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The Impact of Updating Health Benefits Plans on Health Technologies Usage and Expenditures: The Case of Colombia

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Using administrative data in 2012–2019, we estimate the impact of the inclusion of technology into the Colombian health benefits plan (HBP) charged to the capitation payment unit (CPU) on the usage, expenditures, and market conditions. Technologies (drugs and procedures) before and after their inclusion were compared using a Callaway-Sant'Anna's difference-in-differences with multiple time period method and a synthetic control strategy. A substantial increase in the use and prescription of these technologies was noted. Expenditure levels per user slightly increased; however, the response varies over time. Annual expansion of HBP charged to CPU provided tacit benefits to the Colombian population.

Keywords: Health benefits plan, universal health coverage, health expenditures, Callaway-Sant'Anna's method, synthetic control.

JEL classification: C55, I13, I18.

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I. Introduction

As part of the general objective of promoting the well-being of societies, one of the Sustainable Development Goals is to achieve universal health coverage (UHC) (Glassman, Giedion, and Smith 2017). UHC is the pursuit of a comprehensive set of quality health technology[1] services that all individuals can access regardless of their circumstances (named health benefit plans; HBP) (Cotlear et al. 2015). The coverage has three essential dimensions: (1) individuals covered by insurance, (2) services included in the insurance plan, and (3) the proportion financed by individuals or out-of-pocket health expenditure (Etienne, Asamoa-Baah, and Evans 2010; Schreyögg et al. 2005). Currently, several countries are achieving nearly universal coverage with high levels of financial protection (Lozano et al., 2020; McKee et al. 2013). However, Lozano et al. (2020) showed that some countries have similar levels of health expenditures but vast differences in adequate access to health services.

[1] A health technology is defined as "(...) an intervention developed to prevent, diagnose or treat medical conditions;promote health; provide rehabilitation; or organize healthcare delivery. The intervention can be a test, device, medicine, vaccine, procedure, program, or system" (O'Rourke, Oortwijn, and Schuller 2020, 188).

The challenge of implementing HBP lies in financing, which involves defining financial sources and establishing consistent budgets with public (or private) resources. Currently, no society can afford everything: in the US and Europe, there is a growing concern on prices of new technologies, in particular, pharmaceutical products, which accounted for more than 16% of the health budget in the European Union (Conti, Turner, and Hughes-Cromwick 2021; OECD and European Union 2018). Most efforts about containing health expenditures are centered on supply-based regulations, such as price or margins controls (Von der Schulenburg, Vandoros, and Kanavos 2011).

On the demand side, the objective is to convince (or force) prescribers and patients to use specific products or procedures. Although an explicit HBP (positive list of covered technologies) could restrain the supply of certain technologies, it also has a demand-based component as it indicates evidence of the usage of a product for treating specific conditions to prescribers. Moreover, defining and sustaining an explicit plan is an arduous task in practice, with barriers such as legal provisions, political pressures from interest groups, financial pressures, and mainly, the technical and administrative capacity to update it (Glassman et al. 2017). This study aims to understand how updating HBP (inclusions and exclusions of health technologies every certain time) affects the usage, expenditures, and market conditions of health technologies. We focus on Colombia, a country that has been using this strategy, at least informally, since the early 1990s.

As a middle-income country, Colombia provides health insurance coverage to nearly all its citizens (95.7% in 2020) with one of the lowest out-of-pocket expenditures in the OECD and Latin America. The prescribed medications and procedures are covered by the system except from income-based co-payments (Herrero and Herrera 2018).[2] The institutional context of the country provides a special setting for assessment on the inclusion of health technologies. In practice, the health system combines mandatory health insurance containing an explicit HBP—financed through a capitation mechanism

[2] However, it has still several shortcomings in terms of quality and timeliness of health services (Herrero and Herrera2018; OECD 2018).

known as the capitation payment unit (henceforth, HBP-CPU)[3]—periodic updating, and an implicit rationing scheme (technologies funded by specific case analysis, without an explicit list), in which some technologies that are not covered by the HBP-CPU are financed (i.e., *recobros*).[4] Therefore, we may observe how the use and expenditures on specific health technologies initially funded under an implicit system change after they are included in the explicit HBP-CPU (i.e., more expeditious access and without administrative obstacles).

Based on this institutional characteristic, we evaluate the impact of the public policy of progressive updating of the Colombian HBP-CPU. First, we provide evidence of the effects of the inclusion of technologies in the HBP-CPU on (i) costs, (ii) uses, and (iii) market conditions (market concentration). Second, to illustrate the process, we present the characteristics of products included and explore the case of two pharmaceutical products and two procedures. We do so by reconstructing the counterfactual usage of technology using other technologies that are still not included in the HBP-CPU via a Callaway and Sant'Anna (2020) and synthetic control strategies (Cavallo et al. 2010), between 2012 and 2019. These analyses are possible due to the existence of administrative datasets covering all purchases of health technologies (medications, devices, and services) needed to deliver healthcare to citizens. These data sets are part of the country's information systems required for calculating the capitation payment per individual provided to each insurer. We complement these data with information about the characteristics of pharmaceutical products at the wholesale level, including existing regulations, and health technology assessments (HTA).

The present study aims to contribute to the literature exploring the implications of the role of health technologies on crucial aspects of health system's performance. At the patient level and for specific cases, literature on optimal cost-sharing has explored the trade-off between consumption (lowers costs)

[3] The capitation payment unit (CPU) represents more than 80% of the expenditure in the Colombian health system, that is, slightly more than 11 billion US dollars (2019 prices) (Santa-Maria et al. 2021).
[4] From a theoretical and jurisprudential approach, the Colombian health system had a more explicit than implicit health insurance coverage before Law 1751 of 2015. However, from 2016 to 2017, the regulations brought it closer to a vision more implicitly than explicitly. In short, in Colombia, both mechanisms are used simultaneously.

and risk-bearing and substitution between products (increases costs) (Berndt, McGuire, and Newhouse 2011; Berndt and Newhouse, 2012). For instance, Lasio (2016) considered the delisting of oral phlebotonics in France, which were covered by public insurance, in comparison with those never included. They find reductions in the price of the products.

Most literature related HBP studies to the introduction of HBP on populations without prior access to health insurance, but not the marginal expansion of health technologies in the health coverage. This is the case of poor and vulnerable populations in Bangladesh (Khan et al. 2020), Colombia (Miller, Pinto, and Vera-Hernández 2013), Georgia (Gotsadze et al. 2015), India (Aggarwal 2010; Erlangga 2018), Mexico (Galárraga et al. 2010í), and Philipines (El Omari and Karasneh 2021), or more general populations in Burkina Faso (Fink et al. 2013é; Gnawali et al. 2009), China (Green, Hollingsworth, and Yang 2021), Ghana (Lambon-Quayefio and Owoo 2017), Nigeria (Gaag et al. 2013), Sri Lanka (Kumara and Samaratunge 2019), and Vietnam (Nguyen 2012; Thuong 2020). This literature considers the impact of households' out-of-pocket expenditures, usage of health services, and health status in some cases. The Colombian Government has only explored the expansion of benefits plans (Nuñez et al. 2015), in particular, the health plan expansion of the vulnerable in Colombia (i.e., subsidized regime; SR) between 2012 and 2014. This expansion matched the SR HBP-CPU to the HBP-CPU of those who are enrolled through the employment-based insurance scheme (i.e., contributory regime; CR). For a chosen set of 11 technologies, authors found an increase in the use of health services by SR individuals.

The following section describes the background of the Colombian HBP-CPU and how it compares with other health systems. Next, datasets and details of econometric strategies are presented. Finally, we present the discussion and conclusions following the results of the estimation process.

II. Background: The Colombian HBP-CPU

A. The development and functioning of the Colombian HBP-CPU

Colombian HBP was set by Law 100 of 1993, which stated the basis of the UHC of the country. The law defined the managed competition between health insurers of both the CR and SR (Escobar et al. 2009; Giedion and Villar 2009). Individuals employed in the formal sector contribute to their beneficiaries and the payroll that allows them to belong to the CR; meanwhile, people in the informal sector or who cannot contribute have access to health insurance through the RS, which covers health services through public subsidies.

From Law 100 of 1993, with the creation of the General System of Social Security in Health, guaranteed healthcare services were restricted to an explicit HBP-CPU called *Mandatory Health Plan* (POS, by its Spanish acronym), specific for CR (based on the *de facto* HBP of the former national health insurer) and a less broad one for the SR (based on prior social programs). The POS defined a significant percentage of the national health budget, in addition to public health topics in charge of local governments. The Colombian regulatory framework also stated that the POS must be updated, and eventually, POS from the CR and SR should converge into a unique HBP-CPU. However, there was no indication on how to update each of them and when the plans will be unified (Giedion, Panopoulou, and Gomez-Fraga 2009; Giedion et al. 2014). The new health system based on structural pluralism began increasing health coverage in the general population. At the beginning of the 1990s, only one in six people was part of CR (Escobar et al. 2009). By 2008, nearly 90% of the population were already covered, and one out of three individuals was part of the RC, with one of the lowest out-of-pocket expenditure levels of the Americas (OECD 2018).[5]

[5] In Colombia, coinsurance is barely used, and copayments are established by the government, as other price-related parameters of the managed care competition between health insurers (Buitrago, Miller, and Vera-Hernández 2021).

Over time, the lack of an integral and robust process to update the POS resulted in two particular situations. First, insurers could pay for the provision of health technologies outside the POS if a group of clinicians established a medical necessity. Another option was to ask for the technology to be provided via judiciary rulings (*tutelas*) to protect healthcare right. In both cases, these resources are reimbursed by the government outside their capitation contract (CPU). The flaws were found in the structure designed to provide the service. They are also found in both the absence of a legitimate, fair, and efficient prioritization scheme and the lack of technical capacity of the entities in charge of regulating and overseeing the system. This gave rise to gray areas, uncertainties, gaps, and accommodated interpretations in POS, with the consequence of the explosion of *recobros*, as a form of technical-administrative reimbursement mechanism for the health insurers. These reimbursements were processed as *recobros*, essentially a fee-for-service mechanism. Consequently, the initial budget planning failed, and the system started to suffer problems related to financial sustainability, organization, and functionality (Econometría, SEI, SIGIL 2011). In addition to putting pressure on expenditure, the payment mechanism for technologies not financed by capitation generated financial imbalances in both insurers and health service providers.[6]

In 2008, the Constitutional Court ruling T-760/2008 urged the government to implement promises of Law 100 of 1993 and to find a solution to the health system crisis. The unification of the HBP-CPU for both CR and SR started gradually, and the process was finished by 2012[7] (Econometría, SEI, SIGIL 2011). In terms of updating the HBP-CPU process, Law 1438 of 2011 established that the Ministry of Health and Social Protection (MHSP) had to develop the updating process.[8] In response to this, the

[6] These imbalances are fundamentally due to the existence of government glosses to recobros, which generate restraint between the provision of the service and what can finally be paid, leaving a financial gap that ends in the health service provider's account receivable, the health insurer's account payable, and an account receivable glossed in the health insurer to the government. However, the government has only one glossed account and no obligation on its balance sheet.

[7] This process was sequential depending on the health risk by age groups and began with people under 18 years ofage, continuing with those older than 60 years, and culminating with the group between 18 and 59 years of age.

[8] In the 1990s and early 20th century, first the National Council for Social Security in Health (CNSSS by its Spanish acronym) and then the Commission of Health Regulation (CRES by its Spanish acronym), nonexistent state organisms, had the responsibility to update the POS. Currently, this process is carried out by the MHSP.

MHSP issued a series of normative resolutions to update the HBP-CPU. We describe these resolutions, which essentially include the specific technologies to add into the HBP-CPU, in Figure 1.

In Colombia, only in recent years,[9] different prioritization criteria have been used, although not systematically nor integral. Some of these criteria used for the inclusion of new technologies in the HBP-CPU are defined in terms of i) cost-effectiveness, ii) effectiveness, iii) budget impact, iv) safety, v) burden of disease, vi) severity of disease, vii) equity, viii) affordability, and ix) access (MinSalud 2020).

Finally, a large reform took place in 2015 with the enactment of Law 1751 of 2015, a constitutional amendment that introduced a major change in the health system's setup. Instead of the explicit list of health benefits of the POS, the law stated that any technology could potentially be publicly funded unless explicitly defined that it should not be funded. The procedure to ask for a *recobro* was systematized using a digital tool, managed by each prescribing physician. However, the use of the health technology list included in the HBP (now termed as HBP-CPU) still establishes the capitation payment to each insurer company (named Health Promoting Entities in Colombia; EPS by its Spanish acronym)[10].

[Insert Figure 1 here]

B. Criteria for updating PBS internationally and in Colombia

This section contrasts the Colombian HBP system with a group of countries from different continents: Canada, Chile, England, Ethiopia, India, Kenya, Malaysia, Mexico, Netherlands, Norway,

[9] Updating the technologies in health financed by the CPU in Colombia consists of eight steps: i) identification of population needs in health; ii) selection of technologies in health to be evaluated; iii) identification of safe and effective technologies in health; iv) selection of health technologies to be included; v) presentation of the proposal for updating the commission and deliberations to develop a recommendation for decision-making by the MHSP; vi) prior consultation of the proposal for the administrative act to the different actors of the General System of Social Security in Health, through the MHSP website; vii) administrative act signed by the Minister of Health and Social Protection; and viii) socialization of the administrative act to different actors.

[10] Within the complex gear of the Colombian health system, an entity called Administrator of the Resources of the General System of Social Security in Health (ADRES by its Spanish acronym, formerly called FOSYGA) exists, which has been in charge of pooling the financial funds of the system (works like a bank). Its purpose is to transfer the monetary resources of the CPU and recobros to the EPS.

and Uruguay. Lozano et al. (2020) constructed an index (0 to 100) to rank the adequate coverage of a health system based on 23 indicators, including health promotion and treatment of diseases. Panel A of Table 1 shows that countries, such as Ethiopia, India, and Kenya, have values of 52 or below. Meanwhile, others, such as Canada, the Netherlands, or Norway, have levels of 90 or above. Moreover, in all these countries, except for England, some explicit HBPs are in place.

In some countries (e.g., Canada, Ethiopia, India), HBP plans can be decided at national or regional levels, whereas in other cases (e.g., Mexico, Norway, and New Zealand), only the administration occurs at the regional level. For some countries like Kenya, HBP applies only to specific groups of the population; in others like Netherlands, it is the core of the entire health system.

Following Hayati et al. (2018), we divided the HBP criteria into three distinct categories: intervention-, disease-, and community-related criteria. These criteria are based on the number and nature on which HBP is defined and updated in the reference countries. Panel B of Table 1 presents the fundamental criteria to define and update the HBP and our classification for each country. Appendix A presents in detail how we developed this classification. The most widely used criteria were cost-effectiveness, effectiveness, budget impact, safety, equity, affordability, and access in all countries included in the referencing. The burden of disease is also widely used, especially in developing countries like Chile, Mexico, Uruguay, Ethiopia, Kenya, and India. However, innovation and severity of disease are less used, the former mainly in high-income countries.

