Physician supply and health care uptake
Quasi-experimental evidence from Brazil

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August 1, 2022

Abstract

Despite a globally improved access to primary healthcare, many developing and emerging economies still suffer from a geographically highly imbalanced healthcare provision. With this background, this paper exploits the sudden exit of 8,316 Cuban doctors from Brazilian municipalities. The Cuban doctors formed an integral part of Brazil's large-scale "More Doctors Program" which is aimed at increasing the number and coverage of public primary health care, especially in vulnerable areas. Anticipating a rift with Brazil's incoming president, Jair Bolsonaro, most Cuban doctors had to exit the program and Brazil in November 2018, thereby leaving many municipalities deficient in primary health care supply. Leveraging this exodus as an exogenous shock, this paper employs a Difference-in-Difference event study technique to show that there are significant, substantive, and persistent decreases in the number of NCD-related primary care consultations. The effect is limited to doctoral duties, there is no discernible effect on duties performed by nurses and other healthcare workers, and to consultations on NCDs and related risk factors. This paper contributes to the literature by highlighting the essential role of continuity in care in successfully fighting the health and economic burdens of NCDs in low- and middle-income countries.

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1 Introduction

Worldwide, there has been considerable progress towards achieving universal health coverage (UHC), especially through expanding the access to primary health care (PHC) (Stenberg et al. 2019). But particularly low and middle-income countries (LMCIs) still often lack a sufficient and continuous supply of well- qualified health care professionals (Liu et al. 2017; Schwarz et al. 2019). While population growth and the concomitantly growing burden of non-communicable diseases (NCDs) in LMICs call for further expansion of primary health care services (Stenberg et al. 2019), recent trends of declining public health care budgets and increasingly severe shortages in health care professionals puts meeting this need at risk (Adeyi, Chopra, and Nandakumar 2021; Rasella et al. 2019).

How does a lack of physicians affect health care uptake in LMICs? We leverage a short, but pronounced, policy-induced discontinuity of physician supply to estimate the effects on primary health care uptake in Brazil. Our analysis focuses on non-communicable diseases (NCDs) which represent the major health burden, in Brazil (Healthdata 2019) and in LMICs in general (Martinez et al. 2020), and which are particularly susceptible to discontinuities in care (Rabkin and El-Sadr 2011).
Brazil is a conducive case study: it has the largest universal healthcare system in the world, covering more than 190 million people (SUS 2021). The ambitious goal of Brazilian UHC is, however, met by the challenge to provide sufficient and well-qualified physicians nation wide.

To overcome the lack of physicians in its poorest and most remote regions, the government introduced the so-called *More Doctors Program* (Programa Mais Médicos, PMM) in 2013. Over 18,000 physicians enrolled to work in under-served regions, about half of them coming from Cuban (Hone et al. 2020). When Brazil's president Bolsonaro was elected in October 2018, the Cuban government unilaterally decided to withdraw all of its over 8,000 physicians from PMM (Alves 2018). While some municipalities were unaffected by the Cuban exit, other lost some or all of their PMM doctors.

We use a difference-in-difference (DiD)-type event study approach to compare PMM municipalities with no Cuban PMM doctor by the time of the Cuban exit to (1) municipalities with some Cuban PMM doctors, and (2) municipalities with only Cuban PMM doctors. We find that the shock of the Cuban exit led to a strong and immediate decrease in NCD-related PHC uptake. In addition to the short-term supply-side effect, we find evidence for a persistent negative demand-side effect. In the most affected municipalities uptake remains lower even after almost all of the vacant positions have been filled again.

Effects are limited on NCDs and related risk factors. Consultations regarding infectious diseases which require immediate care, such as dengue or tuberculosis, are not persistently affected. Furthermore, effects are limited to physician duties and cannot be observed for non-physician PHC services, which strengthens our causal interpretation. While we do not find evidence for an immediate increase in hospitalizations and mortality, the decrease in NCD-related preventive care uptake is likely to result in an increase in health and economic burden in the longer term (Gray et al. 2018; D. E. Bloom et al. 2012).

To the best of our knowledge, this paper provides the first causal evidence for the significance of providing

consistent and continuous PHC in LMICs - a topic that has been largely overlooked to date (Rabkin and El-Sadr 2011; Schwarz et al. 2019). Our paper furthermore adds to the literature on the provision of health professionals in general and on PMM in particular, being the first study to evaluate a negative supply-side shock. Our findings are relevant for policy makers in LMICs and call for making continuity a priority in the supply of human resources for health.

2 Primary health care in Brazil and the More Doctors Program

Brazil's unified health system (Sistema Único de Saúde, SUS) is the largest public health care system in the world, covering over 190 million people – i.e. more than 75% of Brazil's population (SUS 2021). PHC plays a fundamental role in the country's health system. It is organized and delivered to the local population through decentralized primary health care units (UPSs). UPSs are designed to respond to most of the patients' needs, and to forward the more severe cases to specialized secondary or tertiary health care institutions. Each PHC team usually consists of at least one physician, several nurses, community workers and technicians (Bastos et al. 2017).

Continuity and outpatient care play a strong role in Brazil's PHC system. Ideally, UPSs follow the local patients and their families over their entire lifespan, offering health promotion, disease prevention and small medical procedures (Carrillo and Feres 2019). As NCDs represent Brazil's major health burden, one important focus of its PHC is the prevention and control of chronic diseases (Castro et al. 2019).

Similar to many other LMCIs, Brazil long suffered from an insufficient and geographically highly unequal provision of physicians, and especially urban peripheries and remote areas were severely in need of physicians. Making an effort to increase the supply of PHC doctors in under-served regions, the Brazilian government introduced the so-called *More Doctors Program* (PMM) in 2013. The program, which is still on-going, pays competitive wages and additional benefits to physicians who agree to work in eligible municipalities. Eligibility criteria are based on municipalities' socioeconomic characteristics such as population size, income per capita and poverty rates (Hone et al. 2020).

