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Prescription Drug Cost-Sharing and Health Outcomes: Evidence from a National Copayment System in Brazil

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Abstract

This paper evaluates the health effects of a large-scale cost-sharing system of prescription drugs introduced in Brazil, the *Aqui Tem Farmácia Popular* program (ATFP), which shifted the cost-burden of selected essential medicines from patients to the federal government. We exploit features of the program to identify its effects on hospitalization and mortality rates by circulatory conditions and diabetes for individuals aged 40 years or more. We find that ATFP is significantly associated with a reduction in mortality for the most acute circulatory conditions, such as ischemia and cerebrovascular diseases; and with a reduction in hospitalization rates for the most chronic conditions, such as hypertension and diabetes. Both ATFP utilization and its health effects are more relevant among patients with relatively lower socioeconomic status, which is consistent with lower-SES individuals being more responsive to cost-sharing because of liquidity constraints. The estimated benefit accrued from averted deaths and hospital admissions represents 16 times the total amount of federal reimbursements over the period of analysis.

Key Words: cost-sharing, prescription drugs, hospital admissions, mortality.
JEL Codes: I10; I13; I18; H51.

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1 Introduction

Most leading causes of disability and premature death can be prevented or treated with adequate use of medicines. In the particular case of aging societies, the development of new medicines to manage chronic illness has made access to prescription drugs a cornerstone of an efficient health care system (Goldman et al., 2007). Medicines, however, are costly and comprise a rapidly rising share of health costs for health systems and individuals. Globally, health spending on medicines has reached 25% (Wirtz et al., 2016). In OECD countries, spending on medicines increased by more than 75% between 2000 and 2014 (OECD, 2015). In the US, it has doubled over the same period, while spending on prescription drugs alone has increased threefold – recently outpacing the spending growth rates of all other health services (CMS, 2015).

Increased financial pressures on health systems, at the same time, have made countries adopt a variety of approaches to contain pharmaceutical costs. One of the most widespread and contentious strategy has been the introduction of patient cost-sharing in prescription drugs, which is intended to increase patient costs, to induce more price sensitivity, and to potentially reduce moral hazard and system costs.[1] However, while greater cost-sharing could help reduce the scope for moral hazard, it is also possible that patients could reduce necessary medications because of out-of-pocket costs. This is of particular concern for low-income patients, who may be more responsive to cost-sharing as they face liquidity constraints and may be relatively less able to evaluate the marginal benefit of pharmacy use (Chandra et al., 2014). If this is the case, higher prescription drug cost-sharing may lead to worse health outcomes and to offsetting effects through increased use of downstream health services, disability and mortality. The optimal design of health systems therefore depends not only on whether strategies to contain direct costs are effective in achieving this goal, but also on their ultimate consequences on health outcomes and equity. Notwithstanding its relevance, however, evidence on the effects of cost-sharing on health outcomes is still scant and inconclusive (Baicker and Goldman, 2011; Goldman et al., 2007).

In this paper we evaluate the health effects of a novel and large-scale cost-sharing system of prescription drugs introduced in Brazil. In order to improve access to essential medicines, in 2006 the federal government launched the *Aqui Tem Farmácia Popular* program (ATFP), a copayment system in partnership with private retail pharmacies.[2] In the ATFP system,

[1] In the last decade many high-income countries have increased cost-sharing in health services in general, with the most substantial increases observed in the particular case of prescription drugs – as observed in the UK, Germany, Japan, France, and the US (Zare and Anderson, 2013).

[2] *Aqui Tem Farmácia Popular* in Portuguese stands for "Here There is Popular Pharmacy".

the government establishes a reference price for the generic version of each listed medicine. Patients pay for the difference between the retail price and 90% of the reference price – generally resulting in substantially lower prices for the patient at the pharmacy counter. The government reimburses pharmacies for 90% of the reference price. In the ATFP system, variation in cost-sharing therefore comes from a shift in the cost-burden from patients to the federal government. The program has expanded fast. By 2015 it had reached approximately half the total number of private retail pharmacies in Brazil, and nearly 20 million users. About 95% of all reimbursements have been accounted for by anti-hypertensives and anti-diabetics, which suggests that ATFP users represent a substantial share of the total number of individuals diagnosed with hypertension (33 million) and diabetes (7.5 million) in Brazil. Indeed, according to a recent nationwide survey, 34% of the individuals older than 40 who had recently taken medications for hypertension, had obtained at least some of them through the program. The analogous share for anti-diabetic users was 56% (PNS, 2013).

More specifically, this paper evaluates the effects of ATFP on hospitalization and mortality rates by circulatory conditions and diabetes for individuals aged 40 years or more. In order to assess equity and efficiency, we also examine whether ATFP utilization and its effects on health outcomes vary with socioeconomic status, and provide a cost-benefit analysis in terms of averted deaths and hospitalization costs.

Our empirical strategy is based on a municipality-by-year fixed effects model, and exploits two idiosyncratic features of the Brazilian context to associate variation in prescription drug cost-sharing, through the expansion of pharmacies accredited to ATFP across time and space, with variation in health outcomes. The first feature relates to the design of the Brazilian health system, in which both the public and the private sectors provide health services. The National Health Service (SUS) is committed to provide free, universal, integral, and equal health coverage; while the private sector provides services either funded by out-of-pocket spending or regulated private insurance. Further, access to medicines within the public sector is largely constrained by rationing of pharmaceutical services, while private health insurance rarely covers prescription drugs. For most Brazilians, prescription drugs have been thus obtained through out-of-pocket payments at private pharmacies. In this situation, the ATFP rollout corresponds to a variation in prescription-drug cost-sharing, net of simultaneous changes in access to other health services as well as in other cost-sharing mechanisms aimed at controlling pharmacy use.

Second, we draw on institutional constraints required for pharmacy accreditation in the system to gain exogenous variation in the sequential process of expansion of ATFP phar-

macies across municipalities. Although any private pharmacy is eligible to the program, in practice many fail to meet the official requirements needed even for their operation in the retail market. In particular, many pharmacies are unable to hire and retain a pharmacist on their payroll. While the lack of pharmacists has not represented a *de facto* constraint to pharmacies' operation, accreditation in ATFP strictly requires the pharmacy to continuously prove compliance with this requirement. A limited supply of pharmacists in the local labor market at the time of program introduction is then expected to constrain its expansion throughout the following years. We explore this feature in a IV approach, in which the instrumental variable is defined by the interaction between the supply of pharmacists across municipalities in the baseline year and a linear time trend. Thus, conditional on municipality and time fixed-effects, we expect the process of ATFP diffusion to be relatively slower in localities where the baseline supply of pharmacists was more limited. A series of falsification tests supports the validity of this identification strategy.

We use unique administrative records to build a yearly panel of municipality-level data for the 2000-2012 period. The Brazilian Ministry of Health (Datasus) provides individual-level data on the universe of all deaths in Brazil, and all hospital admissions through the public health system (SUS). These data include main diagnosis, patients' municipality of residence and demographic characteristics, which are used to construct age- and cause-specific mortality and hospitalization rates. In the specific case of hospital admissions, we observe procedures' costs and patients' zip code of residence, which enables us to perform a cost-benefit analysis and further examine heterogeneity by socioeconomic status. The Brazilian Ministry of Health also provides data on the number of retail pharmacies accredited to the program in each municipality and year. In order to examine local labor market dynamics, we complement our data with information on the total number of private retail pharmacies as well as on the number and wages of pharmacists and other pharmacy workers from the *Registro Anual de Informacões Sociais* (RAIS), an administrative microdata set from the Ministry of Labor that contains the universe of formal workers and firms in Brazil.

Our empirical specification yields intent-to-treat estimates at the municipality level of the effects of ATFP on mortality and hospitalization rates. We find that ATFP is significantly associated with a reduction in mortality for the most acute circulatory conditions, such as ischemia and cerebrovascular diseases; and with a reduction in hospitalization rates for the most chronic conditions, such as hypertension and diabetes. Counterfactual simulations indicate that ATFP helped avert approximately 132 thousand deaths by circulatory conditions, which represent 3.9% of the respective number of deaths had ATFP been not implemented. Averted hospitalization costs for hypertension alone account for about 23%

of the counterfactual costs, while the analogous estimate for diabetes is 14%. We also document that both ATFP utilization as well as its effects on health outcomes are more relevant among patients with relatively lower socioeconomic status. This is consistent with low-income patients being more responsive to cost-sharing because of liquidity constraints. If taken together, the estimated benefit accrued from averted deaths and hospital admissions represents 16 times the total amount of reimbursements to accredited pharmacies over the period of analysis.

The existing literature has largely focused on the effects of cost-sharing on health spending and price sensitivity of medical services, while evidence on its effects on health outcomes has been sparse and mixed. Further, evidence has been overwhelmingly raised from US studies, which often explore specific contexts of multiple-payer managed care, and where variation in prescription drug cost-sharing is often bundled with variation in cost-sharing in other health services. For instance, Chandra et al. (2010) find that, among the elderly Medicare population in California, an increase in patient cost-sharing in both physician visits and prescription drugs decreased service utilization, but led to substantial offsetting effects in terms of increased hospitalization. On the other hand, the same authors find that, among low-income enrollees in the Massachusetts' Commonwealth Care program, an increase in cost-sharing reduced services utilization, but did not have any offset effects (Chandra et al., 2014). We also observe mixed results in the few and specific contexts in which exogenous variation in either cost-sharing or health insurance coverage applied solely to prescription drugs. For instance, Gaynor et al. (2007) find that an increase in prescription drug cost-sharing, among the non-elderly enrolled in employer-provided health insurance, reduced pharmacy use, increased outpatient care spending, but did not affect hospitalization. Kaestner et al. (2014) find that obtaining prescription drug insurance through Medicare Part D was associated with a reduction in hospitalization, but not with a decline in mortality rates. Huh and Reif (2017), on the other hand, employ a slightly different empirical strategy and find that the Medicare Part D rollout was significantly associated with a decline in mortality rates among the eligible elderly. Puig-Junoy et al. (2016) find that an exemption from pharmaceutical copayment granted to retired individuals in Spain increased the consumption of prescription drugs, but had any offset effects in terms of reduced hospitalization.