In summary, the overview of prioritization schemes in different countries suggests that criteria and processes for developing HBP differ according to economic, social, and cultural conditions and specific values of each country's society. However, the following criteria are common in informing and are used in the design, prioritization, and updating of HBP: cost-effectiveness, clinical efficacy, the burden of disease, equity, financial protection, and the effects on public and private budgets. Although these criteria are considered when updating the Colombian HBP, a comprehensive and transparent

methodological and institutional framework for updating must be defined, which does not currently exist. In the future, studies on the determinants and factors of success or failure in the policies related to the HBP updating are also required as a means to achieve incremental improvements in the health of the population through universal health coverage and different mechanisms for prioritizing and updating the HBP.

[Insert Table 1 here]

III. Data and Methodology

A. Data

We consider data between 2012 and 2019.[11] As shown in Figure 1, our unit of analysis is the technology, which could be a drug or a medical procedure.[12] Procedures are identified in Colombia according to the Unique Classification of Health Procedures (CUPS, by its Spanish acronym)—a logical and detailed ordering of health procedures and services conducted in the country—and medications are classified according to the anatomical, therapeutic, and chemical classification (ATC) code.[13] Therefore, our dataset considers, for each technology, the frequency of usage, number of unique users, expenditures, the geographic area where the technology was delivered to the patient, and the status concerning the HBP-CPU.

A total of 9,119 health technologies were not included in the HBP-CPU between 2012 and 2019 in the dataset: 7,412 procedures and 1,706 drugs. The main objective was to estimate the economic impact of the use of new technologies included in the HBP-CPU. Thus, we used records of technologies in the

[11] We use information only for EPS from CR that approves the validation system of the MHSP. These insurance companies have approximately 85.54% of the insured people of the RC, that is, approximately 20 million people for 2019.
[12] Medical devices are not considered, as their information is not standardized in the system.
[13] We use the anatomical/therapeutic/chemical classification (ATC) as a system for identification per active principle or chemical substance (the fifth level) in the pharmaceutical products.

system at least since 2012, but not those included in the HBP by such year. We identified 5,700 procedures and 1,218 drugs that meet this criterion (6,918 technologies: 75.9% of the original sample).

HBP-CPU updates.—Figure 2 shows the total number of technologies added to the HBP-CPU per year, according to Colombian legislation issued by the Ministry of Health and Social Protection.

[Insert Figure 2 here]

In the administrative records, we observed 702 technologies included in the HBP-CPU and used at some point between 2014 and 2019. However, not all technologies included are eventually used in the health system. After restricting the data to those used since 2012, we identified 109 procedures and 230 drugs, accounting for 48.3% of the original sample. This selection means that our analysis corresponds to the inclusion into the HBP-CPU of drugs and procedures that have been available for several years in the market.

A general review of the updates issued to the HBP analyzed in this study showed that in 2014, the medicines financed with CPU resources were mainly immunosuppressive agents, immunostimulants, aromatase inhibitors, and some antineoplastics. Most of them are used in the treatment of cancer and autoimmune diseases. Some active ingredients were also identified for the treatment of epilepsy and depression and hormone therapy.

In 2016, the inclusion of medicines by reference subgroup (ATC 4) was mainly observed for insulins and analogs, non-selective beta-blocking agents, calcium channel blockers, proton pump inhibitors, and statins. These medicines are used in the management of chronic non-communicable diseases, such as diabetes, cardiovascular system diseases, gastrointestinal diseases, and lipid disorders. Similarly, some fixed-dose combinations, such as nystatin plus metronidazole and alendronic acid plus vitamin D, were identified.

Concerning 2017, the inclusions involve mainly solutions for peritoneal dialysis, and some systemic antibiotics and other products, such as powdered food with vitamins, iron, and zinc, were financed. An update was submitted in 2018 incorporating several medicines, including direct-acting antivirals, antiretrovirals for the treatment of human immunodeficiency virus (HIV), antineoplastic agents, and immunomodulators for the treatment of cancer, of which four reference subgroups were funded: antithrombotic agents, antihypertensives, hormones, and analgesics. Medicines for the management of mental health pathologies (antidepressants and psychostimulants), the nervous system (selective serotonin agonists, anticholinergic, and dopaminergic agents), and the alimentary tract and metabolism were also include. Finally, for 2019, the funding of many medicines is also highlighted. This update incorporated 15 reference subgroups, including antiemetics as adjuvant treatment in chemotherapy, hypoglycemic drugs that exclude insulins for managing diabetes and hypoglycemia, aldosterone and angiotensin II antagonists for treating hypertension, drugs for managing benign prostatic hyperplasia, protease inhibitors for treating HIV, and bisphosphonates for the prevention and treatment of bone resorption diseases. Urinary frequency and incontinence agents, beta-lactamase-sensitive penicillins, and oxytocin analogs were also included in the subgroups. However, anxiolytics, anti-epileptics, antidepressants, and drugs to improve gastrointestinal motility, among others, were also identified.

During the study period, most procedures correspond to diagnostic tests for neoplastic diseases, gastroesophageal diseases, infectious pathologies, and neonatal screening and those for the prevention and treatment of diseases of the cardiovascular and respiratory systems.

Dependent variables: technologies use and expenditures.—To obtain the number of uses of specific technologies and total expenditures on each one, we use two data sources. The first one was the health expenditure records for each service reported by health insurers in the CR between 2012 and 2019, as part of the HBP-CPU, which manages funds from mandatory contributions (hereinafter, Suficiencia).

Suficiencia is a restricted dataset which the MHSP uses to calculate the amount of money that must be transferred every year to each insurer via capitation.

The second one refers to the fee-for-service payment records of technologies that insurers claim back from the Government (*Recobros*). As explained earlier, this is the case of products not included in the HBP-CPU, which are allowed to be used case by case for individual patients. This dataset only has the name of the technology and the name of the provider/insurer that delivered the technology; thus, the authors added the CUPS and ATC codes and geographical area (see Appendix B for further details).

With this information, we computed the following main dependent variables for specific technologies per year:

- Number of unique users per million affiliates: total patients that have a record of usage of technology (i) divided by the number of insured persons in each year (in millions);
- Frequency of usage: total units delivered of technology (i) divided by the number of unique users to whom technology (i) was delivered;
- Expenditures per user: the total amount of money of technology i (in USD; 2019 exchange rate = 3,281 COP per USD) divided by the total number of users;
- Usage in scattered areas: a dichotomous variable that takes the value of 1 if the technology was used in a special or remote area and 0 otherwise (Figure B1). These areas correspond to mostly rural areas of the country for which transport costs and times are notoriously higher than the rest. Usually, the supply of health services available in these areas is relatively scarce.

Figure 3 presents the distributions of the first three aforementioned variables, for numbers greater than zero. On average, there are 1,000 users per million affiliates of technology each year, used around 1.06 times per user each year, and the expenditure per user is 1,935,609 COP per year (589 USD).[14]

[14] We use an exchange rate of 3,281 COP per USS, which is the average of 2019.

Considering that all three variables have highly skewed distributions, we use the inverse hyperbolic sine transformation, which allows for the presence of zeros. Its interpretation is similar to the logarithmic transformation (a percentage increase).

Panel A of Table 2 presents the means by year of the outcomes described above. Usage in scattered areas grows from 37% to 48% over these years. The table also shows the proportion of the technologies that are procedures (81.3%), technologies included in the HBP by a given year (8.6% by 2019), and those that undergo a health technology assessment (HTA). We observe an important jump in the mean of the usage variables between 2015 and 2016, and on the expenditure variable only in 2017. To the best of our knowledge, these events have no clear explanation beyond a change in the reporting system,[15] but our estimation strategy does not depend on these particular years.

Other variables.—We explored the role of HTA designed as instruments to consider the inclusion of technologies into insurance plans, either national HBP or private companies. These studies include cost-effectiveness analysis, budget impact analysis, and effectiveness and safety assessment studies. Rather than referring to the technology per se, studies consider its specific uses. In Colombia, by legal mandate, HTA is conducted either by the HTA agency (IETS, by its Spanish acronym). We constructed an indicator variable on whether the technology was considered in any HTA study available at a given year.

Market characteristics are also important in determining the expansion of technology. For medications, Colombia has a solid administrative dataset available since 2012 known as SISMED, which records all whole-seller level transactions for any pharmaceutical product. This is conducted to monitor the compliance with (or to establish the need of) the price cap regulation that applies for some specific products, which was designed using external reference pricing. We keep all the transactions in the market originated by the pharmaceutical company or the importing firm. These data are

[15] Resolution 256/2016 introduced a new monitoring scheme on data collection and quality through the health system.

supplemented with the official registry of pharmaceutical products issued by the food and drug surveillance institute (INVIMA).

For medications, we calculate several variables based on both the ATC4 and ATC5. In particular, ATC5 corresponds to the chemical substance, so products with the same ATC5 are likely to be close substitutes. The fourth level corresponds to the chemical group, given the anatomical, therapeutic, and pharmacological characteristics, which indicates a potential substitution between products. Computed variables are a dummy variable that identifies whether generics are available in the market, the number of firms with sales in the market,[16] whether only one firm has registries, the number of years since the register of the product, the industrial concentration via the Herfindahl–Hirschman Index (IHH),[17] whether products in the ATC5 are subject to a price cap regulation,[18] and the proportion of the market sold to the mandatory insurance companies or directly to health providers (institutional market).

[Insert Figure 3 here]

We consider a two-year window for these products transactions because many are reported to be traded only once per year. Panel B of Table 2 presents the progression of these variables, showing the tendency of health markets to be concentrated at the ATC5 level. However, several companies are behind them in general (16 or 17), and a bit more than half of the markets involve institutions from the health system (apart from the first year). Moreover, around 20% of the products belong to an ATC5 market where a price cap regulation exists.

[Insert Table 2 here]

[16] This is known according to the registry owner. However, we are not considering that some of these firms might be owned by other companies. Therefore, our figures could overestimate the effective number of companies operating in the same market.

[17] The IHH is computed as the sum of the squares of the firm's shares in a market. Usually, this is presented multiplied by 10,000, so "10,000" denotes a monopoly, whereas "2,500" denotes a market with four firms with equal participation. An IHH below 2,500 is typically considered a non-concentrated market.

[18] In Colombia, the Government can impose a price cap to pharmaceutical product transactions at product level, provided that there is evidence of concentration in the relevant market (usually the ATC5). The price cap is defined under international reference pricing, without any explicit norm on which products will be regulated in the following years. The products can either be in the HBP or not, sold only to health providers or directly to patients, or original or generics. See, for instance, Andia, Mantilla, Morales, Ortiz, and Rodriguez-Lesmes (2020) and Prada et al. (2018).

Case studies.—We present two medications and two procedures that were included in the HBP during the study period to illustrate the rationale of the inclusions. Later, we will also explore the specific results for these four technologies.

Magnesium hydroxide (ATC5: A02AA04) was included in the HBP-CPU in 2016. A potential reason for its financing is WHO's inclusion of it in the model list of essential medicines within the gastrointestinal medicines used as antacids and other anti-ulcer drugs (WHO 2007). However, other criteria considered for the prioritization of technologies, such as disease burden, epidemiological profile, local Clinical Practice Guideline (CPG) recommendations, and costs, cannot be ruled out (DROAS 2020). Magnesium hydroxide as a monodrug in oral suspension is an effective pharmacological alternative to aluminum hydroxide. Therefore, its prescription and use as an antacid can be frequent in patients with gastrointestinal disorders, and its pharmaceutical form in suspension allows rapid action and easy administration in both adult and pediatric populations (Kluwer 2021). This medication was excluded in the price regulation during the study period, and an HTA process was performed only one year after its inclusion. The product had been in the Colombian market for at least 20 years at the time of inclusion. An IHH of 3,491 for transactions in one year means that the market was highly concentrated. If a two-year window is considered, 20 firms were selling the product in 2015, and the IHH is 2,102. Moreover, 29% of the transactions were in the institutional market, but in previous years, the share was between 5% and 12%.

Quetiapine (ATC5: N05AH04) is an atypical antipsychotic included in 2014; in Colombia, it is indicated for treating bipolar disorder, schizophrenia, and major depressive disorder. It is also considered an alternative treatment for generalized anxiety disorder when the response to other medications is inadequate. The use of quetiapine is recommended in lines of treatment in the local CPGs for depressive episodes and recurrent depressive disorder and schizophrenia (MinSalud, Colciencias, IETS 2014a, 2014b). Note that other criteria, such as disease status, protection of

vulnerable groups, disease burden, and epidemiological profile, could be other considerations in favor of its funding and prescription in the health system (DROAS 2020). Meanwhile, Quetiapine has been registered in the market for 16 years at the year of inclusion in 2014. It was also included in the price regulation scheme in 2014, even though around 40 firms offered the product between 2012 and 2013, with a two-year window IHH of 2,619 (3,028 on a yearly basis). Around 44.7% of the sales were through the institutional section in that year. The product was considered part of an HTA in the same year of the inclusion.

Stress echocardiography, either pharmacological or with exercise (CUPS 881210), is a procedure that involves administering a drug or subjecting a patient to physical activity to achieve myocardial stimulation and increase the heart rate to obtain ultrasound images of the heart to assess myocardial function (Kluwer 2021; MinSalud 2021). Its funding with CPU resources in 2014 and its increase in the number of services in subsequent years could be attributed to the fact that its alternative, included since 2012, stress myocardial perfusion with pharmacological stress (CUPS 920408) or with rest and post-exercise (CUPS 920407), is a diagnostic procedure that requires special supplies and technical equipment to record the distribution of a radiopharmaceutical that allows the assessment of the functioning and blood flow of the heart (Kluwer 2021; MinSalud 2021). This procedure is more difficult to access in its application because it requires specialized radiology services, whereas echocardiography may be a technique with better availability in healthcare services. Therefore, its coverage in HBP increased the demand as it is considered a more available alternative to myocardial perfusion. However, its possible financing with CPU resources could be based on access criteria, the health condition that requires the use of these procedures, and their costs, among other criteria (MinSalud 2014).

The revision and adjustment of external components of an implantable hearing device (CUPS 954903) consist of revising and adjusting the external components according to the patient's needs

(Kluwer 2021; MinSalud 2021). Its increased use may be because this procedure did not present any funded alternative within the HBP before 2016. Therefore, after this device was funded with CPU resources, it provided access to this service for people with implantable hearing devices. Moreover, it was considered a complementary procedure to be requested in the formulation of this type of hearing aid.

B. Empirical strategy

According to previous comments, we excluded exclusive health technologies in the HBP at the beginning of our study period (i.e., 2012). There is a staggering adoption of treatment: inclusion occurs in different periods, and once a health service is included, it will remain treated forever. However, although technologies can be excluded from the HBP, an exclusion is a different sort of treatment.

Callaway and Sant'Anna DiD estimator.—We follow Callaway and Sant'Anna (2020) DiD estimator, which applies when variation exists in treatment timing. The standard strategy, that is, the two-way fixed effect (TWFE) model, delivers biased results (Athey and Imbens 2021; Borusyak and Jaravel 2017).[19] In such an econometric model, under the staggering adoption, the already treated units end up being used as part of the control group, which does not allow identification of the average treatment on the treated (ATT). The CS model ensures that each treated technology's comparison group consists of only units that have not been treated yet.

