Explaining primary care physicians' decision to quit patient-centered medical homes: Evidence from Quebec, Canada

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Objective: To examine the factors explaining primary care physicians' (PCPs) decision to leave patient-centered medical homes (PCMHs).

Data Sources: Five-year longitudinal data on all the 906 PCPs who joined a PCMH in the Canadian province of Quebec, known there as a Family Medicine Group.

Study Design: We use fixed-effects and random-effects logit models, with a variety of regression specifications and various subsamples. In addition to these models, we examine the robustness of our results using survival analysis, one lag in the regressions and focusing on a matched sample of quitters and stayers.

Data Collection/Extraction Methods: We extract information from Quebec's universal health insurer billing data on all the PCPs who joined a PCMH between 2003 and 2005, supplemented by information on their elderly and chronically ill patients.

Principal Findings: About 17 percent of PCPs leave PCMHs within 5 years of follow-up. Physicians' demographics have little influence. However, those with more complex patients and higher revenues are less likely to leave the medical homes. These findings are robust across a variety of specifications.

Conclusion: As expected, higher revenue favors retention. Importantly, our results suggest that PCMH may provide appropriate support to physicians dealing with complex patients.

KEYWORDS

Canada, health care workforce, patient-centered medical homes, physician retention, primary care

1 | INTRODUCTION

Patient-centered medical homes (PCMHs) reflect the fundamental tenets of primary care, as well as substantial changes in practice organization and provider payment.^{1,2} In addition to their focus on accessible, high-quality, coordinated care for patients, PCMHs also have implications for providers. They move away from traditional models where primary care physicians (PCPs) work alone or in monodisciplinary groups, rarely sharing more than a building and administrative staff. They build on interdisciplinary teams, where physicians can use allied health professionals' time and expertise, in addition to their own, to produce services. Allied health professionals

participating in these groups are as varied as nurses, pharmacists, or psychologists.

The enthusiasm for PCMH rests on two key arguments. The first, that interdisciplinary teams will improve access to, coordination, and continuity of care, builds on the observed positive association between primary care and health system performance, health outcomes, and health disparities.^{3,4} The second is that PCMH may be an important tool to increase the attractiveness of family practice by improving the work environment for PCPs, particularly in the context of a clear income gap with other specialties.⁵ Team-based practice can be used to attract physicians to, and encourage them to stay, in underserved areas where access is lacking⁶ and potentially

address the imbalance between the distribution of physicians across specialties and population needs.³

While evidence regarding the effects of PCMH on cost, utilization, and quality of care based on demonstration projects is mounting in the United States,⁷⁻⁹ less is known about their influence on physician labor supply. Canada has been at the forefront in implementing versions of the PCMH model at the system level, with Quebec being the first to introduce Family Medicine Groups (FMGs) in 2002.¹⁰ Findings from a province-wide PCMH initiative in Canada offer a unique opportunity to inform clinicians and decision makers in the United States about the large-scale effects of PCMH.

Despite great enthusiasm for PCMH among policy makers, no one has yet examined the retention of primary care physicians in these organizations. Retaining PCPs in PCMHs is important for the attractiveness of family practice and to ensure PCMH functions properly.¹¹ This paper addresses this gap in evidence by examining the factors explaining PCPs' decision to quit PCMH using population-based data from Quebec, Canada.

2 | BACKGROUND

2.1 | Institutional background

Each Canadian province has a single, public health insurer, which covers all hospital and physician services, and physicians bill according to the provincial fee schedule. Patients pay nothing out of pocket for publicly insured services, but specialist services require referral from a PCP. While approximately equal proportions of physicians nationwide report that their income is substantially blended compared to pure FFS, shares of FFS payment remain high in some provinces, including Quebec. PCPs are community-based and work predominantly in private practices that they own and manage, while billing the public insurer for services provided. Physician density steadily grew in the last decade and has now reached a historical high,⁵ even if it remains modest compared to the OECD average.¹²

Quebec, the second largest Canadian province, implemented the FMG reform in 2002 to address accessibility of primary care services.¹³ A typical FMG is 6-12 full-time equivalent physicians and about 1 nurse per 7500 registered patients. Nurses' salaries are paid directly by the Health Ministry.

