The Relationship Between Physician Hours of Work, Service Volume and Service Intensity

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Avoir accès aux soins d'un médecin est de plus en plus difficile au Canada, et ce, alors que le temps de travail des médecins s'est beaucoup modifié. Au cours de cette étude, nous avons examiné le lien entre, d'une part, le nombre d'heures que les médecins consacrent directement à des patients et, d'autre part, la disponibilité des médecins. Pour cela, nous avons eu recours aux données individuelles d'un échantillon aléatoire de médecins familiaux et généralistes de l'Ontario. Les résultats empiriques révèlent que, parmi les médecins, la variation de la facturation totale est régie par la variation de la facturation des médecins par heure plutôt que par la variation de leurs heures de travail. On observe également une corrélation négative entre la facturation moyenne par heure et le nombre moyen d'heures de soins consacrées aux patients. Cette constante est démontrée par des analyses de sous-groupes définis selon les critères suivants : le sexe des médecins, le lieu de pratique, le type de pratique et le nombre d'années écoulées depuis l'obtention du diplôme.

Problems of access to physician services have arisen in Canada at a time when physician hours of work have been undergoing important changes. This study investigates the relationship between physicians' hours of direct patient care and physicians' service supply using individual-level data from a random sample of Ontario general/family physicians. The empirical findings reveal that the variation across physicians in total billing is dominated by the variation in physicians' billings per hour 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 shown in analyses of subgroups defined by the gender of the physician, by practice location, by practice type, and by years since graduation.

Introduction

Canada has recently experienced a growing shortage of physicians, resulting in compromised access to physician services for many Canadians (Chan 2002; Sanmartin *et al*. 2002). Although Canada has historically experienced physician shortages in selected specialties and in rural and remote areas, recent shortages have developed for general and family practitioners (GP/FPs) even in some urban areas. This shortage and the associated compromised access to care have consistently been identified as one of the most important policy challenges facing the Canadian health-care system (Canadian Health Services Research Foundation 2001, 2004).

Surprisingly, the shortage developed at a time when the real supply of physicians (adjusted for the changing age-structure of the population and the changing age-sex composition of the physician workforce) declined only slightly (Chan 2002). Changing work patterns among the stock of practising physicians appears to have played a critical role in the shortage. Canadian Medical Association (CMA) and other physician surveys show that GP/FP hours of direct patient care have changed markedly since the early 1980s. Physicians under the age of 45 spent 20 percent less time on average providing direct patient care in 2003 than they did in 1982 (Buske 2004). Similarly, Crossley, Hurley and Jeon (2006) document that the average amount of time that Canadian family physicians under age 65 spent in direct patient care fell by approximately seven hours between 1982 and 2003. They further show that this reduction resulted from a decrease in total hours of work rather than a reallocation of time from patient care to research, administration or other professional activities. Other physician surveys document both decreases in hours worked in recent years and a desire by physicians to reduce hours of work further in coming years (College of Family Physicians of Canada 2001; Physician Human Resource Strategy for Canada 2003). Although some of this decline in average hours of work derives from the increasing proportion of females in the physician stock (female physicians work fewer hours on average than male physicians) and the changing age distribution of practising physicians, Crossley, Hurley and Jeon (2006) show that a more important factor has been the secular decline in hours of work by male physicians.

The impact of these changes in hours of work on physician service supply and access to services, however, is unclear. Hours spent in direct patient care and physician service supply, although inextricably linked, are distinct (Brown and Lapan 1979; Evans, Parish and Sully 1973; Evans 1977; Thornton and Eakin 1997). There is no necessary one-to-one relationship between the two. Although a physician's own time is the predominant input used to produce physician services in a practice, the physician can use his or her time in different ways, and combine it flexibly with other inputs to produce physician services. Physicians who work fewer hours may practise more intensively; physicians working fewer hours can also organize their practices differently, using different numbers and types of non-physician staff who perform some tasks otherwise done by the physician. Thornton and Eakin (1997), for example, found that in response to payment changes physicians reduced their own work time but substituted other non-physician inputs so that the number of services provided actually increased.