[19] The TWFE model is

$$Y_{i,t} = \alpha_i + \alpha_t + \delta D_{i,t} + u_{i,t} ,$$

where $D_{i,t}$ is a dummy that takes the value of 1 if the technology i is part of HBP on year t, and 0 otherwise.The regression includes fixed effects by technology (α_i) and year (α_t). Its natural extension is the event study:

$$Y_{i,t} = \alpha_i + \alpha_t + \sum_{k=-K}^{-2} \delta_k^{lead} D_{i,t}^k + \sum_{k=0}^{L} \delta_k^{lags} D_{i,t}^k + u_{i,t}$$

where $D_{i,t}^k$ is an indicator of technology i being k periods away from initial treatment at time t. For example, if technology A is included in the HBP in 2016, then $D_{it}^0 = 1$ only in 2016, $D_{it}^{-2} = 1$ only in 2014, and $D_{it}^2 = 1$ only in 2018. Here, D_{it}^{-1} is excluded from the regression to avoid perfect collinearity. Thus, δ_k^{leads} would assess violations of the pre-trends assumptions (if any of these coefficients is significant). Moreover, δ_k^{lags} would show the impacts specific per period after the inclusion into the HPB.
The models provide unbiased estimates if all inclusions occur simultaneously.

The parameters of interest represent the ATT at period *t* (out of T periods) for technologies included in year $g \in G$ (the set of periods during an inclusion of a technology):

$$ATT(g,t) = E\left[Y_{i,t}(g) - Y_{i,t}(0) \middle| G_{i,g} = 1 \right], for\ t \geq g \qquad (1)$$

where $Y_{i,t}$ is one of the three outcome variables for technology *i* out of *J* technologies in year *t*. $Y_{i,t}(g)$ corresponds to its value if the technology started to be treated in period *g* (a particular normative resolution), and $Y_{i,t}(0)$ denotes its counterfactual value in case of no treatment. $G_{i,g}$ takes the value of 1 if the technology *i* is included in the HBP in year *g*, and 0 otherwise (treatment start-time dummies).

Without covariates and anticipation effects, the central assumption is the conditional parallel trends based on not-yet-treated groups (CS assumption 5).

$$E\left[Y_{i,t}(0) - Y_{i,t-1}(0) \middle| G_{i,g} = 1 \right] = E\left[Y_{i,t}(0) - Y_{i,t-1}(0) \middle| D_{i,s} = 0, G_{i,g} = 0 \right] \qquad (2)$$

for each *g* and each $(s, t) \in \{2, ..., T\} \times \{2, ..., T\}$, such that $t \geq g$ and $s > t$.

In the equation, $D_{i,t}$ takes the value of 1 if the technology *i* is in the HBP at period *t*. Essentially, the time variation on the outcome for technologies included in HBP in period *g* if no treatment occurs can be recovered with those technologies that have not been included by period *t* in HBP (they will be included in period *s*). Given this assumption, the semi-parametric estimator is defined as[20]:

$$\widehat{ATT}(g,t) = E\left[Y_{i,t} - Y_{i,g-1} \middle| G_{i,g} = 1 \right] - E\left[Y_{i,t} - Y_{i,g-1} \middle| D_{i,t} = 0 \right] \qquad (3)$$

The $ATT(g,t)$ estimators are aggregated using a weighted average. We compute the following:

[20] An estimator conditional on covariates is implemented as well. Such version is similar but includes weights basedon the probability of a technology to be included in HBP in a given period. See Callaway and Sant'Anna (2020)for further details.

(i) a general result (group-time average) given by

$$\delta = \sum_{g=2}^{T} \sum_{t=2}^{T} \mathbf{1}\{ g \leq t \} ATT(g,t) \cdot P(G = g) \quad (4)$$

where $P(G = g)$ is a weight based on the number of technologies included in the HBP at period g.

(ii) An event-study aggregation (dynamic effects). For each period τ after the inclusion into the HBP,

$$\delta_{\tau} = \sum_{g=2}^{T} \mathbf{1}\{ g + \tau \leq T \} ATT(g, t+\tau) \cdot P(G = g \,|G + \tau \leq T) \quad (5)$$

Synthetic control.—We follow Cavallo et al. (2010), who, in turn, extended the work on synthetic controls for multiple treated units by Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010) . This strategy constructs a control group for each treated technology by weighting control technologies in such a way that they resemble the behavior of the treated technology over time (before their introduction into the HBP) (Abadie 2021).

If only one technology would be studied (unit i = 1, one of the G treated units), an estimate of the impact in year τ is obtained as follows:

$$\delta_{1,\tau} = Y_{1,\tau} - \frac{1}{G} \sum_{j=G+1}^{J} w_j^{(1)} Y_{j,\tau} \,, \quad (6)$$

where weight $w_j^{(1)}$ is derived for each control technology ($j \in \{G + 1, J\}$). Weights are derived in this case from a constrained quadratic optimization that minimizes the distance $\sqrt{(X_1 - X_0 W^{(1)})' V (X_1 - X_0 W^{(1)})}$ where $W = \left\{ w_j^{(1)} \right\}_{j=G+1}^{J}$ and $X_{k \in \{0,1\}}$ correspond to the variables to match. We match technologies on values of Y before the inclusion into the HBP. Matrix V, a symmetric and positive semidefinite matrix, is chosen so that the root mean squared prediction error

(RMSPE) of the pre-inclusion period is minimized.[21] The outlined procedure for a single treated unit can be extrapolated to multiple treatment units, as in the case of Cavallo et al. (2010). As a result, a general estimate can be obtained:

$$\delta_\tau = \frac{1}{G}\sum_{j=1}^{G} Y_{j,\tau} - \frac{1}{G}\sum_{j=1}^{G}\sum_{k=G+1}^{J} w_k^{(j)} Y_{k,\tau} \ , \qquad (7)$$

Given a large number of potential alternatives, for the synthetic control, we considered for the algorithm only the three closest neighbors for each included technology. This is in terms of their pre-trends for the four outcomes in two years before the inclusion (both in levels and their transformations). The selection was based on the propensity score (Leuven and Sianesi, 2003).

For inference, the standard strategy is to use a permutation test. It is implemented by repeating the analysis described earlier for each control unit, as if they were treated (as placebos), to compute an empirical distribution of the random differences from the procedure. This distribution allows us to test if the estimated effects are statistically different from the placebo results.

Probability of inclusion.—Given that the inclusion of specific technologies into the HBP has no explicit criteria, we explore which characteristics are linked to the probability of inclusion. We model the probability of inclusion in a given period t as

$$\Pr\left(G_{i,t} = 1 \mid G_{i,t-1} = 0\,, X_{i,t-1}\right) = \Lambda(X'\beta) \ , \qquad (8)$$

where $\Lambda(\cdot)$ is the logistic function, and $X_{i,t-1}$ corresponds to a set of control variables in the previous year. On top of the type of technology, it includes (i) the usage outcomes: number of unique users per million affiliate, expenditures per user. In addition, (ii) a dummy that indicates if the usage of the technology was considered in an HTA. For medications only, (iii) market characteristics considering

[21] The RMSPE is computed with the same distance described before, but $\boldsymbol{X}$ corresponds to the value of theoutcome variable at $t = \tau$.

the last two years (for both ATC4 and ATC5) are determined: whether generics are available in the market, the number of firms with sales in the market, whether only one firm has registries, the number of years since the registry of the product, the industrial concentration via the IHH index, and the proportion of the market that is sold to the mandatory insurance companies.

IV. Results

A. Main Findings

Table 3 presents the results of the CS-DiD. For the comparison group, we only consider technologies that were not still included in the HBP-CPU by 2019. We also consider those used in the health system at least since 2012 but were not part of the HBP-CPU (these were not funded by the CPU). In that way, we could estimate effects for several years after the inclusion into the HBP-CPU. After the inclusion of one technology into the HBP-CPU, the overall effects show an increase of nearly 150% users per million affiliates, 50% more entries per technology, around 42% more on expenditures per patient, and a 42.6 pp extra on the probability of such technologies to be used in scattered areas. All these results were significant at the 95% confidence level. However, the dynamic specification shows differences in the pre-inclusion period for unique users and frequency variables, which are significant at the 95% level, which usually introduces a sign of caution for potential parallel-trends violation. However, Figure 4 shows that the differences observed post-intervention are considerably larger than those observed pre-intervention. Therefore, although there might be doubts on the precise estimate, the observed results are unlikely driven by differential trends before the inclusion into the HBP. The graph also evidenced that current data allow for solid conclusions.

We can illustrate the results obtained in our four examples.

For medications, the magnesium hydroxide was used in 2014 (2015) by around 11.77 (18.06) individuals per million affiliates. However, this number increased to 102.34 in 2016 (year of the inclusion) and even to 498.1 by 2019. Before 2016, the product was not used in scattered areas of the country, but it has been the case every year since. In terms of expenditures per capita, in 2014 it was 8.87 USD per year and dropped to 3.84 USD in 2016. The Quetiapine was more common: it was used in scattered areas and had approximately 1,111 users per million affiliates in 2013, a number that drop to 458 in 2014, the year of the inclusion. However, by 2016, it had 2,638 users, and by 2019, it reached 5,374. In terms of expenditures, we observe a reduction from 60 USD in 2013 to 41 USD and 19 USD in 2014 and 2019, respectively.

Concerning the procedures, the stress echocardiography included in 2014, grew from 83.5 unique users per million affiliates in 2013 to 556.7 in 2014, 1,155.7 in 2015, and increased to 2,073.2 in 2019. Moreover, its use only became common in scattered areas since its inclusion in the HBP. Meanwhile, the expenditures per capita started at 155 USD in 2012, then 73 USD in 2013, but it returned to approximately 140 USD the rest of the years. The procedures around the implantable hearing device were very uncommon before 2016: they were used by about 0.05 individuals per million affiliates per year between 2012 and 2015. In 2016, the figure became 0.91, and by 2019, it was already 10.29. Expenditures per capita were highly variable, moving from 84 to 245 USD before 2016, and by 2016, the average was 131 USD. However, the figure jumped to 1,133 USD in 2017 and 1,424 in 2018, and only got back to 115 USD in 2019. This procedure became used in scattered areas only by 2019.

If we consider the results by cohort (Table C1 in the appendix), we observe that increases in all variables are significant for inclusions in 2014, but specially for 2016. The 2018 cohort also present significant modest increases but in the number of users. Apart from expenditures per capita (negative but insignificant coefficient), the estimates of the impact for inclusions in 2017 are in the same direction but are not significant.

[Insert Table 3 here]

[Insert Figure 4 here]

Synthetic control.—The CS-DiD presents striking differences in some outcomes, but there were doubts about the comparability of some technologies before the inclusion. For instance, the 2016 cohort includes technologies with an important jump in frequencies and unique users (see Figure C1 in the Appendix). Hence, the synthetic control strategy will construct a comparison group where pre-trends are similar.

Table 4 presents the results per cohort for the proposed outcome variables, which are presented in levels. Figures C2 and C3 in the Appendix show the average time trends of the included technologies and their synthetic controls. First, it presents those included by the 2013 resolution and entered effectively in 2014 into the HBP. There is evidence of an increase in the total number of users per affiliate and its usage in scattered areas for the first two years. In terms of frequency, the increase is significant for the second to the fourth years. In the case of expenditures, the increase is not significant. However, the matching in the pre-inclusion period is not the best for the 2014 cohort, showing that reconstructing the treated units with the available controls was harder.

Second, for those included in 2017 and 2019, a sustained increase in unique users and usage in scattered areas was observed, but not in terms of frequency. The 2018 cohort coefficients are also positive and large, but they are not significant. Meanwhile, expenditure growth is observed in 2018 and 2019 cohorts. For 2017 and 2019, the matching in pre-trends is good, but less for 2018.

Third, the 2016 inclusions resulted in a substantial increase in the number of users and in frequencies. The coefficients for usage on scattered areas and expenditures are large, but not significant. Meanwhile, the pre-inclusion match is good, but not so much for the expenditure variable, where a preexistent difference explains the large but insignificant result for this variable.

Lastly, Figure 5 presents the overall results, which consider all but the 2019 cohort. There was an increase for at least two years in the number of unique users per million affiliates (161% and 168% for years 1 and 2, respectively). In terms of frequency per user, the increase is notoriously smaller and is significant for only one year (13% and 20%). Meanwhile, the usage increase also goes with a higher probability of usage in scattered areas (+38 pp and +41pp). For expenditures per user, the increase (12% and 20%) is not significant. These results agree with the CS-DiD result in terms of the number of users and usage in scattered areas, but smaller for frequency and expenditures per user.

[Insert Table 4 here]

[Insert Figure 5 here]

B. Type of Technology

The results presented above are larger in terms of unique users for the case of medications and almost nonexistent in terms of expenditures. When we consider only procedures, there is evidence of an increase in terms of unique users and expenditure per user (see Figure 6 Panel A). The ATT is of 119% for unique users per million affiliates. And it is of 64% for expenditure per user. For the case of medications, as shown in Figure 6 Panel B, the ATT of 110% for unique users per million affiliates, and of 6% (insignificant) for expenditures per user. Exact coefficients are presented in the appendix (panel A of table C2, and table C3. Event-study estimates for years four and five of unique users for medications are negative, reflecting a particular consideration of those technologies included in 2014 (from which these coefficients are identified).

Similar results are found when considering the synthetic control, but in this case the impact on expenditures in smaller for procedures (ATT = 24%/39% for the first/second year), and the large

impact on users for the case medications (155%/121% for the first/second year) is not significant. Results are presented in the panel B of appendix table C4 and figure C4.

For the case of medications, we can also consider whether the IHH and share of the market that goes through the institutional market are modified (see figure 7 and appendix table C3). Overall, there is a positive increase on the IHH, but is mostly drive by the results in years four and five, once again coming from years 4 and 5. If we consider the synthetic control instead (see panel C of appendix table C4 and figure C5), the coefficients are negative and insignificant. The coefficients for institutional share are insignificant using both the CS-DiD and the synthetic control.

As for our examples, for the Magnesium hydroxide the market concentration was stable over time, and the proportion of it that was through the institutional market. However, for the Quetiapine, we observe a de-concentration of the market, moving from an IHH=3,028 in 2013 to 1,802 in 2014. Also, the market went from being mostly "private" (44.%) to be dominated by the institutional sector (82.1%).

[Insert Figure 6 here]

[Insert Figure 7 here]

C. Inclusion of Technologies, Market Conditions, and HTA Heterogeneity

Finally, we estimate equation 10 to determine which characteristics are associated with the inclusion into the HBP. Table 5 shows the odds-ratios after estimating this model. Column 1 refers to all technologies, column 2 only to procedures, and columns 3 to 5 only to medications. Columns 4 and 5 include pharmaceutical market characteristics in the regression, but as some medications might not be traded every year, there are less observations available.

[Insert Table 5 here]

Interestingly, the number of users in the previous year reduces the odds of inclusion. Expenditure per user is not associated with the odds of inclusion. Generally, the odds of inclusions are larger for medications than for procedures. What notoriously increases the chances of inclusion for both types of technologies is being assessed by the HTA agency at the time of inclusion decision[22]. The OR for both procedures and medications is large, but we should consider that per inclusion less of 3% of the technologies is included. In total, 224 technologies were assessed by the HTA agency in the study period, and 115 of them were eventually included (51.3%), as compared to 587 inclusions out of 8,894 technologies not included by 2012 (6.6%) and which were not reviewed by the agency. For the case of medications, the odds of inclusion are not linked to the concentration of the market, the time since the registration in the country, the presence or not of generics; if anything, it is higher when more firms are available. Three characteristics are relevant. First, products which have been formerly regulated under the international reference pricing policy are more likely to be included in the HBP. Second, the share of the institutional sector (compulsory insurance companies and health provider institutions) in the transactions: the larger it is, the higher are the odds of inclusion. Third, essential medicines (according to the WHO model list) are less likely to be included. While most of the medicines in such lists were already included in HBP, still 21% of those used in 2012, but not in HBP, were part of the list.