Physicians' participation in FMG is voluntary, and PCPs are free to join or to quit the group at any time. To form a new FMG, a group of physicians applies to the Health Ministry, and additional physicians can enroll in FMG after it is established.¹³ While 3 percent of Quebec's PCPs joined in the first year (2003), the proportion quickly reached 19 percent 2 years after (see Figure A1 in Appendix S1),¹⁴ and as of 2014, 60 percent of Quebec's PCPs worked in 258 FMGs.¹⁵ FMG and non-FMG maintain the same FFS remuneration scheme, but only FMG physicians receive additional yearly *forfait* (CAN\$8.95 lump sum) for patient registration and additional fixed payments for after-hours availability (CAN\$64/eight-hour block). The FMG clinic agrees to provide extended access hours; however, due to a

lack of enforcement mechanisms, this requirement is not always respected.¹⁵

2.2 | Related literature

There is a very limited literature on physician retention in PCMH. One related literature examines the quality of, and barriers to, interprofessional collaboration in teams,^{11,16-18} but it is primarily qualitative in nature and does not explicitly consider retention. The physician retention literature extensively focuses on rural or remote areas, since recruiting and retaining physicians there is a well-known problem in many countries.¹⁹⁻²² Determinants of retention in these areas are now fairly well established and include personal background in the area, familial reasons, and financial motives, to name a few. A more recent and limited literature examines physicians' decision to join PCMH,²³ but again, retention is not considered.

The closest to the present work is Savageau et al,²⁴ who indicate that female physicians, those working in an urban setting, and more experienced doctors were more likely to state that they would remain in community health centers (CHCs) over the next 5 years. It is important to note that the PCMHs differ sharply from the traditional models of CHCs, mainly in patient registration, after-hours requirements, and physician payment systems. Moreover, Savageau et al²⁴ focus on the "safety-net" medicine characteristic of CHCs, which is different from the population-wide intent of the PCMH.

3 | CONCEPTUAL FRAMEWORK

Due to the very limited evidence regarding physician decisions in the interdisciplinary team-based context, we identify four groups of factors that influence physicians' labor supply in other contexts and that might influence their decision to leave the PCMH: physicians' sociodemographic characteristics, revenue, complexity of patient caseload, and practice location.

Sociodemographic factors that influence physician labor supply include gender, experience (age), and geography. Female physicians tend to work less total days and hours per day.²⁵⁻²⁷ Older physicians work fewer hours compared to younger ones.^{25,28} While the FMG requirement of extended access hours might increase the likelihood that female and older physicians quit the group, PCMH offers the support of allied health professionals and other PCPs, such that each physician could reduce her individual workload compared to solo practice, and still offer more hours at the group level. As it is well known that the retention of physicians is lower in remote and rural areas,²¹ this factor may interact with the decision to leave FMGs.

Physicians would be more likely to leave FMG if their revenue was negatively affected by participation in the group. Physicians are compensated on a FFS basis, independent of FMG status, and the financial incentives (*forfaits*) that differentially impact FMG physicians are modest and unlikely to have a direct influence on physicians' revenue. Participation in FMGs could still affect revenue by other means. For example, if PCPs effectively substitute some of

their services with nurses' services, they can free up some time and increase revenue by seeing other patients. They could, however, experience a decline in revenue if they overuse nurses' services, fail to coordinate appropriately with other team members, or sacrifice time spent on patient care for administrative responsibilities.

Physicians balance their own financial interest with their patients' health.²⁹ Proponents of PCMHs believe that team collaboration will provide better support to physicians with more complex patients, both reducing physician inputs and improving patients' outcomes.^{10,30} There is a growing body of evidence on the positive impact of collaboration between nurses and PCPs on patients' outcomes, notably for chronically ill patients.³¹⁻³⁵ Hence, we expect that physicians with complex patients are less likely to leave FMGs.

In Quebec, PCPs can have multiple practice locations (eg, emergency department, private clinic, and long-term care hospitals). We hypothesize that physicians with more diverse practice locations are more likely to leave FMGs, since FMGs may add another layer of administrative complexity. Not all the practice locations are equal though. Due to PCPs' training and the scope of primary care practice, Quebec's community health centers (CLSCs) and private practice clinics, where the patients generally visit for common conditions, are a more natural fit for PCPs than emergency departments or long-term care institutions.³ We expect physicians with more activity in "PCP-friendly" environments to be less likely to quit.

4 | METHODS

4.1 | Data

We rely on an administrative database constructed from billing records from Quebec's provincial public insurer, the *Régie de l'assurance maladie du Québec* (RAMQ), specifically to evaluate the effects of FMGs. It contains information on all 906 PCPs who joined FMGs during the first 2 years of the policy across the entire province. Physicians are identified as FMG when they first register a patient in a FMG, that is, when they claim the FMG *forfait* for a patient. This is defined as their "time-zero," falling between January 2003 and January 2005, and we follow physicians for 5 years after time-zero.

