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Doctor Turnover and Health Outcomes: Evidence from the Exit of Cuban Doctors in Brazil*

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Abstract

This paper studies the effects of a large-scale doctor turnover on health care utilization, health outcomes, and health system inputs in Brazil. Identification relies on an exogenous political shock which led to a massive exit and replacement of primary care doctors in affected municipalities. We document that while there was a strong and persistent decrease in the care of chronic diseases and related risk factors, service utilization for conditions requiring immediate care, such as infections, recovered quickly in tandem with the filling of vacancies during the turnover period. The reduction in primary health care utilization did not translate into any systematic changes in health outcomes. Adaptation of local health systems and demand diversion helped mitigate turnover effects without major immediate adverse repercussions for population health.

JEL Codes: E10, E15, E18.

Keywords: doctor supply, doctor turnover, health outcomes, health systems.

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1 Introduction

Developed and developing countries alike have large regional disparities in the provision of medical doctors, with remote and under-served areas often facing more limited supply of personnel. Additionally, retaining doctors in these areas remains a major challenge (WHO, 2010). Low retention rates and the resulting turnover of doctors can negatively affect health care and health outcomes due to understaffed services, discontinuity of care and disruptions in the patient-doctor relationship (WHO, 2018). Yet, as the global demand for health care professionals continues to grow, doctor turnover is projected to increase, especially in remote areas (Esu et al., 2021; Liu et al., 2017). Evidence on the effects of doctor turnover on health services and health outcomes is nevertheless sparse and has come from specific contexts in developed countries —e.g. from episodes of physician retirement or of changes in the network of providers within private insurance schemes— where relatively fast replacement of professionals, wider access to services and patient choice can, in principle, potentially mitigate any adverse effects on health outcomes. Very little is known, however, about how doctor turnover affects health services and patient outcomes in resource-scarce contexts, and how other health care system inputs respond to the exit and replacement of doctors in general.

This paper studies the effects of a large-scale doctor turnover event on health care utilization and health outcomes, exploiting a unique shock in Brazil. To overcome a chronic lack of doctors in under-served areas, in 2013 Brazil introduced the More Doctors Program (*Programa Mais Médicos* – PMM). Over 18,000 doctors served in primary care services in eligible municipalities, roughly half of them being from Cuba. Five years after the introduction of PMM, following the election of Brazil's former right-wing president Jair Bolsonaro in October 2018, the Cuban government unilaterally withdrew all of the Cuban doctors from the program. The sudden exit led to a major turnover of primary health care doctors in municipalities where Cuban doctors had been working. Some municipalities were left without PMM doctors for a few months, until Cuban doctors were replaced by new doctors. Other municipalities, where no Cuban doctor had been working, remained unaffected.

We exploit the sharp and unexpected exogenous timing of the Cuban exit from PMM in municipalities that relied more *versus* less on Cuban PMM doctors at the time of the exit to estimate the effects of doctor turnover on health care utilization, health outcomes and system adaptation. More specifically, we use an event-study approach to compare outcome changes in affected and unaffected PMM municipalities before and after the Cuban exit, conditional upon time and municipality fixed effects, therefore controlling for baseline heterogeneity in levels and common time trends. We combine different fine-grained administrative microdata sets on health care utilization, hospitalizations and mortality, as well as on the supply of healthcare facilities and personnel, prescription drug sales and private health insurance into a municipality-by-month panel of data between October 2017 and December 2019. The overall evidence indicates that pre-trends in outcome variables remain irrelevant, while alternative specifications, alternative treatment definitions and robustness checks help support our identification strategy.

We find a significant and immediate drop in the number of primary care doctors in affected municipalities from November 2018 onwards. That reduction is particularly pronounced for municipalities where all PMM doctors were Cuban. From January 2019 on, affected municipalities started to fill PMM vacancies, and by May 2019 doctor supply stabilized, almost reaching pre-treatment levels. We call the period in which vacancies were filled as the turnover period. Next, we document meaningful reductions in primary care utilization. Effects are limited to physician duties, and most persist after the turnover period. Persistent reduction in service utilization is primarily driven by conditions requiring prevention and ongoing care, such as chronic conditions and related risk factors. For example, hypertension consultations decline on average by 41% in the most affected municipalities immediately after the Cuban exit, and remain 25% lower than base levels throughout and after the turnover period. Importantly, while there was a strong and persistent decrease in the care of chronic diseases, service utilization for conditions requiring immediate care, such as infections, recovered quickly in tandem with the filling of vacancies during the turnover period. Finally, the reduction in primary health care utilization surprisingly did not translate into any systematic changes in health outcomes even throughout the end of the following year after the Cuban exit. We do not observe any effects on hospital admissions nor on mortality, neither on aggregate levels nor from specific causes.

Adaptation of local health systems and demand diversion seem to have helped mitigate turnover effects without major adverse repercussions for the affected population. We explore different intermediate outcomes that could explain the overall pattern. We first focus on adaptation within primary care services. We do not find any changes in the supply of other health professionals nor in task substitution across different professionals. Moreover, we do not observe an improvement in the experience profile of the new doctors that replaced the Cuban professionals. Yet, patients in need of prescription medication for chronic diseases were able to secure their access despite the reduction in access to other related health care services, such as consultations. Together with the rapid recovery of consultations for conditions requiring immediate care, the overall evidence suggests a prioritization of primary care services towards urgent and curative needs as well as other protective services.

Second, we investigate system adaptation and demand diversion beyond primary care services. While there was not any significant changes in the use of hospitals and specialists, we observe an increase in ER visits for low-complexity conditions as well as in the number of ERs offering basic ambulatory care. Patients therefore seem to partly substitute treatment at primary care centers with treatment at ER facilities, while municipalities start providing more low-complexity services in these facilities. Importantly, this diversion persists even after the turnover ends. Finally, we do not observe any changes in private insurance coverage in affected municipalities nor detect any spillover effects across municipalities. Adaption therefore comes at the cost of a reduction in preventive care in primary care services and an increase in utilization of ER facilities. This could entail fragmentation and decreased efficiency in health care, with potential negative long-term consequences for tackling the increasing burden of chronic diseases.

This paper contributes novel evidence to the emergent literature on the impacts of doctor supply, more generally, and of doctor turnover, more specifically, on health care utilization and outcomes. Existing studies document positive associations between the supply of health professionals and health outcomes, but often struggle to establish causality (Anand & Bärnighausen, 2004; Basu et al., 2019; Singh & Sachs, 2013). Causally identified studies are scarce and document a nuanced picture, especially in resource-scarce contexts. Experimental evidence has recently come from Okeke (2023), who shows that the marginal addition of doctors in primary care services in Nigeria significantly improves health outcomes, while lower-qualified health workers do not have any significant effects. Assessments of the introduction of PMM in Brazil provide quasi-experimental evidence and have gained academic attention both in economics and public health. Similarly to other contexts, the country has long faced an unequal distribution of health care professionals, both in terms of quantity and quality (F. Costa et al., 2019). Differently from Nigeria and other low-income countries, however, where most medical care is paid for out-of-pocket, Brazil has a national health system model where access to services is free at the point-of-use. Despite increasingly dense, the literature on the effects of the introduction of PMM has yielded mixed results. For instance, Carrillo and Feres (2019) document that PMM led to the replacement of nurses by higher-qualified primary care doctors, without any effects on infant health. More aligned with Okeke (2023)'s results, Fontes et al. (2018) and Mattos and Mazetto (2019) find that the introduction of PMM decreased hospitalizations, while

Hone et al. (2020) document a reduction in amenable mortality.

Existing research on doctor turnover, more specifically, has made progress at the micro level by examining the effects of specific disruptions in the patient-physician relationship —e.g., by exploiting the exit of physicians from the labor force or the re-matching of patients to new physicians due to physician retirement or death (A. H. Sabety et al., 2021; Zhang, 2022), practice closures (Bischof & Kaiser, 2021; Simonsen et al., 2021) and changes in insurance managed care networks (Staiger, 2022). Studies come to mixed results. For instance, while Simonsen et al. (2021) do not find major changes in health care utilization in Denmark, A. H. Sabety et al. (2021) and Zhang (2022) find a decrease in primary care utilization which is often substituted by an increase in specialized or emergency care in the US. Effects on hospitalization are often limited, and mortality remains generally unaffected. Yet, studies have focused on managed care and private insurance settings from developed countries, where turnover events may be anticipated, patients can often choose among alternative providers, and may even benefit from changes. As Simonsen et al. (2021) document, in Denmark transition between providers is "smooth", while Simonsen et al. (2021) and Zhang (2022) find an increase in the diagnoses of chronic diseases after patients visit a new primary care doctor, potentially due to changes in practice styles. In that case, the re-matching of doctors can be beneficial for patients.

We contribute novel evidence to the literature by exploiting a unique setting where an exogenous political shock led to a massive exit and turnover of doctors across local health systems in Brazil. We focus at a temporary decrease and replacement rather than an increase in the number of doctors, and characterize the periods of reduction in doctor supply as well as of turnover and supply stabilization. This is relevant as long as hirings and increases in the supply of doctors are generally followed by challenges in workforce retention and turnover, and positive and negative variations in doctor supply do not necessarily lead to symmetric effects on outcomes. Yet, while doctor turnover is a widespread policy challenge in both developed and developing countries, the existing evidence comes from specific disruptions in the patient-provider relationship within developed countries, and generally overlooks response beyond the patient level. In this paper, we not only assess effects on health utilization and population health outcomes in under-served Brazilian localities, but also document how other health care system inputs respond to the exit and replacement of doctors. Results are therefore generally informative for resource-scarce contexts, where health systems are typically less resilient, and access to services and patient choice among providers are often constrained.

This paper is organized as follows. In Section 2 we describe the institutional background. In

Section 3 we detail the data while in Section 4 we describe our empirical model. Results are presented in Section 5. In Section 6 we discuss potential explanations behind the results. Section 7 concludes.

2 Background

2.1 The Brazilian Health System and Primary Care Services

The Brazilian Unified Health System (*Sistema Único de Saúde*, SUS) is a tax-funded public health care system that provides health care services that are free-of-charge at the point of care at all levels of care. Although there exists private provision of health insurance and health services in Brazil, approximately 75% of the Brazilian population rely exclusively on SUS for health care (Rocha et al., 2021).

SUS has successfully expanded access to health care and improved health outcomes in Brazil (Castro et al., 2019). The Family Health Program (FHP), implemented by municipal governments and now covering over 60% of the population, has been key to that success (S. Bhalotra et al., 2020; Mrejen et al., 2021). The program provides preventive and curative primary care services through Family Health Teams (FHTs). Each team is based in a primary health care facility, called Basic Health Unit (*Unidade Básica de Saúde*, UBS), and typically consists of at least one doctor, nurses, community health workers and technicians. Each FHT covers around 3,500 individuals from a specific catchment area, and should respond to most of the population' needs by providing curative care, health education, health promotion, disease prevention, less complex medical procedures, and referencing the more severe cases to specialized secondary or tertiary health care services when needed.

2.2 The More Doctors Program

Despite increasing numbers of doctors over the last decades, the supply of doctors and access to medical services and specialist care remain major bottlenecks for SUS in many regions, resulting in unmet demand, long waiting times, and delays in diagnoses (Castro et al., 2019). Brazil has long suffered from a highly unequal provision of doctors across municipalities, with urban peripheries and remote areas severely under-served. Making an effort to increase the supply of doctors in those regions, in 2013 the Brazilian government introduced the More Doctors Program (*Programa Mais Medicos*, PMM). The program was designed to pay competitive wages and provide additional benefits to doctors who agreed 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).

At the program's inception, the government offered PMM positions to all Brazilian doctors. As low numbers of Brazilian doctors applied to fill the vacancies, the program was opened to doctors trained abroad. Through an international agreement between the governments of Cuba and Brazil, facilitated and managed by the Pan American Health Organization, a substantial number of Cuban doctors were sent to Brazil (Santos et al., 2017). Out of around 18,000 doctors that enrolled in the program between 2013 and 2018, roughly half came from Cuba (Rasella et al., 2019). Whereas Brazilian doctors had priority and were able to freely choose their destination, Cubans were assigned to vacant positions and were seen as the last resort to fill PMM vacancies. Moreover, Brazilian doctors could work at multiple municipalities at the same time, whereas Cuban doctors were only allowed to work in one municipality. Given that Brazilian PMM doctors had a strong preference for urban centers, the Cuban doctors were essential for filling vacancies in poorer municipalities and remote areas (Santos et al., 2018).

In some participating municipalities, PMM doctors work alongside non-PMM primary care doctors. But the work schedules of PMM and non-PMM doctors differ in important ways. First, PMM doctors are only allowed to work in one primary health care unit, while non-PMM doctors are allowed to work in multiple units at the same time, also across municipalities (Santos et al., 2017). Second, PMM doctors are closely monitored and work a set of fixed 40 weekly hours, which make them more accessible and reliable than non-PMM doctors (Comes, Trindade, Shimizu, et al., 2016). Finally, qualitative evidence suggests that PMM doctors play a crucial role in delivering primary care to Brazil's poorest population. Cuban doctors in particular were often integrated into the local community, and most of them decided to apply for an extension of their stay in 2017 (Comes, Trindade, Pessoa, et al., 2016; Rech et al., 2018).

Cuba's participation in PMM was highly politicized. One fierce opponent was Brazil's former president, Jair Bolsonaro, who claimed the true goal of PMM was the installation of a foreign communist guerilla in Brazil (Terra, 2019). Following his election in October 2018, the Cuban government unilaterally and unexpectedly decided to withdraw all of its 8,316 primary care doctors from PMM. As a consequence, Cuban doctors had merely a month to leave the country, and all consequently ceased to work before Bolsonaro took office in January 2019 (Santos et al., 2018).

According to the media and policy makers, the decision came as a shock for PMM doctors and the involved institutions, given that the international contract had been extended only a year before (Sobrinho, 2018). Given the importance of the Cuban doctors for health care delivery, the media and academic community raised strong concerns about the potential adverse effects on health outcomes (Alves, 2018). The Brazilian government put great effort and expenses into trying to replace the missing primary care doctors, managing to fill almost all resulting PMM vacancies after a few months (Maffioli et al., 2019).

3 Data

3.1 Data Sources and Main Variables

We use different data sources to combine information on the number of doctors, health care utilization and inputs, subsidized prescription drug sales, and health outcomes at the municipality-by-month level. We cover the period from October 2017 to the end of December 2019 . We end our analysis in December 2019, a year after the Cuban exit, just before the Covid-19 crisis. We detail below the main variables used in our analysis and their respective sources of data.

Data on doctors and PMM. We use data on municipalities' PMM participation from the Brazilian Ministry of Health. The data set contains PMM eligibility and the number of PMM doctors (Cuban and others) registered in each municipality, for all Brazilian municipalities in a given month. We limit our sample to municipalities that are eligible to participate in PMM. Excluding non-eligible municipalities, which are typically Brazil's most developed ones, makes our main sample more homogeneous.[1] Out of all 5,570 municipalities in Brazil, 4,162 participated in PMM.[2] Given this sample, we divide PMM municipalities into three groups, based on the relevance that Cubans played for the local PMM in October 2018, the month just before the Cuban withdrawal. Municipalities with no Cuban PMM doctors in October 2018 form our control group ($N = 1,320$). Municipalities with Cuban PMM doctors, but also non-Cuban PMM doctors form our first treatment group ($N = 1,260$). This group lost on average around 50% of their PMM doctors with the Cuban exit. Municipalities with only Cuban PMM doctors form our second treatment group ($N = 1,583$). Having temporarily lost all their PMM doctors with the exit, we expect this treatment group to be

[1] Robustness checks show that results remain stable upon including these municipalities into our control group.

[2] We exclude the 34 special indigenous health districts from our analysis, as they can not be adequately captured by municipal borders.

most strongly affected by the shock.

We complement the PMM data with information on the total monthly number of primary health care doctors per municipality (PMM and non-PMM doctors) from the National Registry of Health Facilities (*Cadastro Nacional de Estabelecimentos de Saúde*, CNES). CNES contains information on all Brazilian healthcare facilities, healthcare workers enrolled in each facility, and their weekly working hours. A limitation of the CNES data is that it is not well suited to capture high frequency changes. Even though data is available on a monthly level, information is updated irregularly (facilities need to update their employment numbers only at least every 6-months). Hence, CNES may not fully capture monthly changes and will be used as an auxiliary source of information. Moreover, the CNES data set does not indicate whether primary care doctors are enrolled in PMM or not. To distinguish between PMM doctors and non-PMM doctors in the CNES dataset, we merge the PMM dataset with CNES through the names and municipality work location of the doctors.[3]

Primary healthcare production. We obtain data on primary health care production and utilization from the National Information System on Primary Health Care (*Sistema de Informação Atenção Básica*, SISAB). The system registers all primary care services provided in a given municipality in a given month and funded by SUS, including information on the nature of the service and the responsible health care professional. The system allocates health care services into four overarching categories: consultations, procedures, dental care, and home visits. Out of these four, consultations are predominantly done by doctors, while the others are mostly delivered by other health care workers. Primary care consultations, i.e. doctors' main duties, are further divided into the type of appointment (spontaneous, scheduled one time, scheduled on regular basis etc.) and into specific conditions (diabetes, hypertension, tuberculosis, obesity etc.). Appendix Tables A.1 and A.2 provide the details.

We collect data on primary care utilization related to asthma, diabetes, hypertension, cardiovascular diseases, cancers, chronic obstructive pulmonary disease (CPOD) and mental health as chronic conditions. Related risk factors are malnutrition, obesity, rehabilitation, and consultations concerning tobacco, alcohol, and drug use. Maternal health is concerned with the full cycle of pre- and postpartum. Dengue, leprosy, tuberculosis, and sexually transmitted diseases cover outcomes related to infectious conditions in the data.

We also use data on ambulatory care production from the National Information System of

[3]We were able to match around 81% of PMM doctors to their corresponding CNES information.

Ambulatory Care (*Sistema de Informação Ambulatorial*, SIA). This data set contains information on ambulatory care production by number and type of procedures which are funded by SUS and delivered at different providers, per municipality and month. These data allow us to distinguish between outpatient care provided at emergency rooms, hospitals or specialty centers.

Prescription drugs and private insurance coverage. We obtain data on prescription drug sales from Brazil's large-scale subsidizing program of prescription drugs (*Aqui Tem Farmácia Popular*, ATFP). The program covers sales on medication for different conditions such as diabetes and hypertension, which are handed out to patients at strongly subsidized prices or for free.[4] The data cover the amount and value of prescription drugs handed out by the 24,336 pharmacies enrolled in ATFP, for different conditions, by month and year from Brazil's Ministry of Health. To get access to the subsidized medication, patients need to have a medical prescription, which is valid for up to 180 days (Américo & Rocha, 2020). Both the PMM and the ATFP program aim at ensuring accessible and affordable health care for everyone. In 2019, the ATFP program reached a substantial share of patients suffering from conditions that are covered by the program —around 50% of Brazilian patients who recently took medication for diabetes or hypertension obtained at least some of them via ATFP (K. S. Costa et al., 2022). We use data on private insurance coverage from Brazil's National Agency for Supplementary Health (ANS). The data include information on the number of individuals with a private health insurance per municipality for every three months.

Hospitalization and mortality. We obtain microdata from the National System of Information on Hospitalizations (*Sistema de Informação Hospitalar*, SIH), which includes all hospitalizations publicly funded by SUS disaggregated by primary cause of admission (based on ICD-10 code; International Classification of Diseases 10th Revision) and the patients' municipality of residence. We also obtain microdata from the National System of Information on Mortality (*Sistema de Informação de Mortalidade*, SIM), which includes official registries of all deaths recorded in Brazil. The microdata include the municipality of residence and the ICD-10 code for the main cause of death.

Socioeconomic characteristics. We use annual municipal socioeconomic characteristics as control variables in auxiliary exercises. We include the number of families receiving the Bolsa Familia social welfare transfers per 100,000 residents, and the municipal costs of Bolsa Familia per resident (data from the Ministry of Social Developmen, MDS); the municipal GDP per capita, the value

[4]Drugs for diabetes and hypertension are fully subsidized and free for patients, while prices for other medications did not change during our sample period.

added by public sector employment to the local economy, the share of the population above the age of 65, the sex ratio, the size of the municipal population, and the municipality's population density (data from IBGE).

3.2 Descriptive Statistics

Figure 1 illustrates the spatial distribution of municipalities according to their treatment status. White municipalities are ineligible and thus excluded from our main analysis. Light grey municipalities are our control group, dark grey municipalities represent treatment group 1, and black municipalities form treatment group 2. There is no discernible geographical pattern with respect to the allocation of municipalities into the different groups.