Therefore, the inclusions of products, which were already used in the health system, seem to be driven by selecting the products that are not the most used by patients, for which there is a concern about expenses per user, and that are commonly purchased directly by the health system institutions.

Given the relevance of the HTA, figure 8 presents the main outcomes but considering only as treated those technologies which were included after a HTA process was undertaken by the agency (panel B of

[22] None of the technologies with a former HTA assessment is included, therefore we evaluate the concurrent cases. The Ministry of Health tends to contract HTA assessments to inform the inclusion decision.

appendix table C3)[23]. Overall, there is an average increase of 43.7% on unique users, but this number is not statistically different from zero. Using the synthetic control, the estimate is of 42%/38% for the first/second year, significant at the 95% level (panel C of appendix table C3 and panel B of figure C5). In terms of expenditure, as well there is no evidence of an increase or decrease with the CS-DiD (-9% insignificant), and of an increase of 24.4% (p-value = 0.09) with the synthetic control.

[Insert Figure 8 here]

V. Discussion and Conclusions

Although Colombian health expenditure per capita is low compared to developed countries, there is concern about the sustained increase in health expenditure in Colombia because it represents an important fiscal effort for the country that generates a latent risk of sustainability. Hence, the importance of monitoring and evaluating the impact of the progressive update processes of the HBP-UPC on the spending structure of the system, mainly because it has been identified that 44% of the growth in health spending is explained by the pressure that technological changes they exert on the health system (Gutiérrez 2018).

This study analyzed the effect that the periodic introduction of new technologies within the HBP-CPU, due to the legal mandate to update it regularly, has had on some important fronts of the health system's performance: in the frequency of use and access to these technologies, in the number of users who use them, in the expenditures per user incurred by the Colombian health system and in the use of these technologies in remote or difficult to access regions. The study also explored the role played by factors, such as health technologies assessment and some characteristics of the Colombian pharmaceutical markets, in the dissemination of the technologies recently introduced in the HBP-CPU.

[23] Inclusions in the period of analysis which were not reviewed by the HTA agency are excluded in the sample.

Finally, the analysis also explored the influence of these elements on the probability of inclusion of health technology in the HBP-CPU.

Due to the characteristics of the institutional arrangement of the Colombian health system, two types of statistical methods were used in the evaluation exercise, the Callaway and Sant'Anna method and the synthetic control method, which allow a better understanding of the heterogeneity in the treatment effect, especially when there are multiple periods, variations in the temporality of the treatment and it is important to differentially weight the units that are expected to be used in the preparation of the appropriate counterfactual.

The results obtained using the two methods are consistent. Although the magnitudes of the effects obtained in the two cases differ, the expected signs of the different effects estimated using both methods are congruent. In general terms, the inclusion of a health technology in the HBP-CPU results in increases in the number of new unique users accessing that technology and in the number of times the same patient uses it. However, in the period from 2014 to 2018, the increase in the frequencies of use of the technologies included in the update did not increase expenditure per person, while in the last year of the update analyzed (2019) an increase in expenditure did take place in relation to the inclusion of new technologies in HBP. Thus, during the longest period of observation, per capita expenditure in the health system did not significantly change in relation to the update.

Similarly, although not as clearly as with the previous variables, it can be observed that after the introduction of a technology there is an increase, in some periods, in user access in distant and dispersed areas of the country's geography. However, when technologies are differentiated between drugs and clinical procedures, the entry of drugs into the HBP is followed by an increase in the number of new users who use them while, again, there is no significant increase in expenditure. The opposite occurs with clinical procedures, where new users are few, but the increase in expenditure that is generated appears to be significant. A potential explanation for this result consists of relatively large

capabilities to meet increasing demands for drugs in any region of the country; however, for procedures it becomes harder to expand the supply of services as they require specialized equipment and staff. Thus, the increases in the number of users and its usage in scattered areas are not as noticeable in the first years. Also, higher costs reflect the efforts of building capabilities in more cities and regions of the country.

In relation regarded to the factors that affect the probability of a technology's inclusion in the HBP-CPU, those that are positively associated with increases in the possibility of being included in the HBP are the submission of a technology to an HTA process (regardless of whether it is a drug or a procedure), that its price is regulated (particularly through the international reference price mechanism) and that its sales are mainly made in the institutional market, which supplies health insurers and health service providers.

These findings show that, to the extent that the updating of the HBP-CPU in Colombia follows a prioritization and updating process led by the MHSP, the IETS as the agency in charge of conducting the HTA contributes to improving the performance of the Colombian health system. This is because it allows to support decisions about what is financed and what is not financed through pre-established and socially and politically accepted criteria, and improving efficiency in the allocation of resources to cover those interventions that have the greatest impact on the general health of the population.

The study has three limitations. First, it is important to determine whether the periodic updating of HBP impacts health outcomes and to what extent; after all, the central objective of public health policies is to improve population's health outcomes. In this study, this question remains open to the extent that, due to the structure of the databases used and the type of data included in them, it is impossible to link the findings obtained in updating the HBP with health outcomes. A step to follow in our future research agenda is to build these links and investigate whether there is a positive relationship

between well-founded health prioritization processes with improvements in the population's health outcomes and through what specific mechanisms this would occur.

Second, we did not analyze in depth the potential substitution patterns between technologies that are therapeutic substitutes due to the increased demand of recently introduced drugs. This study does not measure the proportion of the increase in the usage of a given technology that is explained because (i) unmet needs which are now resolved, (ii) of the substitution of "older" technologies that were in place, or (iii) the displaced demand coming from private insurance companies or out-of-pocket expenditures. These characteristics are likely to depend to the specific case of each technology and are particularly hard to provide a general number mainly because several of the inclusions covered entire therapeutic areas in the same year. Hence, we cannot know to what extent the low impact on health expenditure found in our study is partly due to these substitution effects.

Third, the work accounts for half of the insured population in the country, those linked to the CR with the capacity to pay. This is due, once again, to the fact that the used databases exclude data from the SR to the extent that the administration of this regime is in the hands of the country's departmental and municipal governments, which do not have a unified and standardized quality information system on the technologies and benefits provided to the population without the capacity to pay or not linked to the formal sector of the economy. However, given the mandatory convergence of benefit plans between CR and SR, it is expected that the information systems will be unified under the current structure of those that exist under CR.

VI. Public Policy Recommendations

Given the findings of the study and, notwithstanding the aforementioned limitations, several public policy recommendations can be made. First, it is crucial for both the improvement of health outcomes and strengthening the long-term financial sustainability of the health system to advance in the

construction and consolidation of an explicit and effective prioritization system, aimed at the coverage with public resources of technologies that generate demonstrable therapeutic benefits and the strict exclusion of those that do not.

Second, this implies that designing, organizing, and establishing a set of health technologies (in continuous revision), unifying sources and financing mechanisms, for example reconceptualizing the CPU and eliminating *recobros*[24], since the latter constitute a source of income. Implicit reimbursement for technologies whose value has not been demonstrated and that may be diverting public resources from more profitable uses and with a good opportunity cost. In this sense, it is essential to strengthen a horizon scanning system on new health technologies that can reach the country and establishment of a cost-effectiveness threshold (along with other criteria), for evidence-based decision-making in public health policy in Colombia.

Third, our study showed that the inclusion of health technologies in HBP-CPU did not result in lower health expenditures per user, then the financial pressure remained. Therefore, in a context like the Colombian one where the coverage of health technologies with public resources is growing, especially in drugs, it is recommended to adopt expenditure management mechanisms that integrate health services coverage policies with price regulation measures actively and dynamically.

Fourth, an important part of the prioritization system is the IETS. A health technology assessment agency provides a country with legitimacy, scientific precision and efficiency in the decision-making process on the set of health technologies to be financed. In our research, the drugs and procedures that had an HTA before inclusion in HBP-UPC, did not represent a future higher health expenditure per user. In the context of budgetary constraints, these types of technical-scientific entities can contribute to maximizing future health outcomes for the population through studies of cost effectiveness, cost utility,

[24] By 2020, the payment mechanism "recoveries" became one now called maximum budgets, where the health insurer is no longer paid the reimbursement of the ex-post health intervention but is given a prospective ex-ante budget (which projects how much will be spent on health technologies that are not funded by the HBP-CPU but are delivered to users).

cost benefit, budget impact analysis, clinical guidelines, among others. Thus, the IETS could play an even more prominent role in the process of updating the HBP-CPU in the Colombian health system, not only evaluating health technologies for their inclusion but also afterward (post-introduction evaluations in the HBP-CPU, strengthening monitoring schemes), which would allow the correct prioritization of funds destined for this item in the country.

In summary, prioritization and updating processes have important effects on the performance of the health system. This study have estimated some of them and, based on them, we have made some public policy recommendations that seek to increase the capacities of policymakers and that are realistic and feasible in the Colombian health context.

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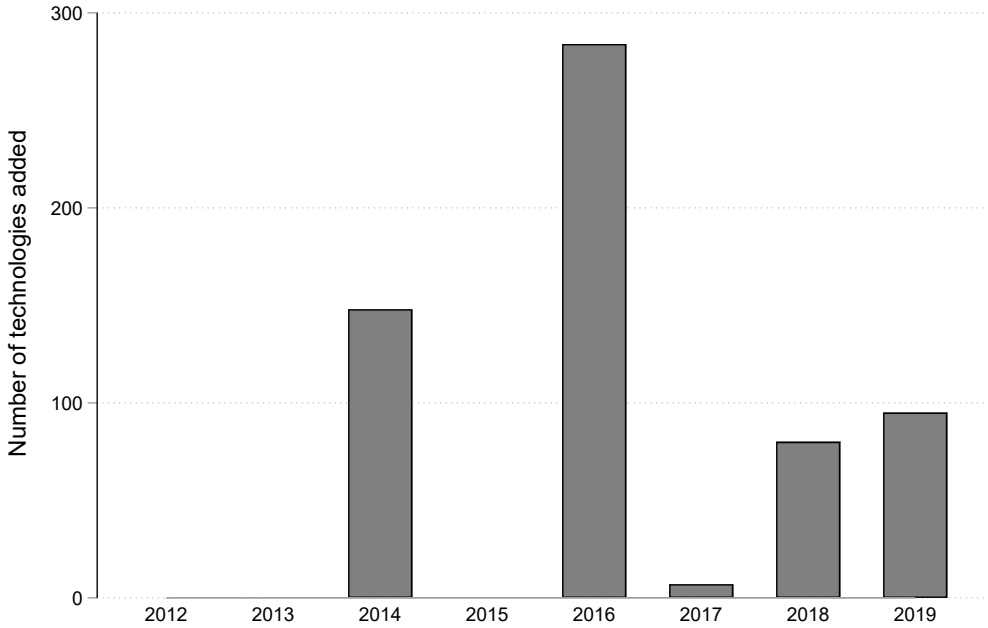
Figures

Figure 1: Timeline of HBP-CPU development in Colombia

Data	POS	1993	**Law 100: Introduction of POS implement**
		2008	**Sentence T-760: Government forced to the updating process**
		2009	Agreement 008 - CRES
		2011	**Law 1438: Updating process defined**
	HBP-CPU	2011	Agreement 029 - CRES
		2013	Resolution 5521 - MHSP
		2014	Resolution 5926 - MHSP
		2015	**Law 1751: Role of HBP-CPU changed**
		2015	Resolution 5592 - MHSP
		2016	Resolutions 0001 and 6408 - MHSP
		2017	Resolutions 0374, 1687 and 5269 - MHSP
		2018	Resolutions 0046 and 5857 - MHSP
		2019	Resolution 3512 and Circular 017 - MHSP
		2020	Resolution 2481 - MHSP
		2021	Resolution 0163 - MHSP

Note: own elaboration.

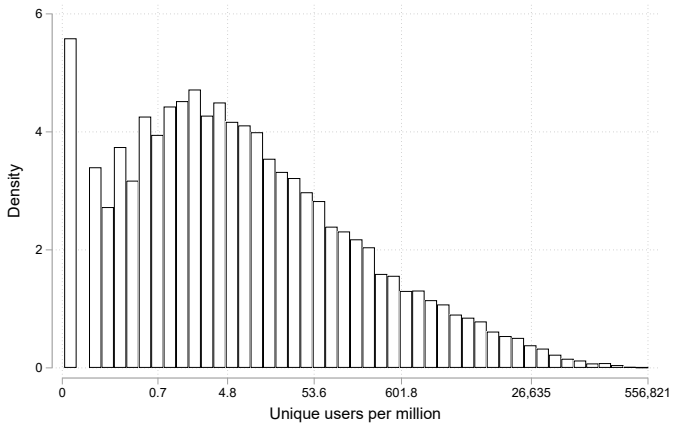
Figure 2: Inclusion process of technologies in the Colombian HBP-CPU



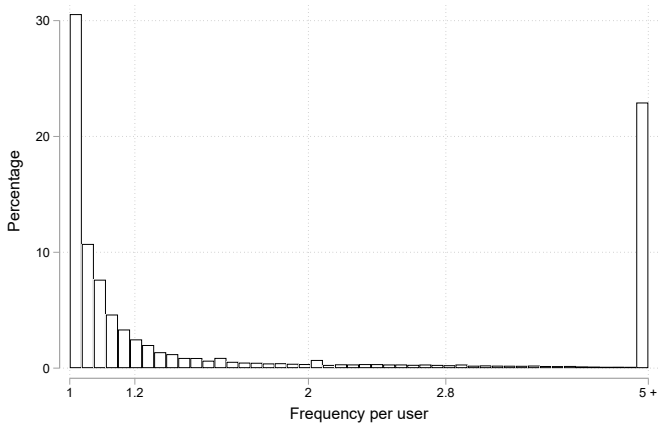
Notes: total number of technologies observed to be included in the HBP-CPU.

Figure 3: Distribution of the main outcomes of interest

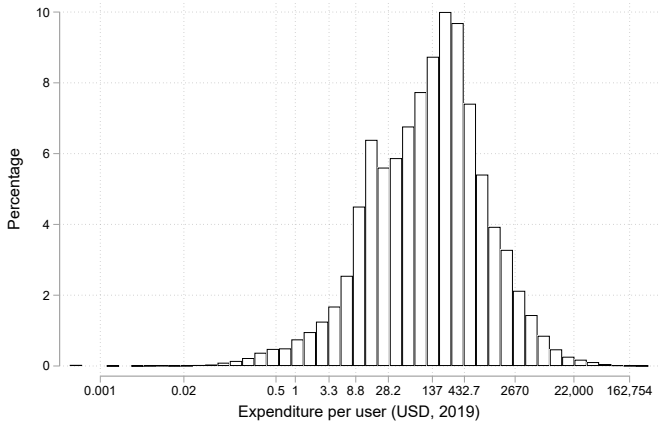
Panel A. Unique users per million of affiliates



Panel B. Frequency per unique user



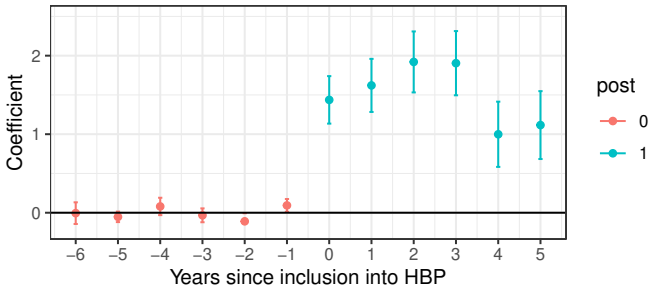
Panel C. Expenditure per individual (USD)



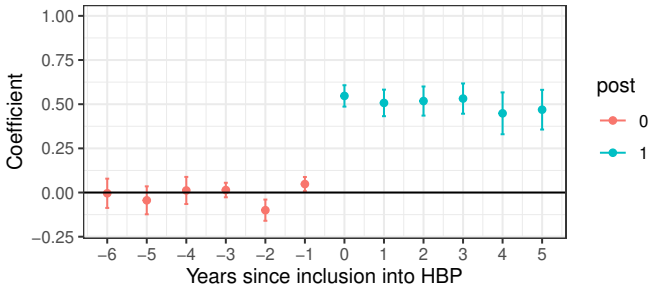
Notes: own calculation using Epanechnikov kernels.