Overall, notwithstanding the efforts from previous studies, the understanding of the extent to which patient cost-sharing affects health outcomes remains unsettled. This may reflect the fact that the existing evidence comes from context-specific settings, within developed countries, where variation in cost sharing often applies to multiple health services at once, and where health care coverage is nearly universal. Indeed, the consequences of

cost-sharing should depend on whether individuals are able to respond to prices so as to minimize adverse health outcomes. If this is the case, we should expect little variation, possibly coupled with mixed results, in health outcomes in contexts where liquidity constraints are relatively less binding and where individuals are often covered by, and could respond differently to distinct insurance schemes. Consistent with that, for instance, Kaestner and Khan (2012) show that prior to Medicare Part D, the elderly without prescription drug insurance filled nearly as many prescriptions per year as elderly with prescription drug insurance.

This paper advances the existing literature by providing new evidence from a nationwide intervention within a unique empirical setting, in which variation in prescription drug cost-sharing comes net of simultaneous changes in access to other health services as well as in other cost-sharing mechanisms, where access to pharmaceuticals are mostly made through out-of-pocket expenses, and where liquidity constraints are relatively binding for most individuals. Differently to prior studies, we thus provide estimates of cost-sharing effects in a context where individuals are more vulnerable and substantially less insured on pharmaceutical services. In that sense, our results are particularly informative to many countries across the globe that are developing or revising health financing policies in an effort to improve health system performance, enhance access to essential medicines, and progress towards universal health coverage.

The remainder of this paper is organized as follows. Section 2 describes the institutional setting. Section 3 describes the data, while section 4 describes our empirical strategy. Section 5 presents the results and robustness checks. In Section 6 we assess equity by examining whether ATFP utilization and its effects on health outcomes vary with socioeconomic status. In section 7 we present a cost-benefit analysis of the program, and further discuss the implications of our results. Section 8 concludes.

2 Institutional Context

2.1 Access to Health Care and Medicines in Brazil

The Brazilian Unified Health System (SUS) is constitutionally committed to provide universal, integral, and equal health coverage, including free-of-charge access to medicines. In particular, medicines listed in the National List of Essential Drugs (RENAME) should be

continuously available at public health facilities.[3,4] In reality, however, access to medicines within SUS is constrained by rationing of pharmaceutical services, as availability in stock is often limited and intermittent (Santos and Nitrini, 2004; Naves and Silver, 2005; Brasil, 2005a).[5] According to a nationwide survey carried out in the early 2000s, only 22% of those households who had recently needed medicines obtained them free-of-charge from public sources. This figure was no higher than 38% among the poorest ones. The vast majority had to resort to the private retail market of pharmacies (Brasil, 2005a).

Given the limited access within SUS, and the fact that private health insurance rarely covers prescription drugs, for most Brazilians medicines have been thus obtained through out-of-pocket payments at private pharmacies. This represents a heavy financial burden for the poor and for the chronically-ill who make continuous use of medications. Out-of-pocket spending with medicines have accounted for about 80% of total spending on health among the poorest households (Menezes et al., 2007), while the elderly have spent, on average, nearly 50% of the minimum wage with monthly medications (Lima et al., 2007). The monthly costs with medications to treat hypertension and diabetes, if purchased in private pharmacies, could reach about 3 and 4 days of work, respectively, in terms of the minimum wage (Pinto et al., 2010; Brasil, 2005a). This means that many essential medicines have been unaffordable and hardly accessible for a substantial part of the population, potentially resulting in either non-adherence or intermittent use of medications for chronic conditions (WHO, 2012).

The federal government has acknowledged that SUS has been unable to grant continuous access to essential medicines, in particular for the urban poor and for the lower-middle classes – populations that usually lack the financial resources to purchase medicines and are barely covered by public primary healthcare programs (Brasil, 2005b). In order to overcome these limitations, in 2004 the federal government launched the *Farmácia Popular* program. In its initial phase, called *Programa Farmácia Popular do Brasil* (FPB, Brazilian Popular Pharmacy Programme), the government created a small number of state-owned retail pharmacies to dispense selected medicines at low fixed prices. FBP was targeted at large urban

[3]RENAME is an extensive list of medicines officially defined as essential, which includes, among many others, medicines for hypertension and diabetes.

[4]Public health facilities are widespread across the country. A recent nationwide survey revealed that in Brazil about 63% of households are located within 1km from a public primary health care unit. This figure is just about 10 percentage points lower than the share of households located within 1km from any private pharmacy (Brasil, 2005a).

[5]Public health studies from different contexts indicate that about 40-50% of the medicines prescribed in public primary health care facilities have not been available in stock (Naves and Silver, 2005; Santos and Nitrini, 2004). Also, even when readily available, supplies might soon run out-of-stock (Brasil, 2005a). Naves and Silver (2005), for instance, observed that interruption of hypertension or diabetes medicine supplies was frequent in public health facilities of Brasília, the federal capital of Brazil.

centers. The ratio of FPB pharmacies per capita, however, remained rather limited, and the program has never reached a relevant scale. In 2006, the program entered into its second phase, called *Aqui Tem Farmácia Popular* (ATFP, Here There is Popular Pharmacy), when it was rapidly expanded through a co-payment system in partnership with private retail pharmacies.

2.2 Aqui Tem Farmácia Popular

In the ATFP, participating private pharmacies dispense selected medicines through a co-payment system. The government establishes a reference price (RP) for the generic version of each medicine. When the pharmacy retail price is equal to or higher than the RP, the government reimburses the pharmacies 90% of the RP; when it is lower, the government reimburses 90% of the retail price. Patients pay for the difference between the retail price and 90% of the reference price.

Patients must hold a medical prescription and must sign for the purchase. Medicines can be dispensed only monthly and directly to the user. Pharmacies must keep a record of medical prescriptions and users' identification. The initial list of medicines covered by ATFP included anti-hypertensives, anti-diabetics and contraceptive pills. In 2010 it was expanded to include also medicines for asthma, dyslipidemia, rhinitis, glaucoma, Parkinson disease, osteoporosis, and influenza H1N1 (see Appendix Table B.1 for a list of medicines covered by ATFP). In 2011, anti-hypertensives and anti-diabetics listed in the program became fully subsided and available for free.

The number of participating pharmacies rapidly increased, from 2,955 in 2006 up to 34,625 in 2015, corresponding to about half the total number of private retail pharmacies in Brazil. The number of municipalities with at least one participating pharmacy increased from 594 in 2006 (about 11% of the total number of municipalities) to 4,445 in 2015 (80%). Figure 1 presents these trends.

In 2015, ATFP reached nearly 20 million users and cost R$3 billion (approx. US$1 billion; see Figure 2). The fact that most of the reimbursements have covered medicines for hypertension and diabetes (about 95%) suggests that ATFP users represent a substantial share of the total number of Brazilians diagnosed with hypertension (33 million) and diabetes (7.5 million).[6] Indeed, according to a recent nationwide survey (PNS, 2013), 34% of the individuals older than 40 who had recently taken medications for hypertension, had obtained at

[6]Source: DAF/SCTIE, Ministry of Health, accessed online on http://sage.saude.gov.br/.

least some of them through the program. The analogous share for anti-diabetic users was 56%.

According to WHO (2012), data from IMS Health Brazil on quantities indicate that retail sales of insulin derivatives not covered by ATFP have remained stable, while there has been a substantial increase in the sales of insulin derivatives listed in ATFP (WHO, 2012). This indicates that overall demand for ATFP-listed medicines has increased, likelly reflecting higher adherence to treatments for chronic conditions. Although each retailer is free to set its own sale price, and despite the increase in sales, the available evidence suggests that users of anti-hypertensive and anti-diabetic medications have paid about 90% less within ATFP in comparison to retail prices (Pinto et al., 2010).

2.3 Accreditation of Pharmacies to the ATFP Program

There are approximately 75,000 private retail pharmacies in Brazil. The retail market is mostly composed of independent pharmacies (90%), with the five main chains representing only a small fraction of the total number of pharmacies (2.8%) (Bertoldi et al., 2012). In principle, accreditation to the ATFP program requires the pharmacy to meet the same official requirements needed for the opening and operation of retail pharmacies in general. These requirements include the submission of (i) state-issued documents attesting compliance with sanitary conditions for operation, as well as with labor and fiscal regulations; and (ii) a document attesting the presence of a technically responsible pharmacist in place – or, more precisely, the pharmacist's Certificate of Technical Responsibility (CRT), issued by the Regional Pharmacy Council. The documentation must be submitted to Caixa Econômica Federal (CEF), the official public bank responsible for the accreditation and the reimbursement systems. Accreditation must be renewed every year based on the submission of updated documentation.

Although any private pharmacy is eligible to the program, in practice many fail to meet the official requirements needed even for their operation in the retail market. In particular, many pharmacies are unable to hold a technically responsible pharmacist in place. According to Law 5,991 of December 1973, retail pharmacies must have a certified pharmacist always available in place to provide assistance to patients. Since pharmacists are required to complete a bachelor's degree to gain their CRT, in many places the supply of pharmacists is limited while their salaries are relatively high. Although penalties should apply in case of non-compliance, both local auditing capacity and enforcement are rather limited. Further,

pharmacy owners can also exploit gray areas of the legislation to overcome sanctions.[7] In consequence, pharmacies are often staffed with non-certified pharmacy technicians, or just pharmacy clerks. According to a recent census of the pharmacy sector, nearly a third of the private retail pharmacies had not a technically responsible pharmacist available in place at the time of the survey, while many failed to have any pharmacist, at anytime (ICTQ, 2014). Thus, the lack of certified pharmacists has not represented a *de facto* constraint to pharmacies' operation in the retail market.

