hourly billing and the average number of hours of patient care. The estimated elasticity of hourly billing with respect to hours of direct patient care is -0.21 which implies that a 1% increase in weekly hours of direct patient care is associated with a 0.21% decrease in hourly billing.

These key findings suggest that physicians who work fewer hours of direct patient care work more intensely and maintain billings levels on par with physicians who work more hours.

Taken together, although FP/GPs are currently reducing hours of direct patient care, this cross-sectional analysis suggests that the total billing may not be reduced in accordance with working hours, because average hourly billings will increase. The data also suggest that a negative correlation between hourly billings and hours of direct patient care is steeper among physicians who graduated in the 70's and 80's compared to physicians who graduated in the 50's.

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**Table 1**  
**Relationship between Hours of Direct Patient Care**  
**and Fee-for-Service Billings.**

Deciles of weekly hours of direct patient care	Average weekly hours of direct patient care	Average annual billing (\$)	Average weekly billing (\$)
1	21.28	92872.17	1938.43
2	30.71	158911.08	3278.27
3	35.10	165270.81	3417.04
4	39.42	179382.30	3684.87
6	43.00	193751.25	4012.55
7	45.44	197905.91	4079.34
8	49.38	208091.27	4272.95
9	53.93	221149.06	4510.72
10	59.90	219779.77	4488.78

**Table 2**  
**Decomposition of the Variance in Weekly Total Physician Billings**

By group	variance of weekly billings	variance of hourly billings	variance of hours of patient care	covariance	correlation coefficient
Whole sample	0.268	0.201	0.084	-0.009	-0.065*
Male	0.24	0.194	0.067	-0.011	-0.093*
Female	0.286	0.217	0.113	-0.022	-0.142*
Urban	0.277	0.206	0.084	-0.006	-0.046
Rural	0.188	0.146	0.088	-0.023	-0.201*
Graduated					
in 50's	0.344	0.231	0.102	0.005	0.033
in 60's	0.246	0.177	0.081	-0.006	-0.049
in 70's	0.231	0.192	0.073	-0.017	-0.143*
in 80's	0.243	0.192	0.087	-0.018	-0.139*

Note: \* is significant at less than 5% significance level.

**Table 3**  
**The Relationship between Hourly Billing (Work Intensity)**  
**and Hours of Patient Care and Physician Characteristics**

Log(hourly billing)	Coef.	Std. Err.	t statistics
Log(hours of direct patient care)	-0.212*	0.045	-4.65
Female	-0.181*	0.034	-5.35
Rural	0.129*	0.039	3.31
Group practice (=2)	-0.071**	0.036	-1.98
Group practice (>2)	-0.081*	0.028	-2.87
Graduated in 60's	0.185*	0.040	4.68
Graduated in 70's	0.271*	0.037	7.41
Graduated in 80's	0.230*	0.041	5.62
Constant	5.079*	0.170	29.95

Note: \* is significant at less than 1% significance level.

\*\* is significant at less than 5% significance level.



**Table 4**  
**The Elasticity of Hourly Billing with Respect**  
**to Hour of Patient Care by Sub-Groups.**

Subgroups	Estimates of elasticity ( $\theta$ )	Std. Err.	t statistics
Male	-0.204*	0.054	-3.78
Female	-0.235*	0.087	-2.70
Urban	-0.184*	0.049	-3.71
Rural	-0.328*	0.111	-2.96
Solo practice	-0.036	0.088	-0.41
Group practice (=2)	0.049	0.122	0.41
Group practice (>2)	- 0.255**	0.100	-2.53
Graduated in 50's	0.041	0.102	0.40
Graduated in 60's	-0.106	0.090	-1.18
Graduated in 70's	- 0.383*	0.081	-4.74
Graduated in 80's	- 0.329*	0.095	-3.47

Note: \* is significant at less than 1% significance level.

\*\* is significant at less than 5% significance level.

#### Note

<sup>1</sup> In general, two distinct kinds of forces likely drive these changes in average physician work patterns over time. One is changes in characteristics of the physician stock (e.g., increasing proportion of female physicians; changing age distribution of practicing physicians, with an increasing average age). The other is changes in physician labour supply conditional on physician characteristics [9].

<sup>2</sup> The Physician Resource Questionnaire (PRQ) for 1982, 1986 and 1990 were census surveys of all physicians licensed to practice medicine in Canada. In 1993 the PRQ shifted to a random sample of physicians. The PRQ contains demographics information (such as year of birth, year of graduation, specialty, gender and practice location), number of weeks worked per year, average number of hours worked per week, remuneration modes and practice setting.

<sup>3</sup> All records were fully anonymized to protect confidentiality.

<sup>4</sup> This variable indicates (excluding on-call time), how many hours per week a physician usually spends on direct patient care regardless of setting.

<sup>5</sup> Among the physicians who billed for 12 months of the year, some physicians were observed working less than 10 hours per week.

<sup>6</sup> Our decomposition reveals only the relationship between average hourly fee-for-service billing and the average working hours of physician. These results do not provide any details concerning the quality of the services the physicians provide, or about their efficient use of time in delivering these services.

<sup>7</sup> We must be cautious to not misinterpret this finding, because variance is not scale-independent, and hours and billings are measured by different scales. See below for elasticity analysis, which is scale-independent.