Given the changes in physician hours of work and problems of access to physician services, better understanding of the relationship between physician hours of patient care and service delivery is a critical

element in developing effective health human resource policies. Even modest changes in the work hours and/or service supply of the existing stock of physicians have greater short-term potential to ameliorate the physician shortage than the large increases in medical school enrolment underway in Canada. Yet, to our knowledge, no Canadian study has examined the relationship between physician hours of work and service supply.

This paper uses individual-level physician data from the province of Ontario to investigate the relationship between GP/FP hours of direct patient care and service provision. We focus in particular on the relationship between hours spent in direct patient care and service intensity, as measured by physician billings per hour. Although one would ideally like to estimate a joint, structural model of physician labour and service supply, no Canadian data are sufficient for that task. The unique data we have, however, do permit a more detailed examination (and quantification) of the hours-service relationship among Canadian family physicians than has heretofore been done. We find that variation in total physician-service provision is dominated by variation in billing intensity (billings per hour) rather than variation in weekly hours of direct patient care. We also find a negative correlation between service intensity and hours of direct patient care (i.e., those who work more hours work less intensively). This relationship is relatively inelastic, however, so that an increase in hours of direct patient care is only partially offset by a decrease in service intensity, leading to an increase in overall service provision.

The next section describes the data and research methods; the third section presents results; and section four discusses implications of the findings.

Data and Methods

Data

We use the 1990 CMA Physician Resource Questionnaire (PRQ)[1] for a random sample of Ontario GP/FPs, linked to administrative data on fee-for-service billings for services provided through the public insurer, the Ontario Health Insurance Plan (OHIP).[2] For each physician in the sample, the PRQ provides information on self-reported weekly working hours of direct patient care, working weeks in a year, and selected physician and practice characteristics.[3] The OHIP data for each physician include monthly fee-for-service billings. Physician payments in Ontario (and Canada more generally) are made through an administered price system. The Ontario Schedule of Benefits lists all services and the associated fees for which a physician can bill OHIP. Fees are set through periodic negotiations between the provincial government and the provincial medical association, and are exogenous to an individual physician. The analysis employs physician billings as a measure of service supply. A physician's billings are simply the sum, across all services in Schedule of Benefits, of the number of times each service was provided times the service's fee. This measure has the advantage of allowing us to aggregate across the full set of services provided by a physician and weight service counts by fees to better reflect the underlying service provision.[4] We examine the relationship between hours of direct patient care and two measures of service supply: total annual service supply and service intensity. Total service supply is just the sum of billings during a year. Service intensity refers to the rate at which a physician provides services per unit of time spent in direct patient care, and is essentially a measure of average service productivity. Service intensity is measured as billings per hour of direct patient care. Billings per hour is calculated by dividing annual average weekly billings (calculated as total annual billings divided by weeks of work per year) by average weekly hours of direct patient care.

The analysis is based on a random sample (n = 1,745) of family/general practitioners practising in Ontario in 1990. We focus on those physicians who are engaged in regular clinical practice for two reasons: such physicians provide the bulk of primary care physician services; and computing average

weekly billings and billings per hour is more likely to suffer from measurement error among physicians who have highly unusual work patterns. We therefore applied the following exclusion criteria: (a) physicians working fewer than 46 weeks a year or billing for fewer than 12 months in a year (n = 248); (b) outliers in the upper and lower 2.5 percent of the hours of direct patient care and annual billings distributions (n = 139).[5] Finally, 139 physicians were missing essential data. The resulting sample is 1,219 GP/FPs. These exclusion criteria imply that the analysis sample is no longer a true random sample of Ontario GP/FPs, however, it focuses the analysis on the subset of physicians who provide the bulk of services and for which we can have the greatest confidence in the measure of practice intensity (billings per hour). Note that these criteria do not limit the sample to those working at or near full-time; the sample includes physicians who work part-time on a regular basis (e.g., among those included are physicians who work on average less than ten hours per week). Table 1 presents descriptive statistics on these physicians.