Covariates are available in, or constructed from, the RAMQ data. Physicians' demographics, including time since graduation and gender, and activity, including number of acts done in different clinical settings, were directly available. PCPs' individual income is not directly provided, but physicians were categorized into 24 revenue strata in the dataset. During the study period, Quebec had 18 administrative health regions. These are categorized into 5 types according to their urbanity and health care resources: urban centers with university-affiliated medical centers, suburban areas, intermediate regions, and rural and distant areas.³⁶

The RAMQ data also contain general information on a physician's patient roster (eg, total number of patients and number of patients by age group). We use a dataset of 797 248 vulnerable patients, that is, elderly and chronically ill, who register with a PCP in our database to supplement the general information on physicians' entire patient

panel. Patient data cover the same time span and share the same "time-zero" structure. We characterize the socioeconomic status of each physician's patients using a census dissemination area-level measure, quintiles of the Pampalon index of economic deprivation (quintile 5 is the most deprived).³⁷ A measure of overall patient morbidity is the Resource Utilization Band (RUB), six categories (0-5) that reflect case mix-adjusted predicted use of health care services.^{38,39}

For this study, a physician quits a FMG when she stops claiming the FMG *forfait*. We verified that physicians who stopped claiming the FMG are not retiring, relocating, or going on leave; hence, our quitting variable isolates FMG quitting from other secular trends in quitting. Among the 906 FMG physicians, 44 (5 percent) physicians quit FMG after 1 year. As shown in Figure A2 in Appendix S1, the number of "quitters" increases steadily over 5 years, and about 17 percent (155 physicians) quit these organizations within 5 years of follow-up.

Table 1 compares the characteristics of PCPs who are still in FMG to the physicians who have quit FMG after 5 years (see Tables A3-A6 in Appendix S1 for intermediate years). FMG "quitters" are less experienced (16 vs 21 years on average) and are more likely to be female (57 percent vs 46 percent) and to work in urban centers (40 percent vs 28 percent). FMG quitters have lower revenue (\$140k-\$150k vs \$190k-\$200k), higher activity in emergency rooms (677 vs 169 acts per year), and lower activity in private practice (1222 vs 3370 acts per year) than their counterparts who remain in FMG. The number of different practice locations is slightly higher among quitters (3.4 vs 2.9). Finally, FMG quitters see fewer patients per year (1318 vs 1719) and their patients are healthier (lower proportion of vulnerable patients in their roster, lower morbidity, and material deprivation). Of course, these descriptive differences make comparisons across individuals with different characteristics, and therefore do not provide strong evidence on whether these factors explain leaving PCMH. We examine within-individual changes in these predictors to better understand their influence on the decision to quit.

4.2 | Econometrics framework

Our dependent variable takes the value of "1" if the physician leaves a FMG and "0" if she stays. We can think of the decision to quit as being the outcome (denoted by y^*) of a cost-benefit calculation undertaken by the PCP and which is generally unobservable (Greene, 2011). While we cannot observe the net benefit of leaving, y^* , we observe whether a PCP quits the group:

$$\begin{cases} y = 1 & \text{if } y^* > 0 \\ y = 0 & \text{if } y^* \leq 0 \end{cases} \quad (1)$$

The net benefit y^* , which determines the decision to leave, depends on many factors, notably physicians' revenue and demographics, and patient and practice characteristics, described in the Conceptual Framework section. Specifically, the reduced-form regression model we estimate is as follows:

$$Y_{ijt} = \alpha_i + \beta_1 D_{ijt} + \beta_2 R_{ijt} + \beta_3 L_{ijt} + \beta_4 P_{ijt} + \delta_j + \delta_t + \delta_{jt} + \varepsilon_{ijt} \quad (2)$$

TABLE 1 Descriptive statistics: FMG stayers vs quitters after 5 years of follow-up

	FMG stayers	FMG quitters
Male (%)	54.5	42.6
Experience (Years since medical degree)	21.4	15.6
Medical degree from a Quebec university (%)	96.8	93.8
Geographic Location (%)		
University Region (urban)	28.0	39.7
Peripheral Region (suburban)	44.3	37.1
Intermediate Region	21.7	16.6
Remote Region (rural and distant)	6.0	6.6
Revenue Strata	13.5 (\$190 k- \$200 k)	9.84 (\$140 k- \$150 k)
Number of acts in emergency department	169.2	676.8
Number of acts in hospital outpatient department	49.5	111.9
Number of acts in home care	90.5	27.7
Number of acts in acute care hospital	417.1	385.3
Number of acts in long-term care hospital	45.3	26.6
Number of acts in community health center	141.5	104.8
Number of acts in private practice	3369.3	1221.9
Number of acts in other settings	14.1	24.6
Number of different locations	2.85	3.35
Total number of patients	1718.9	1317.8
Number of patients aged 75+	169.3	137.0
Number of perinatal patients	41.2	29.0
Number of vulnerable patients	262.8	80.7
Resource Utilization Band (RUB)	3.0	3.0
Material Deprivation Index	2.9	2.8
N	751	155

Notes: The table reports mean values of the variables. When the variable is binary, the value reported is the percentage (eg, the male variable).

where Y_{ijt} is the quitting binary variable for physician i in geographic region j at time t . Fixed and time-varying factors related to the demographic variables, such as gender and experience (linear and quadratic), are in D_{ijt} . R_{ijt} is physicians' revenue. The third group of time-varying factors L_{ijt} includes the number of different practice locations and the number of acts in different settings (eg, emergency department, private clinics). P_{ijt} includes time-varying factors relating to the patient caseload, such as the average patient caseload morbidity and the number of vulnerable patients. To control for fixed unobserved determinants of quitting decision across areas

and over time, we include geographic and year fixed effects, δ_j , δ_t , respectively. δ_j could include systematic difference in PCPs' preference across health regions that could reflect their initial choice of installation in the region. We also include δ_{jt} geographic trends to partially control for unobserved determinants varying across time and space, for example, local health policies that can be implemented by the regional health authority. α_i denotes individual-specific fixed or random effects, and ε_{ijt} is the idiosyncratic error term.