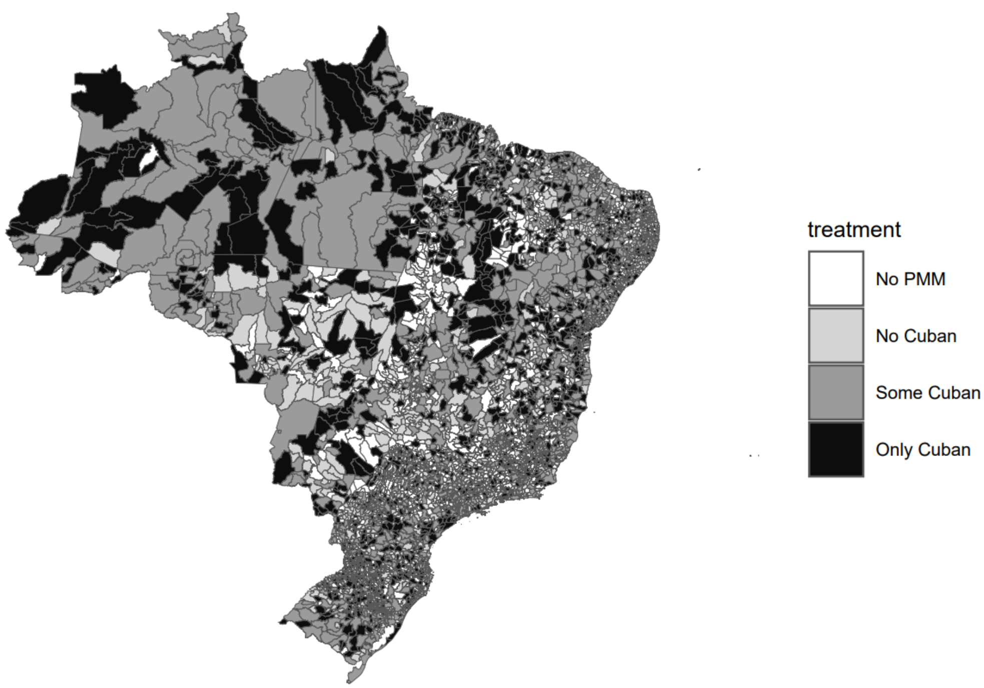

Figure 1: PMM allocation of Brazilian municipalities in October 2018 (last month before the Cuban exit). White municipalities did not participate in PMM and are excluded from the analysis. Light grey municipalities had no Cuban PMM doctor in October 2018, grey municipalities had some Cuban PMM doctors and black municipalities had only Cuban PMM doctors. Original data from the Brazilian Ministry of Health.

Appendix Table A.3 summarizes all outcome variables investigated in our analyses, per 100,000 residents in October 2018 (the baseline month), including doctor supply, health care utilization and health outcome variables. The average control municipality employed 11 PMM doctors per 100,000 residents, as compared to 18 and 20 in our two treatment groups. In our first treatment group, 52%

of PMM doctors were Cuban, which is equivalent to about 29% of all primary care doctors working in public primary care facilities.[5] In municipalities in treatment group 2 the Cubans, and, by extension, PMM doctors, represented approximately 45% of all primary care doctors working in primary care facilities. Primary care doctors were responsible for 64% of the primary care consultations during the pre-treatment period, but only for 4% of the ambulatory procedures and for 0% of home visits and dental care services. Yet, while consultations in general are doctors' main duties, some of them are carried out by other health workers, depending on the specific condition.[6] For descriptive statistics on the auxiliary socioeconomic variables see Appendix Table A.4.

3.3 Trends in PMM Coverage

How did the Cuban exit affect the supply of primary health care doctors? Figure 2 shows the monthly unconditional means of the number of PMM doctors (upper plot), of the number of primary healthcare doctors not affiliated with PMM (middle plot), and of the number of all primary health care doctors (PMM and non-PMM, lower plot) per 100,000 residents by treatment group. In general, the unconditional means move similarly throughout the groups before the treatment. The Cuban exit and resulting turnover clearly marks a recess in the trends for affected municipalities. When examining PMM doctors, we observe a sharp drop in coverage for treatment groups 1 (dark gray) and 2 (black), with treatment group 2 being more strongly affected. While in treatment group 1 the number of PMM doctors is halved, the second treatment group briefly looses all PMM doctors. Importantly, there is not any clear inflection in the control group (light gray). Within a few months after the shock, PMM coverage in treatment municipalities recovers and almost returns to pre-treatment levels.

Although less pronounced, a similar pattern can be observed when looking at overall primary health care doctors (lower plot). The treatment groups experience a drop in coverage, followed by a recovery a few months after the shock. The drop, however, is substantially smaller than the drop in PMM doctors, which can be explained by two factors. First, there was an expansion in primary health care doctors not affiliated with PMM after the Cuban exit which partially cushioned the Cuban exit (middle plot). Second, as mentioned in Section 3.1, even though CNES data is available at the monthly level, records are not immediately updated as facilities need to update

[5] Doctors working in multiple healthcare facilities in the same municipality are not double-counted.

[6] Disaggregating consultations by conditions, however, comes at the cost of decreasing data quality due to missing values. On average, around 40% of all primary care consultations have no information about the related condition and the responsible professional (Appendix Table A.1).

their employment numbers only at least every 6 months, therefore smoothing aggregated trends.

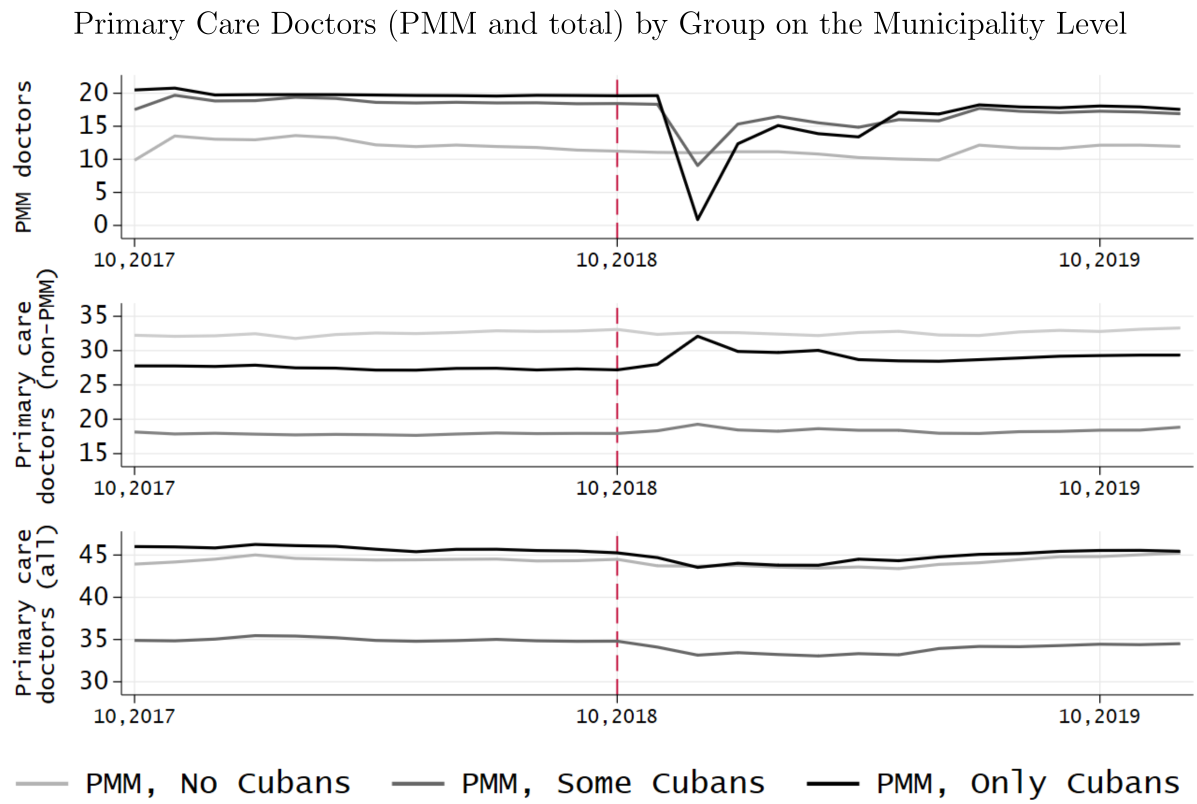

Figure 2: The graphs shows trends in the group means of the number of PMM doctors (upper plot), non-PMM primary care doctors (middle plot), and all primary care doctors (lower plot) per 100,000 residents. The series in dark grey presents treatment group 1, the series in black presents treatment group 2. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Brazilian Ministry of Health and CNES.

4 Empirical Model

We exploit the sharp and exogenous timing of the Cuban exit from PMM in municipalities that relied more *versus* less on Cuban PMM doctors at the time of the exit to estimate the effects of doctor turnover on health care utilization, system adaptation, and health outcomes. More specifically, we use a two-way fixed effects model to compare outcome changes in affected and unaffected PMM municipalities before and after the Cuban exit, conditional upon time and municipality fixed-effects, therefore controlling for baseline heterogeneity in levels and common time trends. For a PMM municipality i at year-month t, the equation takes the following form:

$$Y_{it} = \alpha_i + \gamma_t \times \phi^s + \sum_g \sum_{t=-13}^{t=-2} \beta_t (T_t \times D_i^g) + \sum_g \sum_{t=0}^{t=14} \beta_t (T_t \times D_i^g) + \epsilon_{it} \quad (1)$$

Where Y_{it} refers to outcomes of interest.[7] The term D_i^g is our categorical treatment variable and takes $D_i^{g=1} = 1$ if the municipality had some Cuban doctors, and $D_i^{g=2} = 1$ if it had only Cuban doctors in PMM in October 2018, the month before the Cuban exit. Municipalities are assigned to the control group otherwise.

The first summation set captures the coefficients of the interactions between treatment status and year-month dummies T_t before October 2018, while the second refers to coefficients after the shock. We include municipality fixed effects α_i to control for fixed characteristics and baseline heterogeneity across municipalities. As we focus on a relatively high frequency data just around the shock – i.e. monthly variation within approximately a 2-year period – the term α_i is expected to absorb relevant slow-moving determinants of health, such as the presence of hospitals and transport connections. Year-month fixed effects γ_t control for common time trends, particularly the common timing of the Cuban exit and the influence of the political cycle. Although we focus on a short period of time, we further consider interactions between time and state fixed effects ϕ^s, therefore allowing for flexible time trends per state. This is expected to absorb the influence of state policies, particularly relevant in health care as states are typically responsible for secondary and tertiary health services. We cluster standard errors at the municipality level to allow for correlation of the error term within the same municipality throughout time.

We assume that the variation in the interaction between the sharp and unexpected exit of Cuban doctors (time-series variation) and the baseline variation in the presence of Cuban doctors (across municipalities) is exogenous to municipalities, conditional on fixed effects. Identification relies on the assumption that trends in outcomes in both treatment groups would not have differed from the observed trend in the control group should Cuban doctors had not left PMM. We investigate the parallel trends assumption by looking at monthly differences in outcomes between control and treatment groups throughout the year before the Cuban exit. More specifically, we visually inspect and formally test whether the coefficients β_{-13} (October 2017) to β_{-2} (September 2018) portray

[7]Most outcomes are measured as per 100,000 residents, and we transform them with the hyperbolic sine transformation (HST). For outcomes which display a reasonable amount of zero values (more than 10%), we also repeated all estimation with outcomes as rates per 100,000 residents weighted by the population size of the municipality. Results are robust throughout all forms of outcome specification.

any systematic pattern. The overall evidence, across outcome variables, indicates that pre-trends remain irrelevant.

We also present results from alternative specifications and treatment definitions. First, instead of considering treatment as categorical groups interacted with time fixed effects, we use the share of Cuban PMM doctors among all local primary care doctors at baseline interacted with time fixed effects. This specification follows the equation below:

$$Y_{it} = \alpha_i^* + \gamma_t^* \times \phi^{*s} + \sum_{t=-13}^{t=-2} \beta_t^*(T_t \times S_i) + \sum_{t=0}^{t=14} \beta_t^*(T_t \times S_i) + \epsilon_{it}^* \tag{2}$$

Where S_i refer to the share of Cuban PMM doctors in municipality i in September 2018 among all local primary care doctors (PMM and non-PMM). In this case we must rely on a more stringent assumption of parallel trends along the distribution of S_i. This specification nevertheless comes with the benefit of estimating average effects across all PMM municipalities rather than splitting the estimates for different treatment groups. Finally, although we rely on a high frequency panel of data, in additional robustness checks we include time-varying controls to inspect the stability of our estimates. We show that results remain stable to adjusting for municipality annual GDP per capita, population sex and age structure, and social welfare transfers. We present the results and discuss the robustness of our estimates in the next sections.

5 Effects on Turnover, Health Utilization and Outcomes

5.1 Turnover and Supply of Doctors

We start our empirical analysis by investigating the effect of the Cuban exit on the supply of primary care doctors in affected municipalities. Figure 3 shows event studies for the number of PMM doctors, the number non-PMM doctors (i.e. primary health care doctors not affiliated with PMM) and the number of all primary care doctors (PMM and non-PMM) per 100,000 residents.

We observe a steep reduction in the supply of PMM doctors, especially for treatment group 2. In December 2018, at the height of the impact, PMM coverage decreased, on average, by 52% in municipalities of treatment group 1, and by 96% in municipalities of treatment group 2.[8] This

[8] Cuban doctors left Brazil from mid-November 2018 onward. Thus, December 2018 was the first month in which

Effects on the Supply of Primary Care Doctors

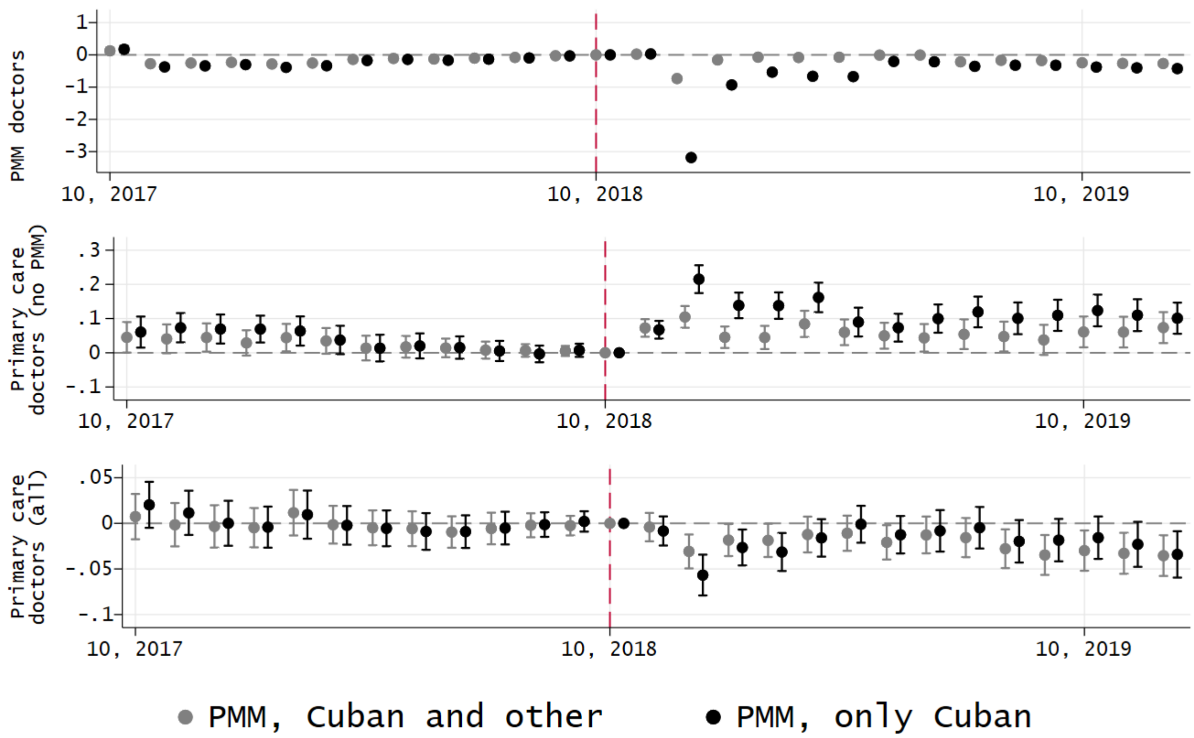

Figure 3: The graph shows event studies for the number of PMM doctors (upper plot), non-PMM primary care doctors (medium plot), and all primary care doctors (lower plot), following equation 1. Outcomes per 100,000 residents and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health and CNES.

corresponds to 9 fewer PMM doctors per 100,000 residents in treatment group 1 (relative to a group average of 18 PMM doctors per 100,000 residents in October 2018) and 19 fewer PMM doctors per 100,000 residents in treatment group 2 (relative to a group average of 20 PMM doctors per 100,000 residents in October 2018).[9] The supply of PMM doctors recovered for both treatment groups a few months after the Cuban exit, with treatment group 1 filling vacancies faster than treatment group 2. While the reduction in PMM coverage remains significant beyond the turnover period, the difference is small in absolute terms and in comparison to pre-treatment levels.

Examining non-PMM primary health care doctors shows there is an expansion in their supply,

vacancies were reported. One reason why the estimated decline in treatment group 2 is slightly short of 100% is that the Brazilian government might have managed to fill few of the resulting vacancies in the second half of November 2018.

[9] Throughout the analysis, we use group-specific means from Table A.3 to interpret effect sizes in absolute numbers.

seemingly as an immediate reaction to the Cuban exit. For treatment groups 1 and 2, there is an increase of 9.4% and 18.9% of non-PMM primary health care doctors in December 2018, corresponding on average to 2 and 5 doctors per 100,000 residents, respectively. These numbers subsequently halve in 2019 as PMM vacancies are being filled, but remain elevated throughout our sample period. We also observe a decaying tendency in the number of non-PMM primary health care doctors by the turn of the 2017-2018 years. This trend is nevertheless smooth and point estimates are relatively small in comparison to the period after the shock. Effects stabilize for most of 2018, remaining systematically around zero in the months before the Cuban exit.

Finally, looking at all municipal primary care doctors (PMM and non-PMM), we see a small but significant drop during the supply shock period. Despite the expansion of non-PMM doctors, the number of all primary care doctors decreased, on average, by 3% in treatment group 1 and 5.5% in treatment group 2 in December 2018, corresponding to roughly one and two primary care doctors per 100,000 residents. These effects can be interpreted as a lower bound as CNES records do not accurately respond to monthly changes in actual figures.

Overall, we document a sharp and short-lived drop in the number of PMM doctors in municipalities where PMM enrolled Cuban doctors. This drop resulted in a large-scale doctor turnover, where non-PMM doctors partly compensated for the exiting Cubans, but still resulting in a transitory decrease in doctor supply.

5.2 Primary Care Utilization

Given the turnover and the short-term drop in the supply of primary care doctors, we expect a concurrent short-term reduction in primary care utilization related to consultations, which are doctors' main duties. Figure 4 shows a 12% reduction in consultations in treatment group 1, and a 28% drop in treatment group 2 in December 2018. Effect sizes are broadly in line with patterns observed just after the introduction of PMM (Carrillo & Feres, 2019; Hone et al., 2020; Mattos & Mazetto, 2019). The decline is meaningful: on average, the reduction corresponds to 1,401 and 4,533 fewer monthly consultations per 100,000 residents in treatment group 1 and 2, respectively. The negative effect largely recovers as vacancies are filled with new PMM doctors. Recovery is quicker in treatment group 1, but a negative effect of around 10% persists beyond the turnover period in both treatment groups until the end of 2019, corresponding to roughly 1,170 and 1,620 fewer consultations per 100,000 residents. Figure 4 also shows that effects are limited to primary care consultations, which are doctors' main duties. There are no significant effects for tasks that are primarily performed by nurses and other healthcare workers in primary health care centers, such as minor procedures. Those patterns reassure us that effects are in fact driven by the doctor turnover and not by other potentially correlated shocks.