These data allow us to document the quantitative relationship between hours of direct patient care, total service provision, and service intensity. A fuller explanatory analysis would require three additional types of data: data on the physician patient populations; data on physician household characteristics; and data on the full set of practice inputs used by a physician. Data on the characteristics of the patients in the physician practices would enable one to determine the extent to which variations in hours and intensity may be driven by differences across physicians in patient characteristics rather than purely physician work choices. Information on the household characteristics of the physicians (e.g., marital status, presence of children, work status of spouse, sources of non-practice income), which are commonly included in models of labour supply, would enable one to identify how such factors influence physician decisions regarding both total hours of work and work intensity. Information on the skill and input mixes used to produce services would increase our understanding of how physicians combine their own time with other inputs to produce services. Such data on the patients, physicians, and their practices would help explain the outcomes we observe. Despite these data limitations, documenting the relationship among hours and services can provide important insight to inform policy.

Methods

Relationship Between Total Annual Billings and Average Weekly Hours of Direct Patient Care. We estimate the elasticity of total annual billings with respect to weekly hours of direct patient care. As is standard, we estimate the elasticity by regressing the log of total annual billings 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.

Decomposing Variation in Total Billings. A physician's total billings *(B)* in any given period (year, month, week) equals the product of the mean billings per hour (B/h) and the number of working hours (h) during the period:

$$B = \left(B/h\right) \cdot h \tag{1}$$

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

$$\log(B) = \log(B/h) + \log(h) \tag{2}$$

The properties of a variance allow us to decompose the variance of log total billings into the variance of log billings per hour, the variance of log number of working hours and the covariance of the log billings per hour and the log number of working hours. (See the Technical Appendix for details.) This decomposition reveals the extent to which variation in total billings is caused by variation in billings per hour (intensity) or variation in working hours. The sign of the covariance indicates the nature of the correlation between billings per hour and average working hours. A negative covariance, for instance, means that, on average, a decrease in working

TABLE 1
Descriptive Statistics on Sample Physicians

			Weekly Hours of Direct Patient Care				Total Annual Billings				Billings per Hour			
	N	*Proportion*	*Mean*	*Std. Dev*	*Min.*	*Max.*	*Mean*	*Std. Dev.*	*Min.*	*Max.*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Whole sample	1,219		41.3	10.5	12	65	180,533	72,339	13,655	392,583	91.3	34.4	6.3	268.1
By sex														
Male	974	0.80	42.9	9.7	12	65	191,372	71,391	13,655	392,583	93.3	34.4	6.3	268.1
Female	245	0.20	35.0	10.8	12	60	137,440	58,855	15,707	345,383	83.6	33.6	7.6	213.6
By practice location														
Urban	1,078	0.88	41.5	10.6	12	65	178,810	72,774	13,655	392,583	89.9	33.7	6.3	239.2
Rural	141	0.12	40.2	10.3	12	65	193,708	67,732	23,697	385,988	102.7	37.5	17.6	268.1
By practice setting														
Sole	594	0.49	42.1	10.5	12	65	187,587	72,545	13,655	385,988	93.4	35.4	6.3	268.1
group(=2)	206	0.17	40.0	11.1	12	65	172,096	76,970	16,029	392,583	89.2	34.6	13.6	213.6
group(>2)	419	0.34	40.9	10.2	12	65	174,681	68,822	13,687	350,617	89.5	32.7	7.6	197.9
By graduation cohort														
Graduated in 1950s	221	0.18	39.5	11.1	12	65	151,670	69,504	13,655	385,988	80.3	34.3	9.4	268.1
Graduated in 1960s	280	0.23	42.3	10.6	12	65	183,603	71,529	23,397	345,383	90.3	33.1	11.9	200.0
Graduated in 1970s	439	0.36	42.4	10.2	15	64	196,605	71,813	14,254	385,947	97.3	34.3	6.3	239.2
Graduated in 1980s	279	0.23	40.1	10.3	12	65	175,025	68,805	16,645	392,583	91.8	33.9	9.1	211.3

hours is associated with an increase in billings per hour. In our analysis, we decompose the variance of weekly total billings (B_w) into variance of billings per hour (B_h), variance of weekly hours of direct patient care (h) and covariance of billings per hour and hours.