We estimate a fixed-effects (FE) logit model, controlling for time-invariant individual-level unobserved heterogeneity so that the only remaining threats to causal inference are factors that change within units over time.⁴⁰ In the FE model, α_i are allowed to be correlated with the other regressors.

The gains in identification in the FE model are tempered by several challenges. All observations where $y = 0$ for all T are dropped (78 percent of our sample in our case). In addition, the FE logit is difficult to estimate and convergence frequently fails with short panels.⁴¹ Finally, we cannot estimate the effects of important time-invariant characteristics like gender or place of training on the decision to quit a FMG, as these are differenced out of the FE model along with α_i . For these reasons, we also estimate random-effects (RE) logit models. RE models are more efficient than FE, but make the extra assumption that α_i is uncorrelated with the regressors. We also estimate a within-between specification of our logit models as a way to temper potential bias from this extra assumption in the RE.⁴² Results are very similar to the RE models and reported in Table S7 in Appendix S1.

We run five specifications of the general model (2): one for each of the four β groups separately, and for completeness, one full model including all the β 's (ie, the independent variables related to all the four groups of variables presented earlier). We computed correlation matrices for our explanatory variables in each of the 5 years and found no evidence of multicollinearity in our models (no strong correlations >0.7). Each model is estimated with both FE and RE logit. For each model, to check robustness, we start from the simplest (no control) and gradually add geographic, time, and time-trends controls with our preferred FE and RE specifications having all these controls. Standard errors are clustered at the physician level. Further robustness checks are discussed in the Section 5.

5 | RESULTS

5.1 | Main results

In Table 2, we present our preferred specifications, with complete results reported in the appendices.

Results relevant to the physicians' demographics are reported in column 1. Contrary to our expectation, gender does not appear to have any effect on the decision to leave a FMG. It is possible that the two opposing effects described in the Conceptual Framework section neutralize each other. Table 2 indicates that if there is an effect of experience, it is negative and relatively small; however, this

TABLE 2 Effects of physicians' demographics, revenue, patient caseload, and practice characteristics on quitting decision

Covariates	Demographics		Revenue		Practice		Patients		Full	
	(1) RE	(2) FE	(3) RE	(4) FE	(5) RE	(6) FE	(7) RE	(8) RE		
Male	0.54 [0.27; 1.09]							1.32 [0.58; 3.02]		
Experience	0.81** [0.70; 0.93]							0.92 [0.79; 1.06]		
Experience-squared	1.00 [1.00; 1.01]							1.00 [1.00; 1.01]		
Medical degree from a Quebec university	0.182* [0.04; 0.80]							0.28 [0.04; 1.83]		
Revenue Strata		0.90** [0.83; 0.97]	0.82*** [0.78; 0.87]					0.97 [0.88; 1.08]		
Number of acts in ED				1.00 [0.94; 1.05]	1.04* [1.01; 1.08]			1.02 [0.92; 1.13]		
Number of acts in hospital outpatient department				1.05 [0.77; 1.43]	1.01 [0.93; 1.10]			1.04 [0.94; 1.14]		
Number of acts in home care				1.54 [0.88; 2.68]	1.01 [0.80; 1.25]			1.32** [1.08; 1.63]		
Number of acts in acute care hospital				0.98 [0.90; 1.06]	1.00 [0.95; 1.08]			1.00 [0.91; 1.09]		
Number of acts in long-term care hospital				0.93 [0.75; 1.15]	0.95 [0.86; 1.04]			0.93 [0.83; 1.05]		
Number of acts in community health center				0.89* [0.81; 0.98]	0.86* [0.76; 0.98]			0.93 [0.79; 1.08]		
Number of acts in private practice				0.94*** [0.92; 0.97]	0.91*** [0.89; 0.93]			0.95 [0.89; 1.02]		
Number of acts in other settings				1.26* [1.06; 1.61]	1.26 [1.00; 1.58]			1.25 [0.98; 1.60]		
Number of different locations				0.84 [0.61; 1.16]	0.78 [0.60; 1.02]			0.75 [0.57; 1.01]		
Total number of patients						0.94* [0.88; 0.99]	0.95* [0.91; 1.00]	1.02 [0.89; 1.17]		
Number of patients age 75+						1.62 [0.96; 2.75]	1.54* [1.06; 2.54]	1.07 [0.60; 1.91]		
Number of perinatal patients						0.63 [0.26; 1.55]	0.55 [0.28; 1.10]	0.59 [0.23; 1.52]		
Number of vulnerable patients						0.30*** [0.16; 0.59]	0.14*** [0.08; 0.25]	0.17*** [0.08; 0.38]		
Resource Utilization Band (RUB)						0.57 [0.22; 1.44]	0.69 [0.34; 1.40]	0.62 [0.27; 1.41]		
Material Deprivation Index						0.59 [0.11; 3.09]	0.35*** [0.19; 0.63]	0.31*** [0.16; 0.59]		
N	4293	814	4473	772	4441	772	4432	4284		