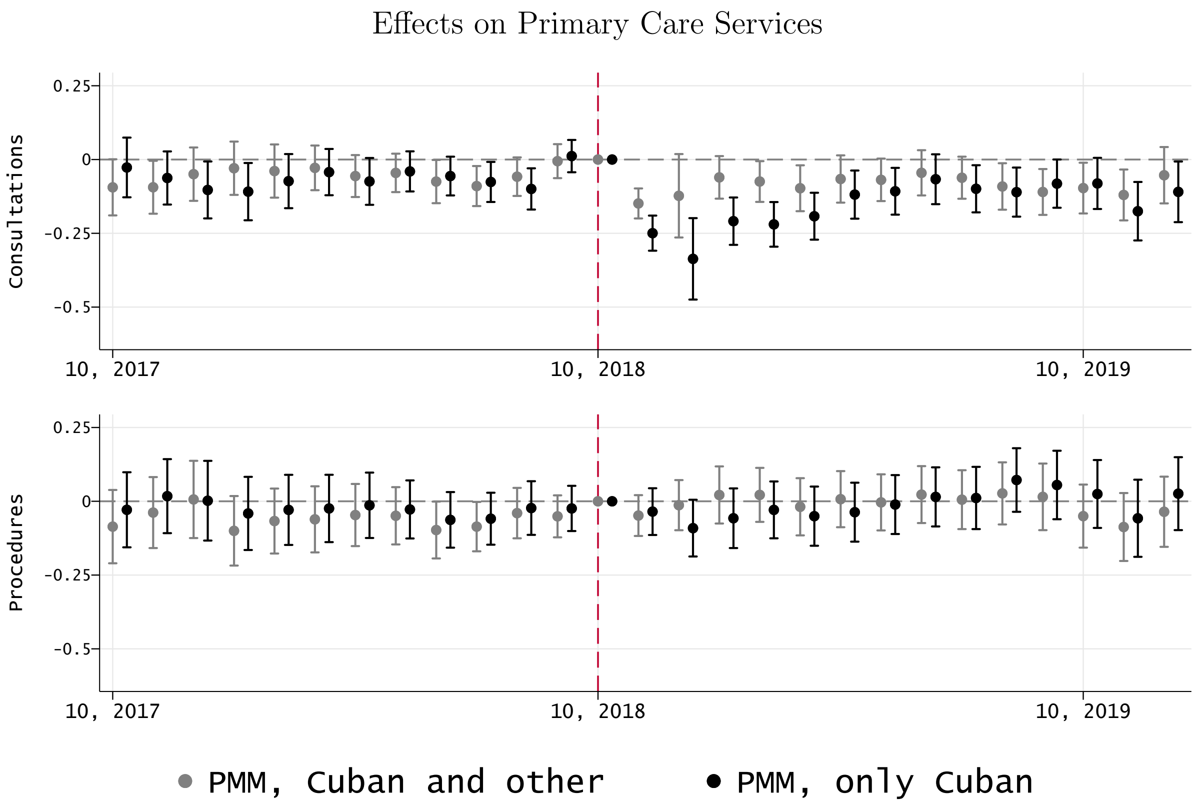

Figure 4: The graph shows event studies for the number of consultations (upper plot) and procedures (lower plot) performed in primary health care facilities, following equation 1. Outcomes per 100,000 residents and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB.

When unpacking consultations further, we see that not all primary care needs are affected in the same way. In Figure 5, we distinguish between primary care consultations on chronic conditions, related risk factors to chronic conditions, maternal health, and infections. The effects on chronic conditions and related risk factors are strong and persistent, especially for treatment group 2. This group experiences a drop of roughly 30% for chronic care (around 1,500 per 100,000) and for related risk factors (around 600 per 100,000) in December 2018, and this decrease persists in magnitude until the end of our sample period. Consultations on maternal health are only temporarily affected and fully recover after the turnover period. For example, there were on average around 12% (around 350 per 100,000) fewer maternal health consultations for treatment group 2 in December 2018, but the trends were indistinguishable from zero for most of 2019. Consultations on infectious diseases experience a short-term reduction, followed by recovery, with some significant effects towards the end of our study period.

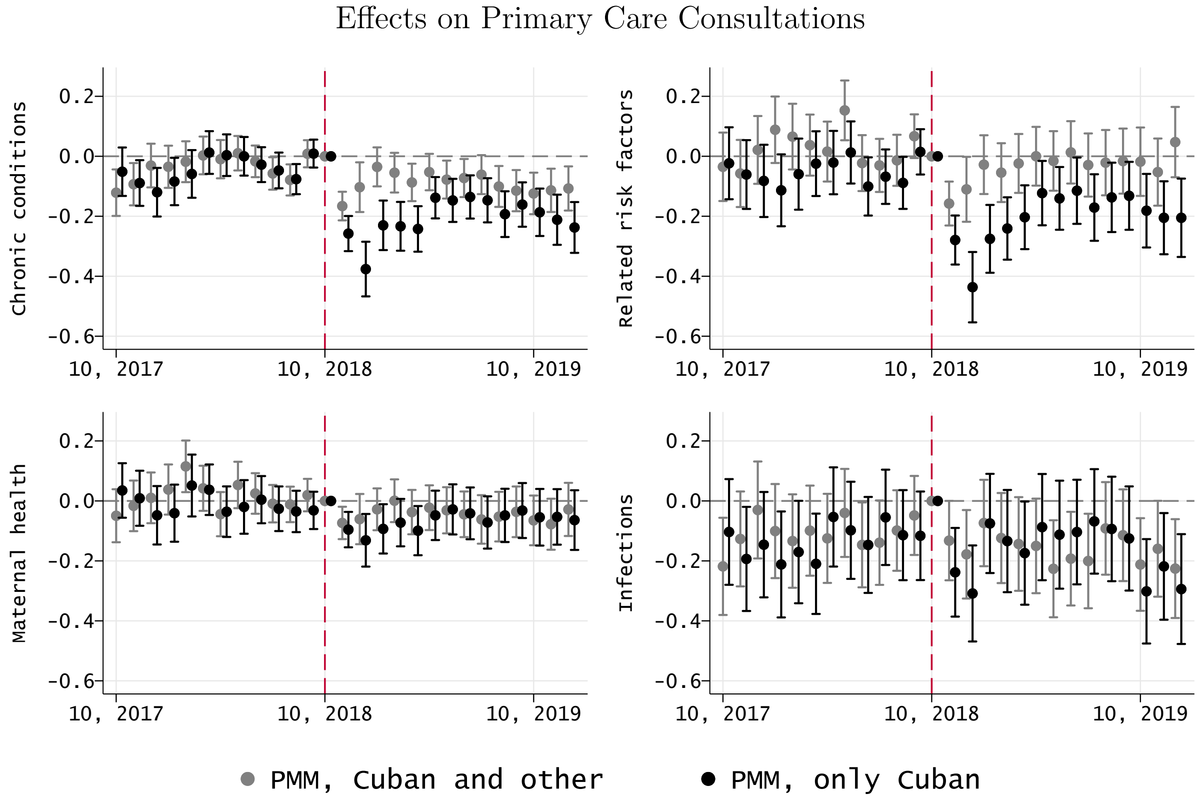

Figure 5: The graph shows event studies for the number of consultations performed in primary health care facilities in four different primary care categories, following equation 1. Outcomes are per 100,000 residents and transformed using the inverse hyperbolic sine. Chronic conditions include asthma, diabetes, hypertension, cardiovascular diseases, cancers, CPOD and mental health. Related risk factors include malnutrition, obesity, rehabilitation and the use of drugs (tobacco, alcohol and other drugs). Maternal health includes the full cycle of pre- and postpartum. Infectious diseases include dengue, leprosy, tuberculosis and STDs. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB.

Appendix Figures B.1, B.2 and B.3 show results on specific diseases and confirms the overall picture. On the one hand, we observe in Figures B.1 and B.2 that consultations on chronic conditions mostly experience a strong and persistent decrease. On the other hand, Figure B.3 shows that infectious diseases are generally less and only temporarily affected, even when doctors are more involved, such as for consultations on STDs.

In sum, there was a sharp decrease in primary care utilization immediately after the Cuban doctor exit. However, while primary care conditions requiring immediate care, such as infections, recovered quickly, there was a strong and persistent decrease in the management and care of chronic conditions, especially in the most affected municipalities, where PMM relied entirely on Cuban doctors.

5.3 Hospitalizations and Mortality

We now investigate whether the exit of Cuban doctors and the resulting turnover of doctors affected health outcomes. Figure 6 presents effects on total hospital admissions as well as by specific causes of admission. Figure 7 reports analogous results for mortality. We distinguish between total outcomes, outcomes amenable to primary care, and those specifically related to infections, infant health, and chronic conditions among the population aged 60 and above. We observe that estimates are close to zero and mostly insignificant, even for outcomes that are expected to be more sensitive to short-term changes in access to health care, such as infant hospitalizations or hospital admissions of causes amenable to primary care (Carrillo & Feres, 2019).

While effects on health outcomes may take a period of time to materialize (Hone et al., 2020; Özçelik et al., 2020), we observe that a sharp and non-trivial reduction in primary health care utilization does not translate into any systematic changes in health outcomes even throughout the end of the following year after the shock. We further discuss this result in Section 6. In particular we examine whether and how demand and local health systems responded to the shock, potentially protecting and leaving health outcomes unaffected.

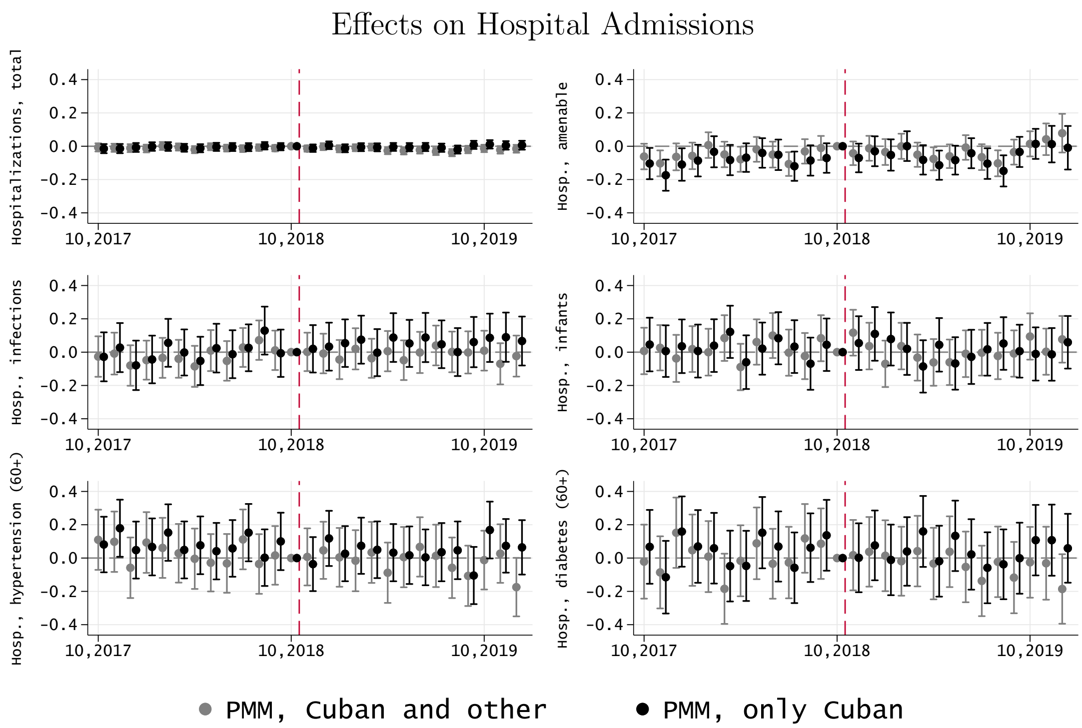

Figure 6: The graph shows event studies for the number of hospitalizations in six different categories, following equation 1. Outcomes per 100,000 residents and transformed using the inverse hyperbolic sine. Where indicated, the number of hospitalizations only includes individuals aged 60 or more. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the SIH/Datasus.

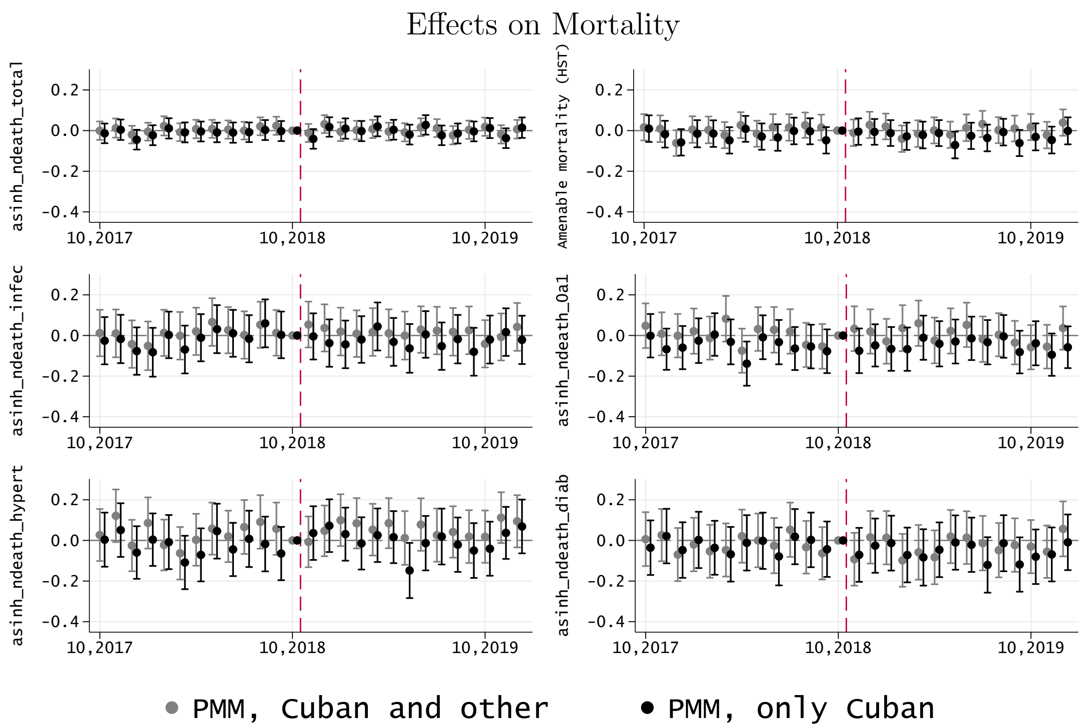

Figure 7: The graph shows event studies for the number of hospital mortality in six different categories, following equation 1. Outcomes per 100,000 residents and transformed using the inverse hyperbolic sine. Where indicated, the number of hospitalizations only includes individuals aged 60 or more. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the SIM/Datasus.

5.4 Alternative Specifications and Robustness Checks

In this section we further discuss the robustness and the interpretations of our main results. We present robustness checks for our main results on primary care utilization (consultations, procedures and consultations by condition type) and on health outcomes (hospitalizations and mortality). We first test the stability of our estimates to the inclusion of time-varying controls. In our main specifications, we employ municipality and state-time fixed effects. Given the high frequency data within a relatively short period of analysis, and conditional upon municipality fixed effects, we expect the observed variation in the supply of doctors to be exogenous to municipality fixed characteristics as well as to slow-moving municipality trends. In order to test for this, in Appendix Section C.1 we replicate all our results now from specifications that include annually available socioeconomic control variables at the municipality level, such as the population share of Bolsa Familia coverage (the main social welfare program in Brazil), Bolsa Familia expenses per capita, GDP per capita, value added by public sector employment (in R$ 1,000), the share of the population above 65, and the sex ratio (Appendix Figures C.1 to C.4). Results remain stable in comparison to our main results in Figures 4 to 7.

Second, in Appendix Section C.2 we test whether our results are robust to alternative definitions of the control group. We do not observe any substantial changes when (i) adding non-PMM municipalities to our control group (Appendix Figures C.5 to C.8) or when (ii) excluding PMM municipalities that employed no PMM doctors in October 2018 from our control group (Appendix Figures C.9 to C.12).

Third, our main results rely on equation (1), where treatment is defined as categorical variables indicating different groups of municipalities, more *versus* less exposed to the Cuban exit. We now present results from an alternative specification, based on equation (2), where exposure is defined as the share of Cuban PMM doctors among all local primary care doctors at baseline interacted with time fixed effects. Appendix Section C.3 replicates our main results. We observe similar patterns. Overall, pre-trends oscillate around zero up to October 2018, when we observe a sharp decline in service utilization (Appendix Figures C.13 to C.14). Again, we do not observe any systematic effects on hospital admissions and mortality (Figures C.15-C.16). In general, results remain qualitatively similar in comparison to Figures 4 to 7.

Finally, as mentioned in Section 3, not all primary care consultations contain information on specific conditions. As a result, Figure 5 plots coefficients only for a subset of all consultations that occurred during our sample period. To ensure that these results are not driven by outliers with more/less information on specific conditions, we re-estimate effects on consultation categories, each time omitting one municipality from the estimation. For simplicity, we re-code the categorical treatment variable into a dummy variable that takes the value of 1 if a municipality has been affected by the Cuban exit and zero otherwise. Appendix Figure C.17 plots the differences between the estimated coefficients from the leave-one-out analysis and the coefficients from the full model for all 4,163 iterations. The closer to the horizontal line at $y = 0$, the less do the point estimates from the leave-one-out analysis diverge from the point estimates in the full model. Gradually omitting municipalities from the analysis leaves all estimated coefficients from Figure 5 virtually unchanged. The largest deviation between coefficients from the full model and coefficients from the leave-one-out analysis is smaller than 0.01.

6 Health System Inputs and Discussion on Mechanisms

The Cuban exit from PMM led to a large-scale turnover of more than 8,000 primary care doctors, affecting over 2,800 municipalities. The turnover reduced primary care services at aggregate levels, but hospitalizations and mortality remained unaffected. Although we are not able to precisely separate demand and supply factors, we can explore different intermediate outcomes to help explain that overall pattern and also characterize changes in healthcare inputs and service prioritization.

Based on the existing literature, we can identify potential channels through which doctor turnover may affect health care utilization and health outcomes. These channels include changes within and beyond the affected providers —primary care centers, in the Brazilian case. Within affected primary health care centers, doctor turnover can lead to disruptions in the patient-doctor relationship and to changes in patient exposure to doctors' quality and practice styles (Fadlon & Van Parys, 2020; Staiger, 2022). The turnover can also lead to changes in the workload, tasks and responsibilities assumed by other primary health care professionals (Carrillo & Feres, 2019). These factors can result in changes in the profile of treatment and service delivery (Reddy et al., 2015). Beyond the affected primary care centers, both demand and supply-side factors can mediate turnover impacts on service utilization and health outcomes. On the one hand, variation in the network or the quality of providers can lead to demand diversion towards alternative health facilities —i.e., as a response to doctor turnover in primary care units, patients may seek care at other public facilities or at fee-for-service providers (S. R. Bhalotra et al., 2020; A. H. Sabety et al., 2021; Simonsen et al., 2021). Moreover, this mobility may occur within or across localities. On the other hand, local health systems may respond to the turnover and to the potential demand diversion by restructuring the supply of facilities and available services.

6.1 What Changed within Primary Care Services?

6.1.1 Doctors' Profile, Workload and Practices

We start by investigating the profile of doctors that replaced the Cubans.[10] We first investigate how affected municipalities managed to attract new primary healthcare doctors and to fill vacancies in PMM. Qualitative evidence suggests that the newly recruited doctors, both PMM and non-PMM, had often little work experience and stayed only for a short time in their new jobs (Poder360, 2019). In contrast, the vast majority of Cuban doctors were experienced general practitioners, specialized in primary care and having accumulated at least 5 years of experience. Furthermore, the Cubans were perceived as being more accessible than their Brazilian PMM colleagues, they had a good relationship with their patients and the local community, and typically stayed in the same municipality for several years (Comes, Trindade, Shimizu, et al., 2016; Rech et al., 2018). These factors likely contributed to accumulating specific knowledge and facilitated ongoing care and a close patient-doctor relationship (Sobrinho, 2018). Descriptive statistics confirm this picture. Appendix Figure D.1 shows the trend in the share of doctors with no prior work experience, i.e., it captures how many of the active doctors started working only in that month. In the upper panel, we see that the share of PMM novices increased to 15% in treatment group 1 and 41% in treatment group 2. This shows that PMM vacancies were largely filled by doctors without any prior work experience. Trends in the experience profile of non-PMM primary health care doctors paint a similar picture for treatment group 2, in which the share of inexperienced non-PMM doctors peaked at 21% in December 2018. Replacing experienced with inexperienced primary care doctors might partly explain the persistent decrease in health care usage.

Next, we examine the participation and tasks performed by healthcare workers other than doctors in public primary care centers. During the turnover period, when vacancies had not been filled yet, non-doctors, such as nurses or community health workers, might have taken over doctoral

[10]Doctors' profiles and related practice styles can impact health care utilization and health outcomes for multiple reasons. First, doctors' individual and shared work experience is important for the quality of services that they deliver (Chen, 2021). Second, health care professionals' performance and practice styles have a strong influence on their patients' health care utilization (Fadlon & Van Parys, 2020; Simonsen et al., 2021). And third, it implies a loss of team and unit-specific human capital built up over various years (Bartel et al., 2014).

duties. Carrillo and Feres (2019) show that the introduction of PMM led to doctors taking over tasks from nurses, resulting in null-effects on infant health outcomes. The opposite might have occurred as PMM doctors left the program. Our data allow us to examine the extensive and intensive margins of adjustment of the labor supply of these professionals, and to identify which task was carried out by which health care professional. Overall, we do not find evidence for a substitution of doctors by non-doctors. Appendix Figure D.2 shows that there was neither meaningful increases in the number of non-doctor primary healthcare workers in public primary healthcare facilities (upper panel), nor in the average weekly hours worked by non-doctors (lower panel). Further, we do not observe changes in the number of consultations, procedures, and home visits carried out by non-doctors (Appendix Figure D.3). The results therefore do not indicate a substitution effect or an increased workload for these workers. If anything, the exit of Cuban doctors might have led to a complementary decrease in procedures performed by non-doctors during the turnover period.