Accreditation in the ATFP program, on the other hand, strictly requires the pharmacy to identify the responsible pharmacist on the submission form, and to submit her CRT jointly with her employment contract. Because ATFP is a federal program, it is subject to tighter enforcement as audits can be directly carried out by federal agencies. Also importantly, in case of any wrongs regarding the accreditation process or the pharmacy participation in the program, the pharmacists are legally liable and could be also subject to penalties. Thus, although any private pharmacy is eligible to ATFP, the actual expansion of the number of participating pharmacies in a given locality should vary with the availability of pharmacists in that locality. We further discuss sources of variation in pharmacy participation in ATFP on Section 4, which presents our empirical strategy.

3 Data

3.1 ATFP and Health Outcomes

Our analysis is based on a yearly panel of data at the municipality level for the 2000-2012 period. Data related to the implementation of the ATFP are obtained from the Brazilian Ministry of Health (Department of Basic Attention, MS/DAB), and provide the number of retail pharmacies accredited to the program in each municipality and year. We complement this information with municipality data on the total number of private retail pharmacies as well as on the number and wages of pharmacists, pharmacy clerks and other pharmacy workers from the *Registro Anual de Informacões Sociais* (RAIS), an administrative microdata set from the Ministry of Labor that contains the universe of formal workers and firms in

[7] According to Article 5 of Law 5,991/1973, if the pharmacy owner proves not to be able to hire a pharmacist – e.g., because of a shortage of pharmacists in the locality – then she may be authorized to register another employee as a substitute. However, this substitute should also be certified by the Regional Pharmacy Council, which usually resists to grant certification for non-pharmacists. In fact, there are as few as about 200 cases of non-pharmacists whom were granted certification after legal action (information from G1, accessed online on http://g1.globo.com/, October 10, 2013).

Brazil.

Data on mortality and hospital admissions are available from the Brazilian Ministry of Health (MS/Datasus). We obtain mortality microdata from the Brazilian National System of Mortality Records (Datasus/SIM). SIM gathers information on every death officially registered in Brazil, and contains information on the descendent's age, gender, and municipality of residence, as well as the diagnostic codes, which are identified according to the International Classification of Diseases, 10th Revision (ICD-10). We obtain hospitalization microdata from the National System of Information on Hospitalizations (Datasus/SIH), which contains administrative information at the hospital admission level. The data are managed by the Health Care Agency (SAS/Ministry of Health) with support of local and regional public health agencies, which receive information about hospitalizations from public and private hospitals through standardized inpatient forms. The dataset includes all hospital admissions funded by SUS. It provides information on cause of hospitalization (ICD-10), duration of stay, final outcome (discharge or death), socioeconomic characteristics of the patient (municipality and zipcode of residence, gender, and age) and costs in BRL.

We select all deaths and hospital admissions of individuals aged 40 or older. These microdata are collapsed into an yearly panel of data at the municipality of residence level. Annual data on municipality population by age are obtained from MS/Datasus. These data allow us to convert number of deaths and hospital admissions into mortality and hospitalization rates, respectively. Cause-specific mortality and hospitalization rates at the municipality-by-year level are then merged with ATFP and RAIS variables.

3.2 Auxiliary Data

We make use of two other pieces of municipality data that are auxiliary to our analysis. First, we obtain from Ipeadata the annual GDP and the area size in km^2 of each municipality. These data enable us to construct, respectively, the municipality GDP per capita and the municipality population density. Second, we collect indicators of healthcare provision. Information on hospital infrastructure (number of hospitals and hospital beds per 100,000 individuals) is obtained from the Ministry of Health. We also collect data from the Ministry of Health on the coverage of the *Programa Saúde da Família* (PSF) and of the *Programa Agentes Comunitários da Saúde* (PACS), the most relevant public primary healthcare programs in Brazil. In particular, PSF is now widespread in the country. It was designed to focus on prevention and provision of basic health care, to handle coordination of public

health campaigns and actions, and to function as the first point of contact between citizens and public health provision.

3.3 Descriptive Statistics

Our final panel of data contains 5,507 municipalities over the 13 years throughout the 2000-2012 period. Table 1 presents some descriptive statistics for municipalities over the years of 2000-2005, the baseline period prior to ATFP introduction. Panel A and B present, respectively, mortality and hospitalization rates for individuals aged 40 or older (per 100,000). In this paper we focus on circulatory diseases and diabetes, medicines to which are associated with 95% of all federal reimbursements. Circulatory diseases include all conditions identified by I00-I99 ICD-10 codes, while diabetes is defined within E-10-E14 codes. We also split circulatory conditions into hypertension (I10-I15), ischemia (I20-I25), cerebrovascular diseases (I60-I69) and other CVDs (the remaining conditions within I00-I99). Together, ischemia and cerebrovascular conditions account for about 60% of the total number of deaths, but only 28% of the total number of hospital admissions by circulatory conditions. Hypertension and diabetes hospitalization rates, on the other hand, are relatively much higher in comparison to their respective mortality rates.

We also construct mortality and hospitalization rates by infectious diseases (A00-B99) and external causes (S00-T98, V01-Y98), which are analysed in falsification tests. Finally, Panel C presents descriptive statistics for municipality economic conditions and healthcare provision, used as control variables in our empirical analysis.

4 Empirical Model

4.1 Empirical Strategy

Our goal is to analyze the extent to which the implementation of the ATFP co-payment system is associated with changes in health outcomes. In order to do so, we explore variation in the the sequential process of expansion of ATFP pharmacies across municipalities. More specifically, the following equation provides our conceptual setup:

$$H_{it} = \alpha_i + \phi_t + \beta_1 ATFP_{it} + \beta_2 Pharmacies_{it} + Controls'_{it}\beta_3 + \epsilon_{it} \quad (1)$$

Where H_{it} is a health outcome in municipality i and year t. Our main variable of interest is $ATFP_{it}$, the number of private retail pharmacies accredited to ATFP per 100,000 inhabitants. The term $Pharmacies_{it}$ indicates the total number of private retail pharmacies per 100,000 inhabitants, and should absorb the confounding effects of the number of private retail pharmacies in general. The term α_i represents municipality fixed effects, which absorb initial conditions and persistent municipality characteristics, such as climate and the epidemiological context. The term ϕ_t represents year fixed effects to control for common time trends, such as macroeconomic conditions, the political cycle and common healthcare policies. The term $Controls_{it}$ includes a series of controls for the influence of other determinants of health and healthcare. First, it includes demand-side determinants of health such as municipality economic conditions (the logarithm of the GDP per capita and of the population density, defined by the number of inhabitants per km^2) and the age composition of the municipality population (the share of inhabitants within each 5-year age bracket, from 5-9 up to 80 years or older). Further, it also includes controls for the provision of healthcare, such as the number of hospitals and hospital beds per 100,000 inhabitants, and the population coverage of PSF and PACS.

Our parameter of interest is β_1. Should the number of ATFP pharmacies per capita be random, β_1 would report the effects on health of an additional pharmacy accredited to the ATFP co-payment system. However, pharmacy selection into ATFP is expected to be endogenous and should correlate with several latent determinants of health. Although we consider a series of controls in equation (1), β_1 can be biased by the influence of non-observable confounding trends. In particular, we do not directly observe trends in health status nor in the demand for healthcare. If pharmacy selection into ATFP responds to a non-observable deterioration in population health, for instance, we should expect attenuation bias in our estimates because of reverse causality.

We thus complement the analysis with a IV strategy that exploits our empirical setting to generate exogenous variation in ATFP diffusion. We draw on the fact that the program expansion has relied on the availability of pharmacists in the local labor market. As mentioned in Section 2.2, while the limited supply of pharmacists has not represented a *de facto* constraint to pharmacies' operation, accreditation in ATFP strictly requires the pharmacy to submit a pharmacist's CRT jointly with her employment contract. The limited supply of pharmacists in the locality at the time of the program introduction is then expected to constrain its expansion throughout the following years. We explore this feature in the following first-stage equation:

$$ATFP_{it} = \alpha_i' + \phi_t' + \gamma_1 Pharmacists_{i,06} * T_t + \gamma_2 Pharmacies_{it} + Controls_{it}'\gamma_3 + v_{it} \qquad (2)$$

where $Pharmacists_{i,06}$ indicates the number of pharmacists per 1,000 inhabitants in municipality i and year 2006, when ATFP is launched. We interact this baseline supply of pharmacists in the local labor market with a function T_t that assumes $T_t = 0$ if $t < 2006$ and $T_t = (t - 2005)$ if $t \geq 2006$. Conditional on the same set of fixed-effects and controls of equation (1), we expect the process of ATFP diffusion to be relatively slower in localities where the baseline supply of pharmacists is more restricted. In particular, municipality fixed-effects should absorb the confounding effects of the cross-sectional variation in the per capita number of pharmacists at the baseline, $Pharmacists_{i,06}$.

The exclusion restriction is valid if, conditional on fixed-effects and control variables, the instrumental variable ($Pharmacists_{i,06} * T_t$) is uncorrelated with any other latent determinant of population health. Although not directly testable, we put this assumption under strain by performing a series of falsification exercises. We present first-stage results and further discuss the validity of our IV approach in the next section.

4.2 First-Stage Results

Table 2 presents first-stage results and falsification tests. All specifications follow equation (2). We weight all regressions by municipality population size and estimate standard errors clustered at the municipality level, to allow for serial correlation within municipalities. The first column of Table 2 reports our first-stage results. We observe a positive and robust coefficient for the interaction term $Pharmacists_{i,06} * T_t$, with a Partial-F of 197.8. This indicates that the availability of pharmacists in the locality at the time of the ATFP introduction is a strong predictor of its expansion over time.