The government offered PMM positions to all Brazilian doctors. However, despite the aforementioned enticing conditions, few physicians applied to fill the vacancies, and the government thus decided to open up PMM to foreign physicians. The country that came to play an essential role in the success of PMM was Cuba: an international agreement between the government of Cuba and Brazil, facilitated and managed by the Pan American Health Organization, agreed to send a significant amount of Cuban physicians to Brazil. In the end, out of around 18,000 physicians enrolled in the program, roughly half came from Cuba, thereby filling those vacancies that no Brazilian physician applied for and ensuring that all eligible municipalities could employ PMM doctors (ibid). Nevertheless, there was a clear procedural distinction between Cuban and Brazilian PMM doctors; whereas the latter group was able to freely chose their destination, Cuban doctors were assigned to vacant positions municipalities.

Cuba's participation in PMM was highly politicized. One fierce opponent was Brazil's current president, Jair Bolsonaro, who claimed the true goal of PMM was the installation of foreign guerilla in Brazil (Terra 2019). When he was elected president in October 2018, the Cuban government unilaterally and unexpectedly decided to withdraw all of its 8,556 PHC doctors from PMM in mid-November 2018 – before Bolsonaro actually taking office in January 2019. The Brazilian government immediately tried to replace the missing PHC doctors and managed to fill almost all resulting PMM vacancies after a few months (Maffioli et al. 2019).

PMM doctors are part of municipalities' overall PHC workforce, but anecdotal evidence suggests that the two groups differ from each other in important ways. First, PMM doctors are only allowed to work in one UPS, while regular PHC doctors are allowed to work in multiple UPSs at the same (also across municipalities). Second, PMM doctors are closely monitored, while regular PHC doctors have a reputation of being notoriously unreliable and of working little hours. Finally, PMM doctors play a particularly important role in delivering primary care to Brazil's poorest population. Discussions with local experts confirmed this anecdotal evidence.

3   Literature Review

Our study builds on the broader literature on human resources for health, and on the More Doctors program in particular. The importance of sufficient and well-qualified health professionals for population health is well established in the literature. A multitude of studies examines the relationship between health professionals and different health outcomes, such as health care uptake, hospitalization and mortality. Hence, the literature focuses on professionals' supply and quality alike, see for example (Anand and Bärnighausen 2004; Rao et al. 2011; Liu et al. 2017; Hongoro and McPake 2004).

When considering health care quality, one important component is *continuity* (Haggerty et al. 2003), that is patients' receiving cohesive and longitudinal care. Continuity in care is especially important for NCD prevention and control (Rabkin and El-Sadr 2011), which stands in contrast to the reality in many low-income settings. Health care in LMICs is typically episodic and fragmented across different providers (Schwarz et al. 2019; Rabkin and El-Sadr 2011). Furthermore, patients suffering from NCDs either lack diagnosis, or drop out of the health care system before proper treatment (Manne-Goehler et al. 2019; Davies et al. 2020; Geldsetzer et al. 2019; Mauer et al. 2022). Besides the ample health burdens of inadequate NCD prevention and control, it also leads to high economic burden due to expensive treatment and loss of human capital (D. E. Bloom et al. 2012).

For high-income countries, continuity of care is generally associated with higher health care uptake and lower hospitalizations and mortality (Sans-Corrales et al. 2006; Gray et al. 2018; Cabana, Jee, et al. 2004). For LMICs, theoretical articles and descriptive evidence point towards a similar direction (Bearden et al.

2019; Yu et al. 2021; Clarke-Deelder et al. 2022; Alizadeh et al. 2019; Kumar et al. 2019), but causal evidence is lacking.

LMICs particularly struggle to provide sufficient and well-qualified health professionals, which severely counteracts the progress towards UHC (Stenberg et al. 2019; Chen et al. 2004; Campbell et al. 2013), with Brazil being no exception. The country introduced PMM with the goal to improve both the supply and the quality of physicians. The program's introduction in 2013 has been investigated in detail, and studies consistently found positive effects on physician coverage in participating municipalities (L. M. P. Santos, A. Oliveira, et al. 2017; Campos and Pereira Júnior 2016; Russo 2021).

The increase in physician supply led to an increase in PHC uptake, but effects on hospitalizations and mortality are mixed and specific on conditions: Mattos and Mazetto (2019) estimate increases in PHC uptake for different aggregate service categories to range between 6% and 30%. According to their study, the increase in uptake translated to a 5% decrease in hospitalizations, while mortality remained unaffected. Carrillo and Feres (2019) find that PMM increased PHC uptake across all age groups between 5% and 8%, but they do not find any effects on different infant health indicators, such as infant mortality or birth weight. Bexson et al. (2021) find that reductions in infant mortality were limited to municipalities with high initial infant mortality rates. Hone et al. (2020) estimate the program's effect on amenable mortality and find a reduction of 1.3%, primarily driven by a reduction in respiratory disease-related mortality. Fontes, Conceição, and Jacinto (2018) find a 6% reduction in hospitalization for ambulatory care sensitive conditions, Özçelik et al. (2020) estimate reductions in primary care sensitive cardiovascular conditions between 1.2% and 1.5%. Importantly, effects on hospitalizations and mortality typically materialized with a time lag of more than a year; one year after the PMM introduction, treatment effects were often still insignificant (Mattos and Mazetto 2019; Özçelik et al. 2020; Fontes, Conceição, and Jacinto 2018).

The literature also hypothesizes that the potential gains from PMM could have strongly exceeded the realized gains. Issues with PMM included that roll-out did not strictly comply with targeting policies (Özçelik et al. 2021), and that PMM doctors partially substituted local PHC doctors or nurses (Hone et al. 2020; Girardi et al. 2016; Carrillo and Feres 2019).

Despite large attention in the public media (Dyer 2018; Schipani 2018), the Cuban exit has gained limited attention in the academic literature. There are a few articles and warning about its potential adverse effects on population health, especially in most vulnerable and deprived municipalities (L. M. P. Santos, Millett, et al. 2018; Alves 2018; Rasella et al. 2019; Nascimento 2022). However, the induced discontinuity in physician supply has never been quantitatively investigated.