(Continues)

TABLE 2 (Continued)

Covariates	Demographics		Revenue		Practice		Patients		Full	
	(1) RE	(2) FE	(3) RE	(4) FE	(5) RE	(6) FE	(7) RE	(8) RE		
SD of within-group residuals	3.82 [3.16; 4.63]		3.83 [3.21; 4.58]		3.72 [3.12; 4.44]		3.39 [2.79; 4.10]	3.33 [2.71; 4.08]		
Rho	0.82 [0.75; 0.87]		0.82 [0.76; 0.86]		0.81 [0.75; 0.86]		0.78 [0.70; 0.84]	0.77 [0.69; 0.84]		
LL	-846.96	-221.63	-927.55	-198.89	-842.15	-193.18	-797.67	-724.43		
AIC	1725.91	459.27	1881.11	429.79	1726.29	412.36	1631.33	1512.86		
BIC	1827.75	496.88	1964.38	504.17	1860.66	472.79	1746.47	1716.46		
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Geo dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Geo trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		

Notes: ED stands for emergency department. Rho is the intraclass correlation. Odds ratios are reported with their 95% confidence intervals in brackets. For the variables number of acts and number of patients, the ORs are reported for a 100 acts or patients. Standard errors are cluster-robust at the physician level.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

result is not robust across specifications (see Table A8 in Appendix S1). Finally, being a graduate from a Quebec university is associated with higher retention in FMG, which may reflect some local attachment. Overall, demographic factors seem to have little impact on the decision to quit.

We ran regressions with 23 revenue strata indicators and found effects close to linear, so we decided to introduce revenue as a continuous variable in our regressions for parsimony. In columns 2 and 3, we see a clear picture of the effect of revenue, which is consistent across the different specifications. For each extra \$10 000 in revenue, PCPs have a 10 percent to 18 percent lower chance of leaving the PCMH.

As shown in columns 4 and 5, an increase in the number of different practice locations has no effect on quitting. However, practice complexity is not only a count of the different locations. Acts in "PCP-friendly" settings—private practice and community health centers—consistently reduce quitting. The effects are reported for a hundred acts. Doing more acts in emergency department, arguably a complex setting for the PCP workforce, significantly increases FMG quitting, but only in the RE models. Overall, these results suggest that the complexity within a practice location matters more than the number of different locations.

For the effects of patient caseload, we see a clear picture in line with our expectations in columns 6 and 7. An increase in the number of vulnerable patients reduces FMG quitting, a consistent result across all specifications (Table A11 in Appendix S1). Having more patients reduces quitting too, but the effect is smaller than the effect of vulnerable patients. The average morbidity of the patient caseload, measured by the RUB, has no effect on the quitting decision, however. The socioeconomic status of the patients does matter. A higher material deprivation of the patient caseload reduces the probability of quitting, a result statistically significant only across the random-effects models. Overall, these results suggest that the collaboration inside FMG may provide a better support to physicians with more complex patients (chronically ill, elder, or of lower socioeconomic status).

We finally turn to a full model that includes regressors for all four groups of variables (column 8). This full specification gives a sense of which of the physicians, practice, and patients' characteristics matter more in the decision to quit a FMG; however, it shall not be interpreted as our preferred specification to interpret the effects of revenue due to the fee-for-service environment. Controlling for the full set of factors, physician demographics remain nonpredictive of the quitting decision. Practice characteristics do not really matter as much as initially thought, once we account for the patient characteristics. It is possible that the practice characteristics that were driving quitting were in fact coming from the varying patient compositions in different work settings. Importantly, we still observe the clear reduction in the probability of quitting FMG when physicians see more vulnerable and materially deprived patients. Finally, and as expected, the effects of revenue disappear, since the coefficient for this variable captures at best only the influence of *forfaits* when

TABLE 3 Discrete-time survival analysis of the effects of physicians' demographics, revenue, patient caseload, and practice characteristics on quitting decision