Figure 4: Dynamic effects Callaway-Sant'Anna DiD

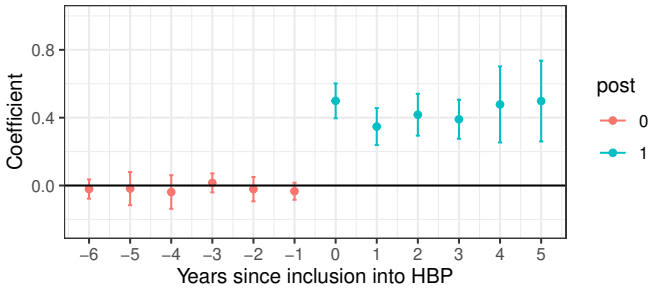
Panel A. Unique users per million affiliates



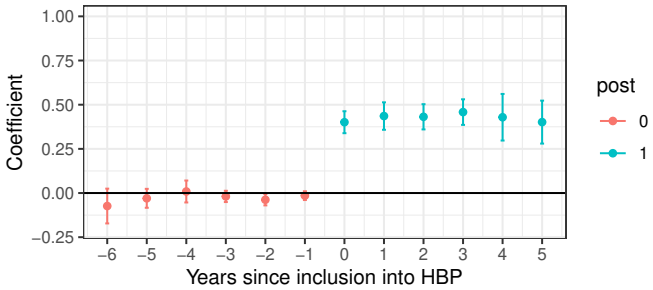
Panel B. Frequency per user



Panel C. Expenditure per individual (Million COP)



Panel D. Scattered areas usage



Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Includes 95% confidence intervals.

Figure 5: Outcomes over time: inclusions and their synthetic control

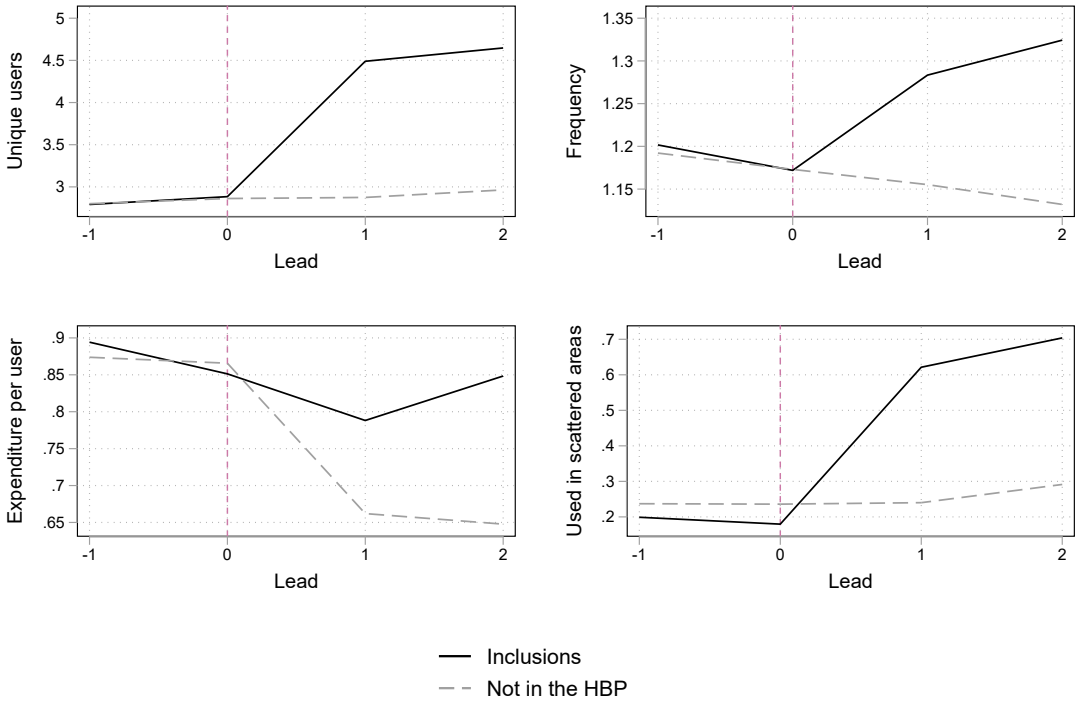
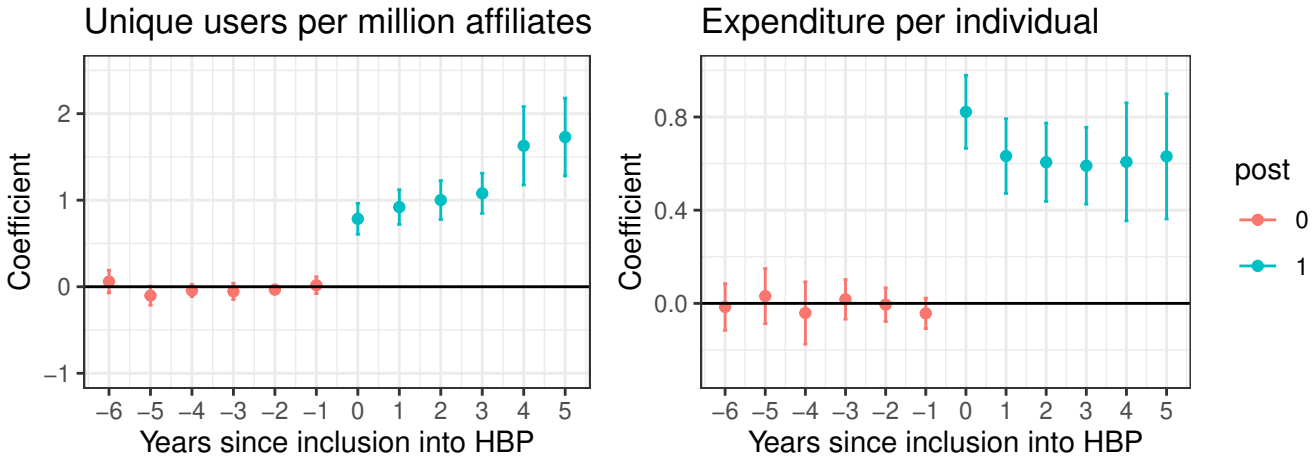
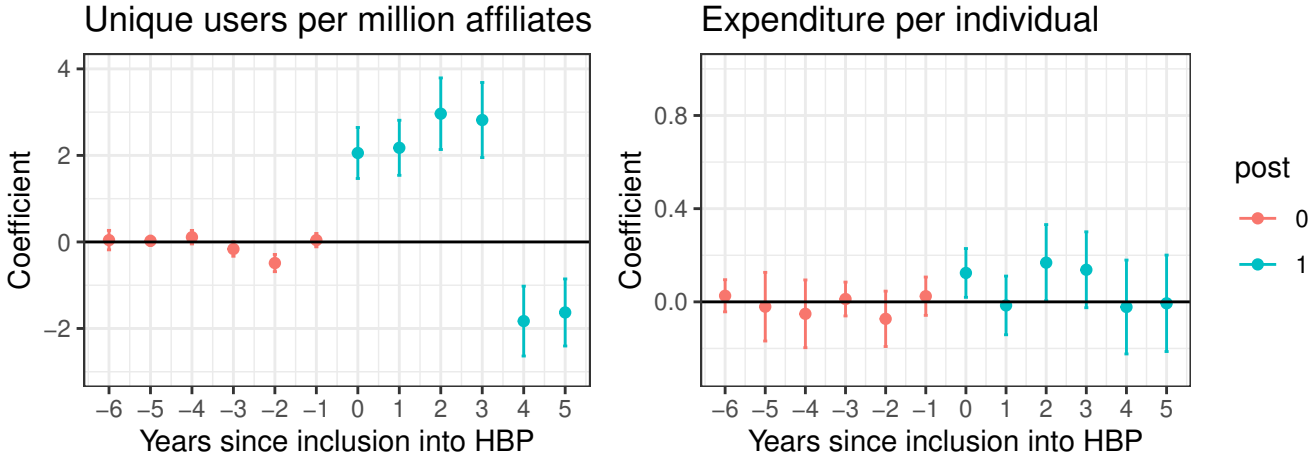


Figure 6: Dynamic effects CS-DiD by type of technology

Panel A. Procedures

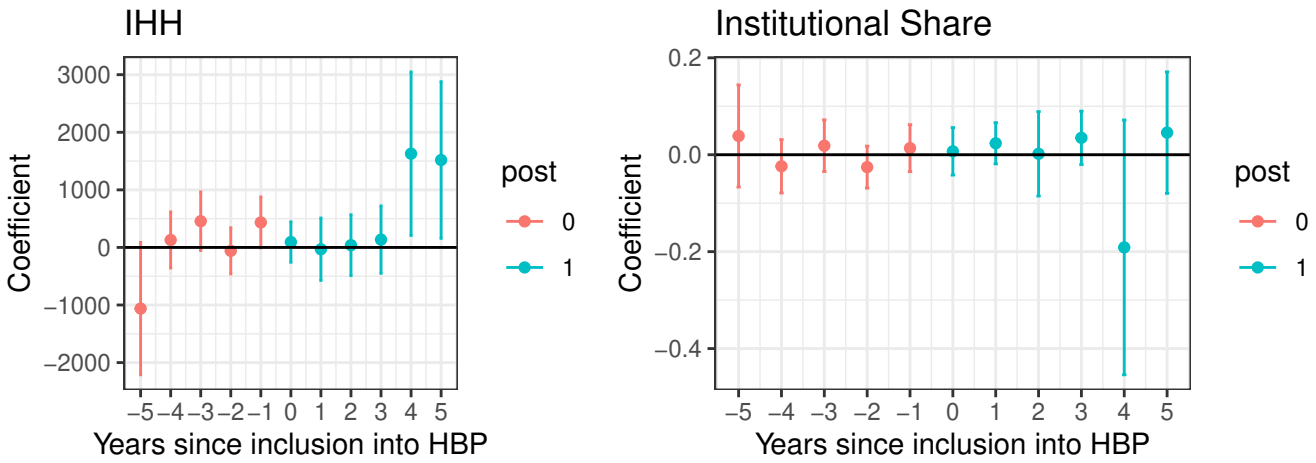


Panel B. Medications



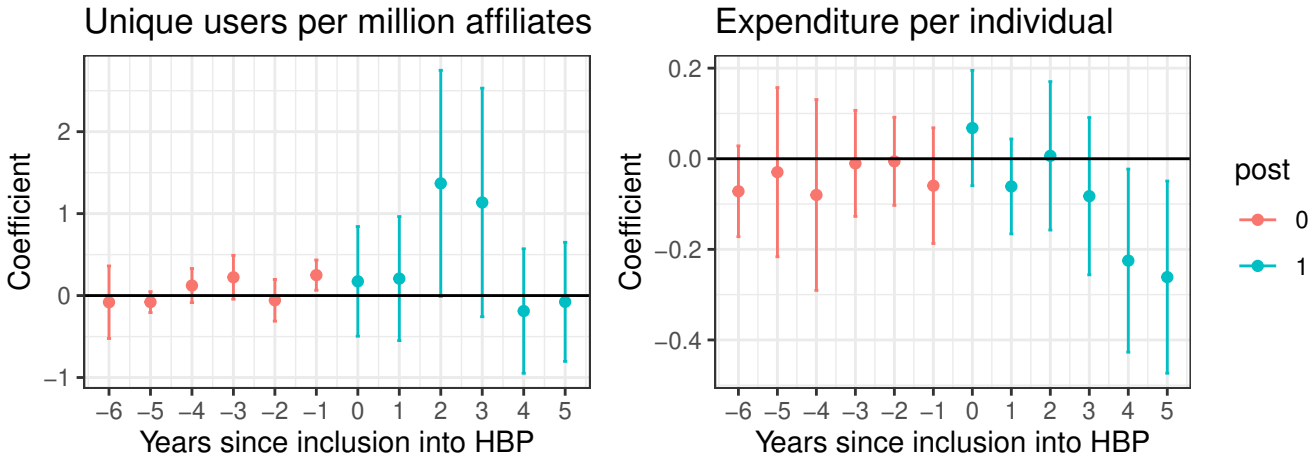
Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Includes 95% confidence intervals.

Figure 7: Dynamic effects CS-DiD on pharmaceutical markets



Notes: markets are defined over ATC5. Coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Includes 95% confidence intervals.

Figure 8: Dynamic effects CS DiD for technologies assessed by the HTA agency



Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Includes 95% confidence intervals.

Tables

Table 1: Criteria for updating HBP in a selected group of countries

	Canada	Chile	Colombia	Ethiopia	India	England	Kenya	Malaysia	Mexico	Norway	New Zealand	Netherlands	Uruguay
Panel A. Characteristics of the system													
Advance of the UHC	90	74	74	47	47	88	52	67	61	94	83	90	69
Explicit HBP	Yes	Yes	Mix	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Central system	No	Yes	Yes	No	No	Yes	Yes	Yes	Mix	Mix	Mix	Yes	Yes
Panel B. Determinant Criteria of HBP													
Intervention-related criteria													
Cost-effectiveness	X	X	X	X	X	X	X	X	X	X	X	X	X
Effectiveness	X	X	X	X	X	X	X	X	X	X	X	X	X
Budget impact	X	X	X	X	X	X	X	X	X	X	X	X	X
Safety	X	X	X	X	X	X	X	X	X	X	X	X	X
Sustainability	X	X		X	X	X	X	X	X	X	X		X
Cost of interventions	X	X		X	X	X	X	X	X	X	X	X	X
Maximising the improvement of population health status	X	X	X			X	X	X		X	X	X	X
Innovation	X					X		X		X	X	X	
Disease-related criteria													
Burden of disease		X	X	X	X		X		X				X
Severity of disease			X	X	X		X		X				X
Community-related criteria													
Equity	X	X	X	X	X	X	X	X	X	X	X	X	X
Affordability	X	X	X	X	X	X	X	X	X	X	X	X	X
Access	X	X	X	X	X	X	X	X	X	X	X	X	X

Notes: own elaboration based on Hayati et al. (2018) criteria categories. Advance of the UHC is measured with the effective coverage of health services index from (Lozano et al., 2020).