We add to the body of the literature by providing first quantitative estimates for the effect of the Cuban exit on the Brazilian health care system, and first causal evidence for the importance of continuity in care for PHC uptake.

4 Data

4.1 Data sources

We combine different data sources on primary health care supply, primary health care production and health outcomes. We link our data sources on the municipality-month-year level and our sample period spans from October 2017 (one year before the Cuban exit) to December 2019. We limit our analysis to December 2019 due to the possible confounding effect of the Covid-19 crisis which hit Brazil shortly after.

We use data on municipalities' PMM participation from the Brazilian ministry of health. The data set contains the municipalities' PMM eligibility and number of (Cuban) PMM doctors registered in a given month. Based on municipalities' PMM participation in October 2018 (the pre-exit month), we group eligible municipalities into three categories: first, municipalities without a single Cuban PMM doctor, which are thus unaffected by the shock; second, municipalities with some Cuban, but also non-Cuban, PMM doctors; third, municipalities with only Cuban PMM doctors which lost all of their PMM doctors with the shock.

We complement the PMM data with information about the total monthly number of primary health care doctors per municipality – PMM and non-PMM – from Brazil's registry of health institutions and professionals (Cadastro Nacional de Estabelecimentos de Saúde, CNES).

We obtain data on primary health care production from Brazil's information system for primary health care (Sistema de Informação Atenção Básica, SISAB). The system registers all PHC services which have been provided in a given municipality in a given month, including detailed information about the nature of the service and the responsible health care professional. The system allocates PHC services into four overarching categories: consultations (atendimentos), procedures (procedimentos), dental care (odontologia) and home visits (visita domicilar). Within each category, services are further divided into subcategories. For example, specific consultations are grouped by the condition they relate to, such as diabetes, hypertension, etc. We focus on consultations, because they represent the main service provided by physicians.

Lastly, we use case-specific hospitalization and mortality data, provided by Brazil's public health system SUS (Sistema Único de Saúde).

4.2 Descriptive statistics

Table 1 summarizes key characteristics of our sample. We divide the sample in three groups, based on the relevance that Cubans played for the local PMM structure.

Municipality characteristics and treatment allocation

As explained, our treatment variable is based on the broadly defined importance of PMM doctors for PHC in Brazil.

The treatment definition captures that the exit of Cuban physicians affected PMM municipalities in distinct ways. Out of all 5,570 municipalities in our sample, 4,162 participated in the program. Out of the latter,

Variable	(Control) PMM, no Cuban Mean	(1) PMM, some Cuban Mean	(2) PMM, only Cuban Mean
PMM doctors per 100k inhabitants	11	18	20
Cuban PMM doctors per 100k inhabitants	0	10	20
Share of Cuban among PMM doctors	0	0.52	1
Share of Cuban among all PHC doctors	0	0.21	0.31
Population size (census 2018)	26842	105000	14787
Population density (census 2018)	100	300	42
N	1317	1260	1587

Table 1: PMM and PHC by treatment status, October 2018

1,316 municipalities did not employ any Cuban doctors, forming our control group. 1,260 municipalities employed both Cuban and non-Cuban physicians. These municipalities, which are partly affected by the exit, form our first treatment group. Treatment group 2 consists of the municipalities which enrolled only Cuban physicians and which were hit hardest by the exit, as they lost all of their PMM doctors. The different groups differ substantially from each other. Based on anecdotal evidence, Whereas treatment group 1 is predominantly composed of urban peripheries and "favelas", wtreatment group 2 is characterized by very remote and rural areas [1]. Looking at population density hints at this exact pattern: whereas treatment group 1 has by far the highest population density, treatment group 2 constitutes of very sparsely populated municipalities, on average. Remote municipalities are the ones most affected by a lack of PHC provision and were considered to gain the most from the introduction of PMM (F. P. d. Oliveira et al. 2015). It is furthermore likely that the municipalities will have a harder time to cushion the exit of their Cuban doctors by attracting new physicians, recently graduated or from other localities, for a longer and stable period of time.[2]

Figure 1 illustrates the spatial distribution of municipalities according to their treatment status. Light grey municipalities are ineligible and thus excluded from further analysis. Dark grey municipalities are our control group, light blue municipalities represent treatment group 1, and dark blue municipalities are treatment group 2. There is no geographical pattern discernible with respect to the allocation of municipalities into the different groups, making spatial, group-related shocks that correlate with the treatment unlikely.

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[1]DSEIs are excluded from our analysis.

[2]As an alternative, we defined treatment as the share of Cuban PMM doctors among all local PHC doctors. The results are very similar, reassuring us of the aptitude of this treatment definition.
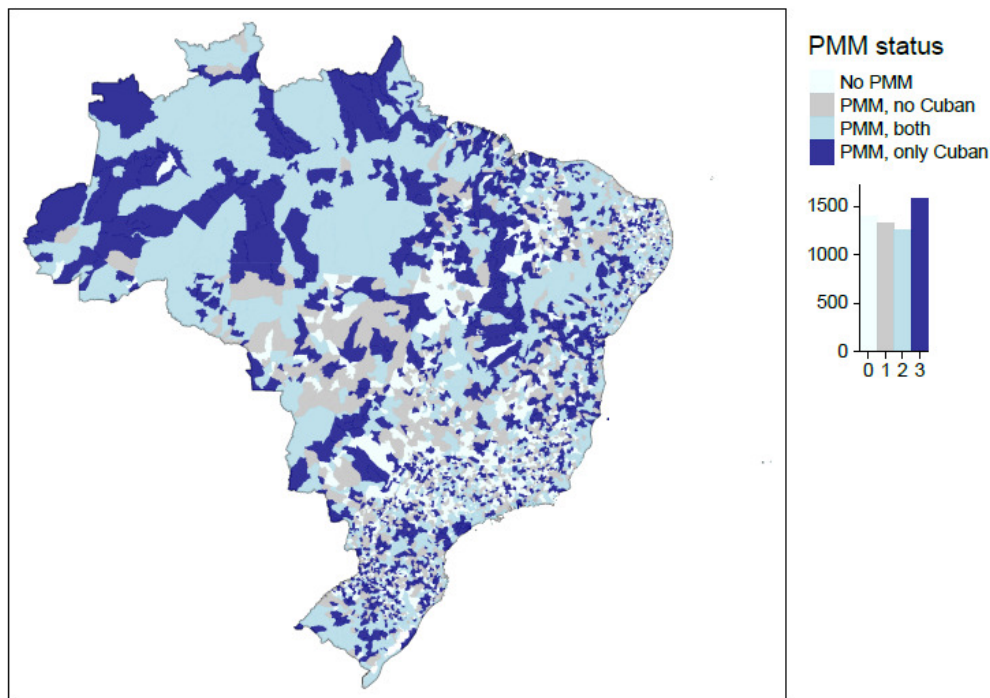
Figure 1: PMM allocation of Brazilian municipalities