Covariates	Demographics (1) DTS	Revenue (2) DTS	Practice (3) DTS	Patients (4) DTS	Full (5) DTS
Male	0.76 [0.51; 1.12]				1.19 [0.75; 1.87]
Experience	0.89** [0.83; 0.95]				0.94 [0.87; 1.01]
Experience-squared	1.00 [1.00; 1.00]				1.00 [1.00; 1.01]
Medical degree from a Quebec university	0.53 [0.23; 1.20]				0.66 [0.26; 1.62]
Revenue Strata		0.90*** [0.87; 0.93]			0.99 [0.94; 1.05]
Number of acts in ED			1.03** [1.01; 1.04]		1.03 [0.98; 1.09]
Number of acts in hospital outpatient department			0.99 [0.94; 1.03]		1.03 [0.99; 1.08]
Number of acts in home care			0.99 [0.86; 1.14]		1.20** [1.06; 1.37]
Number of acts in acute care hospital			1.01 [0.97; 1.04]		1.01 [0.97; 1.06]
Number of acts in long-term care hospital			0.97 [0.92; 1.04]		0.98 [0.91; 1.05]
Number of acts in community health center			0.93 [0.81; 1.06]		0.99 [0.92; 1.08]
Number of acts in private practice			0.96*** [0.95; 0.97]		1.00 [0.97; 1.03]
Number of acts in other settings			1.10 [0.92; 1.31]		1.08 [0.92; 1.26]
Number of different locations			0.89 [0.76; 1.05]		0.87 [0.73; 1.03]
Total number of patients				0.99 [0.96; 1.01]	0.98 [0.90; 1.06]
Number of patients aged 75+				1.19* [0.97; 1.46]	1.01 [0.73; 1.39]
Number of perinatal patients				0.84 [0.49; 1.46]	0.75 [0.46; 1.22]
Number of vulnerable patients				0.24*** [0.14; 0.40]	0.25*** [0.14; 0.47]
Resource Utilization Band (RUB)				1.03 [0.55; 1.92]	0.94 [0.44; 1.97]
Material Deprivation Index				0.57** [0.41; 0.80]	0.52*** [0.36; 0.75]
N	4293	4473	4441	4432	4284
LL	-1187.95	-1310.90	-1176.70	-1033.79	-932.74
AIC	2405.89	2645.80	2393.40	2101.58	1927.48
BIC	2501.36	2722.67	2521.37	2210.32	2124.73
Year dummies	Yes	Yes	Yes	Yes	Yes
Geo dummies	Yes	Yes	Yes	Yes	Yes
Geo trends	Yes	Yes	Yes	Yes	Yes

Notes: ED stands for emergency department. Baseline hazard is fully nonparametric. Odds ratios are reported with their 95% confidence intervals in brackets. For the variables number of acts and number of patients, the ORs are reported for a 100 acts or patients. Standard errors are cluster-robust at the physician level.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

acts and patient composition are included in the regression in a fee-for-service setting. While we use fixed-effects and random-effects logit in the spirit of complementarity, the comparison of FE and RE logit is hardly avoidable. The FE provides better identification, but we faced the expected convergence issues, and the RE is more efficient. Most of the time, and particularly

for important results such as those on patient caseload, results from both models are consistent. We run Hausman tests to compare the simplest FE and RE models in all five specifications, and where possible, the models with time and geographic dummies, and geographic trends. In summary, the Hausman tests favor mostly the FE model, and the RE model in the specification with

TABLE 4 Effects of lagged (one lag) physicians' revenue and patient variables on quitting decision

Covariates	Revenue		Patients		Full
	(1) FE	(2) RE	(3) FE	(4) RE	(5) RE
Lagged Revenue Strata	0.91* [0.83; 0.99]	0.83*** [0.78; 0.87]			0.93 [0.85; 1.01]
Lagged Total number of patients			0.93 [0.85; 1.02]	0.96 [0.92; 1.00]	1.12** [1.03; 1.21]
Lagged Number of patients aged 75+			2.13 [0.83; 5.44]	1.47 [0.98; 2.21]	0.84 [0.50; 1.42]
Lagged Number of perinatal patients			0.65 [0.42; 1.02]	0.63 [0.37; 1.09]	0.91 [0.45; 1.87]
Lagged Number of vulnerable patients			0.42* [0.18; 0.97]	0.21*** [0.12; 0.34]	0.33** [0.16; 0.67]
Lagged Resource Utilization Band (RUB)			1.19 [0.38; 3.67]	1.12 [0.48; 2.62]	1.60 [0.58; 4.39]
N	563	3593	549	3566	3407
SD of within-group residuals		4.37 [3.68; 5.19]		4.08 [3.38; 4.92]	4.13 [3.36; 5.07]
Rho		0.85 [0.80; 0.89]		0.84 [0.78; 0.88]	0.84 [0.77; 0.89]
LL	-153.41	-839.73	-143.74	-788.27	640.79
AIC	320.81	1703.45	309.476	1608.53	1341.59
BIC	351.14	1777.69	356.865	1707.40	1525.59
Year dummies	Yes	Yes	Yes	Yes	Yes
Geo dummies	Yes	Yes	Yes	Yes	Yes
Geo trends	Yes	Yes	Yes	Yes	Yes
Other covariates	No	No	No	No	Yes

Notes: ED stands for emergency department. Rho is the intraclass correlation. Odds ratios are reported with their 95% confidence intervals in brackets. For the variables number of acts and number of patients, the ORs are reported for a 100 acts or patients. Standard errors are cluster-robust at the physician level.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

all the dummies and trends. We can thus be quite confident in the interpretation of the fully controlled RE models' results presented in Table 2.