In columns 2-4 of Table 2 we test whether ATFP responds to alternative predictors in falsification tests. In column 2 we follow equation (2), but replace the number of pharmacists by the number of pharmacy clerks and other pharmacy workers per 1,000 inhabitants as our variable of interest. We find a weak and non-robust correlation of pharmacy clerks and other pharmacy workers at the baseline with ATFP diffusion. This helps reassure that the results from column 1 reflect a specific institutional constraint to the program expansion, irrespective of a more general dynamics of employment in the local pharmacy retail market. More generally, however, the number of pharmacists at the baseline might be simply

reflecting the confounding influence of a high-profile local labor market and the presence of other college-degree workers in general. In columns 3 and 4 we examine whether ATFP responds to the number of lawyers and college-degree management workers per 1,000 inhabitants, as also recorded by RAIS data at the municipality level for 2006 – being law and business & administration the majors that enroll the largest shares of undergraduate students in Brazil (Censo da Educação Superior, 2015). We find again weak and statistically insignificant coefficients. Column 5 reports a specification that simultaneously includes all these variables. We still observe a robust coefficient for the term $Pharmacists_{i,06} * T_t$, with a large Partial-F. The coefficient for other pharmacy workers is negative and statistically significant, but rather small in magnitude (Partial-F of 3.99), while the remaining coefficients are again non-significant.

Figure 3 complements this analysis and further test whether the results from columns 1-5 are picking any idiosyncratic non-linearities instead of the actual influence of the baseline supply of pharmacists on ATFP diffusion. We follow again equation (2), but now estimate coefficients of interaction terms between $Pharmacists_{i,06}$ and year dummies for the entire period. Panel A plots the results. We observe an increasing influence of the number of pharmacists per capita in the baseline year on the expansion of ATFP pharmacies. Indeed, availability of pharmacists, which may be considered inelastic in the short-term, should become relatively tighter as the program expands. Panel B plots analogous results for other pharmacy workers. Although both baseline variables have similar descriptive statistics (see Appendix Table B.2), the influence of the number of other pharmacy workers on ATFP expansion is limited and converges to zero. We observe a similar pattern for the cases of lawyers and college-degree management personnel (results available upon request).

Appendix Table B.3 provides additional results. We examine how pharmacists' wages respond to the availability of pharmacists in the locality at the time of ATFP introduction. In column 1 we follow equation (2), but replace the diffusion of ATFP pharmacies as dependent variable by the logarithm of the yearly average wage of pharmacists in the locality. We observe that wages increase relatively less in places with a larger supply of pharmacists at the baseline. On the remaining columns we find no statistically significant association for the cases of pharmacy workers, lawyers and college-degree management personnel. These results, which are consistent with the observed patterns from Table 2 and Figure 3, help reassure the view that the ATFP diffusion was restricted by a specific institutional constraint, irrespective of any more general dynamics of the local labor market.

5 Main Results

In this section we analyze the extent to which the ATFP co-payment system has impacted health outcomes by estimating its reduced-form effects on mortality and hospitalization rates. We complement the analysis in Sections 6 and 7, in which we examine the program's heterogeneous effects by socioeconomic status and present a cost-benefit analysis, respectively.

5.1 ATFP Effects on Mortality

Tables 3 and 4 present ATFP effects on mortality and hospitalization rates, respectively. In both tables, the first column reports the results of OLS regressions based on equation (1) for different outcome variables, while the second column presents analogous results for our 2SLS specification. We weight all regressions by municipality population size and estimate standard errors clustered at the municipality level, to allow for serial correlation within municipalities.

The first row of Table 3 reports ATFP effects on mortality rates by circulatory diseases. We find negative and robust coefficients, ranging from -0.947 in the OLS specification to -4.492 in the 2SLS column. The following rows report ATFP effects on mortality rates by different conditions within circulatory diseases. We observe the largest effects for ischemia and cerebrovascular diseases, the most acute conditions. Regarding hypertension, a chronic condition, the coefficient flips from positive in the OLS column to negative in the 2SLS specification, but remains statistically insignificant. The coefficient for other CVDs is negative in both columns, but becomes statistically insignificant in the 2SLS specification. Despite an increase in its point estimate, standard errors also increase and the coefficient becomes no longer significant. Diabetes is also a chronic condition and, similarly to the case of hypertension, its point estimate flips from positive in the OLS column to negative in the 2SLS specification. In this latter specification the coefficient becomes borderline significant at 10%, despite a fourfold increase in standard errors.

The bottom panel of Table 3 presents falsification tests. We report the effects of ATFP on mortality rates by infectious diseases and by external causes, both of which expected to correlate with socioeconomic trends in general, but not to respond to ATFP in particular. We observe insignificant coefficients for infectious diseases, while the robust positive coefficient for external causes in the OLS column becomes negative and insignificant in the 2SLS specification.

Overall, the comparison of OLS and 2SLS point estimates suggests attenuation bias across all OLS specifications. This is expected should pharmacy selection into ATFP respond to a non-observable deterioration in population health and to an increase in the demand for health care. If this is the case, OLS coefficients can be regarded as lower-bound effects of ATFP on mortality. The effects of an additional ATFP pharmacy per 100,000 inhabitants on the mortality rate by circulatory conditions thus range from a decrease of 0.947 deaths per 100,000 individuals in the OLS specification to a decrease of 4.492 deaths in the 2SLS column. The 2SLS point estimate represents 0.9% of the average baseline rate of 481 circulatory deaths per 100,000 individuals aged 40 years or more (see Table 1).

5.2 ATFP Effects on Hospital Admissions

Table 4 presents ATFP effects on hospitalization rates. We find similar patterns in comparison to the case of mortality rates, but relatively larger coefficients for the most chronic conditions. ATFP effects on hospital admissions by circulatory diseases now range from -6.551 in the OLS column to -26.886 in the 2SLS specification. The point estimates for the hospitalization rates for hypertension range from -1.878 in the OLS column to -12.423 in the 2SLS specification, which corresponds to 3% of its average baseline rate of 421. We also observe robust and large effects of ATFP on hospitalization rates by diabetes. The 2SLS point estimate indicates that an additional ATFP pharmacy per 100,000 inhabitants is associated with a decrease in the hospitalization rates by diabetes of 8.127, which corresponds to 3.6% of its baseline rate of 226. On the bottom panel, we observe statistically insignificant coefficients for hospital admissions by infectious diseases and external causes. Overall, we find negative, robust and non-trivial effects of ATFP on mortality rates for the most acute conditions, and on hospitalization rates for chronic conditions.

5.3 Robustness Checks

In this section we perform additional robustness tests. More specifically, we examine whether our estimated effects of ATFP on mortality and hospitalization rates hold when conditioned on the potentially confounding influence of municipality specific trends. In order to do so, we add to our 2SLS specification interaction terms between a linear time trend (which varies across years) and baseline municipality characteristics (which vary across municipalities, for the year 2000).

Table B.4 presents the results. The first four columns report the effects of ATFP on mortality

rates, while the remaining columns present the results for hospitalization rates. Columns 1 and 5 replicate the results from our 2SLS specifications of Tables 3 and 4, respectively. In the specification of columns 2 and 6 we add an interaction term between a linear time trend and the municipality share of individuals aged 40 years or older in the baseline year 2000. Analogously, in columns 3 and 7 the interaction term considers the number of hospital beds per capita, while in columns 4 and 8 we consider the PSF coverage.

The specifications of Table B.4, therefore, test for the potentially confounding influence of municipality specific trends from initial conditions of relevant demand-side and supply-side determinants of health. Overall, we observe that the results remain qualitatively unchanged in comparison to the benchmark, while the point estimates are stable across most specifications. Coefficients remain particularly stable for hospitalization rates. Regarding mortality rates, we observe that the point estimate drops in magnitude for the specific case of cerebrovascular diseases, when conditioned on the share of individuals aged 40 or older, but remains negative and statistically significant at 5%. Thus, Table B.4 shows generally stable coefficients despite reporting the results of rather demanding specifications.

6 Heterogeneity by SES

Patients are allowed access to medications within ATFP once they hold a medical prescription, irrespectively of their socioeconomic status, age or health condition. Given that anti-diabetic and anti-hypertensive drugs are now available free-of-charge at accredited pharmacies, ATFP mimics SUS in the sense that it has granted equal access to listed medications for all prescription holders. However, although the poor have in general resorted to SUS in order to access health services, while the rich have generally used the private system, there is no evidence on whether this pattern also holds within the particular case of ATFP. In practice, better-off individuals could benefit relatively more from ATFP have they had better access to accredited pharmacies as well as to information regarding their own health status, medication needs, and eligibility to the program. This would make ATFP a regressive co-payment system, potentially escalating the gap between the poor and the rich in terms of access to resources and health outcomes.[8] In this section we examine whether both ATFP utilization and its effects on health outcomes vary with socioeconomic status.

We start by exploring the microdata from the National Health Survey (*Pesquisa Nacional de*

[8]The Brazilian tax system is not far from neutral as it largely relies on indirect taxation (OECD, 2009). Thus, given that the ATFP's sources of financing are not particularly progressive, the program becomes relatively more regressive as the participation of the better-off in pharmaceutical spending increases.

Saúde, PNS), a nationwide survey carried out in 2013 by IBGE and the Brazilian Ministry of Health. The PNS contains household and individual socioeconomic information as well as a series of questions related to health conditions, lifestyle, access to (and utilization of) health and pharmaceutical services, and so forth. In particular, the PNS contains questions on ATFP utilization. By the year of the survey, the program had already completed most of its expansion, both across and within municipalities. As mentioned in Section 2.2, according to PNS data, 34% of the individuals older than 40 who had recently taken medications for hypertension, had obtained at least some of them through the program. The analogous share for anti-diabetic users was 56%.