Table 2: Mean of products' characteristics per year

	2012	2013	2014	2015	2016	2017	2018	2019
Panel A. Any technology								
Frequency per user	1.017	0.992	0.979	0.994	1.151	1.181	1.084	1.125
Unique users per million	669.260	740.116	840.172	797.371	1,236.804	1,257.048	1,200.625	1,311.379
Expenditure per user (million COP)	2.151	1.855	1.379	1.749	2.045	2.696	1.732	1.878
Expenditure per user (USD, 2019)	655.510	565.402	420.317	532.978	623.423	821.653	527.743	572.531
Technology is a procedure	0.813	0.813	0.813	0.813	0.813	0.813	0.813	0.813
Included in the HBP	0.000	0.000	0.022	0.024	0.061	0.062	0.073	0.086
Usage in scattered areas	0.373	0.382	0.386	0.410	0.470	0.467	0.456	0.485
Has a HTA study	0.000	0.000	0.004	0.005	0.010	0.010	0.021	0.025
Panel B. Only medications								
WHO essential medicine 2021	0.216	0.214	0.195	0.201	0.216	0.213	0.213	0.215
Price cap regulation	0.185	0.192	0.192	0.207	0.204	0.208	0.212	0.210
Only one firm per ATC5	0.036	0.029	0.030	0.035	0.043	0.043	0.041	0.042
Years from registry oldest product	19.791	19.788	19.229	18.717	18.432	18.048	17.846	17.744
Presence of generics	0.528	0.543	0.525	0.514	0.508	0.494	0.486	0.493
IHH of both market ATC4		2,966.848	2,919.920	2,428.763	2,601.793	2,436.336	2,939.776	2,952.222
IHH of both market ATC5		4,708.722	4,497.491	4,069.868	4,246.310	4,170.329	4,427.873	4,421.823
Firms per ATC4		56.001	54.669	55.691	55.672	56.964	57.242	55.800
Firms per ATC5		17.014	15.949	16.349	15.956	16.074	16.231	15.939
Share institutional market ATC4		0.334	0.450	0.615	0.632	0.630	0.483	0.503
Share institutional market ATC5		0.382	0.465	0.572	0.604	0.605	0.519	0.544

Notes: panel A presents usage variables derived from SUFICIENCIA and RECOBROS datasets, plus the cumulative proportion of technologies included in the HBP, and with a HTA. Panel B is based on own calculations using SISMED's transactions per product for the previous two years, and INVIMA registries. HTA corresponds to the inclusion of products in any HTA.

Table 3: Impact of inclusion into HBP Callaway-Sant'Anna DiD

	Unique users per million affiliates			Frequency per user			Expenditure per user (Million COP)			Scattered areas (1: Yes, 0 No)		
time	ATT	Std. Error		ATT	Std. Error		ATT	Std. Error		ATT	Std. Error	
-6	-0.0054	0.0528		-0.0043	0.0298		-0.0207	0.0217		-0.0736	0.0344	
-5	-0.0527	0.0258		-0.044	0.0274		-0.0183	0.0397		-0.0299	0.0189	
-4	0.08	0.038		0.0117	0.0285		-0.0384	0.037		0.0087	0.0193	
-3	-0.033	0.0331		0.0141	0.0151		0.0156	0.0221		-0.0191	0.011	
-2	-0.1096	0.0363	*	-0.0999	0.0221	*	-0.0214	0.0298		-0.0379	0.0105	
-1	0.0933	0.0296	*	0.0479	0.0147	*	-0.0337	0.0208		-0.0148	0.0088	
0	1.4372	0.1138	*	0.5468	0.0248	*	0.4992	0.0389	*	0.4009	0.0233	*
1	1.6212	0.1348	*	0.5072	0.0289	*	0.3475	0.0441	*	0.4357	0.0255	*
2	1.9205	0.1432	*	0.5178	0.0321	*	0.4175	0.0466	*	0.4315	0.025	*
3	1.9043	0.1422	*	0.5318	0.0288	*	0.3907	0.0484	*	0.4581	0.0247	*
4	0.9989	0.1478	*	0.4483	0.0432	*	0.4781	0.0842	*	0.4289	0.0425	*
5	1.116	0.1748	*	0.4689	0.0419	*	0.4981	0.0952	*	0.4015	0.0434	*
Overall	1.4997	0.1135	*	0.5035	0.0274	*	0.4276	0.0411	*	0.4261	0.0214	*

Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Significant at 95% level: *.

Table 4: Impact of inclusion into HBP Synthetic Control: Group-Time Average Treatment Effects

		Unique users per million affiliates			Frequency per user			Expenditure per user (Million COP)			Scattered areas (1: Yes, 0 No)		
Group	Time	ATT	p-value		ATT	p-value		ATT	p-value		ATT	p-value	
2014	2014	2.167	< 0.001	*	0.344	0.234		0.596	0.382		0.282	$0 < 0.001$	*
2014	2015	2.345	< 0.001	*	0.497	< 0.001	*	0.666	0.237		0.372	$0 < 0.001$	*
2014	2016	0.988	0.666		0.298	0.044	*	0.682	0.732		0.446	0.24	
2014	2017	0.643	0.653		0.455	0.001	*	0.894	0.408		0.42	0.24	
2014	2018	0.445	0.74		0.359	0.44		1.077	0.254		0.414	0.424	
2014	2019	0.578	0.677		0.393	0.578		1.092	0.248		0.445	0.24	
2016	2016	2.052	0.254		0.233	0.554		0.123	0.003	*	0.318	0.423	
2016	2017	1.858	< 0.001	*	0.27	< 0.001	*	0.361	0.436		0.376	0.423	
2016	2018	2.103	< 0.001	*	0.166	0.691		0.3	0.026	*	0.311	0.423	
2016	2019	2.155	< 0.001	*	0.195	0.444		0.36	< 0.001	*	0.354	0.426	
2017	2017	4.657	0.025	*	0.256	0.298		-0.015	0.916		0.979	< 0.001	*
2017	2018	4.64	0.025	*	0.218	0.531		0.142	0.165		0.915	0.007	*
2017	2019	4.89	0.025	*	0.286	0.293		0.202	0.145		0.97	< 0.001	*
2018	2018	1.451	0.719		0.151	0.565		0.637	< 0.001	*	0.679	< 0.001	*
2018	2019	1.974	0.07		0.144	0.006	*	0.617	< 0.001	*	0.743	< 0.001	*
2019	2019	2.791	< 0.001	*	0.493	0.314		0.488	< 0.001	*	0.763	< 0.001	*
Overall	0	1.614	0.001	*	0.128	0.031	*	0.126	0.774		0.381	< 0.001	*
Overall	1	1.683	0.001	*	0.192	0.839		0.201	0.682		0.413	< 0.001	*

Notes: coefficients obtained after a synthetic control implemented with *synth_runner* package in Stata 16. Robust p-values are derived from permutation tests after 1'000,000 placebo averages. Significant at 95% level: *.

Table 5: Odds-Ratio after a logistic regression over technologies not included before in the HBP

	(1)	(2)	(3)	(4)	(5)
	ALL	Procedures		Medications	
Medication × asinh unique users per million	0.946*				
	(0.0283)				
Procedures × asinh unique users per million	0.736***				
	(0.0567)				
asinh unique users per million		0.750***	0.930**	0.888***	0.884***
		(0.0627)	(0.0283)	(0.0293)	(0.0298)
Medication × asinh expenditure per user	1.019				
	(0.0736)				
Procedures × asinh expenditure per user	1.128				
	(0.117)				
asinh expenditure per user		1.139	1.049	0.952	0.955
		(0.120)	(0.0751)	(0.0796)	(0.0784)
Technology is a procedure	0.194***				
	(0.0515)				
HTA in the year of inclusion	104.8***	41.04***	128.7***	121.0***	118.8***
	(24.17)	(31.09)	(36.12)	(35.60)	(33.94)
WHO essential medicine				0.576**	0.535**
				(0.145)	(0.133)
Price cap regulation				1.385	1.295
				(0.343)	(0.317)
Only one firm per ATC5				0.805	0.753
				(0.172)	(0.174)
Years from registry oldest product				1.000	1.001
				(0.0163)	(0.0172)
Presence of generics				1.235	1.116
				(0.234)	(0.220)
Firms per ATC4 Last 2 years				1.004**	
				(0.00156)	
Firms per ATC5 Last 2 years					1.007*
					(0.00391)
Share institutional market ATC4 Last 2 years				6.154***	
				(2.007)	
Share institutional market ATC5 Last 2 years					3.502***
					(0.914)
IHH of both market ATC4 Last 2 years				1.000	
				(0.0000419)	
IHH of both market ATC5 Last 2 years					1.000
					(0.0000489)
Constant	0.0317***	0.00314***	0.0430***	0.00714***	0.0105***
	(0.00528)	(0.00123)	(0.00703)	(0.00261)	(0.00428)
Observations	32026	21362	5519	5449	5449
Technologies included	7764	6268	1478	1455	1455
Pseudo-R2	0.305	0.0905	0.298	0.324	0.316

Notes: Odds-ratios after a logistic regression which includes years fixed effects. *asinh* refers to the inverse hyperbolic sine transformation of the value of the variable. Clustered at technology level, standard errors in parentheses. Significance: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

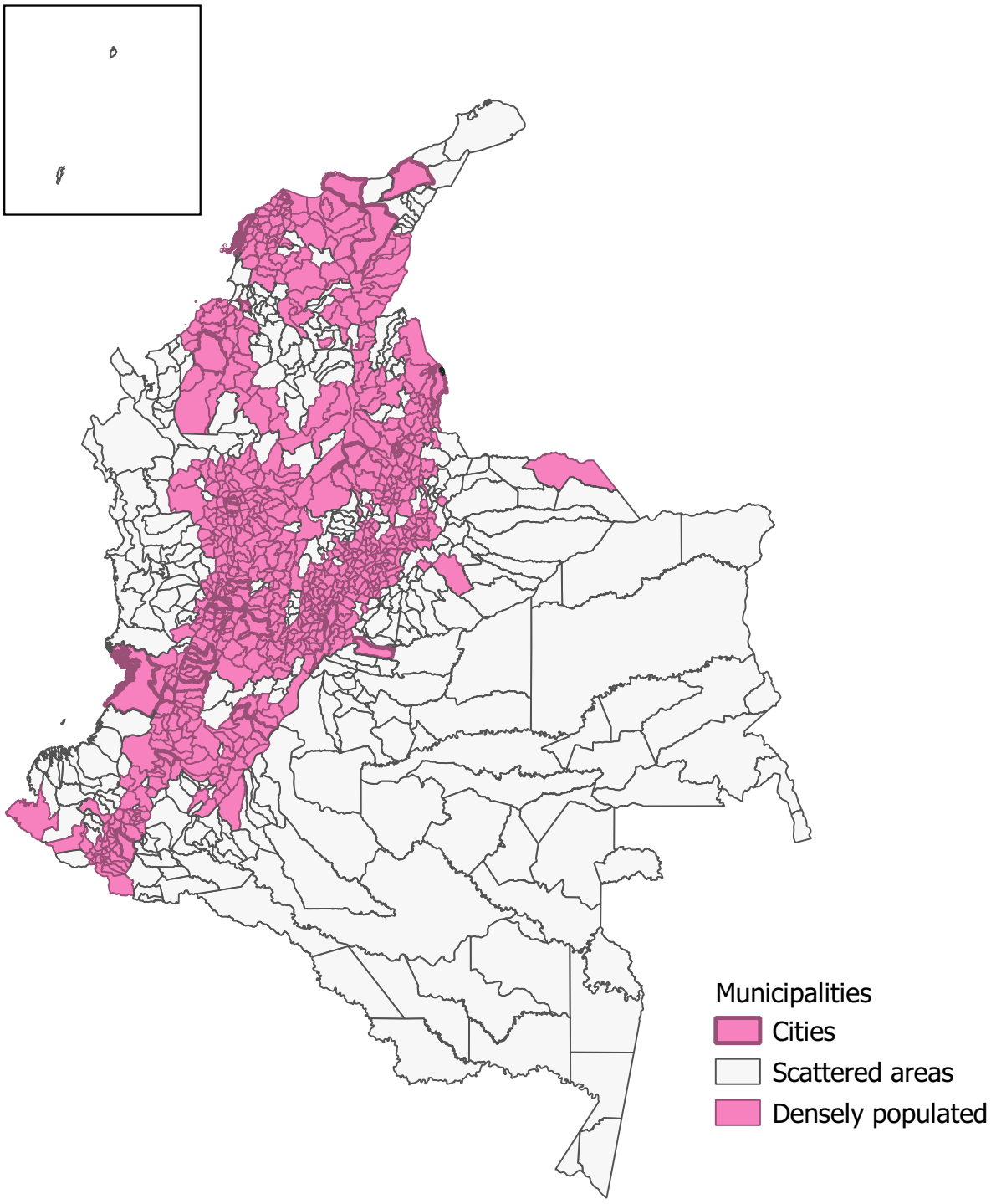
A Determining criteria of HBP in a selected group of countries

In theory, almost all of these criteria are used in the definition and updating of HBP in virtually all countries included in the referencing. However, this may not be the case and, at least in the literature consulted, it was not possible to establish the distance between official statements of intent and what actually happens in practice. On the other hand, some criteria often lack clear definitions or are difficult to instrumentalise and implement, such as sustainability, innovation, equity, affordability and access insofar as they link debatable concepts such as those associated with ethical and normative considerations in the value-related category with other concepts on which there is not complete agreement, such as health or sustainability.