Prevalent primary health care structure

Table 1 further summarizes the number of PMM and PHC doctors by group in October 2018 (the last pre-treatment month). The average control municipality employed 11 PMM doctors per 100,000 inhabitants, as compared to 18 and 20 in our two treatment groups. Among our treatment groups, there were on average twice as many Cubans present in municipalities in treatment group 2 than in treatment group 1. Treatment group 1 lost on average 52% of their PMM doctors with the Cuban exit, equivalent to 21% of their total PHC workforce. Treatment group 2 lost all of their PMM doctors, equivalent to 31% of their PHC doctors.

Figures 2 and 3 plot the number of PMM and PHC doctors per 100,000 inhabitants by group over time. When looking at PMM doctors, we can clearly see the sharp drop in coverage for treatment groups 1 (light blue) and 2 (dark blue), whereas treatment group 2 is much stronger effected. Our control group (grey), however, is completely unaffected by the Cuban exit. Within a few months after the shock in November 2018, PMM coverage in treatment municipalities recovers and almost catches up with pre-treatment levels. Nevertheless, in line with earlier assumptions, the exit of the Cuban doctors seemed to mark a shift from a very stable period, in which the number of PMM physicians barely changed, to a tumultuous aftermath with strong doctoral turnover in both treatment groups.

Although less pronounced, a similar pattern can be observed when looking at overall PHC doctors. Whereas the control group is unaffected, the treatment groups see a drop in PHC doctors coverage, followed by a recovery a few months after the shock.
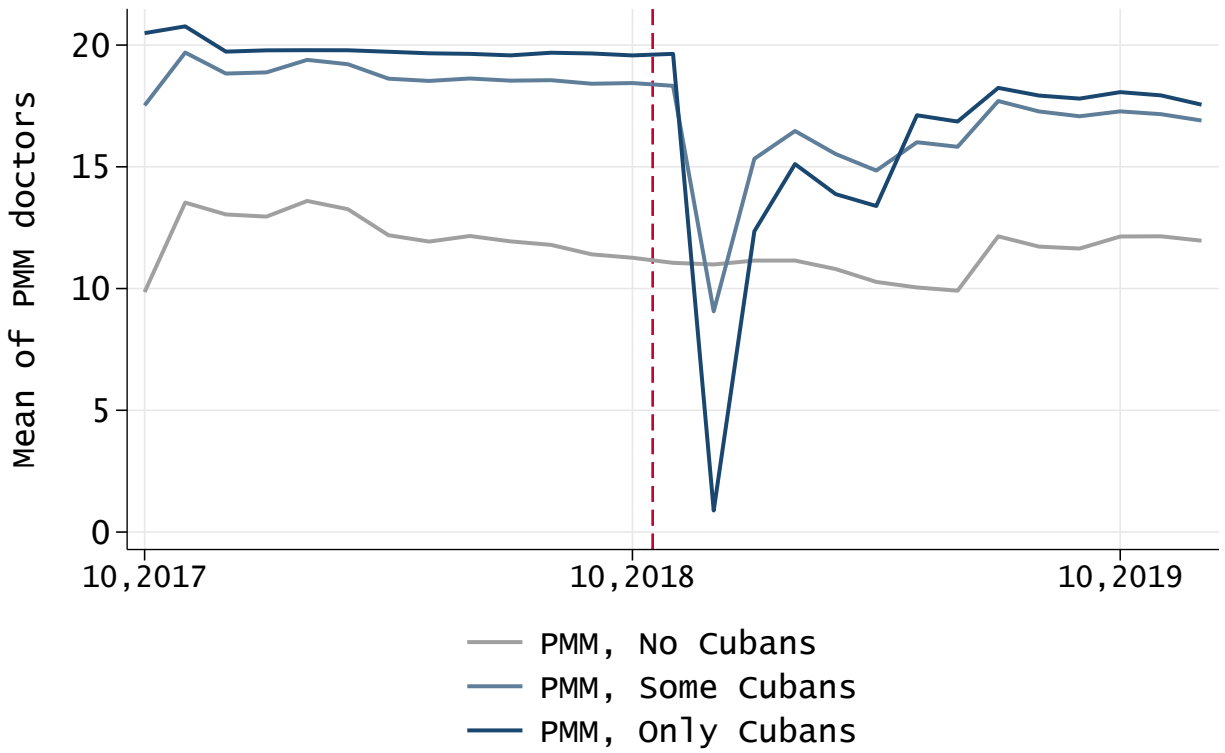
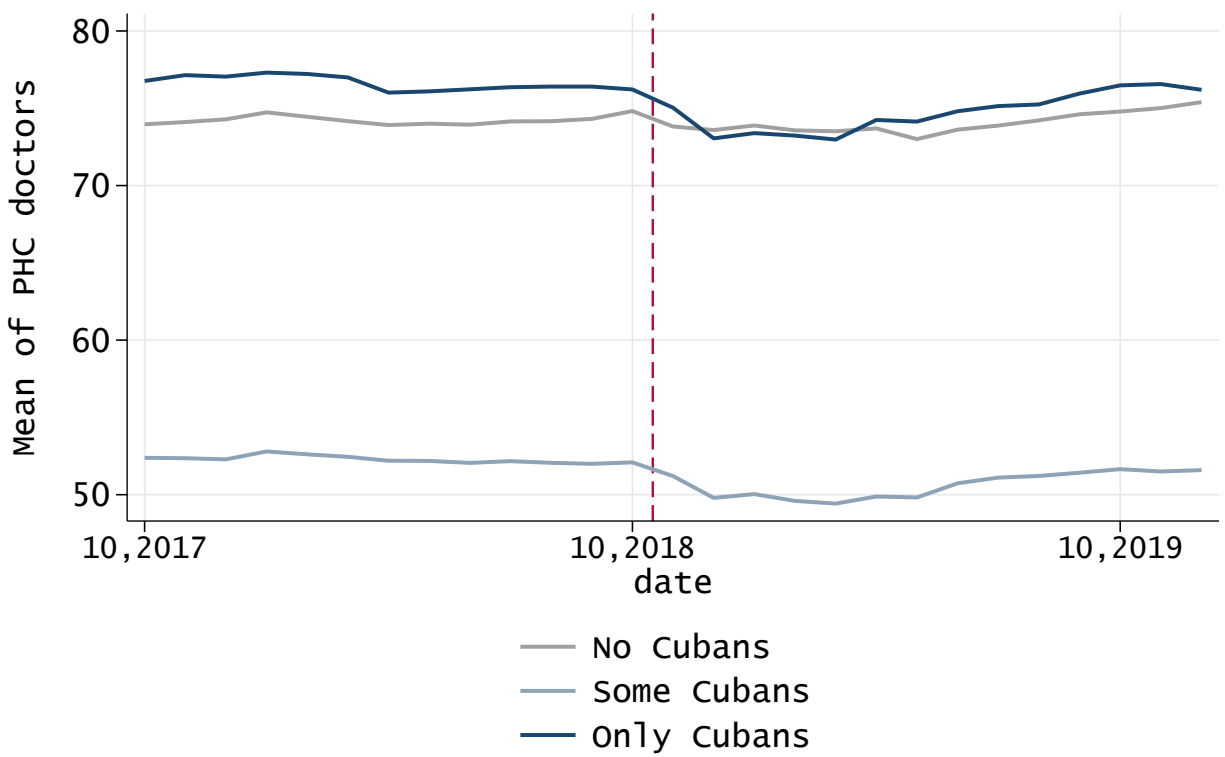**Figure 2:** Mean of PMM doctors in municipality