We now use PNS data to test whether ATFP utilization varies with socioeconomic status. Table 5 reports two sets of OLS regressions based on the sub-sample of individuals aged 40 years old or more. All specifications include state fixed-effects.[9] In the first two columns we further restrict the sample to those individuals who had been recently prescribed any medication, and regress on socioeconomic variables an indicator of whether the individual obtained any of the prescribed drugs through ATFP. The specification in the first column includes demographic variables (dummies for gender, race, urban, and age in completed years) and dummies for levels of schooling. We observe that ATFP utilization monotonically decreases with education, being individuals with college degree 13.4 percentage points less likely to use ATFP than those with no schooling (the omitted category). In column 2 we observe that part of the negative association between schooling and ATFP utilization is absorbed by dummies indicating PSF and private insurance coverage. The overall pattern indicates that ATFP utilization correlates with lower socioeconomic status.

In the third column we restrict the sample to those who had recently taken anti-hypertensive drugs, and regress on the same set of variables included in column 2 an indicator of whether the individual had obtained any of those drugs through ATFP. Column 4 reports the analogous results for anti-diabetics. We observe again a negative correlation between ATFP utilization and socioeconomic status, in particular for those taking anti-diabetic medication.

Having shown that ATFP utilization by the chronically-ill is relatively higher among the poor, we next examine whether and how the program's effects on health outcomes vary by socioeconomic status. We focus on hospital admissions, for which we have the patients' zip codes of residence. We first use GIS to match zip codes to census tracts and their respective average income, obtained from the 2000 Census.[10] This enables us to associate each zip

[9] We do not observe municipality identifiers in the PNS data.

[10] The data at the census tract level are geocoded and publicly provided by IBGE. More specifically, our average income variable refers to the average income of the heads of the households located in the census

code with a dummy indicating whether it is located in a poor *vs* a non-poor census tract, i.e., respectively, below *vs* above the median average income. Next, we count the number of hospital admissions of patients aged 40 years old or more from zip codes located in poor census tracts by cause of hospitalization, municipality and year. We analogously repeat the counting for admissions of patients from non-poor zip codes. The final variables are then merged with our main panel of data at the municipality-by-year level.

We follow our benchmark 2SLS specification to estimate the ATFP effects on the logarithm of the number of hospital admissions of patients from poor *vs* non-poor zip codes.[11] Table 6 presents the results. The first column reports the ATFP effects on the number of hospital admissions of patients from poor zip codes, while column 2 shows the analogous estimates for non-poor ones. The comparison of the point estimates from columns 1 and 2 suggests that ATFP effects are larger for patients from lower socioeconomic status. This assertion is particularly robust for the case of diabetes, which is consistent with our findings on ATFP utilization from Table 5. Despite the fact that access to listed medications is equal for all prescription holders, irrespective of socioeconomic status, the overall evidence supports the view that, in practice, patients from relatively lower SES have benefited the most from ATFP.

7 Cost-Benefit Analysis

In 2015, ATFP cost almost R$3 billion (approx. US$1 billion), the largest amount of resources ever transferred to accredited pharmacies since the launch of the program. This represented about 3% of the annual budget of the Ministry of Health, and more than twice the costs of Rename, the national list of essential medicines which in theory should be continuously available at public health facilities. The fact that most of the reimbursements have covered medicines for hypertension and diabetes (about 95%), which are currently free-of-charge for patients, means that pharmacies are paid the program's reference prices, and are thus not able to mark-up retail prices. In this sense, ATFP transfers are supposed to be entirely channeled towards patients. In this section we first use counterfactual simulations to estimate ATFP effects in terms of the total number of averted deaths and hospitalization costs. The estimates are then used as input for a simple cost-benefit analysis.

tract. The year of 2000 is the first of our period of analysis.

[11] We are unable to build hospitalization rates by zip codes because we do not observe the respective population at risk at this level of geographical aggregation.

7.1 Averted Deaths

We depart from our baseline 2SLS specification, and focus on mortality by circulatory diseases. This specification delivers a predicted mortality rate $\widehat{M}_{it}$ for each municipality and year. Given the estimated parameters, we are able to recalculate each $\widehat{M}_{it}$ under the alternative condition $ATFP_{it} = 0, \forall(i,t)$. We then multiply these rates by the population at risk in each municipality and year (individuals aged 40 years old or more) to estimate the respective number of deaths. This calculation delivers the predicted number of deaths had ATFP been not implemented. Finally, we sum up deaths across all municipalities and all years to estimate the total number of deaths by circulatory diseases had ATFP been not implemented.

Column 1 of Table 7 shows the observed number of deaths by circulatory diseases for the 2000 through 2012 period. In column 2, we present the counterfactual trend for the hypothetical scenario described above. As seen in column 1, the number of observed deaths totaled 3,222,791. We estimate that, had ATFP been not implemented, this number would have equaled 3,355,186. This indicates that ATFP averted 132,396 deaths, which represent 3.9% of the total number of deaths predicted in the counterfactual scenario.

Average estimates of the statistical value of life in Brazil range from R$0.74 million to R$5.7 million (Corbi et al., 2006). To the best of our knowledge, however, there does not exist any age-adjusted estimates for the Brazilian case. For individuals aged 45 years old or more in the US, Aldy and Viscusi (2008) estimate a statistical value of life ranging from US$1.78 million to US$8.7 million. Some studies adjust these estimates, by a factor ranging from 0.6 to 1.25, in order to extrapolate the US estimates to other countries (Barham, 2011). If we consider the most conservative factor of 1.25, the statistical value of life for individuals aged 45 years old or more in Brazil would range from R$0.43 million to R$2.1 million. If we take again the most conservative bound, of R$0.43 million, we estimate that the benefit accrued from the total number of averted deaths represents R$56.3 billion.

7.2 Averted Hospitalization Costs

Hospitals determine procedures and services provided to SUS patients, and charge the Ministry of Health according to fixed official fees. SIH is the administrative hospitalization dataset that informs the costs in R$ for each hospital admission within SUS. We collapse admissions' costs by year and patients' municipality of residence in order to build an annual measure of hospitalization costs per capita – total and by cause of admission. We

focus on hospitalization costs for hypertension and diabetes, and follow exactly the same counterfactual exercise described above to estimate ATFP effects in terms of averted costs.

Column 1 of Table 8 shows the observed hospitalization costs for hypertension for the 2000 through 2012 period, while column 2 reports the counterfactual trend had ATFP been not implemented. The remainder two columns report the analogous results for diabetes. The simulations indicate that ATFP averted R$178 million and R$114 million on hospital admissions for hypertension and diabetes, respectively. In other words, the Ministry of Health would have transferred an additional R$293 million to hospitals had ATFP been not implemented.

It is important to mention, however, that official reimbursement fees within SUS are usually low, so the total amount of averted transfers in R$ can be considered undervalued for international standards. Indeed, the estimated averted hospitalization costs for hypertension (R$178 million) represents 23% of the costs had ATFP been not implemented. The analogous estimate for diabetes is 14%. The amount of averted costs is thus substantial in relative terms.

7.3 Cost-Benefit

Throughout the 2006-2012 period, the ATFP system transferred approximately R$3.6 billion to accredited pharmacies. The total benefit accrued from averted deaths for circulatory conditions represents R$56.3 billion, while averted hospitalization costs for hypertension and diabetes amount to nearly R$0.3 billion. If taken together, the estimated benefit accrued from averted deaths and hospital admissions sums up to R$57 billion, which represents 16 times the total amount of transfers to accredited pharmacies over the period of analysis.

8 Final Comments

This paper evaluates the health effects of a large-scale cost-sharing program of prescription drugs introduced in Brazil, the *Aqui Tem Farmácia Popular* program (ATFP), aimed at increasing access to essential medicines. In our empirical setting, variation in prescription drug cost-sharing comes net of simultaneous changes in access to other health services as well as in other cost-sharing mechanisms; also, access to pharmaceuticals are mostly made through out-of-pocket expenses, and liquidity constraints are relatively binding for most individuals. Differently to prior studies, we thus provide estimates of cost-sharing effects

in a context where individuals are more vulnerable and substantially less insured on pharmaceutical services.

We find that ATFP is significantly associated with a reduction in mortality for the most acute circulatory conditions, such as ischemia and cerebrovascular diseases; and with a reduction in hospitalization rates for the most chronic conditions, such as hypertension and diabetes. The estimated benefit accrued from averted deaths and hospital admissions represents 16 times the total amount of reimbursements to accredited pharmacies over the period of analysis. We also document that both ATFP utilization as well as its effects on health outcomes are more relevant among patients with relatively lower socioeconomic status. Our results thus support the view that cost-sharing strategies might have relevant impacts on health outcomes and equity, particularly in a context where patients are more vulnerable. In this situation, the optimal design of health systems and cost-sharing policies should take into account their potential offsetting effects on the utilization of downstream health services and health outcomes. This is informative to many countries across the globe that are developing or revising health financing policies in an effort to improve health system performance, and progress towards universal health coverage.