B Construction of the dataset

Variable name	Description	Source database
CODMUNI	Municipality code. Allows to identify the CPU analysis zones.	Suficiencia
FECHASERV	Date on which the health technology was required	Suficiencia
ACTIVIDAD	Identifies the health technology in demand	Suficiencia
VALORTOTAL	Expenditure on demanded health technology	Suficiencia
IDEANONIMA	User identifier. It allows to obtain the unique people who demanded health technologies.	Suficiencia
VALORRECOBRADO	Expenditure on demanded health technology	Recobros
MESSUMINISTRO	Month in which the health technology was required	Recobros
ANOSUMINISTRO	Year in which the health technology was required	Recobros
NITPROVEEDOR	NIT of the service provider. It is used to identify the CPU analysis zones in this base.	Recobros
NOMBREPROVEEDOR	Name of service provider	Recobros
CODMEDSERPREST	Health technology code	Recobros
NOMMEDSERPREST	Health technology name	Recobros

Figure B1: Scattered areas



C Additional tables and figures

Table C1: Impact of inclusion into HBP Callaway-Sant'Anna DiD: Group-Time Average Treatment Effects

		Unique users per million affiliates			Frequency per user			Expenditure per user (Million COP)			Scattered areas (1: Yes, 0:No)		
Group	Time	ATT	Std. Error		ATT	Std. Error		ATT	Std. Error				
2014	2013	-0.0296	0.0146		0.0021	0.0279		-0.0204	0.0276		-0.0375	0.0254	
2014	2014	0.4183	0.1285	*	0.4773	0.048	*	0.4426	0.0783	*	0.0836	0.0464	*
2014	2015	0.8072	0.1562	*	0.4698	0.0536	*	0.3774	0.076	*	0.245	0.0511	*
2014	2016	0.9687	0.1396	*	0.4947	0.048	*	0.4719	0.0852	*	0.3762	0.0469	*
2014	2017	0.8322	0.1496	*	0.4807	0.049	*	0.4499	0.0886	*	0.3583	0.0447	*
2014	2018	0.9989	0.1633	*	0.4483	0.0447	*	0.4781	0.079	*	0.4289	0.0424	*
2014	2019	1.116	0.1709	*	0.4689	0.0435	*	0.4981	0.0911	*	0.4015	0.0471	*
2016	2013	-0.1141	0.0274	*	-0.001	0.0225		0.007	0.0297		-0.0069	0.0132	
2016	2014	-0.1926	0.0417	*	-0.1818	0.029	*	-0.042	0.0398		-0.0078	0.0101	
2016	2015	0.052	0.0223		0.0516	0.0216		-0.0332	0.0295		-0.0105	0.0087	
2016	2016	2.5323	0.2037	*	0.6858	0.0374	*	0.4439	0.0578	*	0.445	0.0311	*
2016	2017	2.4649	0.1965	*	0.5851	0.0375	*	0.3393	0.0595	*	0.4826	0.0311	*
2016	2018	2.4224	0.2052	*	0.5377	0.0362	*	0.4046	0.0581	*	0.4604	0.0305	*
2016	2019	2.463	0.1993	*	0.5584	0.037	*	0.3599	0.052	*	0.5101	0.0307	*
2017	2013	-0.2975	0.1655		-0.299	0.2399		-0.2951	0.3179		-0.0105	0.0034	
2017	2014	-0.0652	0.0743		0.0316	0.031		0.0639	0.0471		-0.0042	0.004	
2017	2015	-0.1163	0.3215		0.1219	0.2052		0.0461	0.1533		-0.021	0.0041	
2017	2016	0.5723	1.1622		0.0435	0.1729		0.2622	0.3798		0.0984	0.1812	
2017	2017	1.5878	1.0689		0.3074	0.1833		-0.0987	0.3511		0.4309	0.1574	
2017	2018	1.4762	1.0902		0.1395	0.166		-0.1034	0.2996		0.4475	0.1583	
2017	2019	1.6808	1.0852		0.1984	0.2401		-0.2104	0.2987		0.4268	0.159	
2018	2013	-0.0599	0.0282		-0.0517	0.049		-0.0861	0.0779		-0.023	0.0235	
2018	2014	-0.0169	0.0276		0.0096	0.0521		0.0154	0.0895		-0.0417	0.0303	
2018	2015	0.2636	0.0879	*	0.0512	0.0392		0.0112	0.0586		0.004	0.032	
2018	2016	-0.2785	0.0745	*	0.0404	0.0371		0.1059	0.0753		-0.0694	0.0315	
2018	2017	0.3891	0.1084	*	0.1005	0.043		0.097	0.0695		-0.0476	0.0284	
2018	2018	-0.0346	0.1498		0.3795	0.0615	*	0.5992	0.135	*	0.5666	0.06	*
2018	2019	0.1445	0.1137		0.3322	0.0569	*	0.3609	0.1122	*	0.6209	0.0571	*
2019	2013	-0.0054	0.0519		-0.0043	0.03		-0.0207	0.0201		-0.0736	0.0337	
2019	2014	-0.0467	0.0383		-0.0376	0.0267		0.0388	0.0286		-0.0358	0.0247	
2019	2015	0.1895	0.0669		0.0364	0.0316		-0.0648	0.0243		0.0526	0.0331	
2019	2016	-0.0382	0.101		0.0268	0.0257		0.0416	0.042		-0.076	0.0383	
2019	2017	0.2813	0.1038		0.0105	0.038		-0.0721	0.0461		-0.1029	0.0342	
2019	2018	0.1235	0.1393		0.064	0.0452		-0.1876	0.0676		0.0271	0.0214	
2019	2019	0.9787	0.1853	*	0.3984	0.0454	*	0.7125	0.101	*	0.6214	0.0466	*

Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Standard errors are presented in parentheses. Significant at 95% level: *.

Figure C1: Unique users and inclusion cohorts over time

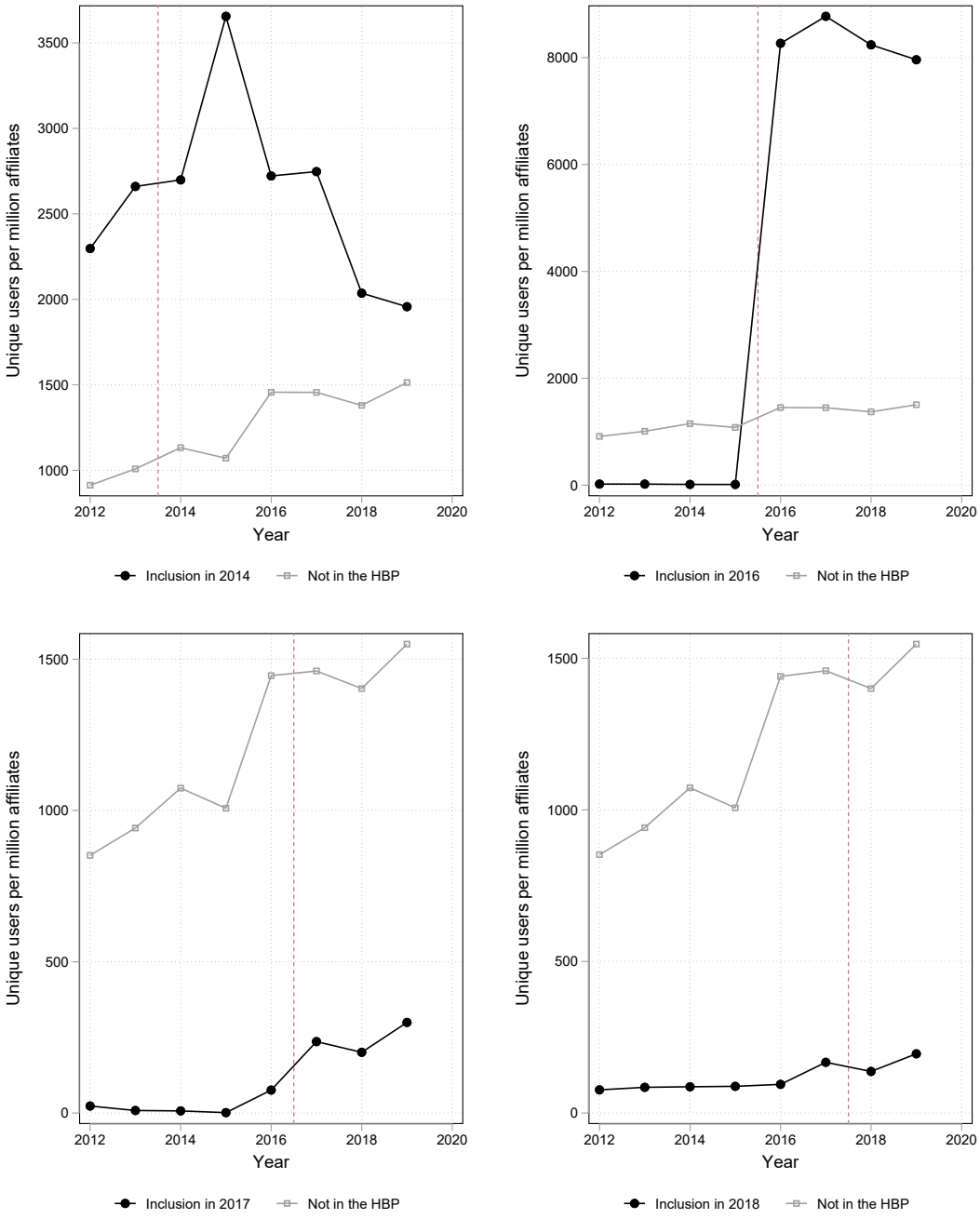
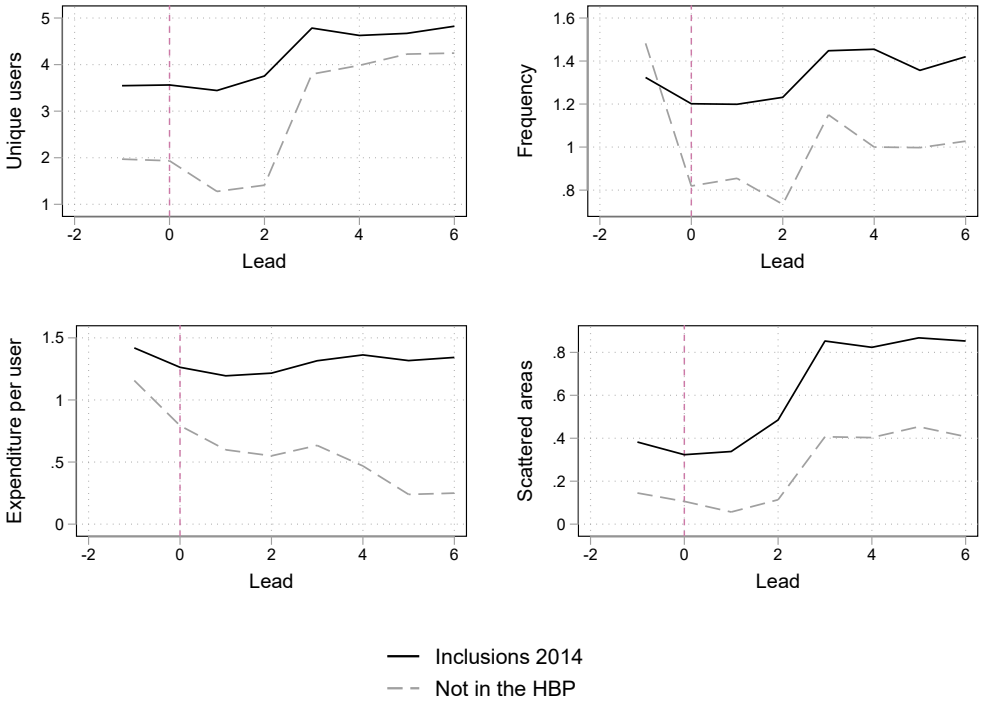


Figure C2: Synthetic control: group-time trends (I)

Panel A. Inclusions in 2014



Panel B. Inclusions in 2016

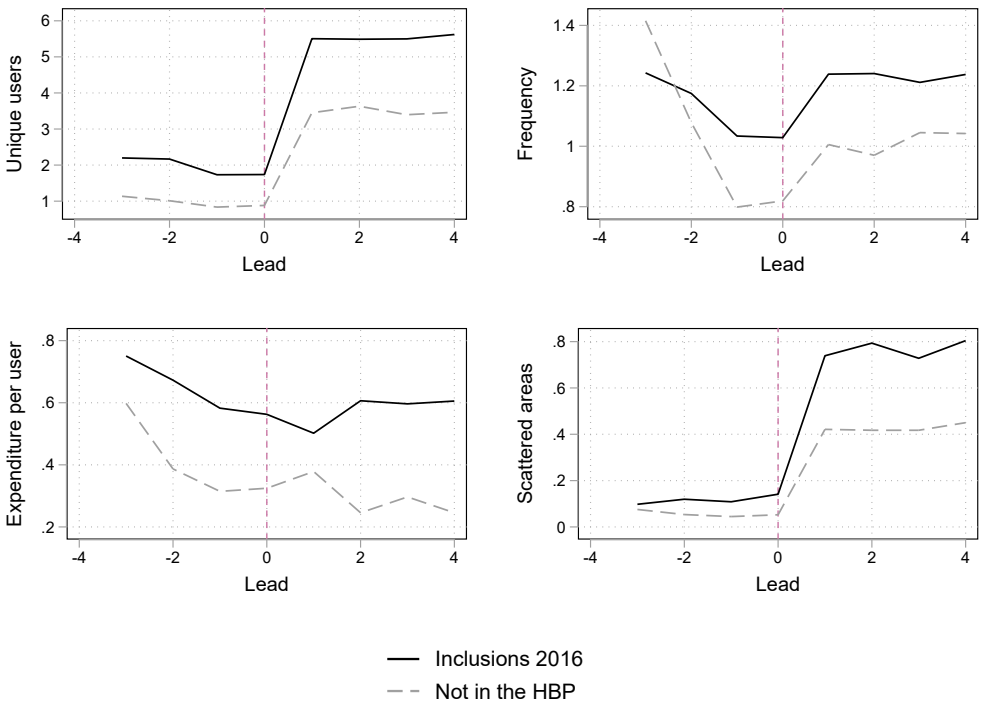
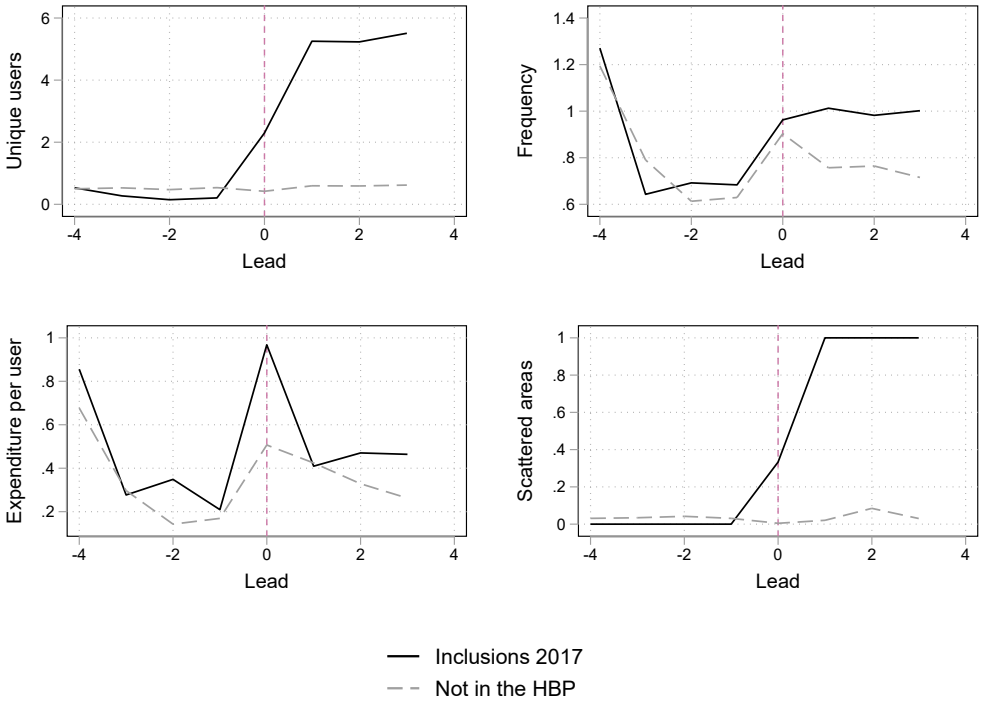


Figure C3: Synthetic control: group-time trends (II)