In sum, we do not observe an improvement in the experience profile of the new doctors that replaced the Cuban professionals. We neither observe an increase in the supply of other health care professionals, nor task substitution across different healthcare professionals. In that sense, while some of these factors may help explain changes in service utilization, the replacement of professionals of different quality, the reallocation of practices among professionals, and changes in the supply of other health professionals are unlikely explanations for the lack of turnover effects on health outcomes.

6.1.2 Health Service Delivery

We now assess the profile of the services delivered at primary care centers by examining how the turnover affected different types of consultations and access to medication. First, SISAB data broadly distinguishes between two types of consultation: scheduled and spontaneous ones. Scheduled consultations are further subdivided into one-time consultations and consultations which are part of ongoing care. Spontaneous consultations are divided into walk-ins and urgent care. We estimate effects for each type of consultation.

Appendix Figure D.4 shows the results. Urgent care remains completely unaffected by the turnover, even though it is the consultation type with the highest doctoral share (70% in October 2018). However, urgent care requires prioritization by the health team even when severely understaffed and cannot be postponed. For spontaneous walk-ins and scheduled one-time care, we see a strong short-term drop of around 10.5% and 10% (around 470 and 430 per 100,000) in treatment group 1, and 18% and 21.5% (around 1,390 and 1,130 per 100,000) in treatment group 2 during the turnover period, respectively, but both types of treatment mostly stabilize back to base levels as soon as missing doctors are replaced. For consultations focused on health conditions requiring scheduled ongoing care, we observe a decrease that seems to persist until the end of the period of analysis in the most affected municipalities, even though point estimates are not always significant. Initial decreases are 10% (around 230 consultations per 100,000) in treatment group 1 and 17% (around 470 per 100,000) in treatment group 2, and stabilize at around 5% (around 110 per 100,000) and 11% (around 300 per 100,000) fewer scheduled ongoing consultations throughout 2019. These results suggest a restructuring of service delivery towards a prioritization of urgent and curative care over ongoing care for chronic diseases. This is consistent with evidence indicating that the latter can be delayed without immediate adverse health effects (Shurtz et al., 2022).

If primary care centers accommodate the turnover shock by de-prioritising ongoing care and care for chronic conditions, how does this affect patients that require related essential services, such as access to prescription drugs? Many essential prescription drugs in Brazil can be purchased at highly subsidized prices (Américo & Rocha, 2020). As access to subsidized drugs in Brazil is conditional on a medical prescription, the decrease in health care utilization for chronic diseases might translate into a decrease in related medication utilization. When examining trends in medication for diabetes and hypertension, we see a short but pronounced decrease in medication purchased. However, this is limited to shortly after the exit of the Cuban PMM doctors. In December 2018, the value of medication sold for hypertension and for diabetes (Appendix Figure D.5) decreased both by roughly 7% (around R$4,860 and R$2,130, respectively) in treatment group two. The reduction in medication sales quickly disappears and does not persist beyond the turnover period. Plausibly, patients in need of prescription medication for chronic diseases were therefore able to secure access to medications despite the reductions in primary care consultations. While patients are supposed to renew their prescription every month, doctors can write prescriptions covering up to 180 days (Américo & Rocha, 2020). Patients and/or doctors may have responded to the shock by guaranteeing access to medication even in a setting where access to consultations was restricted. Such adaptation would be in line with a prioritization of services concerning the most immediate needs, thus consistent with a pronounced but only short-term drop in drug sales.

In sum, the results suggest the possibility of demand adaptation and of restructuring of health service delivery towards urgent and curative needs as well as other protective services, buffering patients against more extreme adverse outcomes such as hospitalizations and deaths.

6.2 What Changed Beyond Primary Care Services?

We now examine whether the turnover led by the Cuban exit had impacts beyond the changes in the profile of professionals and services delivered at primary care centers. We first assess impacts on service use from other health care providers. We then examine private insurance markets and spillover effects on neighboring municipalities.

6.2.1 Other Health Care Services and Providers

With a reduction in the availability of primary care consultations, patients might seek for care in other sources of health services. The existing studies on small-scale turnover events provide evidence that doctor turnover can lead to patients substituting primary care by directly going to specialists, hospitals or emergency rooms (Agha et al., 2019; A. H. Sabety et al., 2021). Patients could also opt to increasingly use private health care by resorting to out-of-pocket spending and the purchase of private insurance plans (Silva et al., 2022). To investigate whether patients bypass the primary care sector to seek ambulatory care at other facilities, we turn to data on ambulatory care visits beyond primary care centers, distinguishing between specialist, hospital, and emergency room (ER) visits, as well as by complexity of treatment (basic, medium, high). Primary care needs mostly fall under the basic complexity category.

While we do not find significant changes for the use of hospitals and specialists for basic procedures (see Appendix Figure D.6), we do find a significant increase for such procedures performed at ERs. Figure 8 shows that the number of basic complexity treatments performed in ERs gradually increases following the turnover. The upper panel shows the number of basic complexity procedures at ERs, and the lower panel indicates how many ER facilities reported having supplied basic complexity treatments. By the end of 2019, ERs reported around 18% more treatments of basic complexity in both treatment groups, while treatments of higher complexity remain unaffected. Parallel to this, we also find that more ER facilities start delivering basic ambulatory care services (around 2% in treatment group 1 and 3.5%-4% in treatment group 2 from April 2019 onward). Patients therefore seem to partly substitute treatment at primary care centers with treatment at ER facilities, while municipalities start providing more low-complexity services in these facilities. It is important to note that the diversion persists even after the turnover ends. Although ERs are very accessible to the general population and cannot deny services to patients, they are explicitly not set up to take care of ongoing care or deferrable treatments (Carret et al., 2009). These upward trends in the use of ER facilities thus suggest increased fragmentation and misallocation of resources within municipalities, with preventive care being reduced and basic services being diverted towards facilities that should handle more urgent cases and emergencies.[11]

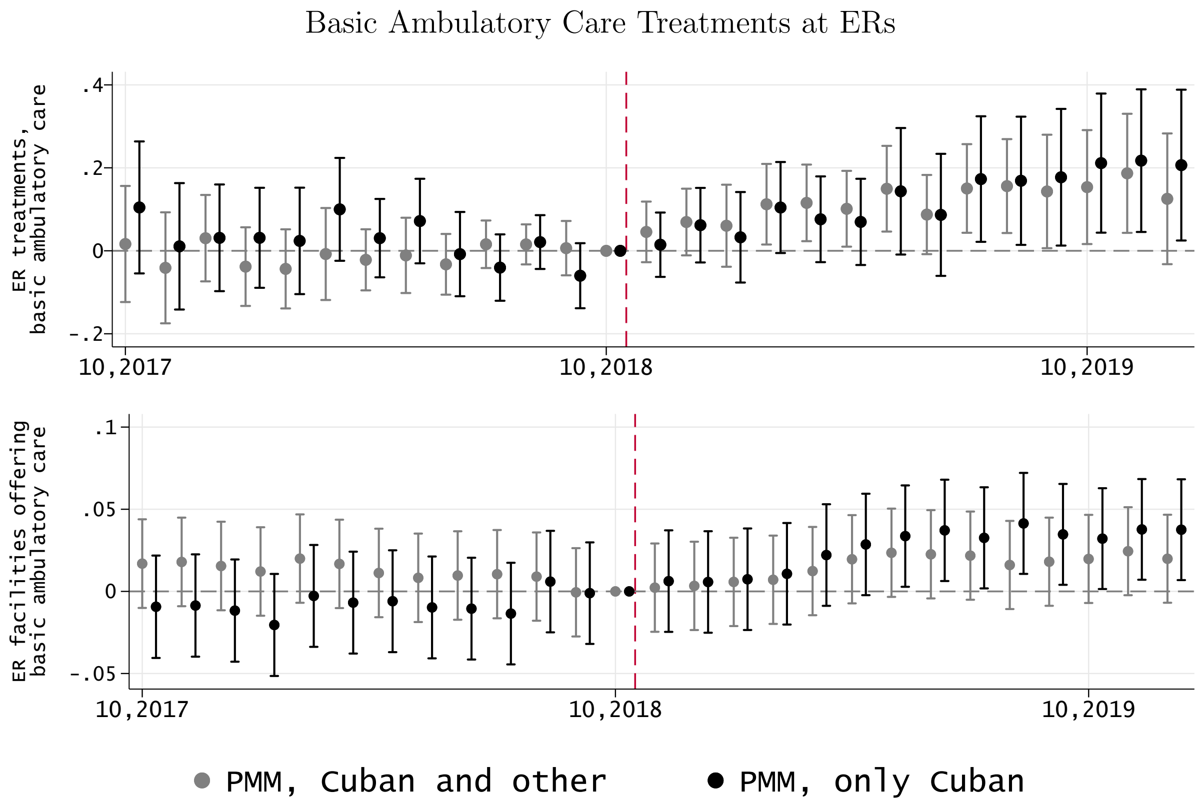

Figure 8: The graph shows event studies for the number of emergency room treatments of basic ambulatory care (upper panel) and the number of ER facilities reported to have offered basic ambulatory care treatments (lower panel), following equation 1. Outcomes per 100,000 residents and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health, SIA/Datasus and CNES.

6.2.2 Private Insurance and Private Services

Patients might substitute health care delivered by the public sector with private health care. Yet, we do not observe any changes in private insurance coverage in affected municipalities (see Figure

[11] A substitution of primary care by emergency care following disruptions in primary care services is also documented for the US context —see, for example, A. Sabety (2023) and Zhang (2022).

Appendix D.7). While we are not able to measure out-of-pocket expenditure, we conjecture that a similar pattern would emerge. The PMM's target population are of low socioeconomic status. Given that SUS provides access to services for free at the point of use, low-SES patients have long resorted to public services when seeking care. In that sense, we expect patients to mainly bypass the primary care services in order to seek care at other public facilities. Offsetting effects through private care utilization are therefore unlikely.

6.2.3 Geographical Spillovers

Finally, patients from affected municipalities might seek care in neighboring municipalities that have been unaffected or less affected by the turnover. This type of spillover is nevertheless unlikely in our setting. Primary health care units are explicitly set up to cover a specific catchment area and its resident population. Still, spillovers might be active to some extent.

We test for spillover effects between neighboring municipalities by accounting for neighbors' average treatment status. For each municipality i, we calculate the average share of Cuban PMM doctors among all primary care doctors of i's neighboring municipalities in October 2018.[12] We then follow equation 2, where we include both the interactions of municipality i's baseline share of Cuban doctors with time dummies, and the interaction of neighbors' average baseline share of Cuban doctors with time dummies. If patients from affected municipalities seek primary care in neighboring municipalities, we would expect a positive relationship between the average treatment intensity of municipality i's neighbors and municipality i's primary care consultations or procedures after the Cuban exit. Appendix Figure D.8 plots the coefficients from the interaction between neighbors' average share of Cuban doctors and the time dummies, for consultations per 100,000 residents (upper plot) and procedures per 100,000 residents (lower plot) as outcome variables. We do not find any evidence of spillover effects.

7 Final Comments

In this paper we investigated the unique case of a large-scale turnover of doctors in Brazil, where over 8,000 doctors from more than 2,800 municipalities left the health system. We found a significant

[12] To calculate municipality i's neighbors' average treatment status, we use a row-standardized contiguity matrix. We use all municipalities (PMM and non-PMM) to calculate neighbors' average treatment. For the estimation, we only use PMM participating municipalities.

and meaningful decrease in health care utilization, but no effect on hospitalizations and mortality during our sample period. These results are robust to multiple checks and sensitivity analyses.

The results suggest that patients and local health care systems were able to adapt within a few months, and generally proved flexible when under distress. Adaptation nevertheless came at the cost of de-prioritizing ongoing care and care for chronic conditions. This may be an issue over the longer-run as chronic conditions require prevention, early detection and ongoing care. Existing challenges, such as under-diagnosis and insufficient treatment of chronic conditions, may be strongly exacerbated by doctor turnover as it implies a loss of location- and position-specific knowledge (Davies et al., 2020; Geldsetzer et al., 2019; Manne-Goehler et al., 2019; Mauer et al., 2022). We also identified an increase in the use of ER facilities for low-complexity treatments. Besides being inefficient, seeking treatment for non-urgent conditions at ERs does not promote the rebuilding of long-term patient-doctor relationships and concomitant patient education, two factors highly desired within health care (Carret et al., 2009; Gill, 1999).

Doctor turnover is expected to be of increasing concern, especially so for deprived regions. Already facing challenges in retaining doctors, increasing shortages in doctors and regional imbalances in their supply can aggravate this issue considerably (Adovor et al., 2021; Dussault & Franceschini, 2006). It is thus relevant to understand how health systems can adapt and respond to turnover of doctors in efficient and equitable ways.

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Appendix

Doctor Turnover and Health Outcomes:
Evidence from the Exit of Cuban Doctors in Brazil

By Stefan Sliwa Ruiz, Malte Becker, Thomas Hone, and Rudi Rocha

December 2023

A Additional Descriptive Statistics

Table A.1: Primary Care Consultations: Conditions and Consultation Types by Responsible Professionals, PMM Eligible Municipalities

	Mean per 100k inhab.	Share doctors	Share non-doctors	Share no information
Consultations	14,527	.64	.36	0
	By condition			
Related to chron. cond.	4,196	.61	.34	.06
Asthma	68	.87	.13	0
COPD	43	.8	.2	0
Diabetes	601	.7	.29	.01
Hypertension	1,738	.69	.25	.06
Mental health	1,149	.66	.32	.02
Breast cancer screening	205	.45	.54	.01
Cervical cancer screening	333	.32	.67	.01
Cardiovascular screening	61	.68	.32	0
Related to risk factors for chron. cond.	1,547	.48	.5	.02
Malnutrition	74	.74	.26	0
Obesity	224	.57	.43	0
Smoking	65	.68	.32	0
Alcohol	32	.73	.27	0
Other drugs	16	.64	.36	0
Rehabilitation	1,136	.31	.67	.02
Related to maternal health	2,817	.45	.51	.04
Prenatal care	638	.51	.48	.01
Pediatrics	1,215	.45	.52	.03
Postpartum care (first 42 days)	48	.37	.63	0
Sexual and reproductive health	915	.39	.58	.03
Related to infectious diseases	60	.57	.43	0
STDs	34	.61	.39	0
Dengue	5	.77	.23	0
Hansen's disease	12	.53	.47	0
Tuberculosis	10	.48	.52	0
Without classified conditions	5,969			
	By type of consultation			
Scheduled singular care	4,962	.65	.35	0
Scheduled ongoing care	2,606	.41	.59	0
Non-scheduled walk-ins	6,483	.67	.33	0
Non-scheduled initial hearing	1,053	.15	.85	0
Non-scheduled urgent care	259	.7	.3	0
Without classified type	0			

Notes: Municipality averages of consultations performed in primary health care facilities for October 2018 (the pre-treatment month). Non-PMM eligible municipalities are excluded. Consultation are grouped by category, condition and consultation type. Column 1 shows average rates per 100,000 inhabitants. Column 2 to 4 show the shares done by doctors, non-doctors and with no information. Shares done by (non-)doctors are calculated within condition categories and sum up to 1 for each category of condition or type. Original data from SISAB.

Table A.2: Definitions of the Type of Consultations according to SISAB

Type of consultation	Definition according to SISAB
Scheduled continuous consultations	These are consultations that constitute individual programmatic actions, directed to life cycles, diseases and priority diseases, which require continuous monitoring. As an example, the care given to pregnant women, children, the elderly, people with chronic diseases (hypertension, diabetes) etc.
Scheduled consultations	It comes from spontaneous demand or by direct appointment at the reception, of a non-urgent nature, not attended on the same day of the demand, but scheduled for another day. For example, cases of skin lesions, without signs of inflammation or infection; nonspecific complaints of fatigue; tiredness; chronic headache; change or beginning of contraceptive contraceptive medication, etc.
Initial reception/orientation	Refers to reception done by a senior professional at the moment the user arrives at the health service, reporting complaints or signs of symptoms. When the patient arrives at the health service, reporting complaints or signs and perceived symptoms It does not include flow orientations within the UBS.
Consultation on the same day	A consultation that takes place on the same day that the user seeks service, of a non-urgent nature. As an example, cases with symptoms of great pain or those that cannot wait for an appointment on another day, such as low back pain, sore throat, urinary symptoms, etc. Another characteristic for same-day care may be related to the social or psychological vulnerability of the patient.
Urgent consultations	Care provided to the patient when there is a possibility of worsening of the condition or risk of life and that determines the need for immediate relief of physical and/or psychological suffering, recovery of the health condition, stabilization/life support and/or referral to another part of the network when necessary. For example, cases of chest pain, neurological symptoms and/or symptoms and/or neurological signs, hypertensive emergency, etc.

Table A.3: Municipality Averages of Main variables in October 2018

	Pooled		By Treatment groups		
	All munis	PMM munis	Control	Treat 1	Treat 2
Primary health care professionals					
Primary care doctors (per 100k)	44	42	44	35	45
Non-doctors (per 100k)	257	318	172	761	87
PMM doctors (per 100k)	12	17	11	18	20
Cuban PMM doctors (per 100k)	8	10	0	10	20
Share of Cubans among PMM doctors	.59	.59	0	.52	1
Share of Cubans among all PC doctors	.19	.26	0	.29	.45
Total hours, non-doctors (per 100k)	22,947	22,704	22,775	22,111	23,118
Av. weekly hrs., primary care doctors	36	36	36	36	37
Avg. weekly hrs., non-doctors	38	38	38	37	38
Primary care services					
Consultations (per 100k)	15,734	14,527	15,260	11,676	16,190
by condition group					
Chronic conditions	4,331	4,196	4,242	3,835	4,448
Related risk factors	1,703	1,547	1,747	1,112	1,731
Maternal health	2,864	2,817	2,765	2,740	2,920
Infections	58	60	50	67	62
No classification	6,884	5.969	6,603	3,927	7,069
by consultation type					
Scheduled singular care	5,244	4,960	5,200	4,341	5,271
Scheduled ongoing care	2,786	2,607	2,806	2,255	2,745
Non-scheduled walk-ins	7,243	6,484	6,992	4,481	7,698
Non-scheduled initial hearings	1,286	1,053	1,183	680	1,274
Non-scheduled urgent care	312	259	246	212	320
Share consultations by doctors	0.64	0.64	0.64	0.63	0.65
Procedures (per 100k)	16,231	14,307	15,052	10,258	16,915
Share procedures by doctors	0.04	0.04	0.03	0.03	0.04
Home visits (per 100k)	26,295	25,235	26,500	21,132	27,455
Share home visits by doctors	0	0	0	0	0
Hospitalizations					
Total (per 100k)	563	557	562	537	570
Amenable to pc (per 100k)	119	120	115	110	132
Non-amenable to pc (per 100k)	444	437	447	426	438
Chronic conditions (per 100k)	186	181	188	163	190
Infections (per 100k)	40	41	36	39	46.81
Infants (per 100k)	16	17	16	19	17
Diabetes (60+, per 100k)	33	35	32	35	37
Hypertension (60+, per 100k)	21	22	18	21	26

Continued on next page

Table A.3, continued from previous page

	Pooled		By Treatment groups		
	All munis	PMM munis	Control	Treat 1	Treat 2
Mortality					
Total (per 100k)	57	55	58	51	56
Amenable to pc (per 100k)	17	16	17	15	16
Non-amenable to pc (per 100k)	40	39	41	36	39
Chronic conditions (per 100k)	37	36	38	34	37
Infections (per 100k)	2	1.9	1.93	1.87	1.86
Infants (per 100k)	1.5	1.6	1.35	1.62	1.67
Diabetes (60+, per 100k)	22	22	21	22.5	22
Hypertension (60+, per 100k)	19	19	21	18	19
Medication					
Subs. hypertension med. (R$, per 100k)	65,239	62,386	69,793	47,368	69,425
Subs. diabetes med. (R$, per 100k)	33,270	31,411	34,982	28,819	30,461
Private health insurance					
Beneficiaries (per 100k)	8,038	8,234	8,254	10,438	6,462
Ambulatory care outside of UBS					
Basic complexity treatments					
Emergency rooms (per 100k)	19	19	16	26	10
Hospitals (per 100k)	158	147	69	108	179
Specialists (per 100k)	138	138	153	125	143
Facilities offering basic complexity treatments					
Emergency rooms (per 100k)	1	1.5	2	5	6
Hospitals (per 100k)	4	4.5	6	2.5	6
Specialists (per 100k)	4	5	5	5	6
N	5,561	4,163	1,320	1,260	1,583

Notes: Municipality averages in rates per 100,000 inhabitants for October 2018 (the pre-treatment month). Data on private insurance coverage for September 2018 (the last available pre-treatment period). Where specified, variables only include observations for individuals aged 60 years or more. Column 1 includes all Brazilian municipalities (excluding special indigenous districts). Column 2 includes all municipalities that participated in PMM. Columns 3 to 5 distinguish PMM participating municipalities based on the presence of Cuban PMM doctors in October 2018. Control municipalities had no Cuban PMM doctor in October 2018. Treatment group 1 (T1) had some Cuban and some non-Cuban PMM doctors in October 2018. Treatment group 2 (T2) had only Cuban PMM doctors in October 2018. Numbers within columns do not always sum up as data becomes less precise with disaggregation. Data on doctor supply originally from the Ministry of Health. Data on primary care services originally from SISAB. Data on mortality and hospitalizations originally from SIM/Datasus and SIH/Datasus. Data on medication originally from the Ministry of Health. Data on private insurance coverage originally from ANS. Data on ambulatory care in secondary and tertiary care centers originally from SIA.