Estimating the Elasticities of Billings Per Hour with Respect to Hours of Direct Patient Care. We employ a regression approach to estimate the elasticity of billings per hour with respect to hours of direct patient care while controlling for physician characteristics. Letting B_h denote billings per hour and h denote hours of work per week, we estimate the following regression:

$$\ln(B_h) = \alpha + \beta X + \theta \ln(h) + \varepsilon \qquad (3)$$

where, X is a set of physician characteristics and ε is a stochastic error term (see the Appendix for details). The coefficients on the physician characteristics (β's) indicate how service intensity differs on average across differing types of physicians. The coefficient (θ) on $\ln(h)$ is the estimated elasticity of billings per hour with respect to hour of patient care. We estimate this regression first for the whole sample (while controlling for physician characteristics). This provides an estimate of the elasticity across all physicians. We then estimate the regression for subsamples of physicians defined by sex; geographic location (rural, urban); practice setting (solo, group); and years in practice (graduated in the 1950s, 1960s, 1970s, and 1980s). This provides insight into how the elasticity varies across these physician groups.

One concern is measurement error in the self-reported hours of direct patient care, which can bias ordinary least squares (OLS) estimates. To correct for such bias, we employ the "method of group averages" as described in Kmenta (1986) and Bowden and Turkington (1984). Method of group averages is a special case of two-stage instrumental-variable (IV) methods.[6] In the first stage we predict hours of patient care using an instrument (plus the other covariates in the model); in the second stage we estimate (3) substituting fitted (instrumented) hours of direct patient care ($\hat{h}$) derived from the first-stage estimation.[7] In the method of group averages the instrument is constructed as follows: divide the sample into three groups — low, middle, and high — based on self-reported hours of work; then create a new categorical variable to indicate the "hours group" to which a physician belongs; this categorical variable is the instrumental variable. We define the three groups using deciles in the distribution of hours of direct patient care: the low group includes those in the first to third deciles; the middle group includes the fourth to seventh deciles; and the high group includes the eighth to tenth deciles.[8] We test for the presence of bias induced by measurement error using a Hausman test for inconsistency in OLS estimates.

Results

We present results first for the relationship between total hours and total billings; then for the decomposition of variation of total billings into that attributable to intensity and hours respectively; and lastly, we present estimates of the hours-intensity elasticity for the full sample and selected subsamples defined by physician characteristics.

Table 2 displays the deciles of weekly hours of direct patient care, with associated data on annual billings and average weekly billings. The data exhibit the expected positive relationship between hours and billings: there is a consistent gradient whereby those who report higher hours of direct patient care also have higher mean annual or weekly 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

TABLE 2
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 ($)*	*Std. Dev. in Annual Billings*	*Average Weekly Billing ($)*	*Std. Dev. in Weekly Billings*
1	21.28	92,872.17	45,461.29	1,938.43	951.11
2	30.71	158,911.08	71,984.05	3,278.27	1,480.00
3	35.10	165,270.81	66,238.36	3,417.04	1,366.37
4	39.42	179,382.30	62,772.74	3,684.87	1,273.92
6	43.00	193,751.25	64,486.89	4,012.55	1,341.22
7	45.44	197,905.91	65,694.43	4,079.34	1,336.45
8	49.38	208,091.27	61,974.62	4,272.95	1,266.84
9	53.93	221,149.06	65,213.43	4,510.72	1,317.57
10	59.90	219,779.77	65,899.23	4,488.78	1,361.65

relationship is nearly one-to-one: the estimated elasticity of total annual billings of physicians with respect to hours of direct patient care is 0.92 [$p < 0.01$]. This implies that a 1 percent increase in weekly hours of direct patient care is associated with a 0.92 percent increase in total annual billings. However, the non-systematic variation is large: there is a substantial variation in the annual billings among physicians providing the same number of hours of direct patient care per week. Within deciles, for instance, the standard deviation of billings ranges from over $45,000 to $72,000. Therefore, further investigations into the variation in total billings may provide insight into how differences in hours of work relate to service provision.

Table 3 displays the variance of weekly billings decomposed into the variance of average billings per hour, the variance of weekly hours of direct patient care and covariance between them. For both the full sample and each of the subgroup analyses, the variation across physicians in weekly billings is dominated by the variation in billings per hour rather than by the variation in weekly hours of direct patient care. That is, the variance in billings per hour contributes a much larger proportion to the variance in total weekly billings than does the variance in hours of direct patient care.[9] We also find significant negative correlations between billings per hour and number of hours of direct patient care: those who work more hours practise less intensively than those who work fewer hours. For the full sample, the correlation coefficient is –0.065 [$p < 0.05$]. Although the correlations are negative for all the subgroups except those graduating in the 1950s, the magnitudes vary substantially: the correlation is 50 percent larger for females than males; almost five times larger for rural than urban physicians; and nearly three times as large for older physicians as for younger physicians.