Panel A. Inclusions in 2017



Panel B. Inclusions in 2018

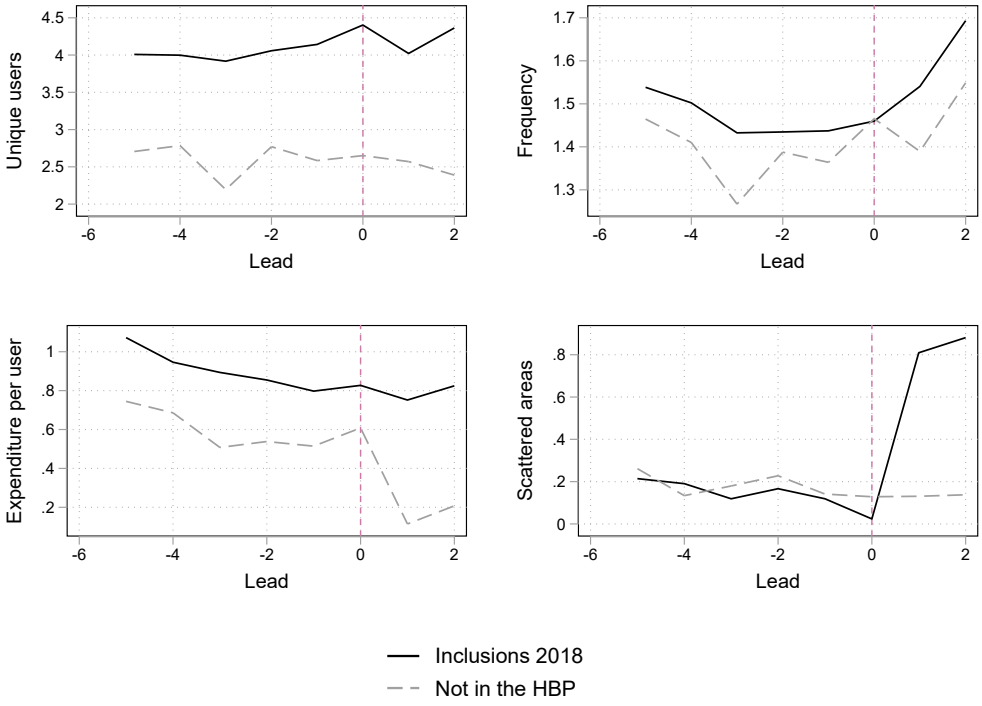


Table C2: Impact of inclusion into HBP DiD CS: Additional exercises

A. Only health procedures

	Unique users per million affiliates			Expenditure per user (Million COP)		
Time	ATT	p-value		ATT	p-value	
-6	0.0592	0.0504		-0.0155	0.0399	
-5	-0.1025	0.0423		0.0311	0.0452	
-4	-0.0443	0.0253		-0.0412	0.0471	
-3	-0.0538	0.0348		0.0172	0.0319	
-2	-0.0334	0.0153		-0.0056	0.0318	
-1	0.0175	0.0375		-0.043	0.0246	
0	0.7849	0.0802	*	0.8221	0.0572	*
1	0.9203	0.0843	*	0.6322	0.0606	*
2	1.0014	0.0875	*	0.6058	0.0615	*
3	1.0793	0.0913	*	0.5909	0.0613	*
4	1.6289	0.164	*	0.6074	0.1006	*
5	1.7299	0.1752	*	0.6309	0.1057	*
Overall	1.1908	0.0951	*	0.6482	0.059	*

B. Only for technologies with HTA

	Unique users (Thousands)			Expenditure per user (Million COP)		
Time	ATT	p-value		ATT	p-value	
-6	-0.0812	0.1783		-0.0718	0.042	
-5	-0.0796	0.0454		-0.0296	0.079	
-4	0.1222	0.08		-0.08	0.0874	
-3	0.2231	0.0963		-0.0102	0.0458	
-2	-0.0575	0.0946		-0.0057	0.0403	
-1	0.2496	0.072	*	-0.0594	0.0532	
0	0.1735	0.2506		0.0678	0.0555	
1	0.2073	0.3055		-0.0611	0.0464	
2	1.3693	0.5138	*	0.0065	0.0669	
3	1.1364	0.5414		-0.0826	0.0757	
4	-0.1886	0.28		-0.2249	0.0899	*
5	-0.0766	0.2831		-0.2614	0.082	*
Overall	0.4369	0.2848		-0.0926	0.0554	

Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Standard errors are presented in parentheses. Significant at 95% level: *.

Table C3: Impact of inclusion into HBP DiD CS: Only for medications

Time	Unique users per million affiliates ATT	p-value		Expenditure per user (Million COP) ATT	p-value		IHH (0 - 10.000) ATT	p-value		Instit share (0 - 1) ATT	p-value	
-6	0.0424	0.0849		0.0261	0.0263							
-5	0.0255	0.0413		-0.0207	0.0558		-1061.9022	408.6808		0.0388	0.0422	
-4	0.1103	0.0579		-0.0513	0.0575		129.5968	171.6554		-0.0238	0.0213	
-3	-0.1633	0.0575	*	0.0122	0.027		456.1577	188.9625		0.0186	0.0198	
-2	-0.4878	0.0762	*	-0.0729	0.0519		-59.4345	141.0786		-0.0255	0.016	
-1	0.0418	0.0538		0.0243	0.0319		434.8642	156.9702	*	0.0136	0.0175	*
0	2.0562	0.2097	*	0.1242	0.0397	*	93.585	129.2968		0.007	0.0183	
1	2.1761	0.2532	*	-0.0153	0.0413		-31.1194	199.8306		0.0237	0.0169	
2	2.9635	0.2984	*	0.1683	0.0645	*	39.356	196.3376		0.0019	0.0313	
3	2.8179	0.3475	*	0.1377	0.0624		135.7525	240.279		0.0349	0.0211	
4	-1.829	0.2831	*	-0.0221	0.0758		1628.1765	532.7228	*	-0.1912	0.0951	*
5	-1.6299	0.2721	*	-0.0062	0.0866		1517.7675	521.2388	*	0.0457	0.0533	*
Overall	1.0925	0.2058	*	0.0644	0.0451		563.9197	227.8589	*	-0.013	0.0308	*

Notes: coefficients obtained after a Callaway-Sant'Anna DiD. Dependent variables are transformed with the Inverse hyperbolic sine transformation, therefore coefficients can be interpreted as percentage changes. Standard errors are presented in parentheses. Significant at 95% level: *.

Table C4: Impact of inclusion into HBP Synthetic Control: Additional exercises

A. Only for technologies with HTA

	Unique users per million affiliates			Frequency per user			Expenditure per user (Million COP)			Scattered areas (1: Yes, 0 No)		
Time	ATT	p-value		ATT	p-value		ATT	p-value		ATT	p-value	
0	0.421	0	*	0.16	0.254		0.245	0.096		0.285	0.554	
1	0.38	0.001	*	0.257	0.442		0.256	0.565		0.284	0.496	

B. Only health procedures

	Unique users per million affiliates			Frequency per user			Expenditure per user (Million COP)			Scattered areas (1: Yes, 0 No)		
Time	ATT	p-value		ATT	p-value		ATT	p-value		ATT	p-value	
0	1.013	0.047	*	0.198	0.339		0.247	0.011	*	0.247	0.001	*
1	1.351	0.028	*	0.257	0.463		0.397	0	*	0.412	0	*
2	1.477	0.041	*	0.225	0.482		0.435	0.029	*	0.347	0	*
3	1.654	0.018	*	0.326	0.463		0.491	0.104		0.428	0	*

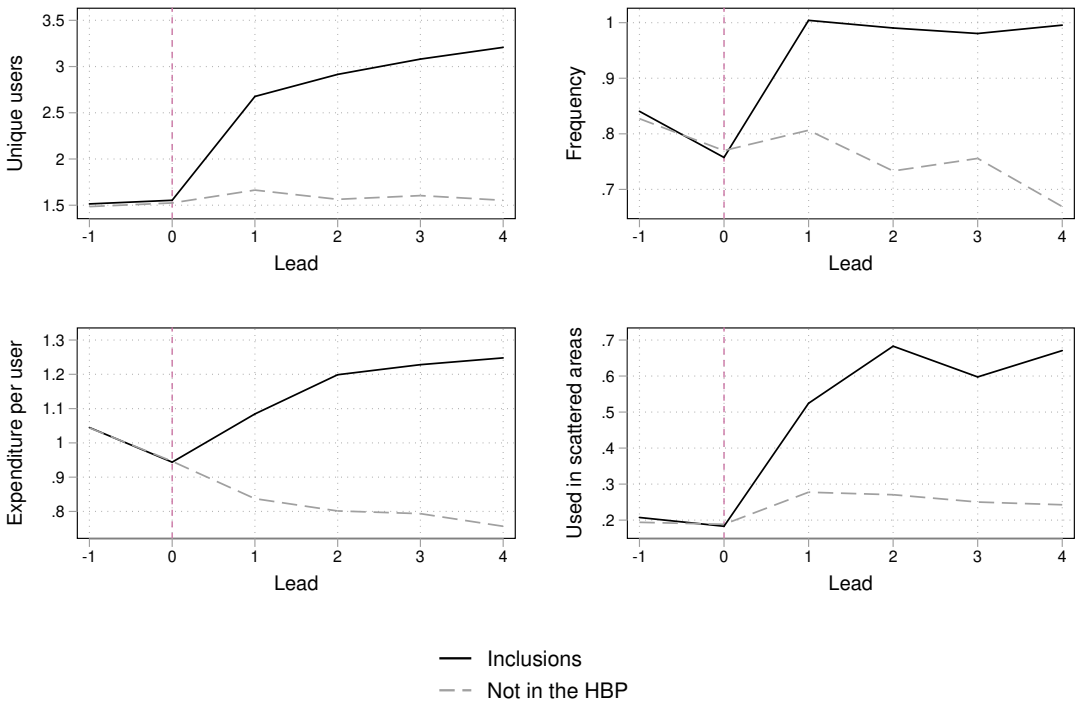
C. Only medications

	Unique users per million affiliates			Frequency per user			Expenditure per user (Million COP)			Scattered areas (1: Yes, 0 No)		
Time	ATT	p-value		ATT	p-value		ATT	p-value		ATT	p-value	
0	1.55	0.275		-0.022	0.431		0.116	0.005	*	0.403	0.394	
1	1.211	0.279		0.044	0.319		0.129	0.007	*	0.398	0.342	
	IHH (Percent P)			Frequency (Percent P)								
Time	ATT	p-value		ATT	p-value							
0	-243.424	0.35		0.023	0.841		0	0				
1	-82.088	0.35		0.051	0.378		0	0				

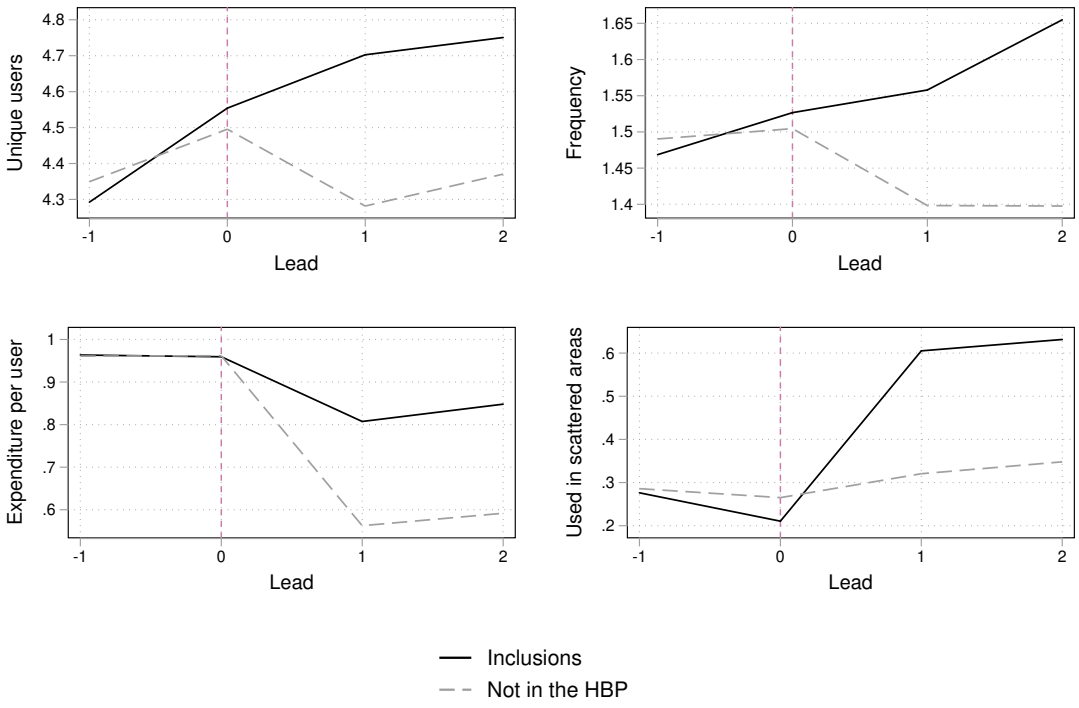
Notes: coefficients obtained after a synthetic control implemented with *synth_runner* package in Stata 16. Robust p-values are derived from permutation tests after 1'000,000 placebo averages. Significant at 95% level: *.

Figure C4: Synthetic control: impact only for procedures and for technologies with a HTA

Panel A. Health Procedures only



Panel B. Only technologies with HTA prior to inclusion

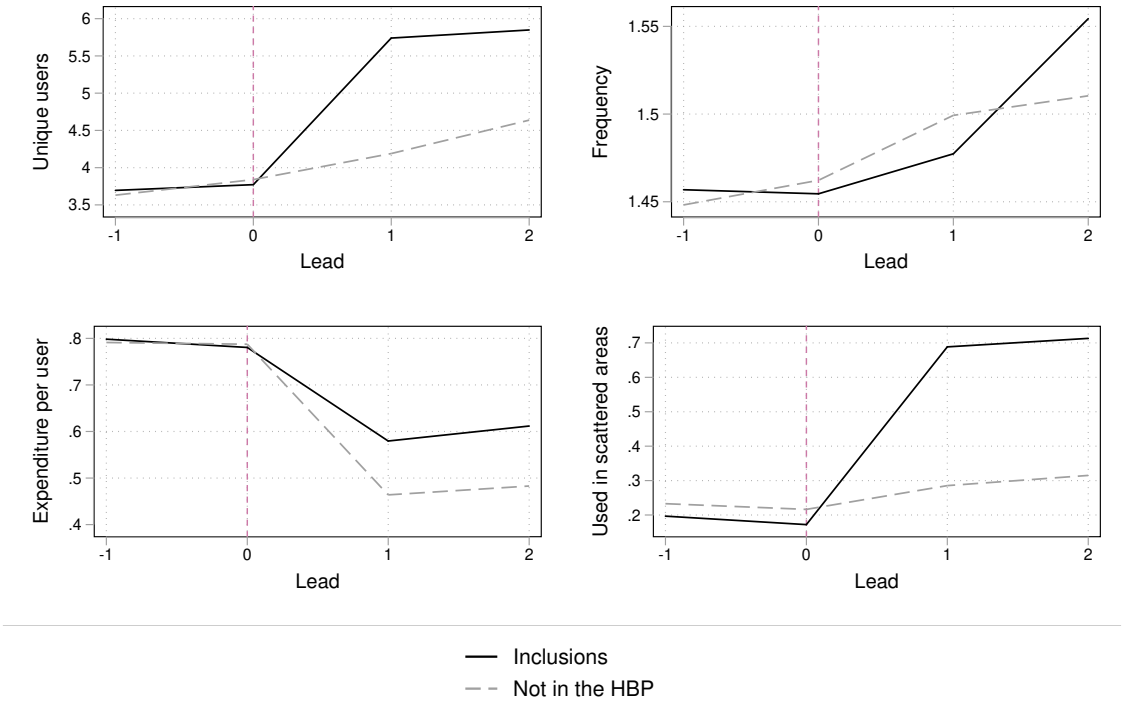


Inclusions

Not in the HBP

Figure C5: Synthetic control: impact only for medications

Panel A. Main outcomes



Panel B. Pharmaceutical markets outcomes