Table A.4: Socio-demographic Control Variables on the Municipality Level

	Mean	SD	Min	Max
Number of families receiving Bolsa Família (per 100k)	9,985	6,593	74	36,072
Bolsa Familia expenses per resident (R$)	281	222	3	1,361
GDP per capita (R$)	22,732	22,575	4,779	419,448
Value added by public sector employment (R$; per 100k)	484,137	131,949	276,843	3,420,000
Share of population over 65 (%)	10	3	1	24
Population size	45,873	253,874	1,324	12,000,000
Population density per km^2	139	691	.006	14,007
Sex ratio in the municipality	102	21	81	1,283

Notes: Monthly municipality averages for the year 2018, pooled across all Brazilian municipalities. Original data from the Brazilian Institute of Geography and Statistics (IBGE).

B Additional Results

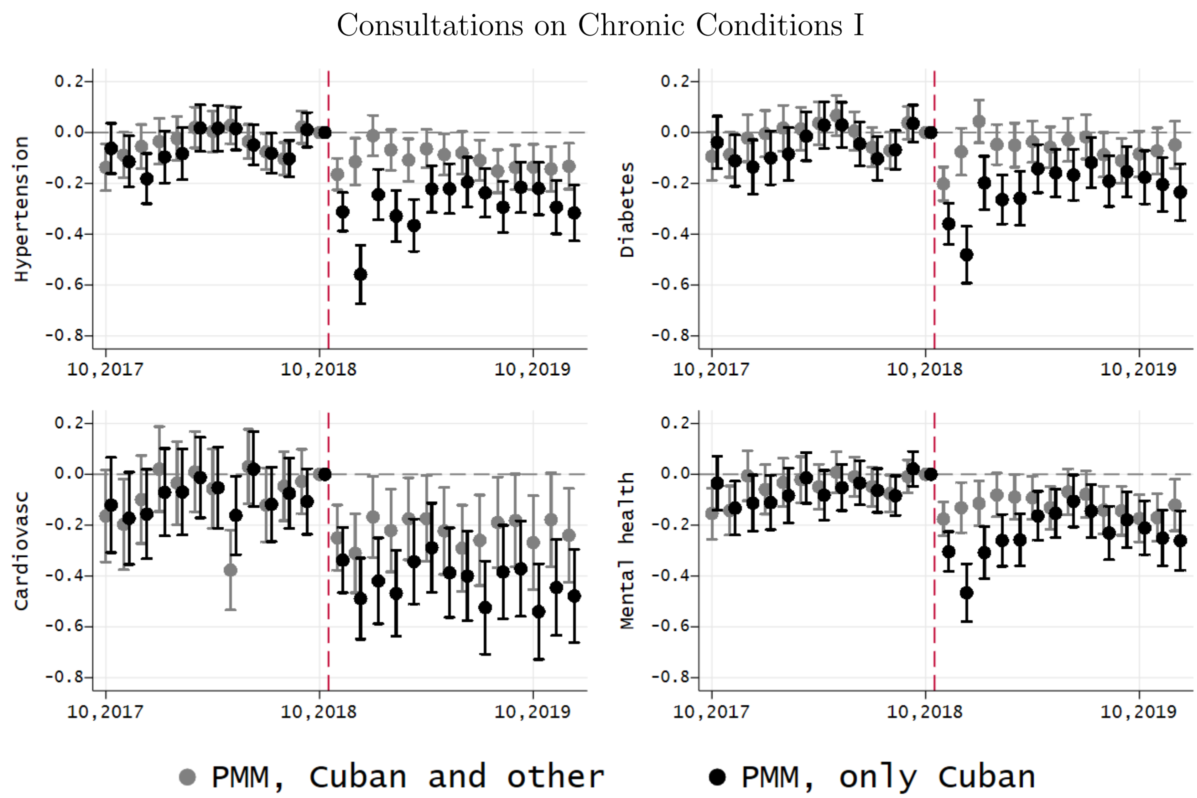

Figure B.1: The graph shows event studies for the number of primary care consultations on chronic conditions, (hypertension, diabetes, cardiovascular diseases, and mental health), following equation 1. Outcomes are per 100,000 inhabitants and and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health and CNES.

Consultations on Chronic Conditions II

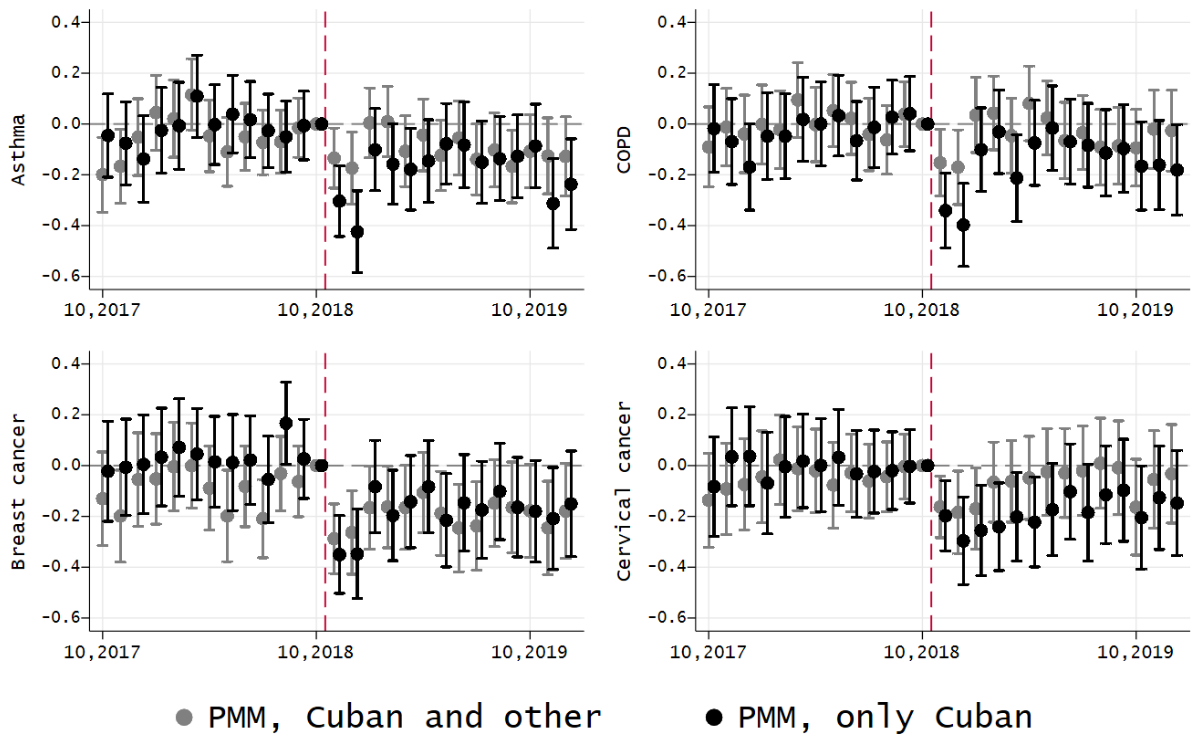

Figure B.2: The graph shows event studies for the number of primary care consultations on asthma, COPD, and breast and cervical cancer screenings, following equation 1. Outcomes are per 100,000 inhabitants and and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health and SISAB.

Consultations on Infections

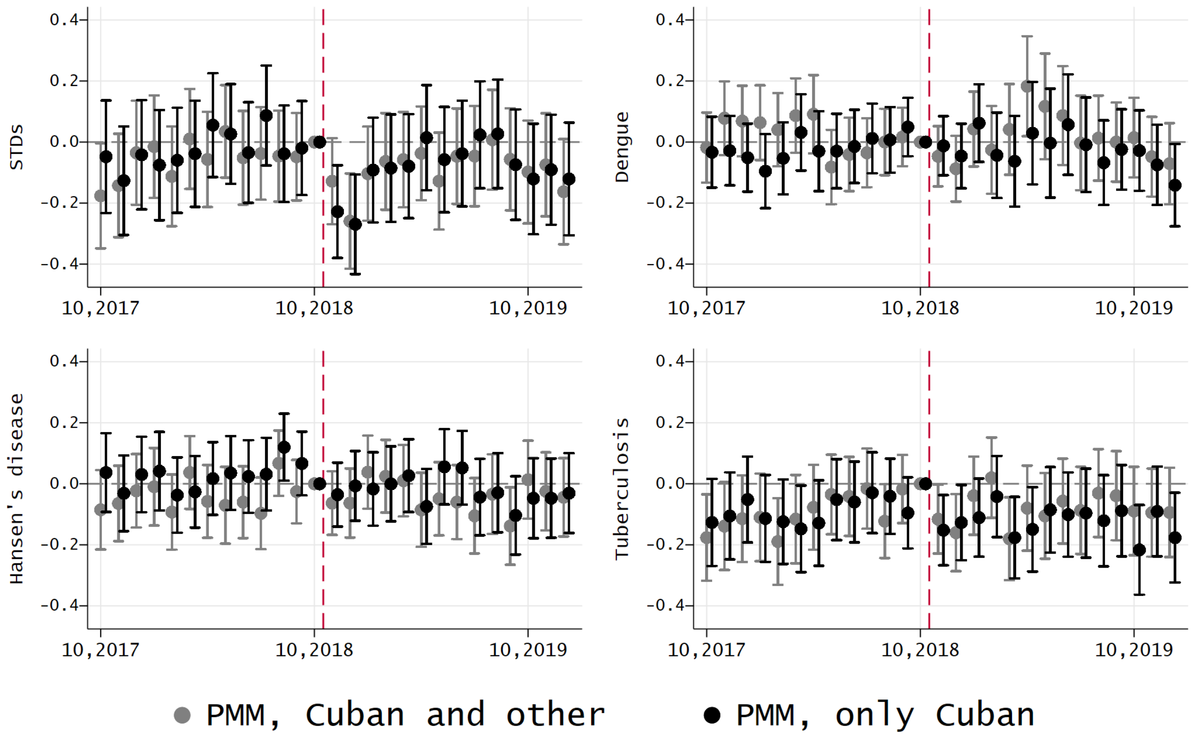

Figure B.3: The graph shows event studies for the number of primary care consultations on sexually transmitted diseases, dengue, Hansen's disease, and tuberculosis, following equation 1. Outcomes are per 100,000 inhabitants and and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health and SISAB.

C Robustness

C.1 Time-Varying Controls

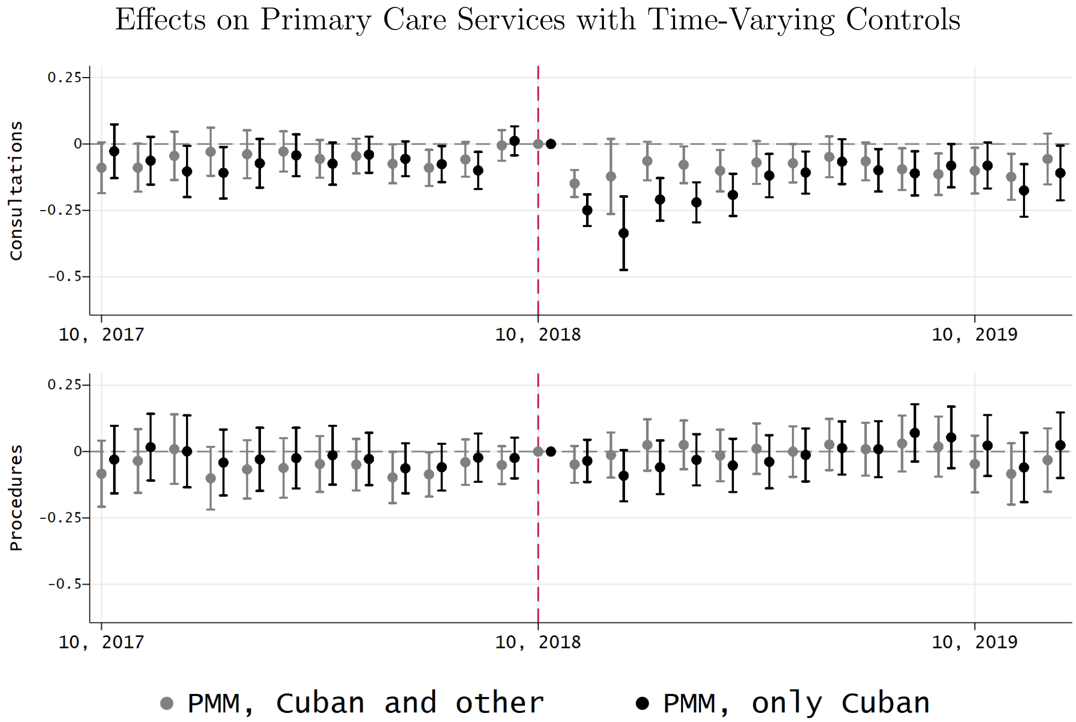

Figure C.1: The graph shows event studies for the number of consultations (upper panel) and procedures (lower panel) performed in primary health care facilities, following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects, together with annual municipality-level controls (population share of Bolsa Familia coverage, Bolsa Familia expenses per capita, GDP per capita, value added by public sector employment (in R$ 1,000), the share of the population above 65, and the sex ratio). Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB, the Ministry of Health and IBGE.

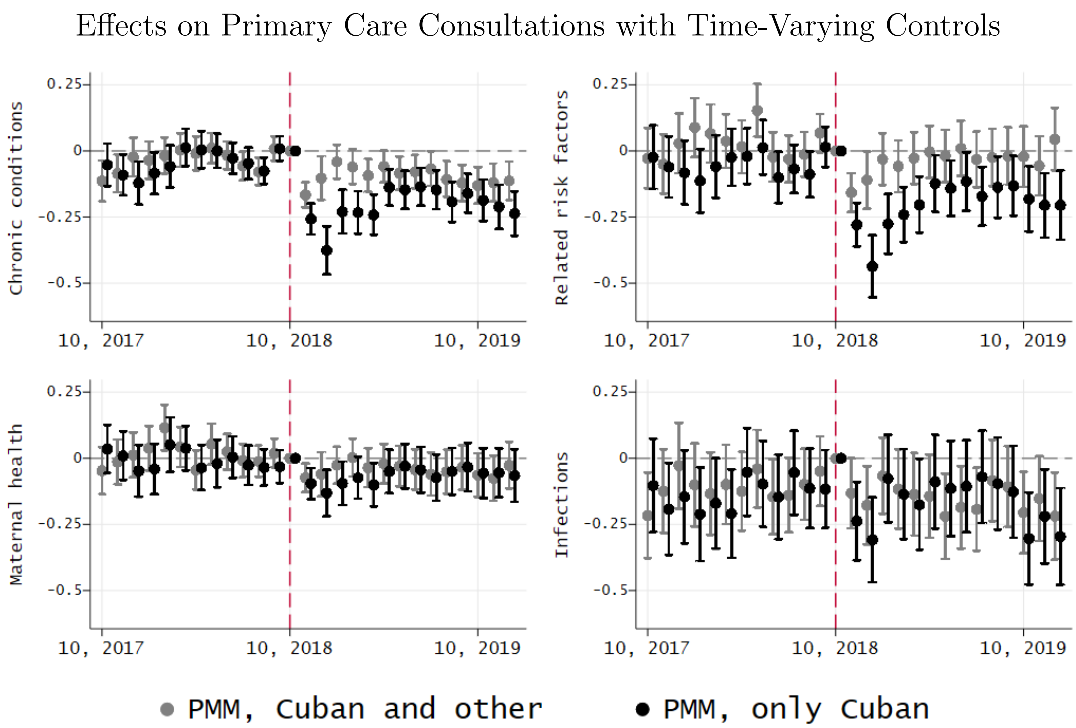

Figure C.2: The graph shows event studies for the number of consultations in four different categories, performed in primary health care facilities, following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects, together with annual municipality-level controls (population share of Bolsa Familia coverage, Bolsa Familia expenses per capita, GDP per capita, value added by public sector employment (in R$ 1,000), the share of the population above 65, and the sex ratio). Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB, the Ministry of Health and IBGE.

Effects on Hospitalizations with Time-Varying Controls

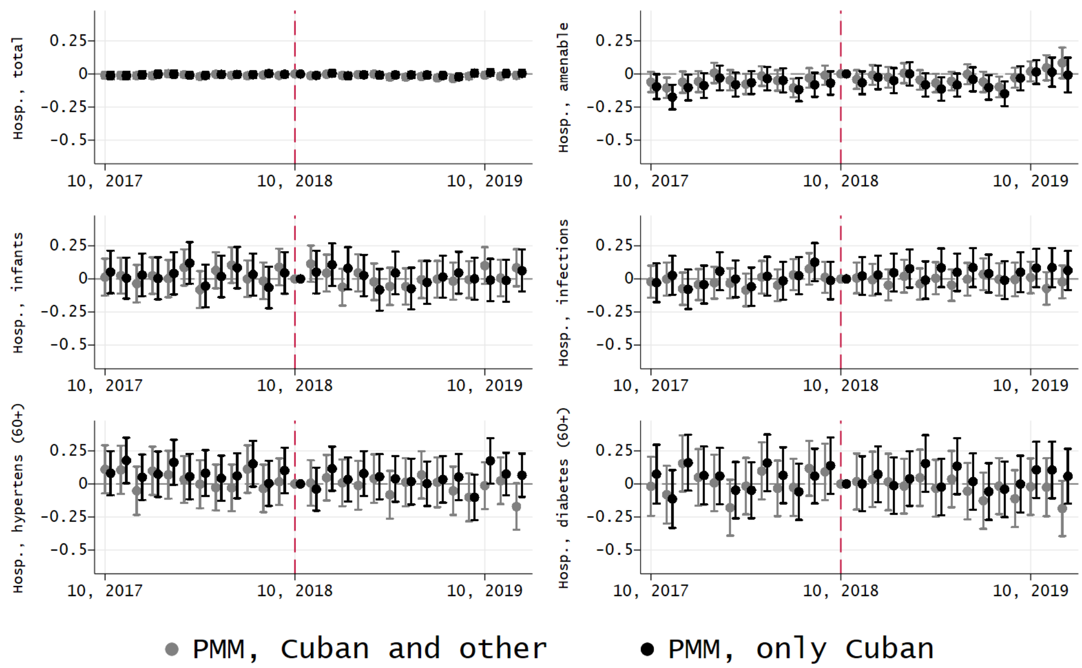

Figure C.3: The graph shows event studies for the number of hospitalizations in six different categories, following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects, together with annual municipality-level controls (population share of Bolsa Familia coverage, Bolsa Familia expenses per capita, GDP per capita, value added by public sector employment (in R$ 1,000), the share of the population above 65, and the sex ratio). Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SIH/Datasus, the Ministry of Health and IBGE.