Table 4 reports the regression estimates for the analysis of the relationship between billings per hour and hour of direct patient care (equation (3) above). The coefficients and associated elasticities from uncorrected OLS regressions are shown on the left-side of Table 4; the IV-corrected estimates are shown on the right side. Similar to other literature on physician practice patterns, which has documented systematic differences according to commonly measured characteristics (e.g., Boerma and van den Brink-Muinen 2000; Chan 2002; Cohen *et al*. 1991; Hurley, Woodward and Brown 1996; McMurray *et*

TABLE 3
Decomposition of the Variance in Weekly Total Physician Billings

By Group	Variance of Weekly Billings	Variance of Billings per Hour	Variance of Hours of Patient Care	Covariance	Correlation Coefficient
Whole sample	0.268	0.201	0.084	–0.009	–0.065*
Male	0.240	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 1950s	0.344	0.231	0.102	0.005	0.033
in 1960s	0.246	0.177	0.081	–0.006	–0.049
in 1970s	0.231	0.192	0.073	–0.017	–0.143*
in 1980s	0.243	0.192	0.087	–0.018	–0.139*

Note: *significant at 5 percent level.

TABLE 4
The Relationship Between Billings per Hour (work intensity) and Hours of Patient Care and Physician Characteristics

	Uncorrected, OLS Estimates			Corrected, IV Estimates		
Log(billings per hour)	Coef.	Std. Err.	t Statistics	Coef.	Std. Err.	t Statistics
Log (hours of direct patient care)	–0.212**	0.045	–4.65	–0.278**	0.054	–5.13
Female	–0.181**	0.034	–5.35	–0.197**	0.035	–5.69
Rural	0.129**	0.039	3.31	0.126**	0.039	3.22
Group practice (=2)	–0.071*	0.036	–1.98	–0.073*	0.036	–2.03
Group practice (>2)	–0.081**	0.028	–2.87	–0.083**	0.028	–2.94
Graduated in 1960s	0.185**	0.040	4.68	0.191**	0.040	4.82
Graduated in 1970s	0.271**	0.037	7.41	0.279**	0.037	7.58
Graduated in 1980s	0.230**	0.041	5.62	0.236**	0.041	5.76
Constant	5.079**	0.170	29.95	5.323**	0.201	26.47

Note: **significant at 1 percent level.
*significant at 5 percent level.

al. 2002; Slade and Busing 2002; Woodward and Hurley 1995), we find systematic differences in service intensity among physicians: (a) female physicians work less intensely than male physicians, (b) rural physicians work more intensely than urban physicians, (c) group practice physicians work less intensely than solo practice physicians, and (d) younger graduation cohorts work more intensely than older cohorts.

The OLS-based hour-elasticity of service intensity estimate is –0.21 implying a negative but inelastic relationship between billings per hour and hours of direct patient care. This implies, for instance, that when hours of direct patient care are 1 percent higher, service intensity falls by 0.21 percent, so that a physician's total billings would increase. This negative-inelastic relationship between hours of direct patient care and billings per hour imply a positive, but less than proportional relationship between hours of direct patient care and total service provision.

The Hausman test rejects the null hypothesis of no systematic difference in coefficients between OLS and IV estimates $(\chi^2(1) = 5.12,\ p\text{-}value = 0.0236)$, indicating that the OLS estimates suffer from bias due to measurement error. Measurement error causes a downward bias in coefficient estimates. As expected, the IV estimate is greater in absolute value at 0.28; it is also statistically significant ($p < 0.01$). Although the magnitude of IV-corrected elasticity is larger than the OLS estimate, it remains inelastic. It implies that 1 percent decrease in weekly hours of direct patient care is associated with a 0.28 percent increase in billings per hour (service intensity). Physicians who work fewer hours practise more intensively, so that differences among physicians in service provision are likely smaller than differences in hours worked. Hence, the basic conclusion from the OLS analysis holds even after correction for potential measurement error.