Figure 3: Mean of PhC doctors in municipality

Primary health care consultations

Table 2 summarizes PHC consultations in October 2018 by condition, pooled across all municipalities. In the following empirical analysis, we focus on consultations related to cardiovascular diseases, hypertension, asthma, and diabetes. These four NCDs are high-burden conditions, meaningful in absolute numbers, and primarily delivered by medical doctors. Conditions that represent only a small fraction of PHC consultations (such as chronic obstructive pulmonary disease), or that do not primarily fall under the responsibility of physicians (such as sexual and reproductive health), go beyond the scope of our analysis.

Condition	Total consultations	Share done by physician
Asthma	132 383	0.86
Dengue	7072	0.71
Leprosy	17 577	0.43
Tuberculosis	43 980	0.46
Chronic obstructive pulmonary disease	66 927	0.80
Under-nutrition	99 780	0.750
Diabetes	1 243 135	0.72
Sexually transmittable diseases	94 372	0.43
Hypertension	3 127 790	0.75
Obesity	380 844	0.59
Prenatal	1 227 229	0.51
Childcare	2 321 806	0.45
Puerperium	97 668	0.4
Breast cancer screening	355 475	0.35
cervical cancer screening	759 125	0.30
Cardiovascular risk screening	82 995	0.76
Rehabilitation	1 150 500	0.42
Mental health	1 612 819	0.71
Sexual and reproductive health	1 755 346	0.40
Tobacco	126 155	0.64
Alcohol	52 931	0.59
Other drugs	37 476	0.51

Table 2: PHC consultations share performed by physicians in Brazil, October 2018

4.3   Methods

We leverage the sudden and unexpected exit of Cuban PHC doctors to estimate its effect on health care uptake and health outcomes. We use a two-way fixed effects (TWFE) DiD model in an event study design in order to compare affected and unaffected PMM municipalities before and after the Cuban exit.

Using unaffected PMM municipalities as the counterfactual, we rely on the parallel trends assumption. That is, we assume that in absence of the Cuban exit affected PMM municipalities' outcomes would have followed the same trend as unaffected municipalities. We investigate the parallel trends assumption by looking at pre-treatment differences in outcome dynamics between the control and treatment groups; no significant pre-treatment divergences support the parallel trends assumption. As this holds for all our analyses, we are confident in claiming that any potential divergences after the Cuban exit are caused by the sudden lack of

PHC doctors and the resulting discontinuity in care.

For a PMM municipality i at year-month t, our model equation takes the following form:

$$Y_{i,t} = \alpha_i + \alpha_t + \sum_{\tau=-T}^{\tau=-1} \beta_\tau D_i + \sum_{t=0}^{\tau=T} \beta_\tau D_i + \alpha_i \times t + \epsilon_{i,t}$$

$$\text{with } D_i \begin{cases} = 2 : \text{PMM municipality; only Cuban doctors} \\ = 1 : \text{PMM municipality; some Cuban doctors} \\ = 0 : \text{PMM municipality; no Cuban doctors} \end{cases}$$

Outcomes $Y_{i,t}$ are health outcomes, most saliently NCD-related consultations in PHC. We log transform all outcome variables, adding unity to the values in order to not lose potential null-values.[3]

D_i is our treatment variable, expressed categorically: PMM municipalities are allocated to different treatment levels according to their share of Cuban PMM doctors in October 2018, thus immediately before the time of the sudden Cuban exit two weeks later (mid-November 2018, here $t = 0$).[4] The control group consists of municipalities that participated in PMM but employed no Cuban doctors. The underlying assumptions is that this definition of treatment allocation captures the importance of the Cuban involvement in PMM, and hence the strength of the exit shock, on the local level. By defining treatment purely on the number of Cuban PMM doctors in October 2018, we estimate the intention-to-treat effect among Brazilian PMM municipalities.