Effects on Mortality with Time-Varying Controls

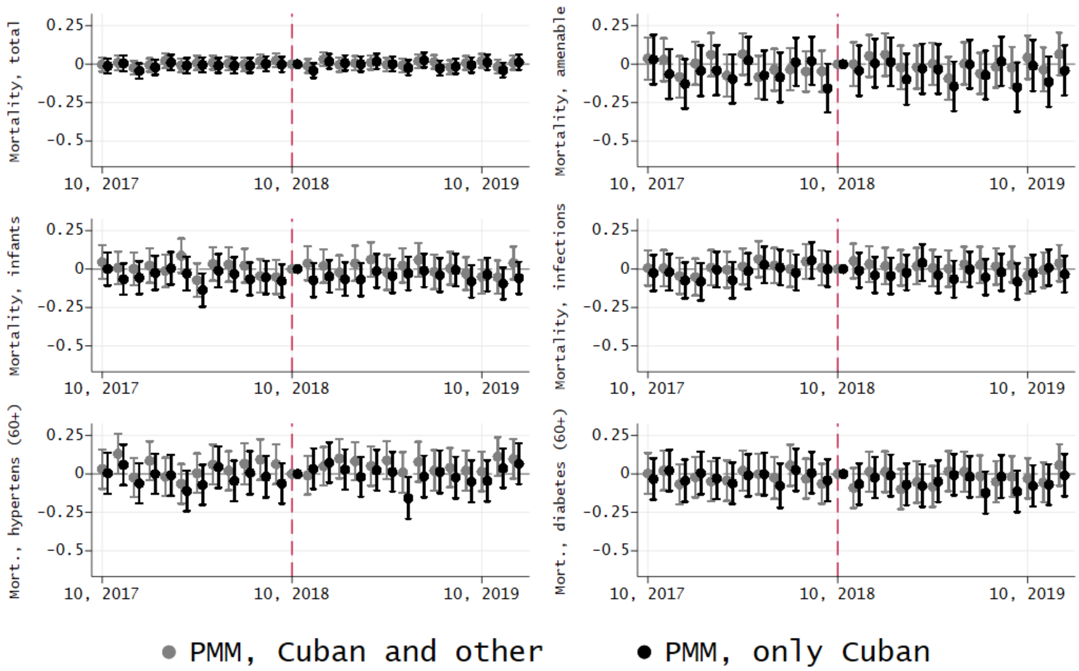

Figure C.4: The graph shows event studies for the number of hospital mortality in six different categories, following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects, together with annual municipality-level controls (population share of Bolsa Familia coverage, Bolsa Familia expenses per capita, GDP per capita, value added by public sector employment (in R$ 1,000), the share of the population above 65, and the sex ratio). Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SIM/Datasus, the Ministry of Health and IBGE.

C.2 Alternative Definition of the Control Group

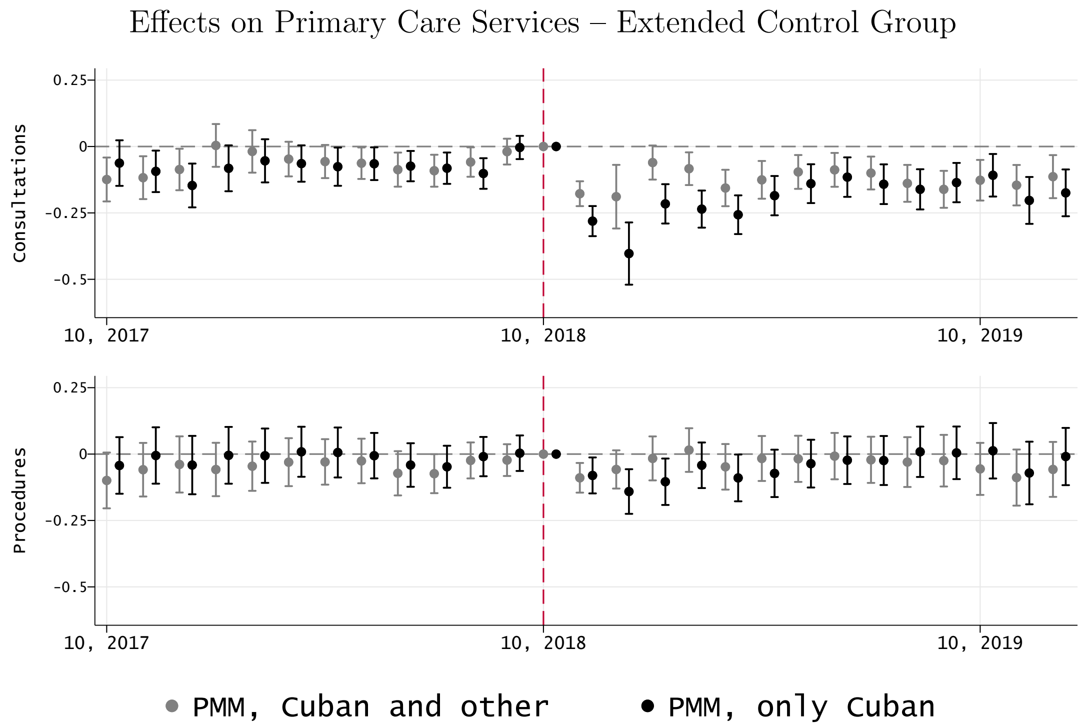

Figure C.5: The graph shows event studies for the number of consultations (upper panel) and procedures (lower panel) performed in primary health care facilities, following equation 1 but including non-PMM municipalities in the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

Effects on Primary Care Consultations – Extended Control Group

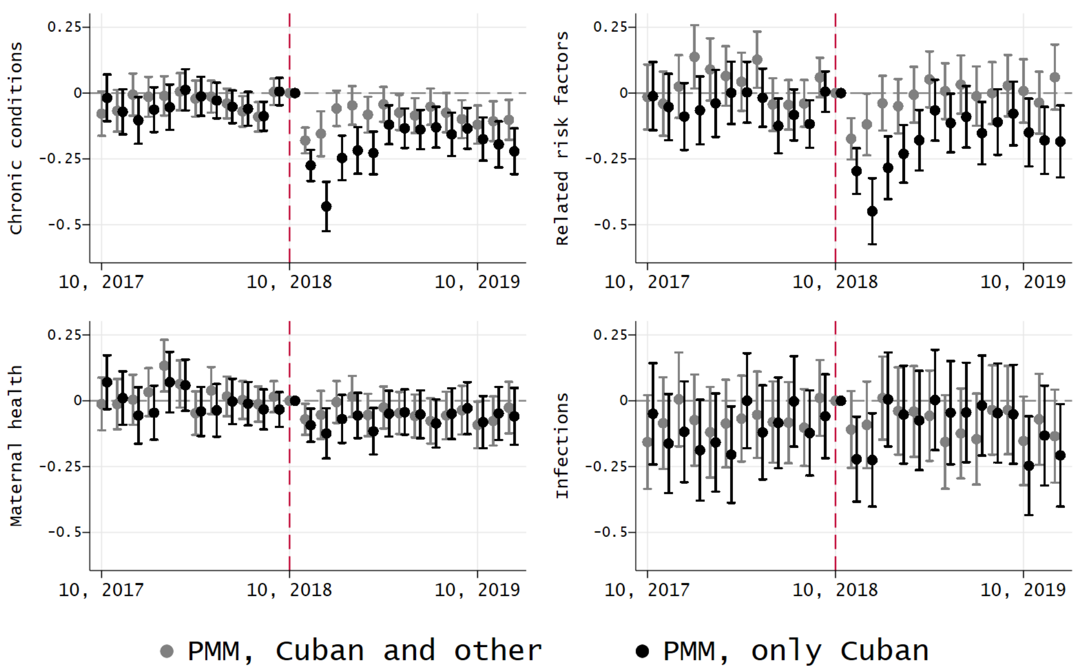

Figure C.6: The graph shows event studies for the number of consultations in four different categories, performed in primary health care facilities, following equation 1 but including non-PMM municipalities in the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

Effects on Hospitalizations – Extended Control Group

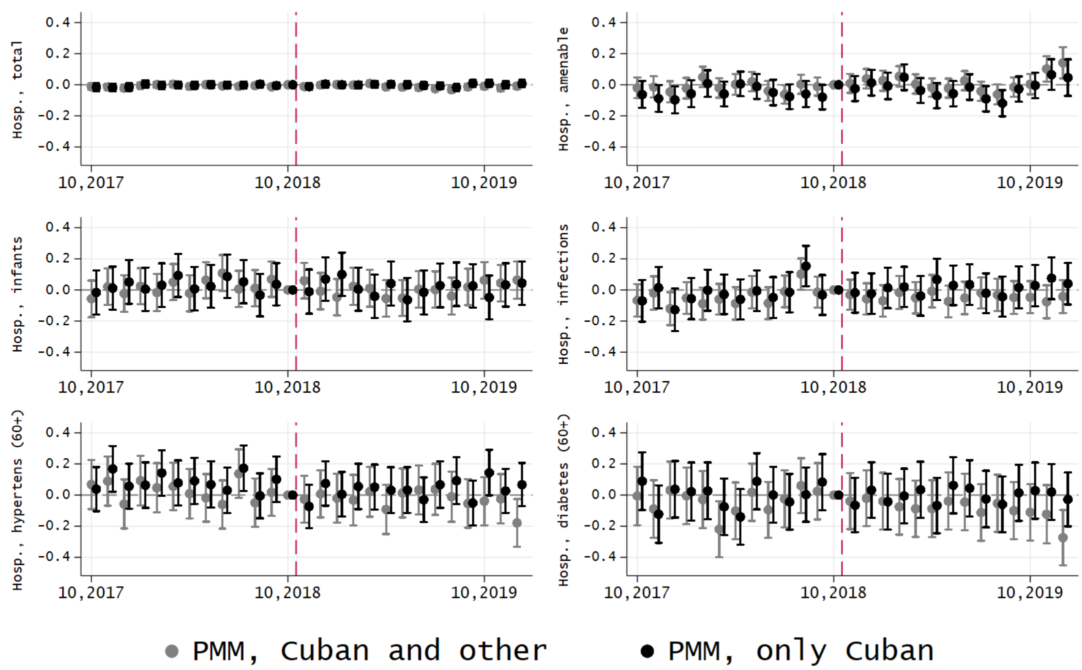

Figure C.7: The graph shows event studies for the number of hospitalizations in six different categories, following equation 1 but including non-PMM municipalities in the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SIH/Datasus and the Ministry of Health.

Effects on Mortality – Extended Control Group

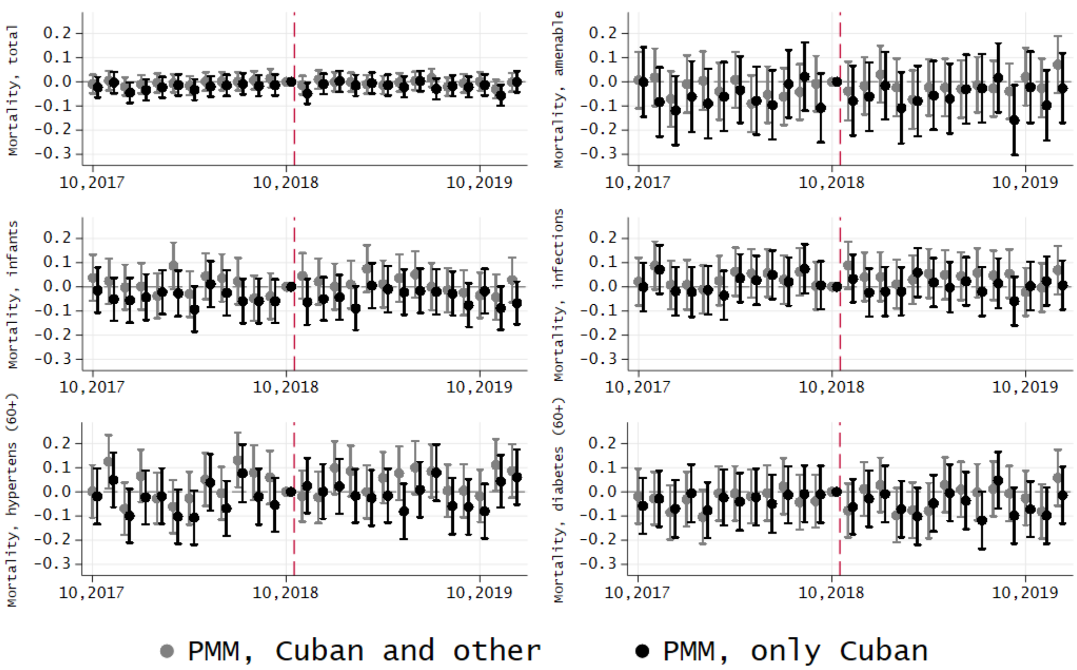

Figure C.8: The graph shows event studies for the number of hospital mortality in six different categories, following equation 1 but including non-PMM municipalities in the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SIM/Datasus and the Ministry of Health.

Effects on Primary Care Services – Restricted Control Group

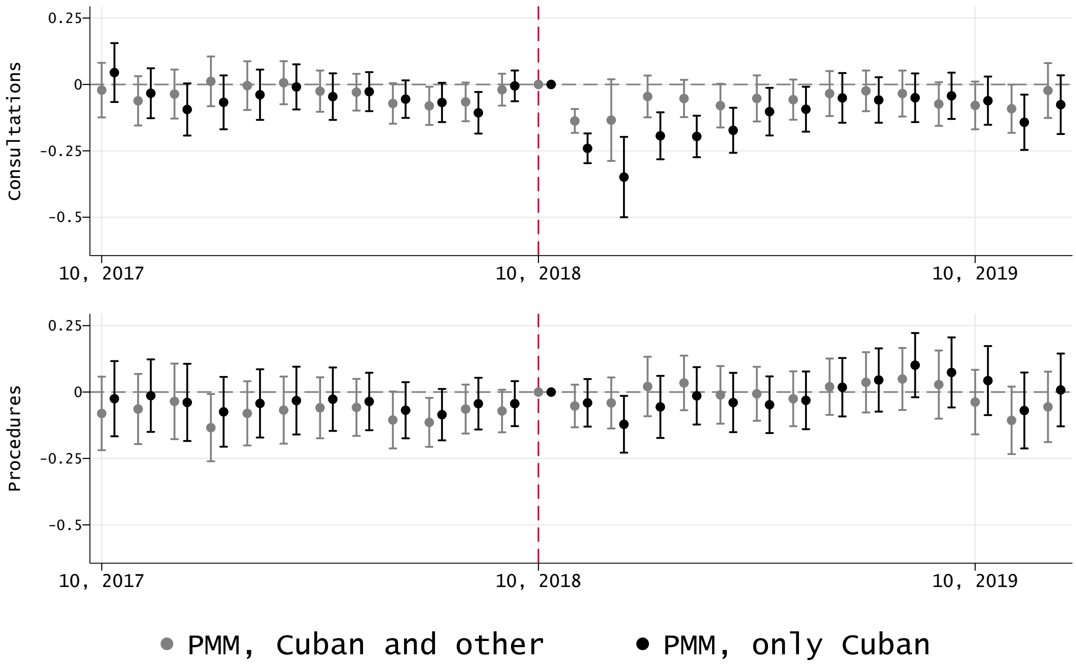

Figure C.9: The graph shows event studies for the number of consultations (upper panel) and procedures (lower panel) performed in primary health care facilities, following equation 1 but excluding municipalities which were formally part of PMM but did not employ any PMM doctor in October 2018 from the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

Effects on Primary Care Consultations – Restricted Control Group

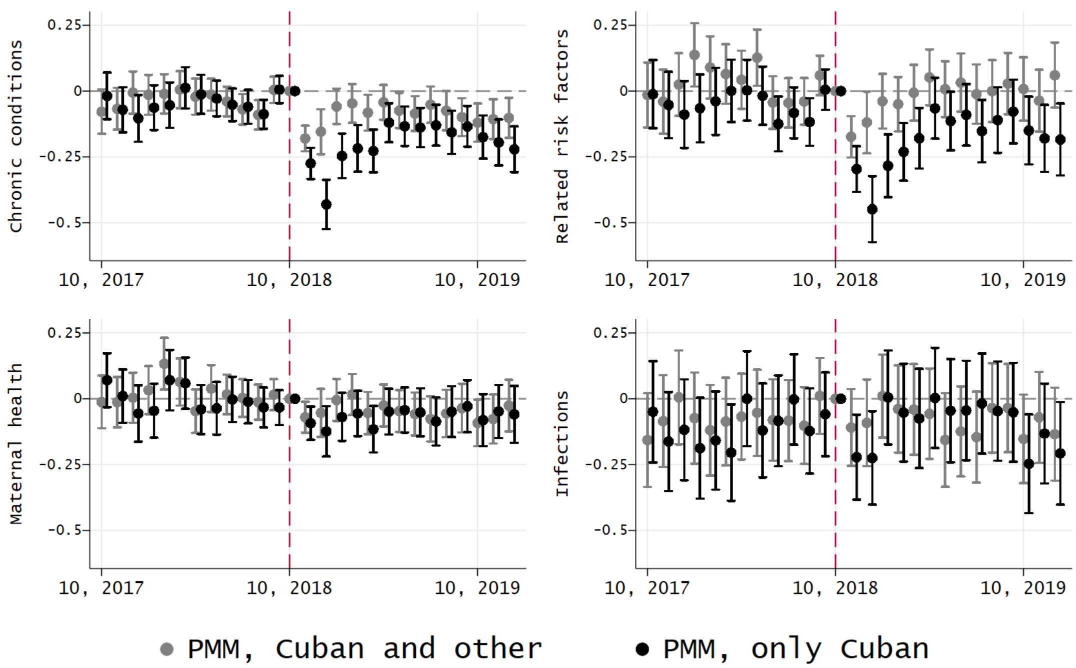

Figure C.10: The graph shows event studies for the number of consultations in four different categories, performed in primary health care facilities, following equation 1 but excluding municipalities which were formally part of PMM but did not employ any PMM doctor in October 2018 from the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

Effects on Hospitalizations – Restricted Control Group

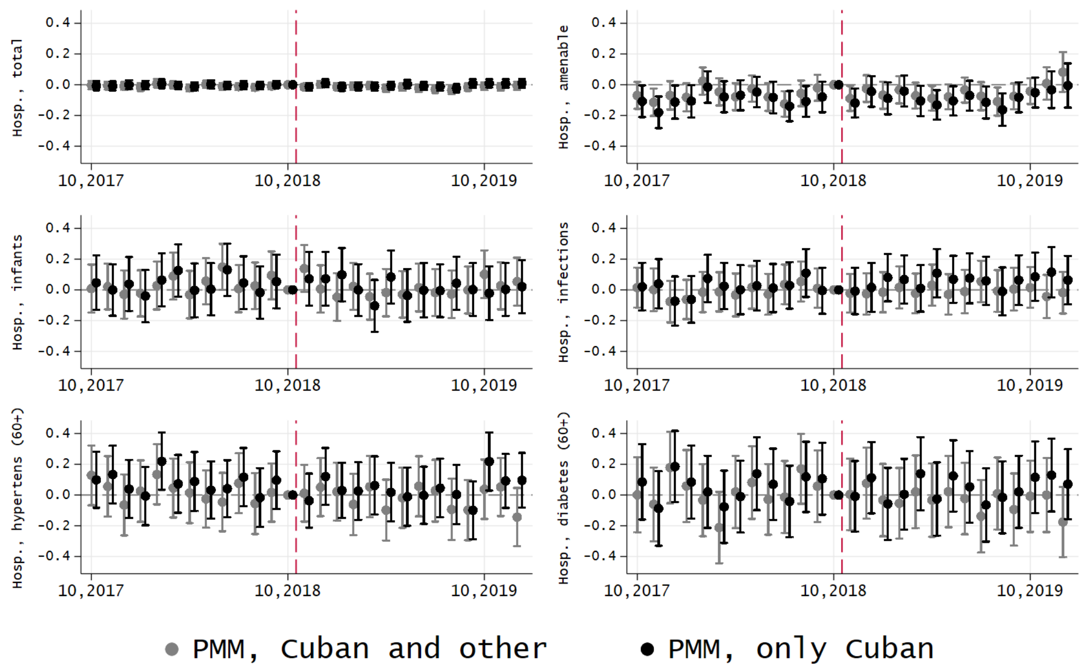

Figure C.11: The graph shows event studies for the number of hospitalizations in six different categories, following equation 1 but excluding municipalities which were formally part of PMM but did not employ any PMM doctor in October 2018 from the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SIH/Datasus and the Ministry of Health.