Finally, the results of this paper are also informative for the design of policies aiming at the provision of essential medicines. While never before have there been so many resources for medicines worldwide (PAHO, 2011), and so many countries expanding universal health coverage (Rodin and de Ferranti, 2012), there still exists an enormous gap between what countries achieve and what they could potentially achieve with the same resources (WHO, 2010). Particularly in developing countries, the lack of access to essential medicines often reflects the lack of state capacity to provide public goods and services in general. Despite all donor or government sponsored programs devoted to improving access to medicines in low and middle-income countries, for instance, median availability of selected generic drugs in public health facilities is no higher than 37% and 46%, respectively (WHO, 2017). While improving public service delivery is one of the biggest policy challenges worldwide (Besley and Ghatak, 2007), the delivery of pharmaceutical services is particularly difficult. The management of medicines supply requires a series of complex steps, such as the selection of drugs according to local needs, procurement, storage, distribution, and dispensing. The magnitude of inefficiencies, waste and diversion over the entire supply cycle can be substantial in developing countries, where government failures are widespread (MSH, 2012). The identification of efficient ways of delivering essential medicines has become a center piece of policymaking in health care. In this regard, we document the implementation and the outcomes of a program built in partnership with the private retail sector to enhance access to essential medicines. Our results indicate that

the ATFP program has overcome logistical challenges for the delivering of pharmaceutical services in a cost-efficient way.

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Tables and Figures

A Main Results

Table 1: Mortality and Hospitalization Baseline Rates (at the Municipality-Year Level, per 100,000 Individuals Aged 40+) and Controls

	Observations (Mun*Years)	Mean	SD	Min	Max
		Panel A - Mortality Rates			
Circulatory	33,042	481	267	0	2,602
Hypertension	33,042	55	68	0	906
Ischemia	33,042	136	119	0	1,831
Cerebrovascular	33,042	158	112	0	1,115
Other CVDs	33,042	132	108	0	1,403
Diabetes	33,042	62	64	0	840
Infectious	33,042	48	59	0	1,115
Injuries	33,042	79	74	0	1,064
		Panel B - Hospitalization Rates			
Circulatory	33,042	2,480	1,621	0	95,311
Hypertension	33,042	421	507	0	7,859
Ischemia	33,042	280	305	0	18,485
Cerebrovascular	33,042	391	341	0	20,379
Other CVDs	33,042	1,388	1,149	0	51,668
Diabetes	33,042	226	233	0	8,747
Infectious	33,042	874	974	0	45,284
Injuries	33,042	486	363	0	38,954
		Panel C - Controls			
Ln GDP per capita	33,042	9	1	7	13
Hospitals per 100,000	33,042	6	8	0	92
Hospital Beds per 100,000	33,042	217	272	0	5,339
Ln Density	33,042	3	1	-2	9
PSF	33,042	49	40	0	100
PACS	33,042	23	31	0	100
Private Pharmacies per 100,000	33,042	61	39	0	483

Notes: Mortality and hospitalization rates per 100,000 individuals aged 40 years or more, for periods prior to the implementation of ATFP (panel data from 2000 to 2005), calculated at the municipality-year level. Data originally from: SIM/Datasus, SIH/Datasus, Ipeadata and RAIS/MTE.

Table 2: First-Stage Results and Falsification Tests

	Dep. Var.: ATFP per 100,000 Inhabitants				
	(1)	(2)	(3)	(4)	(5)
T_t * Pharmacists	2,924				3,420
	(0.208)***				(0.228)***
T_t * Other pharmacy workers		0.311			-0.389
		(0.206)			(0.195)**
T_t * Lawyers			-0.011		-0.173
			(0.189)		(0.189)
T_t * Managers				-0.029	-0.055
				(0.077)	(0.079)
Partial F-Stat	197.8	2.275	0.003	0.143	225.7
Observations	71,591	71,591	71,591	71,591	71,591
Number of Municipalities	5,507	5,507	5,507	5,507	5,507
R^2	0.611	0.583	0.582	0.582	0.615
Year and Municipality FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Notes: This table reports first-stage results and falsification tests. Dependent variable in all columns: ATFP per 100,000 inhabitants. In column (1), the variable of interest is the number of pharmacists per 1,000 inhabitants in 2006 interacted with a function T_t that assumes $T_t = 0$ if $t < 2006$ and $T_t = (t - 2005)$ if $t \geq 2006$. In columns (2)-(4) the variables of interest are, respectively, the number of pharmacy clerks, lawyers and managers per 1,000 inhabitants in 2006 interacted with T_t. All regressions include municipality and year fixed effects as well as the following additional controls (not shown in the table): health infrastructure (hospital beds, hospitals and private pharmacies per capita), logarithm of GDP per capita, population density and others health programs (PSF and PACS coverage in %). Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Effects of ATFP on Mortality Rates
(per 100,000 Individuals aged 40+)

	Dep Var: Mortality Rates	
	OLS	2SLS
Circulatory	-0.947	-4.492
	(0.206)***	(0.878)***
Hypertension	0.032	-0.450
	(0.067)	(0.307)
Ischemia	-0.442	-1.812
	(0.109)***	(0.518)***
Cerebrovascular	-0.217	-1.678
	(0.064)***	(0.355)***
Other CVDs	-0.320	-0.553
	(0.092)***	(0.381)
Diabetes	0.038	-0.625
	(0.056)	(0.354)*
Infectious	-0.050	-0.213
	(0.036)	(0.156)
Injuries	0.173	-0.340
	(0.047)***	(0.218)
Observations	71,591	71,591
Number of Municipalities	5,507	5,507
Year and Municipality Fixed-Effects	Yes	Yes
Controls	Yes	Yes

Notes: Each cell reports the effects of ATFP on mortality rates by specific causes of death. The first column shows coefficients from OLS specifications, while the second presents 2SLS coefficients. Dependent variables: mortality rates per 100,000 individuals aged 40 years or more by cause of death. Variable of interest is the number of pharmacies accredited to ATFP per 100,000 inhabitants. All regressions include municipality and year fixed effects as well as the following additional controls (not shown on the table): health infrastructure (hospital beds, hospitals and private pharmacies per capita), logarithm of GDP per capita, population density and others health programs (PSF and PACS coverage in %). Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Effects of ATFP on Hospitalization Rates
(per 100,000 Individuals aged 40+)

	Dep Var: Hospitalization Rates	
	OLS	2SLS
Circulatory	-6.551	-26.886
	(1.522)***	(8.539)***
Hypertension	-1.878	-12.423
	(0.432)***	(2.401)***
Ischemia	-0.151	-3.853
	(0.296)	(1.526)**
Cerebrovascular	-1.008	-1.212
	(0.294)***	(1.659)
Other CVDs	-3.515	-9.399
	(0.939)***	(5.012)*
Diabetes	-1.025	-8.217
	(0.269)***	(1.526)***
Infectious	-0.384	-1.403
	(0.628)	(2.421)
Injuries	0.197	-2.743
	(0.553)	(2.686)
Observations	71,591	71,591
Number of Municipalities	5,507	5,507
Year and Municipality Fixed-Effects	Yes	Yes
Controls	Yes	Yes

Notes: Each cell reports the effects of ATFP on hospitalization rates by specific causes of hospital admission. The first column shows coefficients from OLS specifications, while the second presents 2SLS coefficients. Dependent variables: hospitalization rates per 100,000 individuals aged 40 years or more by cause of hospital admission. Variable of interest is the number of pharmacies accredited to ATFP per 100,000 inhabitants. All regressions include municipality and year fixed effects as well as the following additional controls (not shown on the table): health infrastructure (hospital beds, hospitals and private pharmacies per capita), logarithm of GDP per capita, population density and others health programs (PSF and PACS coverage in %). Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Determinants of ATFP Use, Individuals Aged 40+

	Dep. Var: Dummy for Any Medicines Purchased at ATFP		Hipert. Drugs Purchased at ATFP	Diabt. Drugs Purchased at ATFP
	(1)	(2)	(3)	(4)
Male	0.001	0.001	-0.017	-0.040
	(0.010)	(0.010)	(0.010)*	(0.020)**
Age	0.001	0.001	-0.001	-0.003
	(0.000)***	(0.000)***	(0.000)***	(0.001)***
Non-White	0.004	-0.002	0.008	0.038
	(0.010)	(0.011)	(0.011)	(0.021)*
Urban	0.007	0.019	0.012	0.022
	(0.014)	(0.014)	(0.014)	(0.028)
Education - Primary (incomp)	0.001	0.006	0.015	0.032
	(0.015)	(0.015)	(0.015)	(0.027)
Education - Primary (comp)	-0.003	0.010	0.002	-0.043
	(0.018)	(0.018)	(0.017)	(0.032)
Education - Secondary (incomp)	-0.045	-0.024	-0.029	-0.089
	(0.027)*	(0.027)	(0.030)	(0.058)
Education - Secondary (comp)	-0.053	-0.018	0.019	-0.137
	(0.017)***	(0.018)	(0.019)	(0.035)***
Education - College (incomp)	-0.063	-0.015	0.000	-0.177
	(0.030)**	(0.031)	(0.037)	(0.066)***
Education - College (comp)	-0.134	-0.074	-0.073	-0.190
	(0.018)***	(0.019)***	(0.021)***	(0.040)***
Covered by PSF		0.038	0.042	0.090
		(0.010)***	(0.011)***	(0.020)***
Private Health Insurance		-0.077	-0.038	-0.219
		(0.012)***	(0.012)***	(0.023)***
Sample	**If Recently Prescribed**	**If Recently Prescribed**	**If Hipert. Drugs Taken**	**If Diabt Drugs Taken**
Observations	8,749	8,749	9,133	2,579
Dep. Var. Mean	0.261	0.261	0.329	0.380

Notes: This table reports the determinants of ATFP use. In the first two columns, the dependent variable is a dummy that indicates whether medicines were purchased through ATFP. In columns (3) and (4) we restrict the sample, respectively, to those who had recently taken anti-hypertensive and anti-diabetics drugs. For columns (1)-(4) the independent variables are dummies indicating gender, age, race, urban and level of schooling. For columns (2)-(4), we also include dummies indicating PSF coverage and private health insurance. All regressions include state fixed effects. Data from PNS (2013). Robust standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: ATFP Effects on Hospitalization by Zipcode Income