Table 5 contains IV estimates of the elasticity (θ) for each subgroup and an indication of whether the elasticity is significantly different from zero. We also tested whether the elasticity estimates differ between the categories within each characteristic (e.g., males versus females). There is a trend for men to have a larger elasticity than women, and for rural physicians to have a larger elasticity than urban physicians, but in neither case is the difference statistically significant. However, the elasticities are significantly different between group practitioners and solo practitioners (significant at 5 and 10 percent levels for group practices of two or more than two, respectively). The elasticity for group practitioners is smaller in absolute value than the elasticity for solo practitioners. If a solo practitioner reduces hours of direct patient care by 1 percent, their billings per hour likely increase by 0.40 percent; for a physician in a large group, they would be predicted to increase by 22 percent. In comparing subgroup of graduation year, the elasticities of billings per hour with respect to hours of direct patient care are significantly different only between those physicians who graduated in the 1970s and 1980s and those who graduated in the 1950s (at 10 percent significant level). Estimated results suggest that the negative correlation between service intensity and hours of direct patient care is steeper among younger physicians.

Conclusions

This analysis has generated a number of important findings regarding the relationship between physician hours of direct patient care and average billings per hour. Although there is a strong, nearly one-to-one systematic relationship between weekly hours of direct patient care and total annual billings, there is a large variation in total annual billings among physicians who worked the same number of hours of direct patient care per week.

TABLE 5
The Elasticity of Billings per Hour with Respect to Hour of Patient Care by Subgroups (IV-corrected estimates)

Subgroups	*Estimates of Elasticity (θ)*	*Std. Err.*	*t Statistics*
Whole sample	–0.278**	0.054	–5.13
Male	–0.296**	0.063	–4.70
Female	–0.231*	0.108	–2.13
Urban	–0.244**	0.059	–4.15
Rural	–0.454**	0.137	–3.32
Solo practice	–0.402**	0.071	–5.65
Group practice (=2)	–0.032	0.126	–0.26
Group practice (>2)	–0.219*	0.107	–2.04
Graduated in 1950s	–0.118	0.125	–0.95
Graduated in 1960s	–0.113	0.104	–1.09
Graduated in 1970s	–0.405**	0.094	–4.29
Graduated in 1980s	–0.397**	0.116	–3.43

Note: **significantly different from zero at the 1 percent level.
*significantly different from zero at the 5 percent level.

Furthermore, there is a negative correlation between the billings per hour and the average number of hours of patient care among all GP/FPs. This negative relationship is relatively inelastic, however; the estimated elasticity of billings per hour with respect to hours of direct patient care is –0.28. This implies that a 1 percent increase in weekly hours of direct patient care is likely associated with a 0.28 percent decrease in billings per hour. The effect on service provision of an increase in hours of direct patient care is therefore only partially offset by a decrease in physician work intensity. Although increases in the supply of providers may be important long-run policies, in the near term the most effective means of increasing access would be to increase hours of work and service provision by the existing stock of practising physicians.

Although this elasticity does not differ significantly between male and female physicians, it does vary with other physician and practice characteristics. The absolute value of the elasticity is nearly twice as large for rural physicians as it is for urban physicians. Although the difference between the two estimates is not statistically significant, the trend suggests that increased work hours among rural physicians will reduce service intensity more and elicit a smaller increase in total service provision than among urban physicians. Combined with the fact that rural physicians already provide more hours of direct patient care and practise more intensively than urban physicians, policies that attempt to increase hours of patient care are perhaps better targeted at urban physicians. The elasticity is smaller for physicians practising in larger groups, which make up an increasing proportion of GP/FPs. Perhaps surprisingly, the elasticity is larger for younger physicians (though it is estimated imprecisely) than older physicians.

Having identified these important aspects of the hours-services relationship, the next step to inform policy will be to provide insight into the impact of physician, household, and practice-related factors on physician hours of work and service provision. Such information is crucial for developing sound physician human resource policies. Generating such information will require joint models of physician labour supply and physician service supply, which in turn will require much richer datasets than are currently available combining information on labour supply, service supply, physician characteristics, and economic aspects of the practice environment.

Notes

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[1]The Canadian Medical Association has regularly conducted national physician surveys on physician workforce issues since 1982. The Physician Resource Questionnaire (PRQ) for 1982, 1986, and 1990 were census surveys of all physicians licensed to practise medicine in Canada (both members and non-members of provincial medical associations).