Effects on Mortality – Restricted Control Group

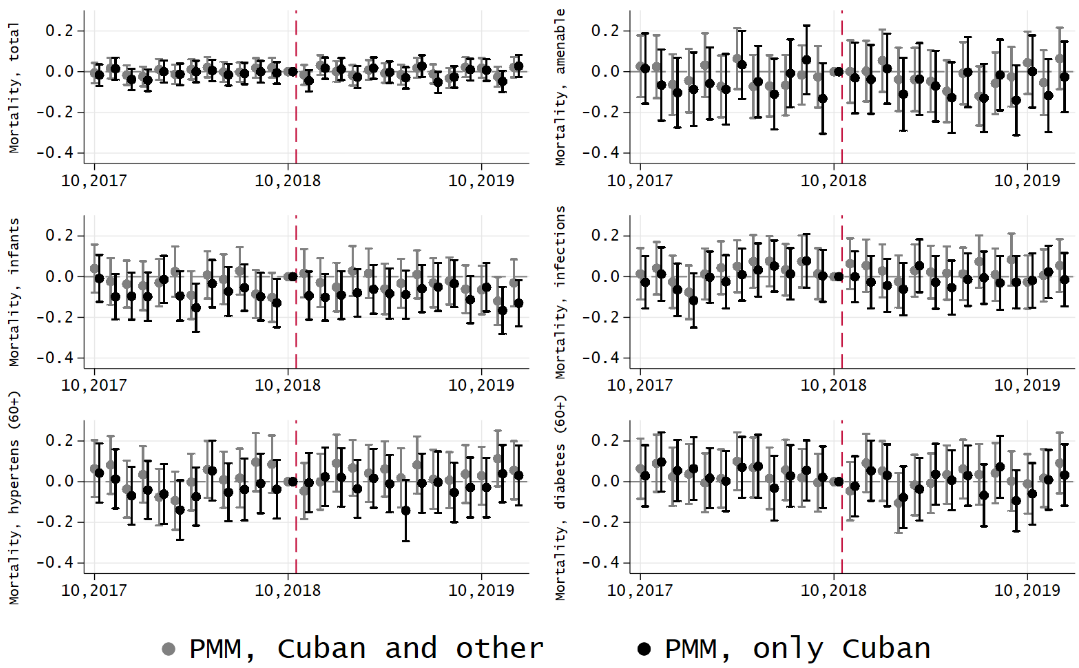

Figure C.12: The graph shows event studies for the number of hospital mortality in six different categories, following equation 1 but excluding municipalities which were formally part of PMM but did not employ any PMM doctor in October 2018 from the control group. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Standard errors are clustered at the municipality level. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SIM/Datasus and the Ministry of Health.

C.3 Alternative Definitions of Treatment Variables and Specifications

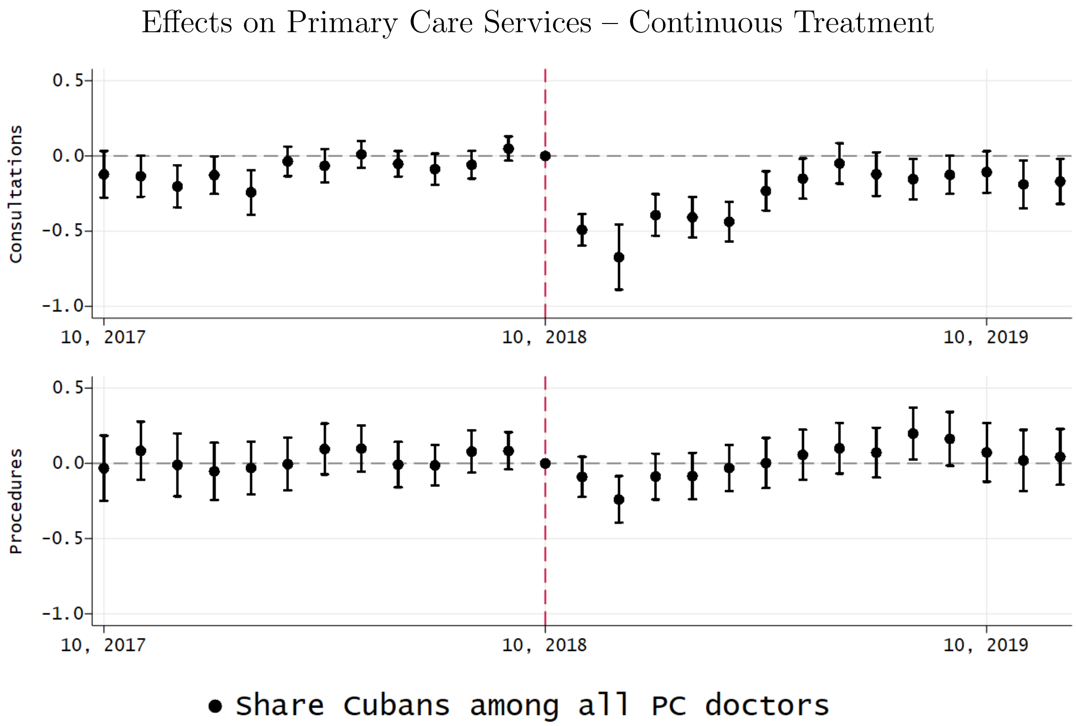

Figure C.13: The graph shows event studies for the number of consultations (upper panel) and procedures (lower panel) performed in primary health care facilities, following equation 2, where the treatment variable is defined as the share of Cubans among all municipal primary care doctors in October 2018 (PMM and non-PMM). Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB, the Ministry of Health and CNES.

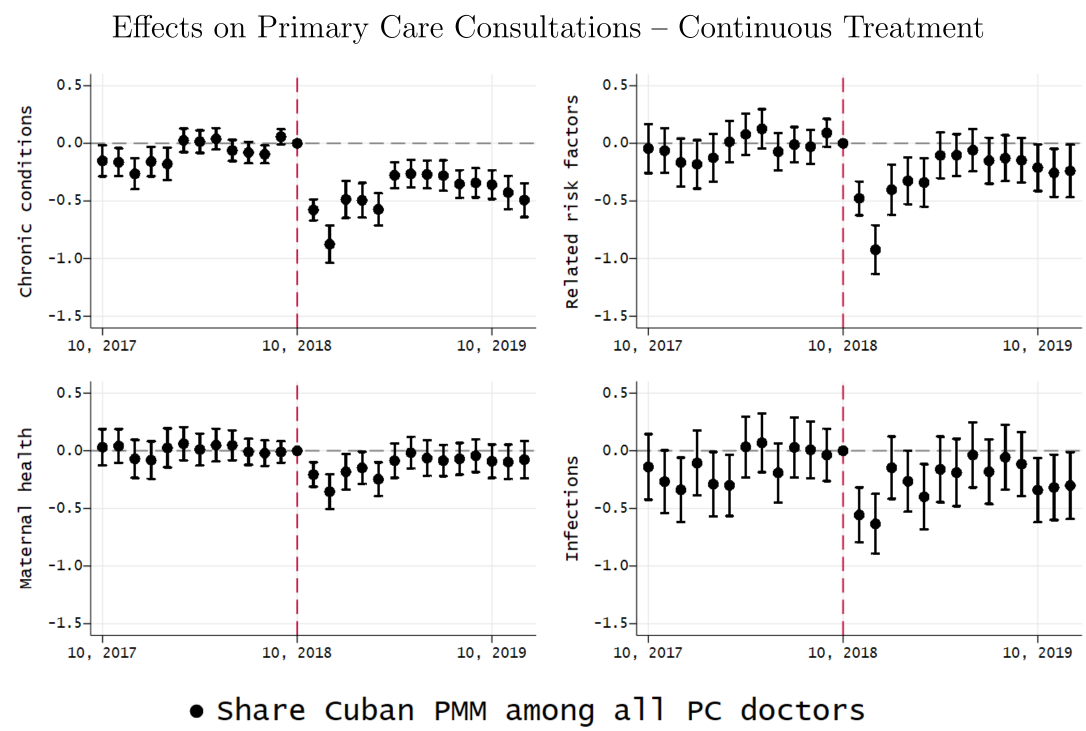

Figure C.14: The graph shows event studies for the number of consultations in four different primary care categories performed in primary health care facilities, following equation 2, where the treatment variable is defined as the share of Cubans among all municipal primary care doctors in October 2018 (PMM and non-PMM). Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB, the Ministry of Health and CNES.

Effects on Hospitalizations – Continuous Treatment

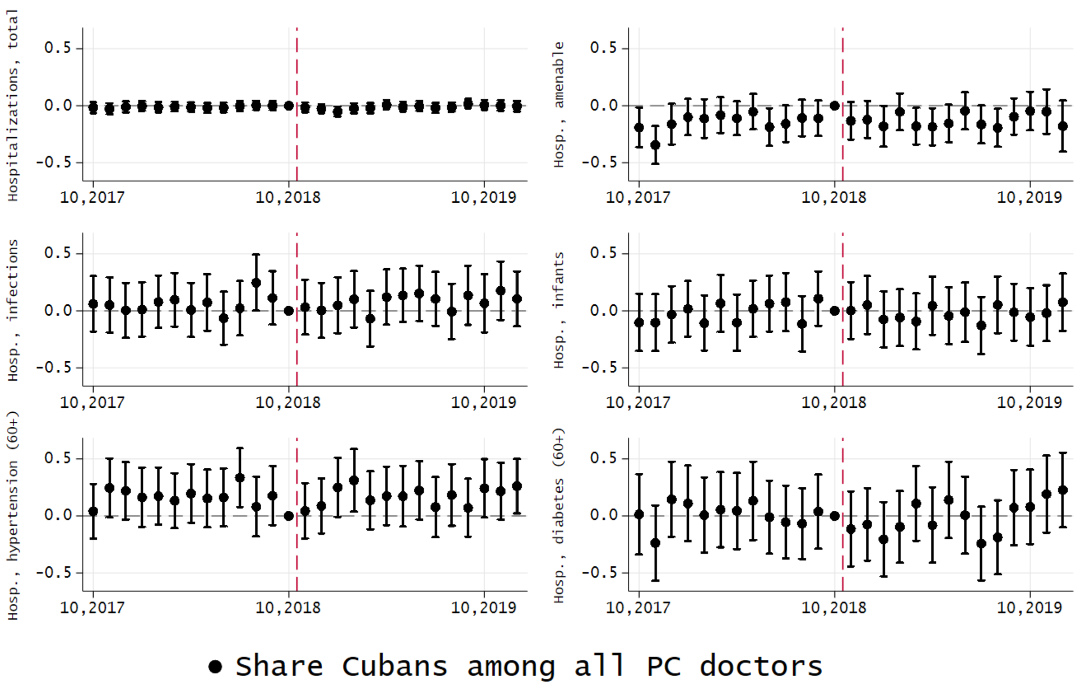

Figure C.15: The graph shows event studies for the number of hospitalizations in six different categories, following equation 2, where the treatment variable is defined as the share of Cubans among all municipal primary care doctors in October 2018 (PMM and non-PMM). Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Where indicated, the number of hospitalizations only includes individuals aged 60 or more. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the SIH/Datasus, CNES and the Ministry of Health.

Effects on Mortality – Continuous Treatment

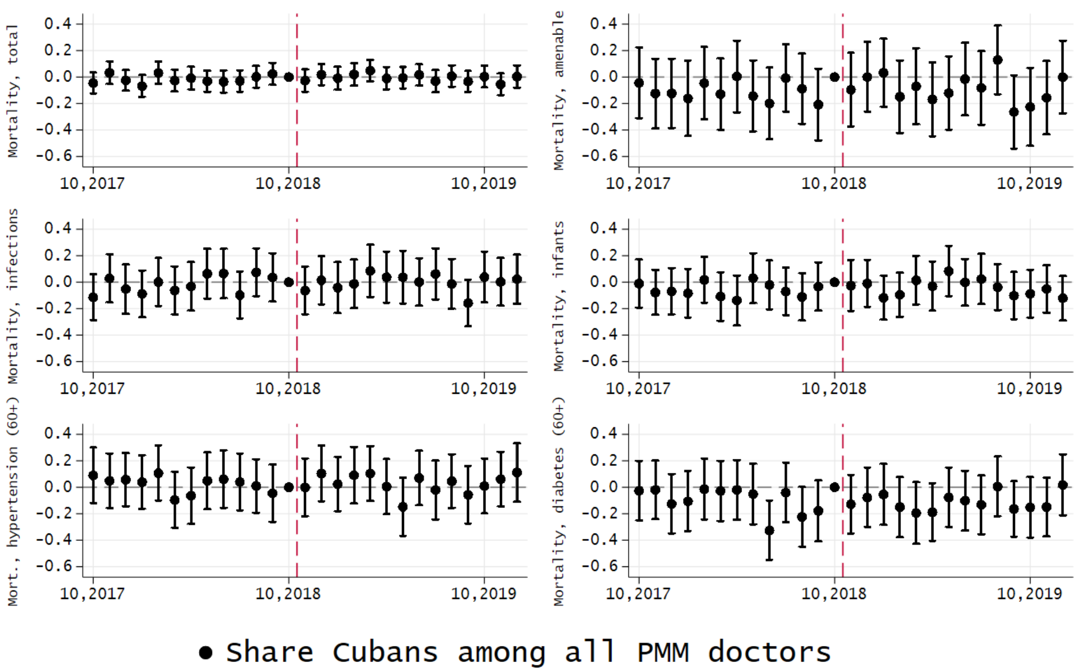

Figure C.16: The graph shows event studies for the number of hospital mortality in six different categories, following equation 2, where the treatment variable is defined as the share of Cubans among all municipal primary care doctors in October 2018 (PMM and non-PMM). Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Where indicated, the number of hospitalizations only includes individuals aged 60 or more. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the SIM/Datasus, CNES and the Ministry of Health.

C.4 Leave-One-Out Analysis

Effect on Consultation Categories: Leave-One-Out-Analysis

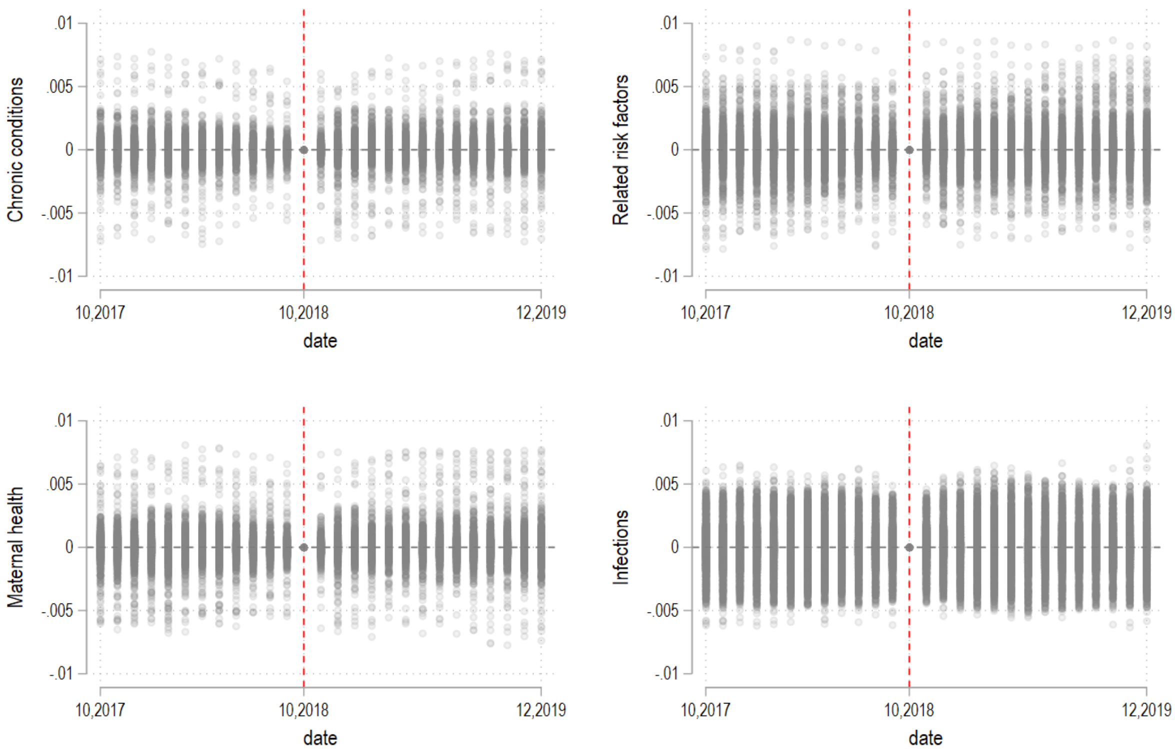

Figure C.17: The graph shows the differences between the estimated coefficients from the full event study and the leave-one-out analysis for the number of consultations performed in primary health care facilities in four different primary care categories. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. We follow equation 1, but use a binary treatment variable instead of a categorical one. Regressions include municipality, month and state times month fixed effects. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

D Discussion on Mechanisms and Health Systems Response: Additional Results

D.1 What Changed Within Primary Care Centers?

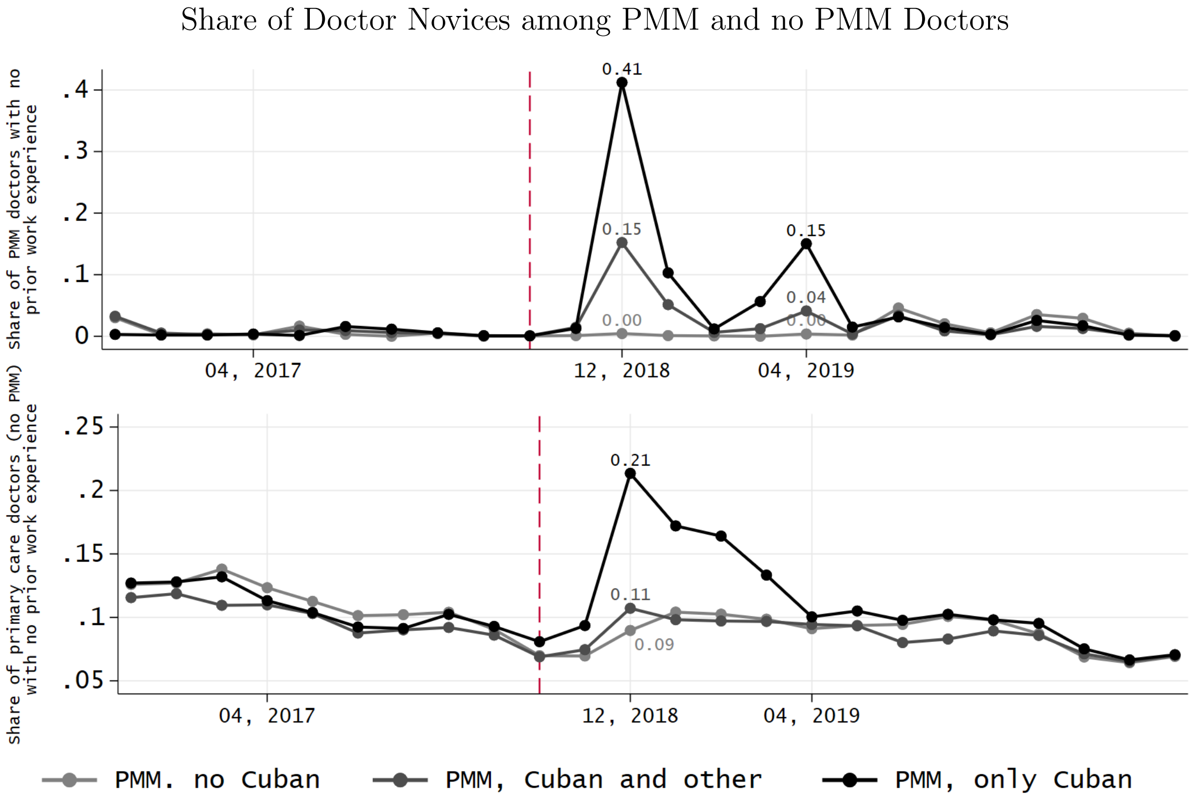

Figure D.1: The graph shows the share of PMM doctors with no prior work experience among all PMM doctors, calculated on the municipality-month level for all PMM-participating municipalities. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health and CNES.