5.2 | Additional robustness checks

The comparison of the results across the FE and RE logit, as well as changing the control variables, provides a first series of robustness checks. Important results, like the effects of patient complexity, appear to be robust. In addition, we examine the sensitivity of our results to different subsamples, where we focus our comments on the random-effects logit model with all covariates for conciseness. We also adopt an alternative modeling approach with a survival analysis.

We first exclude physicians from Montreal. Montreal is the major urban center, with large tertiary hospitals and some of the lowest rates of primary care accessibility in the province. Second, we exclude physicians with the highest and lowest number of total visits (top and bottom 5 percent) to verify that our main results are not overly influenced by highly/lowly active physicians. Third, we conduct the analyses separately on a sample of early quitters and

late quitters. We assume that those who quit FMG early might do so for reasons that may differ from those who did so later on. Because there was a clear jump in the number of quitters between years 3 and 4, suggestive of a second wave, we define early quitters as those quitting in the first 3 years. Results of these subsample analyses are reported in Table A13 in Appendix S1. Despite a few differences between the early and late quitters (eg, experience is significant for late quitters), the most important finding is the robustness of the impact of patient complexity across different subsamples.

The physician decision to quit can also be analyzed from the perspective of a survival model, rather than a latent cost-benefit calculation, which allows to address potential challenges from right-censoring while providing an additional robustness check. Since there is no clear "competing risk" in the Quebec context (compared to Ontario, for example⁴³), and given our data are interval-censored, we run a discrete-time survival (DTS) analysis (results reported in Table 3). Results from this analysis are overall similar to our main findings, notably for patient complexity and revenue, further reinforcing the robustness of our findings.

TABLE 5 Effects of physicians' revenue and patient caseload on quitting decision—matched sample

Covariates	Revenue		Patient		Full
	(1) FE	(2) RE	(3) FE	(4) RE	(5) RE
Male					0.66 [0.15; 2.88]
Experience					1.19 [0.90; 1.58]
Experience-squared					1.00 [0.99; 1.00]
Medical degree from a Quebec university					0.25 [0.01; 8.36]
Revenue Strata	0.86 [0.71; 1.04]	0.83** [0.75; 0.92]			0.87 [0.74; 0.02]
Number of acts in ED					1.00 [0.85; 1.17]
Number of acts in hospital outpatient department					1.03 [0.88; 1.21]
Number of acts in home care					1.48 [0.99; 2.22]
Number of acts in acute care hospital					1.06 [0.94; 1.19]
Number of acts in long-term care hospital					0.90 [0.78; 1.04]
Number of acts in community health center					0.87 [0.67; 1.12]
Number of acts in private practice					0.93 [0.83; 1.04]
Number of acts in other settings					1.61 [0.93; 2.78]
Number of different locations					0.64 [0.38; 1.06]
Total number of patients			0.89 [0.77; 1.02]	0.97 [0.89; 1.05]	1.10 [0.88; 1.38]
Number of patients aged 75+			1.25 [0.39; 3.97]	1.38 [0.74; 2.59]	1.07 [0.45; 2.56]
Number of perinatal patients			2.58 [0.87; 7.67]	0.50 [0.18; 1.41]	0.82 [0.30; 2.22]
Number of vulnerable patients			0.27* [0.97; 0.75]	0.15*** [0.06; 0.34]	0.16*** [0.06; 0.44]
Resource Utilization Band (RUB)			0.55 [0.08; 3.64]	0.82 [0.24; 2.79]	0.87 [0.25; 3.01]
Material Deprivation Index			0.01* [0.00; 0.92]	0.29* [0.09; 0.90]	0.30 [0.08; 1.13]
N	383	101	366	993	993
SD of within-group residuals		4.31 [3.32; 0.60]		4.12 [3.13; 5.42]	4.42 [3.30; 5.91]
Rho		0.85 [0.77; 0.90]		0.84 [0.75; 0.90]	0.86 [0.77; 0.91]
LL	−66.60	−425.84	−52.63	−386.99	−372.70
AIC	147.20	875.68	129.256	807.99	807.40
BIC	174.84	934.67	176.088	891.30	959.33
Year dummies	Yes	Yes	Yes	Yes	Yes
Geo dummies	Yes	Yes	Yes	Yes	Yes
Geo trends	Yes	Yes	Yes	Yes	Yes