The first summation represents the year-month cells before October 2018. The second summation then shows the coefficients after the shock. Under the parallel trends assumption, we expect the coefficients β_{-T} (October 2017) to β_{-1} (October 2018) to not be significantly different between the control and the treatment groups. In contrast, we expect a significant decrease in primary healthcare uptake in the treated groups in the months after the shock.

α_i are municipality fixed effects, α_t are year-month fixed effects, and $\alpha_i \times t$ captures linear trends on the municipality level.

5 Regression Results

5.1 NCD-related consultations

We expect that the exit of the Cuban PMM doctors affected most severely consultations on NCDs. This is because for these lingering ills, in contrast to urgent infections and accidents, a continuity in care is especially important (Cabana, Jee, et al. 2004).

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[3]This transformation is adequate as our outcome variables are right-skewed and displays few null values (Wooldridge 2015, p.188). Using alternative transformations, such as the inverse hyperbolic sine transformation, does not change the results in any meaningful way.

[4]Note the missing time subscript in D_i. This is because we define treatment solely on municipality status in October 2018.

In line with our expectations, the Cuban exit resulted in a strong short-term drop in consultations of all types of diseases in both treatment groups. However, there is a persistent negative effect on NCD-related consultations only in our most affected treatment group. For example, consultations concerning cardiovascular diseases per 100 000 inhabitants (4a) and hypertension (4b) failed to recover to pre-treatment levels until the very end of our sample period, fully 14 months after the Cuban exit.

Figure 4 plots the trends for the four major health burdens in Brazil, the NCDs of (a) cardiovascular diseases (b) diseases related to hypertension, (c) asthma, and (d) Diabetes.
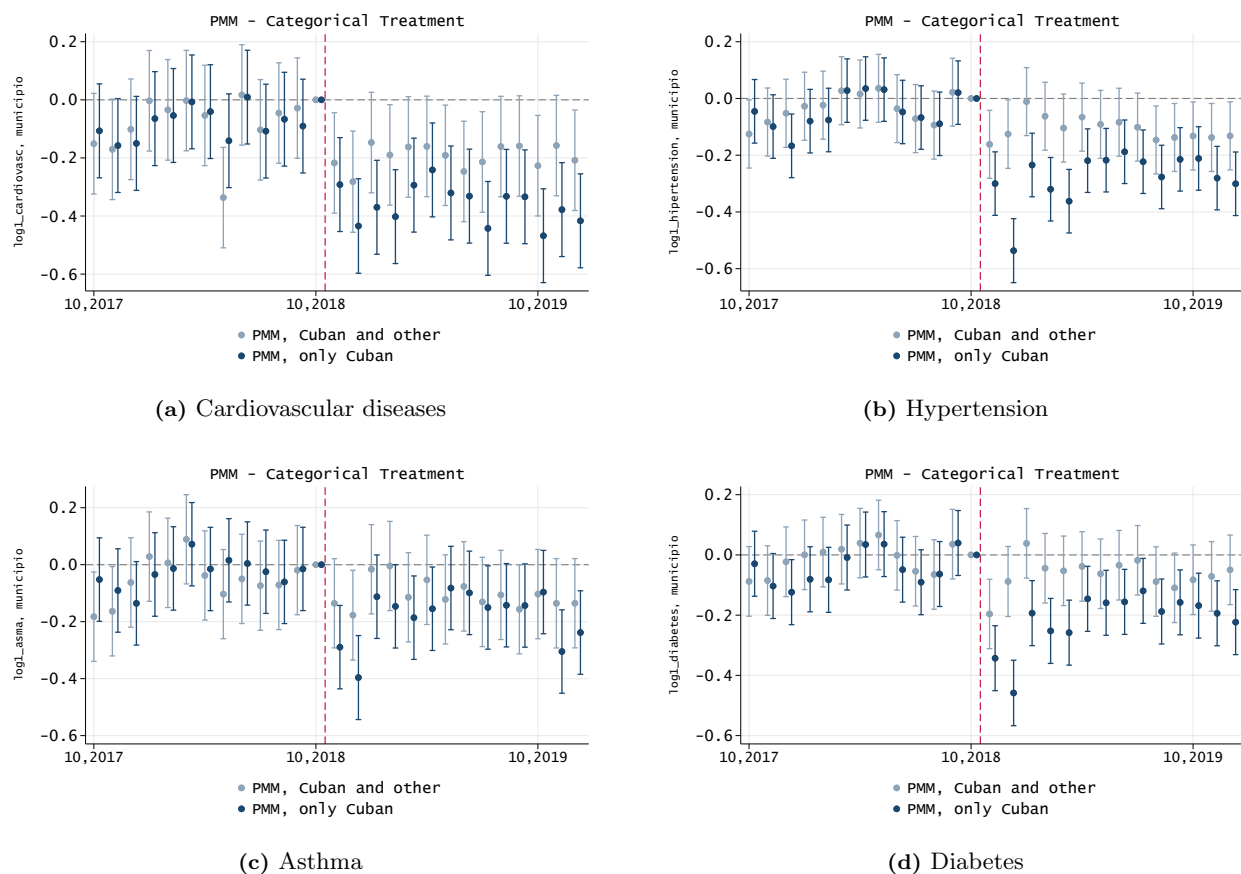

(a) Cardiovascular diseases

(b) Hypertension

(c) Asthma

(d) Diabetes

Figure 4: Consultations on the four major NCDs per 100k inhabitants. The coefficients are relative to the null-effect in the control group.

The effects are significant and substantial. In December 2018, 1.5 months after the Cuban exit, there were on average approximately 35.22% fewer consultations on cardiovascular diseases in municipalities which lost all their (Cuban) PMM doctors than in the control group. This negative effect was persistent and did not recover, as there were still 34% less consultations happening a year later.

In treatment group 1, the decline was much less pronounced: in December 2018, consultations dropped by about 24.55%. This significant short term drop was remediated in the following months, albeit some

months still reported significantly less consultations. See figure 4a for an illustration of the time trend on PHC treatment of and consultations on cardiovascular diseases.