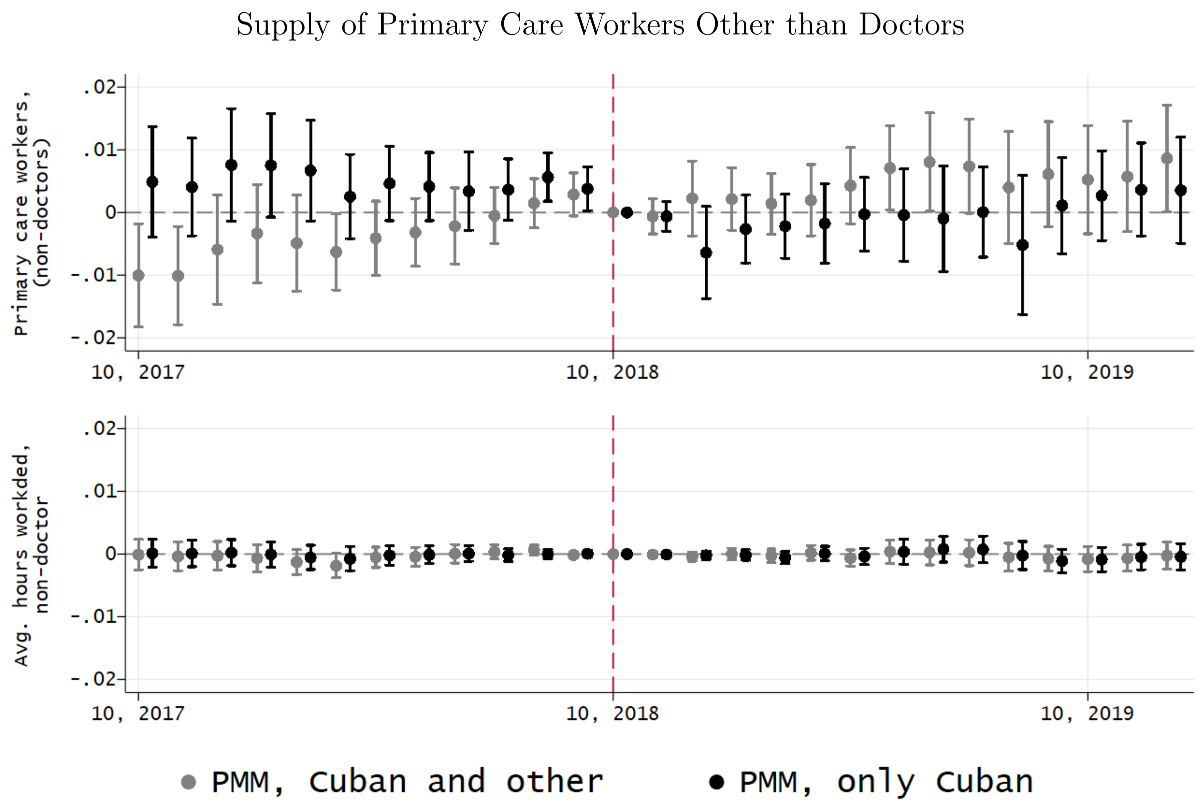

Figure D.2: The graph shows event studies for the the number and average hours worked of non-doctors (nurses and community health workers) following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health and CNES.

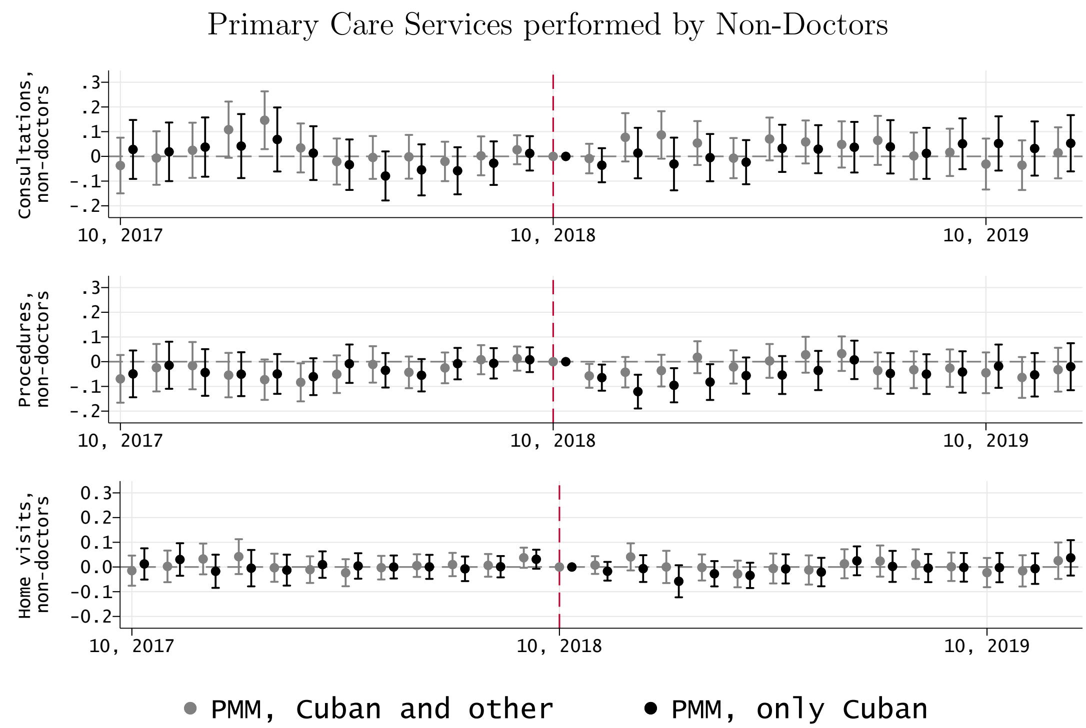

Figure D.3: The graph shows event studies for the number of consultations (upper panel), procedures (middle panel) and home visits (lower panel) performed in primary health care facilities by non-doctors, following equation 1 Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

D.2 Health Service Delivery

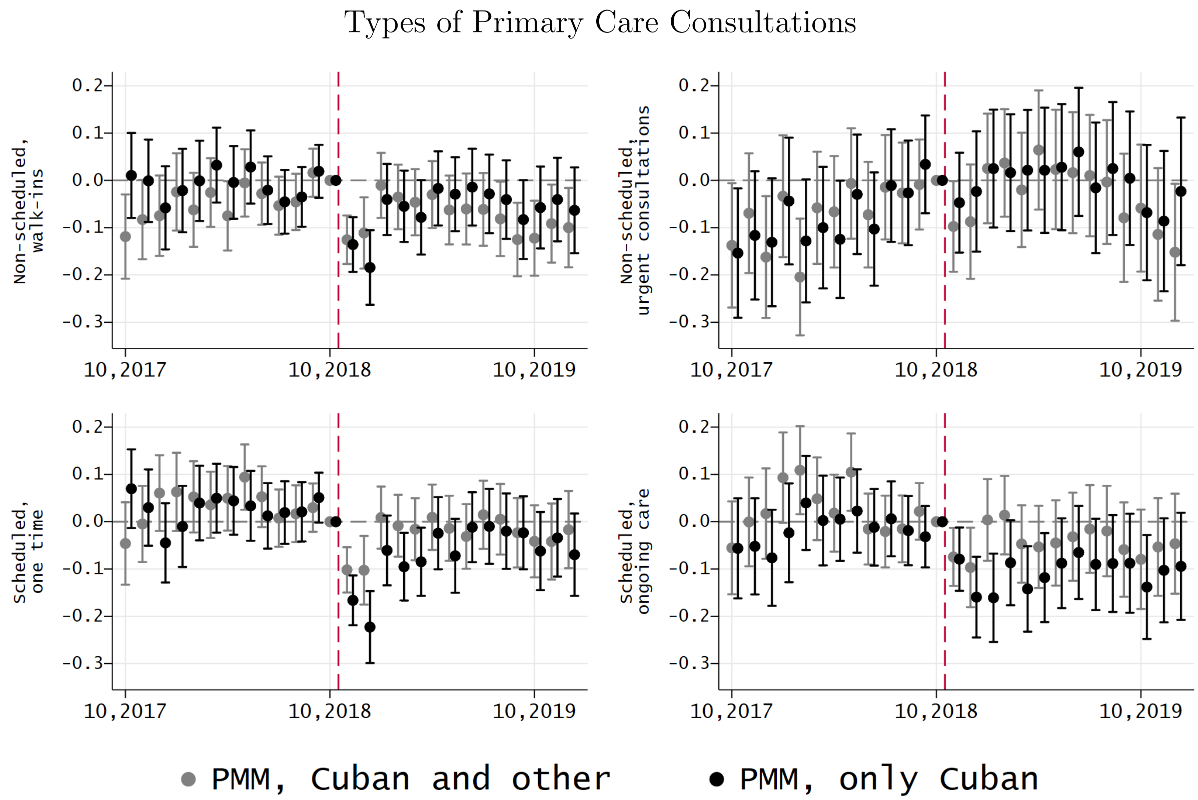

Figure D.4: The graph shows event studies for the number of consultations performed in primary health care facilities by the type of consultation, following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB and the Ministry of Health.

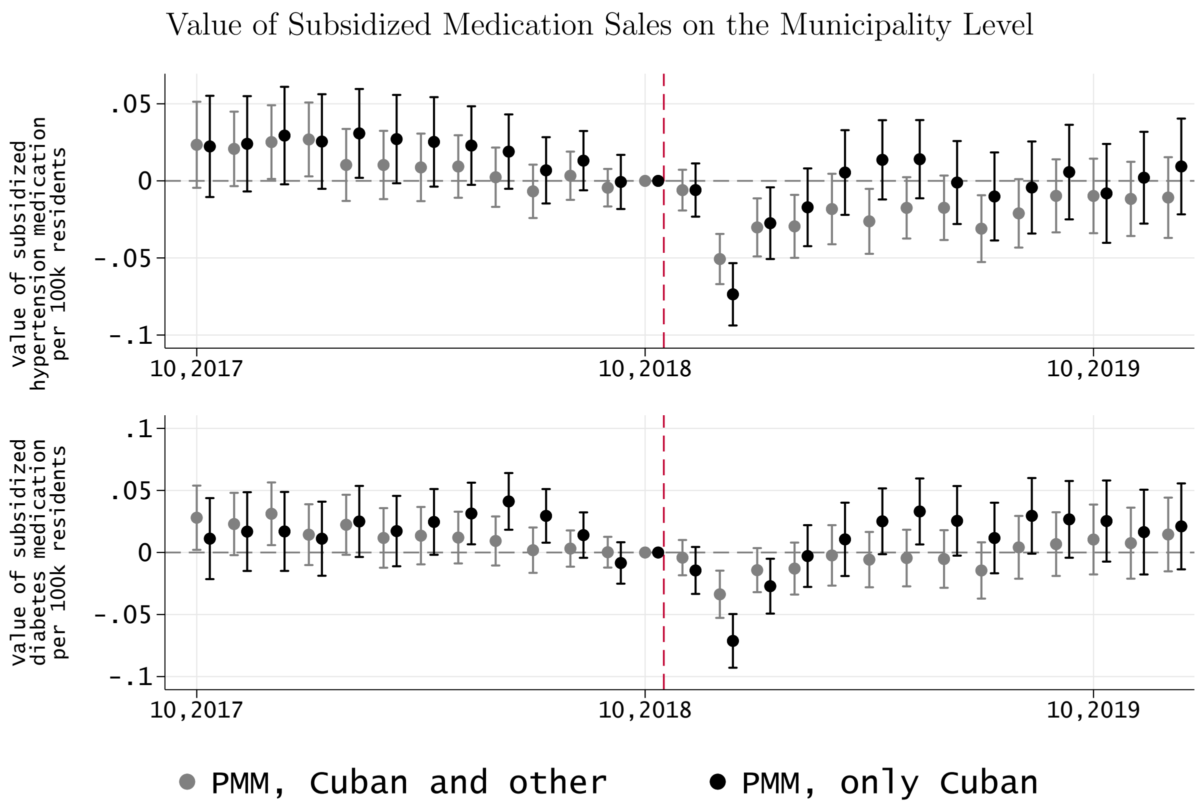

Figure D.5: The graph shows event studies for the value of prescription drugs for hypertension (upper panel) and diabetes (lower panel), distributed through *Aqui Tem Farmácia Popular*, following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the Ministry of Health.

D.3 What Changed Beyond Primary Care Centers?

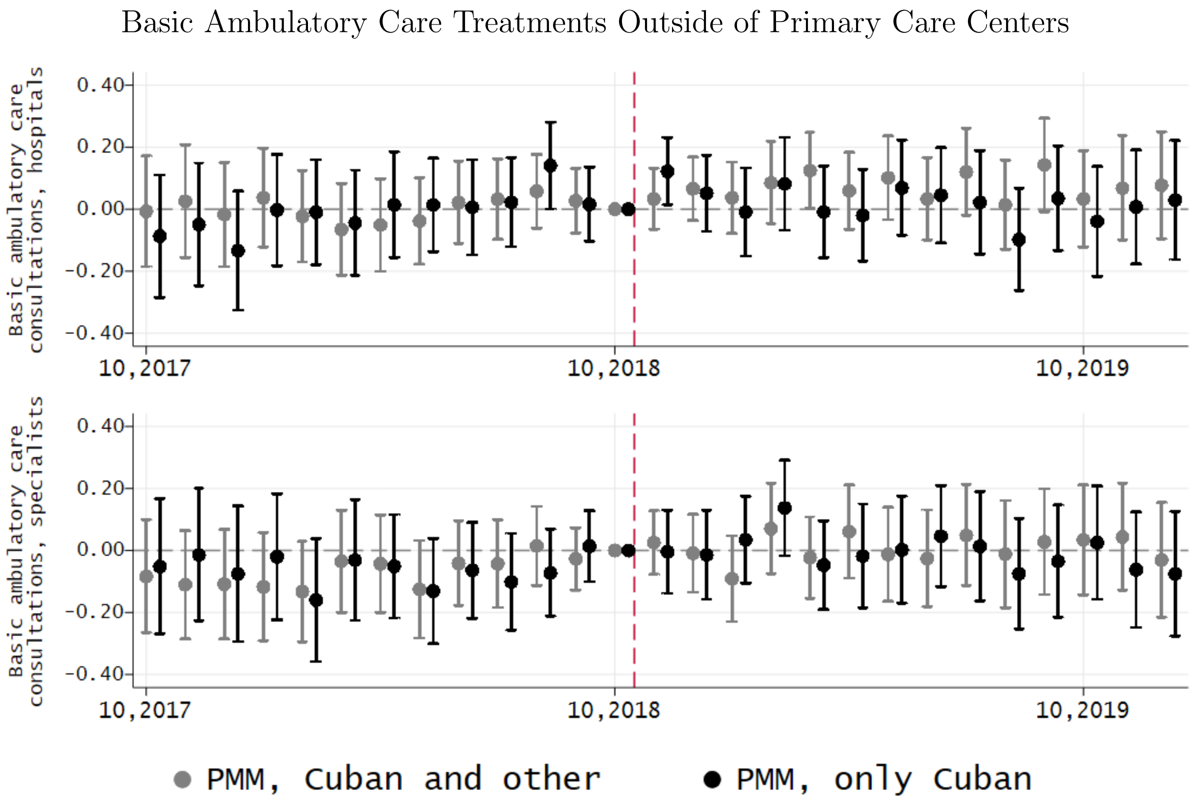

Figure D.6: The graph shows event studies for the number of basic ambulatory treatment at hospitals (upper panel) and specialists (bottom panel), following equation 1. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. The series in grey presents treatment group 1, the series in black presents treatment group 2. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from the SIA/Datasus and the Ministry of Health.

Privately Insured Individuals

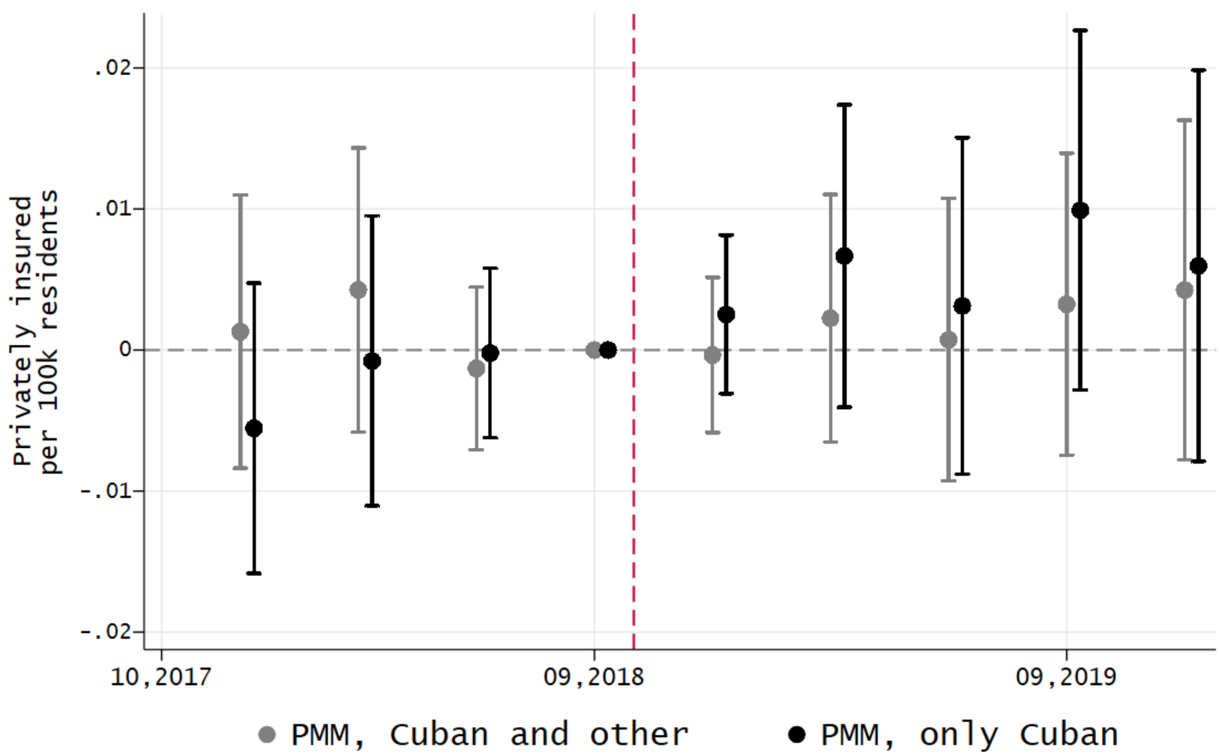

Figure D.7: The graph shows event studies for the number of privately insured people, following equation 1. The data is available every three months. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present September 2018, the last month with data availability before the treatment. Original data from ANS and the Ministry of Health.

Effect of Neighbors' Treatment on Primary Care Consultations on the Municipality Level

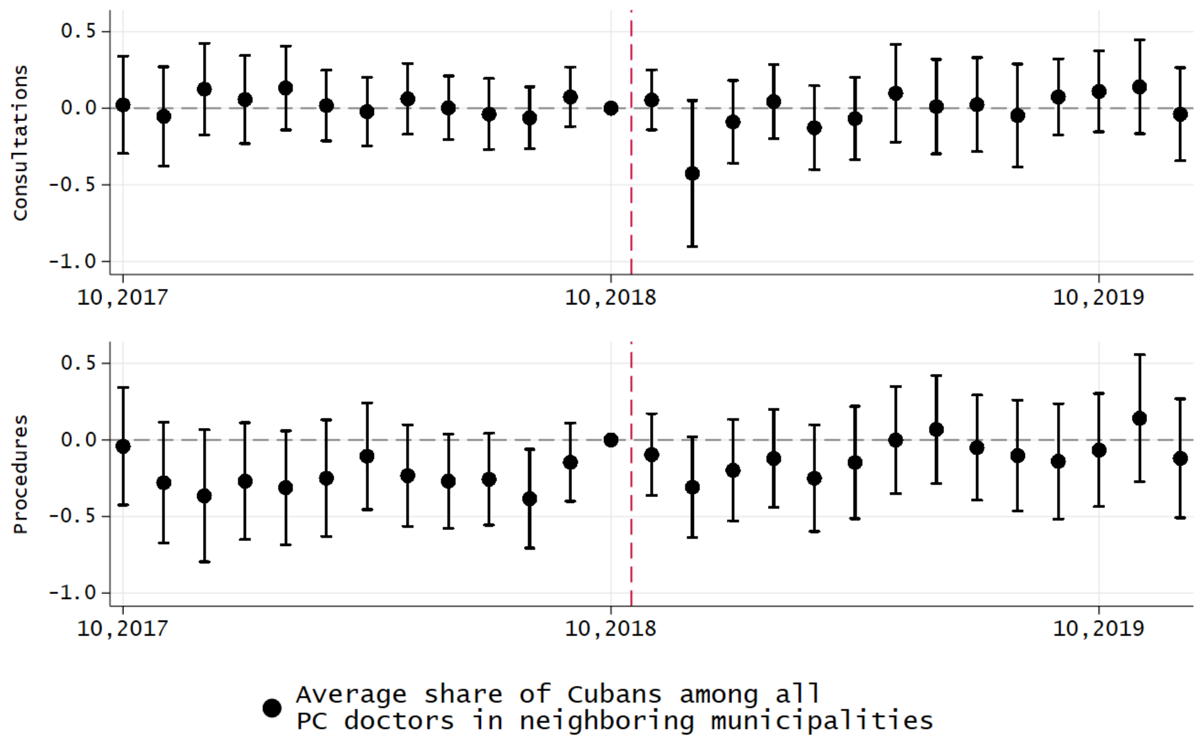

Figure D.8: The graph shows event studies for the effect of municipality i's neighbors' average share of Cuban PMM doctors among all primary care doctors in October 2018 on municipality i's primary care consultations (upper panel) and procedures (lower panel). Neighbors' average treatment status is calculated using a row-standardized continguity matrix. Outcomes per 100,000 inhabitants and transformed using the inverse hyperbolic sine. Regressions include municipality, month and state times month fixed effects and control for municipality i's own treatment. Whiskers around the point estimates present 95 percent confidence intervals, where standard errors are clustered at the municipality level. The dashed vertical lines present the pre-treatment month October 2018. Original data from SISAB, municipality shape files from IBGE.