Notes: ED stands for emergency department. Rho is the intraclass correlation. Odds ratios are reported with their 95% confidence intervals in brackets. For the variables number of acts and number of patients, the ORs are reported for a 100 acts or patients. Standard errors are cluster-robust at the physician level. Physicians matched sample only.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

5.3 | Further analyses for a causal interpretation

While we cannot reach the same level of evidence as with a randomized experiment,⁴⁴ we want to investigate whether the impact of patient complexity and of revenue on retention is reliably causal. The FE estimator has a causal interpretation if the unobserved heterogeneity is time-invariant, but as we suspect reverse causality, the FE is not

sufficient. Indeed, it is plausible that physicians choose to stay in the FMG to see more complex patients if they believe that the group will help provide quality care and if they are interested in patients' health.²⁹ To ensure that the causes precede the consequence, we first use lagged values of the patient caseload and revenue variables in our regressions.

While we acknowledge that our periods are quite large (1 year) for our question of interest, it is possible that physicians delay their

decision to quit the PCMH to the next year. They could decide to leave the group after realizing that their revenue the preceding year was not up to their expectations, for example. Results are reported in Table 4. Higher revenue in the preceding year consistently reduces the probability of leaving in the given year (columns 1-2), except in the full specification where acts are included (column 5), for reasons mentioned in the Main results section. Patient complexity measures, particularly the number of vulnerable patients, also keep the same sign as before. Having more vulnerable patients in the roster in the preceding year reduces quitting in the given year in all specifications (columns 3-5).

Second, we use a propensity score (PS) matching procedure. The PS matching helps rule out that FMG stayers and quitters were already very different when joining the FMG, at least on observable characteristics, meaning that unobserved confounding may still be a challenge. We create a control group of stayers as similar as possible to the physicians who leave FMG using an estimated PS that includes all described variables (demographics, revenue, practice, and patient variables). We define our treatment group as the 155 PCPs who have quit in year 5 and construct our control at baseline. We use nearest neighbor matching with replacement and restrict analysis to the common support. After matching, no significant difference remains on the covariates at baseline (see Table A14 and Figure A15 in Appendix S1 for the pre-post matching covariates comparison and PS distribution and Table A16 in Appendix S1 for the DTS on the matched sample). We rerun the fully controlled regressions for the revenue, patient, and full model on the matched sample. Table 5 shows results consistent with the main analysis: Higher revenue reduces quitting (column 2), and higher patient complexity, measured by the number of vulnerable patients and the material deprivation, does the same (columns 3-5).

6 | DISCUSSION AND CONCLUSION

Our study adds to the PCMH literature and, for the first time, examines the factors explaining PCPs' decision to quit these teams, using population-wide administrative data from physicians in Canada's second largest province. Our key result is that patient complexity reduces rates of PCMH quitting. While our data do not allow us to precisely disentangle them, potential mechanisms for this response to patient complexity include physicians' intrinsic motivation to serve the neediest patients or the appeal of a clinically challenging workload. Given the findings from previous studies that physicians with more complex patients are less likely to join PCMHs in the first place,^{23,45} our results underscore the power of this selection mechanism by highlighting that, conditional on joining a PCMH, patient complexity also reduces the likelihood of PCMH quitting.

Our study has some limitations. First, we use administrative data and thus have no information on the work satisfaction and personal motivations that can explain quitting. It is indeed possible that physicians leave PCMH because of bad team climate. The evidence on

interdisciplinary collaboration clearly indicates that good team climate is necessary for success,^{11,35} and this might contribute to trigger health professionals to stay on the team. Family status is another important variable that we are not able to account for, despite its impact on physician labor supply and retention in remote areas.^{22,46} However, the main advantage of using administrative data is that we observe real quitting or staying, and not statements about a willingness to stay or quit.

Second, our sample is of "first-generation" FMG physicians. These physicians were among the most enthusiastic regarding new PCMHs, and reasons that explain quitting may differ from those who have chosen to join FMG when the policy was more mature. Our results are thus certainly not representative of the PCP population, as early FMG adopters differ from those who do not join FMG in the first years of the policy.²³

Despite these limitations, our study sheds some light on the understudied topic of physicians' decision to quit PCMHs. While the evidence regarding physician decision to collaborate with other health professionals is mounting,^{16,47} this is the first quantitative study to address the question of why physicians decide to quit PCMH. Future studies could compare retention in PCMHs and in traditional primary care organizations.

One important policy implication is that the FMG policy appears to fulfill one of the promises of the new interdisciplinary PCMHs:³⁰ providing appropriate support to physicians dealing with more complex patients. More research is necessary to understand the effect of PCMH on health care providers. Indeed, beyond ours, only one study so far examined the effect of this primary care delivery transformation on providers, looking at burnout.⁷ Such research will echo the call for expanding the Triple Aim to a Quadruple Aim inclusive of providers' welfare.⁴⁸

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