	Hospitalization (ln)	
	Poor Zipcodes	Non-Poor Zipcodes
Circulatory	-0.020	0.001
	(0.029)	(0.022)
Hypertension	-0.129	-0.083
	(0.040)***	(0.024)***
Ischemia	-0.062	0.001
	(0.033)*	(0.024)
Cerebrovascular	-0.032	-0.033
	(0.029)	(0.025)
Other CVDs	-0.030	-0.013
	(0.030)	(0.024)
Diabetes	-0.114	-0.039
	(0.033)***	(0.022)*
Infectious	-0.043	-0.028
	(0.027)	(0.027)
Injuries	-0.027	0.004
	(0.024)	(0.027)
Observations	71,591	71,591
Number of Municipalities	5,507	5,507
Year and Municipality Fixed-Effects	Yes	Yes
Controls	Yes	Yes

Notes: Each cell presents the effects of ATFP on hospitalization rates by cause of hospital admission and average income. The first column shows coefficients from 2SLS estimation by poor zipcodes (below the median of household income per capita), while the second presents 2SLS coefficients for non-poor zipcodes. Dependent variables: the logarithm of the number of hospital admissions of individuals aged 40 years or more by cause of admission. Variable of interest is the number of pharmacies accredited to ATFP per 100,000 inhabitants. All regressions include municipality and year fixed effects as well as the following additional controls (not shown on the table): health infrastructure (hospital beds, hospitals and private pharmacies per capita), logarithm of GDP per capita, population density and others health programs (PSF and PACS coverage in %). Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Counterfactual Simulation: Circulatory Deaths

Year	Circulatory	
	Observed	Predicted
2000	210,721	210,721
2001	213,635	213,635
2002	218,351	218,351
2003	224,964	224,964
2004	235,806	235,806
2005	234,889	234,889
2006	253,290	256,956
2007	253,780	261,504
2008	266,730	276,935
2009	268,321	285,125
2010	274,921	297,430
2011	284,516	316,456
2012	282,867	322,416
Total Mortality, 2006-2012	3,222,791	3,355,186
Averted Mortality, 2006-2012		132,396
Averted Mortality, 2006-2012 (in % of predicted)		3.9%

Notes: Counterfactual simulations as described in section 7.1. Column 1 shows the observed number of deaths by circulatory diseases from 2000 to 2012. In column 2, we present the counterfactual trend for the hypothetical scenario had ATFP been not implemented.

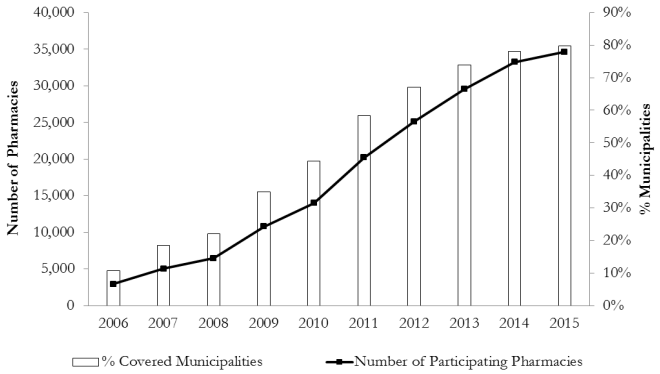
Table 8: Counterfactual Simulations: Hospitalization Costs in R$1,000 of 2012 (Hypertension and Diabetes)

Year	Hypertension		Diabetes	
	Observed	Predicted	Observed	Predicted
2000	47,895	47,895	69,005	69,005
2001	54,916	54,916	67,848	67,848
2002	45,684	45,684	52,725	52,725
2003	55,330	55,330	49,154	49,154
2004	52,867	52,867	52,241	52,241
2005	51,674	51,674	50,947	50,947
2006	51,636	56,576	47,036	50,209
2007	44,259	54,670	47,050	53,736
2008	48,390	62,144	61,881	70,713
2009	43,261	65,908	74,290	88,833
2010	36,589	66,925	77,470	96,950
2011	33,669	76,715	73,970	101,611
2012	24,710	78,010	60,775	95,001
Total Spending, 2006-2012	590,880	769,314	784,392	898,971
Averted Costs, 2006-2012		178,433		114,580
Averted Costs, 2006-2012 (in % of predicted)		23.2%		12.7%

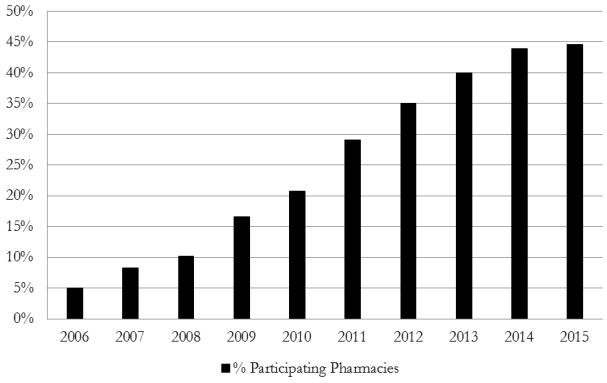
Notes: Counterfactual simulations as described in section 7.2. Columns 1 shows the observed hospitalization costs for hypertension from 2000 to 2012. In column 2, we present the counterfactual trend for the hypothetical scenario had ATFP been not implemented. The remainder two columns report the analogous results for diabetes.

Figure 1: ATFP Expansion, 2006-2015

(a) Total Number of ATFP Pharmacies and Municipality Coverage

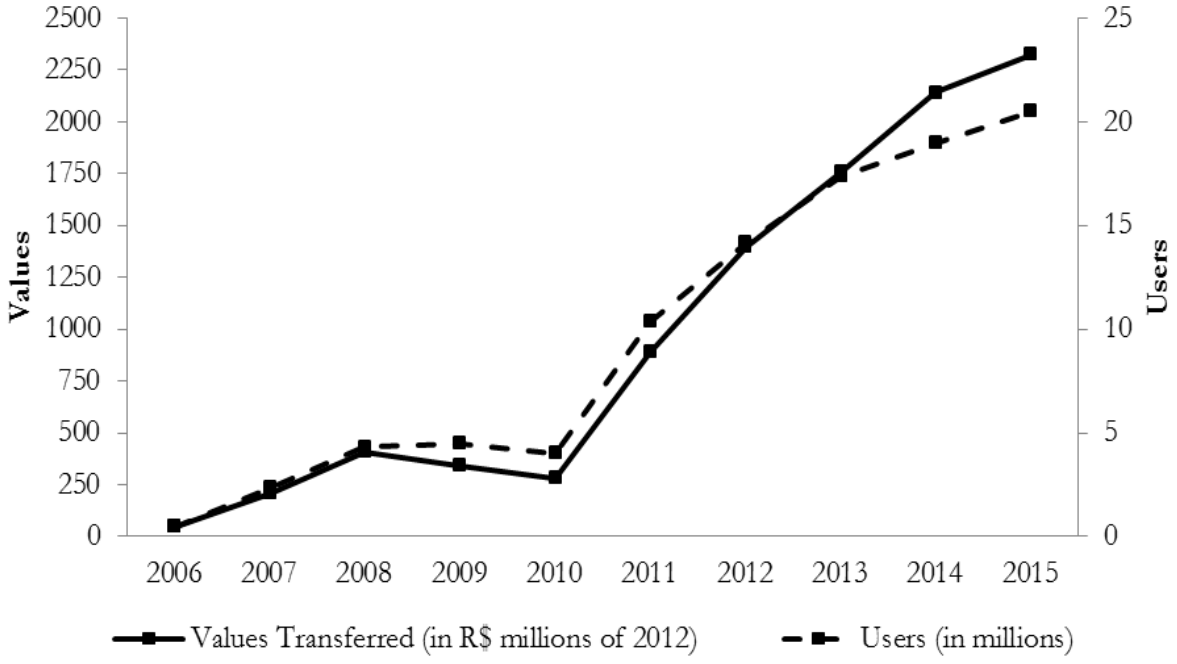


(b) Share of Private Pharmacies Accredited to ATFP



Source: Data on ATFP pharmacies from the Ministry of Health (SAGE/MS), available on http://189.28.128.178/sage/. Total number of pharmacies from RAIS.

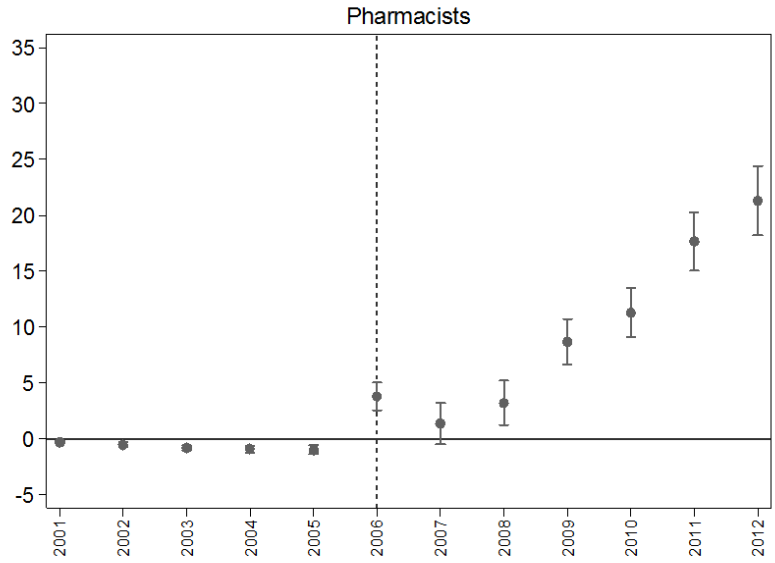
Figure 2: Users and Values Transferred from ATFP between 2006 and 2015



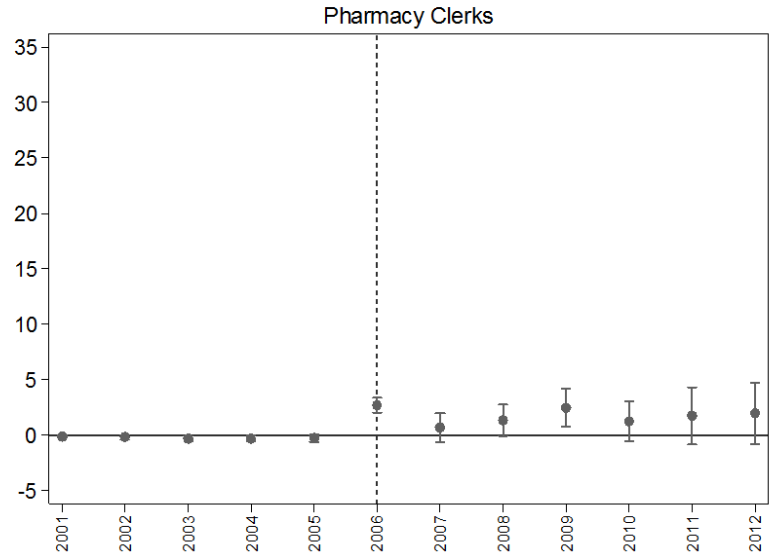
Source: Ministry of Health (SAGE/MS), available on http://189.28.128.178/sage/.