The short-term impact on hypertension consultations (figure 4b) is even more striking: consultations dropped by roughly 41.52% in treatment group 2, leveling off at an approximate 25% decline until the end of our sample period. In treatment group 1, we hardly see a significant effect, besides the short-lived supply shock in physicians.

The impact is less severe for consultations related to Asthma (figure 4c). While suffering a strong short-term decline, consultations on asthma recovered rather quickly and somewhat concurrently with the gradual filling of PMM vacancies. We assume that many consultations and treatment on Asthma are of such urgency that they cannot be postponed in the same way to the other NCD consultations. Thus, the patients sought out treatment regardless, and given the nature of the diseases they could not be denied treatment by the UPSs.

Plotting coefficients on Diabetes consultations, on the other hand, again confirms the overall picture (figure 4d.

Overall, we find thus strong evidence that consultations on NCDs experienced a significant, persistent, and meaningful drop following the shock of the Cuban PMM exit. The evidence extends to treatments on comparable ills – negligible on the short but severe and costly in the long run – that are equally mainly performed by physicians, such as consultations on mental health and undernutrition.

5.2 Sensitivity analysis

We assume that the discontinuity in care is the main causal mechanism of why uptake of NCD-related PHC consultations remains low. To test this, this section looks at what happens to PHC tasks which are not primarily performed by doctors, such as small procedures and home visits, and to consultations on infectious diseases, which are arguably not prone to be discontinued if the patient loses her PHC physician.

In line with our expectations, only doctoral duties decrease significantly after the Cuban exit; there is no significant effect for duties primarily done by nurses and other healthcare workers, such as minor procedures (5), dental care, or home visits.

Again in line with our expectations, infectious diseases only suffer from a short-term drop, if any at all. As soon as PHC doctors were replaced, patients sought out consultations and treatment for the health issues which cannot be postponed and neglected. Figure 6 shows that consultations on tuberculosis per 100 000 local residents, a task that can arguably not be postponed and is performed around half by PHC physicians, barely did not change after the shock.

Figure 5: Aggregate PHC procedures per 100k inhabitants. The coefficients are relative to the null-effect in the control group.

Figure 6: Consultations PHC treatment on tuberculosis per 100k inhabitants. The coefficients are relative to the null-effect in the control group.

5.3 Mechanisms

How can we explain this diversion between consultations concerning distinct medical needs?

We assume that it is the discontinuity in care which causes consultations to remain low on a longer-term. However, an alternative explanations is that the exit of the Cuban physicians led to an overall drop in the availability of doctors, resulting in decreasing supply of doctors even after the PMM vacancies have been filled (e.g. because local non-PMM physicians filled in the vacancies). However, we would then see a more persistent drop in all types of consultations. Also, the descriptive evidence presented in figure 3 and figure 2 does not point to a severe lack in either PMM or PHC doctors.

We nevertheless scrutinize this assumption more carefully. In figures 7 and 8, we plot the coefficients of our TWFE DiD model with either the number of PMM or of PHC doctors as the outcome variables.

The overall number of PHC doctors returned to pre-treatment level after a few months, see figure 7.

Figure 8 shows that, naturally, there was a massive drop in PMM doctors per 100 000 inhabitants, especially in treatment group 2.[5] These numbers remained statistically negative until the end of our sample period for both treatment groups. However, the magnitude is small and leveled off after a few months.

The longer-term drop in consultations can thus not entirely be explained by a long-term drop in PHC physicians. It is also striking to see that while both treatment groups display a relative lack in PMM doctors in the second half of 2019, the decline in consultations persist mainly for treatment group 2, thus reaffirming our argumentation on the relevance of the PMM structure, and the part that the Cuban involvement had in ensuring its well-functioning, for the local PHC infrastructure and continuity in PHC in general.

Hence, we deem that the temporary fragmentation of local health care structures and discontinuity in care, result of the sudden mass exodus of Cuban doctors, as the likeliest reasons for why treatment uptake remained relatively lower, even when the supply of physicians was restored rather quickly. In other words, the Cuban exit yielded a temporary discontinuity in treatment which translated into a more permanent rupture between client and local health care provider.

There are several underlying mechanisms why this might be the case. Social components, i.e. having lost their known doctor and the discomfort of seeking a new contact for conditions that are just a nuisance on the short therm, could reinforce patients' inertia in anew seeking treatment. Also conceivable is that the Brazilian doctors, which came to close the breach left by the Cuban exit, filled the resulting vacancies only for a very short time before leaving again due to relatively unfavorable local living conditions. However, it is up to future work to substantiate these speculations.