[2]All records were fully anonymized to protect confidentiality. In Canada, 98.5 percent of all physician expenditures are financed by provincial public insurers such as OHIP (the percentage is even higher for GP/FPs, which are the focus of this study). Therefore, our billings data effectively capture all of the service activity of physicians in our sample.

[3]Physician are asked to indicate the amount of time they spend in a series of professional activities, including research, administration, teaching, indirect patient care, and direct patient care. "Direct patient care" is therefore meant to indicate time for which the physician's primary activity is providing clinical services to patients, regardless of the setting. Note that this excludes on-call time.

[4]A simple sum of services would fail to capture true service output. For instance, if one physician provided a minor assessment, but a second provided a major assessment, the count of services would indicate equal service provision by the two physicians, failing to capture the additional service of the physician providing the major assessment. Because the fee for a major assessment is higher than the fee for a minor assessment, the sum of billings better reflects underlying service provision.

[5]The responses by some outliers were not plausible (implying, for example, over 15 hours of direct patient care per day, 365 days per year), or simply highly unusual (e.g., less than one hour of direct patient care per week on a regular basis).

[6]*Method of Group Averages* (Kmenta 1986; Bowden and Turkington 1984) is a classic strategy to correct for measurement error. The general idea is that if "hours" are measured with error, "group average of hours" is correlated with hours, but is much less affected by measurement error because very few physicians would be assigned to the wrong group.

[7]The first-stage equation is: $\ln(h) = \alpha + \beta X + \gamma G + u$, where h is self-reported hours, X are the physician characteristics as in (3), and G is a set of dummy variables indicating in which of the three "hours groups" the physician fell, and u is a error term. The equation is used to generate $\hat{h}$ for the second-stage equation.

[8]Those in the low group provided an average of 29.06 hours of direct patient care per week (range: 12, 36); those in the middle group provided an average of 41.71 hours of direct patient care per week (range: 37, 47); those in the high group provided an average of 53.50 hours of direct patient care per week (range: 48, 65).

[9]We must be cautious not to misinterpret this finding, because variance is not scale-independent and hours and billings are measured by different scales. See elasticity analysis below, which is scale-independent.

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Technical Appendix to the Methods Section

Decomposing Variation in Total Billings

From (2), let

$$\log(B) = \log(B / h) + \log(h) \tag{A1}$$

Denote the variance of log total billings by $\sigma^2_{\log(B)}$, the variance of log billings per hour by $\sigma^2_{\log(B/h)}$, the variance of log number of working hours by $\sigma^2_{\log(h)}$, and the covariance of the log billings per hour and the log number of working hours by $\text{cov}(\log(B / h), \log(h))$. By the properties of variance:

$$\sigma^2_{\log(B)} = \sigma^2_{\log(B/h)} + \sigma^2_{\log(h)} + 2\text{cov}(\log(B / h), \log(h)) \tag{A3}$$

$$\sigma^2_{\log(B)} = \sigma^2_{\log(B/h)} + \sigma^2_{\log(h)} + 2\rho_{B/h,h}\sigma_{\log(B/h)}\sigma_{\log(h)} \tag{A4}$$

where $\rho_{B/h,h} = \dfrac{\text{cov}(B / h, h)}{\sigma_{\log(B/h)}\sigma_{\log(h)}}$, the correlation coefficient between log(B/h) and log (h).

Estimating the Elasticities of Billings per Hour with Respect to Hours of Direct Patient Care

Let $B_w(h)$ denote total weekly billings when hours of work per week equal h, and $B_h(h)$ denotes the billings per hour for h hours per week. It follows that

$$B_w(h) = B_h(h) \cdot h \tag{A5}$$

and that

$$\frac{dB_w(h)}{dh} = \frac{d(h \cdot B_h(h))}{dh} = B_h(h) + h \cdot \frac{dB_h(h)}{dh} = B_h(h)[1 + \theta] \tag{A6}$$

where θ is the elasticity of billings per hour with respect to hours of direct patient care (Sundstrom 1993). In order for (A6) to be positive, the elasticity, θ, must be greater than –1 ($\theta > -1$). This elasticity (θ) can be estimated using a standard regression approach while controlling for physician's characteristics: equation (3).