Figure 3: First-Stage Results in a Flexible, Non-Linear Specification: How the Annual Expansion of ATFP Responds to the Supply of Pharmacists

(a) Pharmacists in the Baseline Year and the Expansion of ATFP



(b) Other Pharmacy Workers in the Baseline Year and the Expansion of ATFP



Notes: We follow equation (2), but now estimate coefficients of interaction terms between $Pharmacists_{i,06}$ (Panel A) or $PharmacyWorkers_{i,06}$ (Panel B) with year dummies for each year over the entire period.

B Appendix Table and Figures

Table B.1: List of Medicines Covered by ATFP

Indication	Active principle and Composition
Contraception	Medroxyprogesterone Acetate 150 mg
Contraception	Ethinylestradiol 0,03 mg + Levonorgestrel 0,15 mg
Contraception	Norethisterone 0,35 mg
Contraception	Estradiol Valerate 5 mg + Norethisterone Enanthate 50 mg
Asthma	Ipratropium Bromide 0,02 mg
Asthma	Ipratropium Bromide 0,25 mg
Asthma	Beclometasone Dipropionate 200 mcg
Asthma	Beclometasone Dipropionate 250 mcg
Asthma	Beclometasone Dipropionate 50 mcg
Asthma	Salbutamol 100 mcg
Asthma	Salbutamol 5 mg
Diabetes	Metformin 500 mg
Diabetes	Metformin 500 mg - Prolonged Release
Diabetes	Metformin 850 mg
Diabetes	Glibenclamide 5 mg
Diabetes	Human Insulin 100 IU/ml
Diabetes	Regular Insulin 100 IU/ml
Dyslipidemia	Simvastatin 10 mg
Dyslipidemia	Simvastatin 20 mg
Dyslipidemia	Simvastatin 40 mg
Glaucoma	Timolol 2,5 mg
Glaucoma	Timolol 5 mg
Hypertension	Atenolol 25 mg
Hypertension	Captopril 25 mg
Hypertension	Propranolol 40 mg
Hypertension	Hydrochlorothiazide 25 mg
Hypertension	Losatan Potassium 50 mg
Hypertension	Enalapril Maleate 10 mg
Influenza H1N1	Oseltamivir Phosphate 30 mg
Influenza H1N1	Oseltamivir Phosphate 45 mg
Influenza H1N1	Oseltamivir Phosphate 75 mg
Osteoporosis	Alendronate Sodium 70 mg
Parkinson's disease	Carbidopa 25 mg + Levodopa 250 mg
Parkinson's disease	Benserazide 25 mg + Levodopa 100 mg
Rhinitis	Budesonide 50 mcg

Notes: This list include all medicines covered by ATFP. Information from SAGE, MS: http://sage.saude.gov.br/

Table B.2: Descriptive Statistics: Instrumental Variable and Variable of Interest

	Observations (Mun*Years)	Mean	SD	Min	Max
Panel A: Instrumental Variables, 2006					
Pharmacist	5,507	0.2	0.2	0.0	3.5
Other pharmacy workers	5,507	0.2	0.3	0.0	4.2
Lawyers	5,507	0.1	0.2	0.0	4.3
Managers	5,507	0.1	0.4	0.0	15.8
Panel B: ATFP per 100,000					
2006	5,507	0.5	2.0	0	59
2007	5,507	1.3	4.0	0	67
2008	5,507	1.9	5.3	0	120
2009	5,507	5.0	9.8	0	123
2010	5,507	8.1	13.0	0	124
2011	5,507	13.2	16.9	0	136
2012	5,507	17.1	18.9	0	136

Notes: This table reports descriptive statistics for our instrumental variable and variable of interest. Panel A presents the number of pharmacists, other pharmacy workers, lawyers and managers per 1,000 inhabitants in 2006. Data originally from 2006 RAIS. Panel B presents the number of ATFP per 100,000 inhabitants for each year over 2006-2012. Data originally from SAGE/MS. All cells report calculations at the municipality-year level.

Table B.3: Additional Results: Supply of Pharmacists in the Baseline Year and Wages

	Average Wage (ln)			
	Pharmacists	Other Pharm. Workers	Lawyers	Managers
	(1)	(2)	(3)	(4)
T_t * Pharmacists	-0.041	-0.000	-0.005	0.015
	(0.007)***	(0.007)	(0.011)	(0.012)
Observations	45,302	35,315	37,638	30,192
R^2	0.314	0.398	0.022	0.019
Number of Municipalities	4,802	4,271	4,393	4,222
Year and Municipality FE	Yes	Yes	Yes	Yes
Partial F-Stat	36.17	0.003	0.178	1.541

Notes: This table reports how pharmacists' wages respond to the supply of pharmacists in the locality at the time of ATFP introduction. Dependent variables: average wage in natural logarithm for, respectively, pharmacists, pharmacy clerks, lawyers and managers. The variable of interest is the number of pharmacists per 1,000 inhabitants in 2006 interacted with a function T_t that assumes $T_t = 0$ if $t < 2006$ and $T_t = (t - 2005)$ if $t \geq 2006$. All regressions include municipality and year fixed effects as well as the following additional controls (not shown in the table): health infrastructure (hospital beds, hospitals and private pharmacies per capita), logarithm of GDP per capita, population density and others health programs (PSF and PACS coverage in %). Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table B.4: Effects of ATFP on Mortality and Hospitalization Rates
2SLS Results Conditional on Municipality Specific Trends

Linear trends on:	Dep. Vars: Mortality Rates				Dep. Vars: Hospitalization Rates			
	None	Share Pop 40yo+	Hospital Beds	PSF Coverage	None	Share Pop 40yo+	Hospital Beds	PSF Coverage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Circulatory	-4.492	-2.582	-3.721	-4.431	-26.886	-24.134	-22.532	-26.945
	(0.878)***	(0.966)***	(0.909)***	(0.860)***	(8.539)***	(10.785)**	(8.692)***	(8.516)***
Hypertension	-0.450	-0.346	-0.393	-0.436	-12.423	-12.225	-12.541	-12.454
	(0.307)	(0.367)	(0.321)	(0.311)	(2.401)***	(2.982)***	(2.518)***	(2.394)***
Ischemia	-1.812	-1.236	-1.621	-1.783	-3.853	-3.666	-3.677	-3.823
	(0.518)***	(0.594)**	(0.537)***	(0.505)***	(1.526)**	(1.953)*	(1.620)**	(1.525)**
Cerebrovascular	-1.678	-0.832	-1.368	-1.664	-1.212	0.559	-0.214	-1.215
	(0.355)***	(0.365)**	(0.355)***	(0.353)***	(1.659)	(2.160)	(1.692)	(1.657)
Other CVDs	-0.553	-0.168	-0.340	-0.548	-9.399	-8.802	-6.100	-9.454
	(0.381)	(0.475)	(0.385)	(0.379)	(5.012)*	(6.113)	(5.099)	(4.988)*
Diabetes	-0.625	-0.357	-0.598	-0.611	-8.217	-7.938	-8.697	-8.196
	(0.354)*	(0.413)	(0.366)	(0.356)*	(1.526)***	(1.911)***	(1.626)***	(1.519)***
Infectious	-0.213	-0.238	-0.187	-0.214	-1.403	1.949	-1.275	-1.473
	(0.156)	(0.184)	(0.165)	(0.156)	(2.421)	(2.973)	(2.626)	(2.417)
Injuries	-0.340	-0.201	-0.408	-0.328	-2.743	-2.107	-2.224	-2.708
	(0.218)	(0.236)	(0.227)*	(0.219)	(2.686)	(3.558)	(2.807)	(2.671)

Notes: Each cell reports 2SLS effects of ATFP on mortality (columns 1-4) or hospitalization rates (5-8) by specific causes. Columns 1 and 5 replicate results from 2SLS specifications of Tables 3 and 4, respectively. Specifications of the remainder columns add municipality-specific linear trends according to the variables listed at the top of each column (linear trends refer to an interaction term between a linear time trend and the variable listed at the top of each column and recorded for the year 2000 for each municipality). The variable of interest is the number of pharmacies accredited to ATFP per 100,000 inhabitants. All regressions include municipality and year fixed effects as well as the following additional controls (not shown on the table): health infrastructure (hospital beds, hospitals and private pharmacies per capita), logarithm of GDP per capita, population density and others health programs (PSF and PACS coverage in %). Robust standard errors allowing for clustering at the municipality level in parentheses; regressions weighted by population. * significant at 10%; ** significant at 5%; *** significant at 1%.