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[5]Cuban doctors left Brazil in the middle of November 2018. Thus, December 2018 was the first month in which their vacancies were reported, and the coefficient indicates a drop of 93% in this month. One reason for why it is slightly short of 100% is that the Brazilian government managed to fill few of the resulting vacancies in the second half of November 2018.
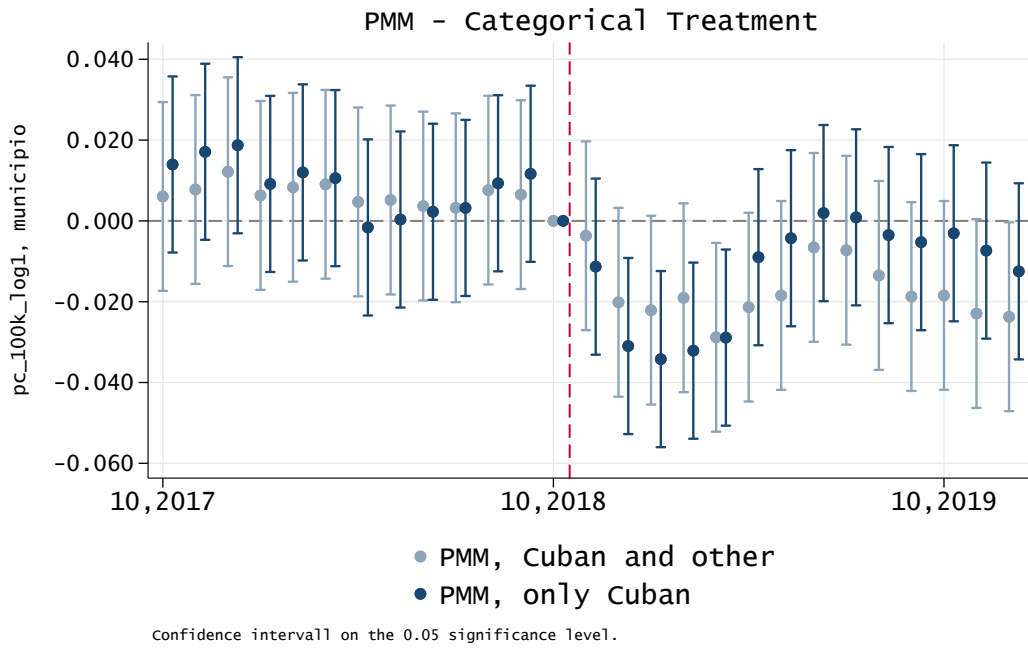
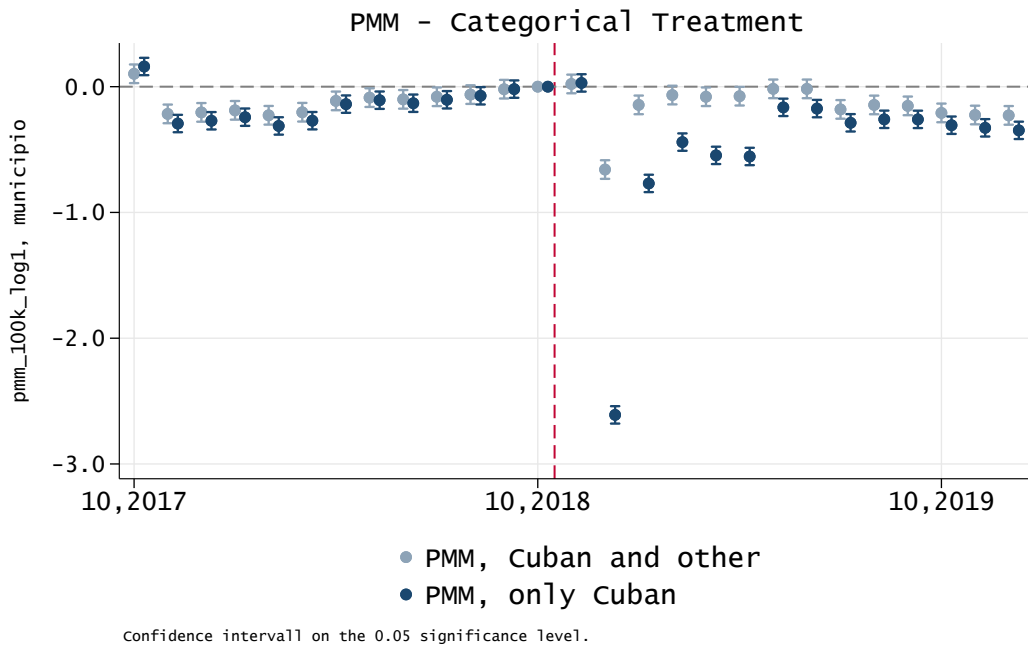**Figure 7:** Trend PHC workers by treatment groups

Figure 8: Trend PHC workers by treatment groups

5.4 Robustness checks

So far, we have assumed that control municipalities are completely unaffected by the physician shortage in other municipalities. However, we can imagine two types of spillover effects that might affect our results.

First, people from treatment municipalities might seek PHC in unaffected or less affected municipalities, which would lead to overestimation of the treatment effect. While patients in Brazil have the right to seek PHC in whichever UPS they want, they should ideally attend their locally responsible UPS. Therefore, visits from non-locals are recorded in the SISAB data. Following the Cuban exit, we do not observe any effect on the share of non-local patients seeking care in a given municipality.

Second, PHC doctors from treatment municipalities might fill vacancies in control municipalities. This would lead to an underestimation of the treatment effects, making our results lower-bound estimates.

We also test for task-shifting within UPSs. Based on findings from (Carrillo and Feres 2019), one can imagine non-physicians taking over doctoral duties. We test for effects on the share of aggregate consultations done by non-physicians and fail to observe any signs of task-shifting.

5.5 Health Outcomes: Hospitalizations and Mortality

The decline in NCD-related consultations did not (yet) translate to increased hospitalizations or mortality rates. This is not wholly unexpected, as previous evidence emphasize that effects on health outcomes take a long period of time to materialize. Prolonging our sample period faces challenges; the subsequent COVID19 health crisis hit municipalities differently and not concurrently. A future study should disentangle the deleterious effects of the sustained depression in PHC uptake and of the Corona virus.

6 Conclusion

We investigate a short but pronounced lack of physicians in Brazil's PHC sector. We find that the induced discontinuity in physician supply led to a persistent decrease in NCD-related PHC uptake, even after physician vacancies had been filled almost completely. We find the strongest persistent negative effects on PHC uptake in municipalities which suffered the largest shock to their local health infrastructure. Placebo tests on non-physician duties and infectious diseases strengthen our interpretation.

Our results provide the first causal evidence for the importance of continuity in care for NCD-related PHC uptake in LMICs, and are in line with existing descriptive studies, such as Schwarz et al. (2019), Yadav et al. (2021), and Rabkin and El-Sadr (2011).

While our study focuses on Brazil, our findings are relevant for a broader set of countries. Many LMICs face similar challenges in providing UHC, such as the lack of well-qualified health professionals

(Stenberg et al. 2019; Hongoro and McPake 2004), a fragmented health care system (Schwarz et al. 2019; Rabkin and El-Sadr 2011) and a lack of continuity in NCD prevention and control (Geldsetzer et al. 2019; Davies et al. 2020; Manne-Goehler et al. 2019; Mauer et al. 2022).

Our results call for a stronger emphasis on securing the continuity of policies geared towards achieving UHC and fighting the health and economic burdens of NCDs.

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