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The “Dr Google” Effect: Online Health Information and its Implications

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and Lorien Sabatino^{**}**

Abstract

This paper investigates the causal impact of broadband diffusion on the consumption of diagnostic medical services in Lombardy, Italy, between 2013 and 2019. Using a difference-in-differences estimator for continuous treatments, we estimate the impact of increased internet availability on patient behavior in the healthcare system. Our findings suggest that greater broadband coverage leads to a significant rise in the number of diagnostic prescriptions, including magnetic resonance imaging scans, tomographs, and sonograms. We interpret this pattern as consistent with a behavioral mechanism: individuals with enhanced internet access are more likely to search for health information online, which may trigger anxiety or precautionary responses, ultimately increasing demand for medical testing. Boxplot analyses reveal a strong gradient across broadband coverage quartiles, reinforcing the association between digital access and healthcare utilization. These results raise important considerations for health policy, particularly regarding digital health literacy and the design of interventions to manage demand in digitally connected health systems.

JEL Classification: I18; I12.

Keywords: Broadband; Continuous treatment, Diff-in-Diff; Overprescription.

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1 Introduction

The internet has become a primary source of health-related information for millions of people across the world. The widespread use of the internet for health-related information, commonly referred to as consulting “Dr Google”, has transformed how patients engage with their health and healthcare providers. The internet is increasingly considered a practical tool for healthcare planning and decision-making, particularly in contexts of uncertainty or limited access to medical professionals ([Link et al. \(2022\)](#)[Di Novi et al. \(2024\)](#)). The growing use of search engines in the healthcare context is not limited to self-diagnosis. Results of a study conducted in the UK suggest that online health searches are often driven by three complementary reasons: supportive role in health decision, a stimulating role and an interactional role which impacts the patient-doctor relationship [Bussey and Sillence \(2019\)](#). The consequences of this trend are mixed, shaped by a complex interaction between patient characteristics, information quality, and clinical context.

In the United States, data from [Eligibility.com](#) indicate that nearly nine out of ten citizens look up their symptoms on the internet before contacting a doctor. This practice is often motivated by the desire to gauge how serious a condition might be before deciding whether professional care is necessary ([Eligibility.com, 2019](#)). A similar trend has been documented across Europe, where reliance on digital tools for health-related purposes has systematically grown. According to Eurostat, in Finland, 83% of individuals search online for health information and almost four out of five consult their medical records digitally, while in Denmark 66% of citizens use the internet to book appointments—double the European average of 33% ([Eurostat, 2025](#)).

Italy shows a comparable, though somewhat delayed, trajectory. The most recent survey reports that 53% of Italians between the ages of 16 and 74 search online for health information, a striking increase compared with 32% in 2013. These searches most often concern symptoms, illnesses, healthcare services, and preventive measures.

The growing body of research suggests that the “Dr. Google” phenomenon has both advantages and drawbacks. Patients using online resources tend to arrive at medical visits better informed and more engaged ([Powell et al., 2011](#)). Importantly, the doctor’s reaction also matters. When physicians respond with respect, they are more likely to strengthen trust and cooperation. Conversely, if patients feel dismissed, especially when online information conflicts with professional advice, the relationship can be undermined ([Powell et al., 2011](#)). However, this appears to be relatively uncommon, as only around 5% report a decline in trust in their physicians as a result of online searching ([Powell et al., 2011](#); ?).

Nevertheless, this phenomenon is not without its drawbacks. One of the most prominent concerns is cyberchondria, defined as repeated and compulsive internet searches for medical information, often resulting in heightened anxiety or panic ([Jungmann et al., 2020](#); [McMullan et al., 2019](#)). Younger patients are particularly vulnerable to this effect, frequently interpreting vague or benign symptoms as signs of serious illness ([Starcevic and Berle, 2013](#)). Many physicians report an

uptick in patients who arrive at appointments requesting specific diagnostic tests or medications, often based on what they’ve read online. In particular, viral syndromes or other self-limiting conditions are frequently over-medicalized. Patients may pursue antibiotics, supplements, or scans based on symptom checker outputs, even when clinical guidelines would recommend conservative management (Powell et al., 2011). For instance, a survey of 2,000 Americans found that 43% of people who Googled their symptoms misdiagnosed themselves, often leading to increased worry and requests for unnecessary tests. One patient, convinced she had a brain tumor after Googling fatigue symptoms, insisted on multiple scans and blood tests, which were ultimately unnecessary and costly (Insights, 2022). In addition, the tendency to self-diagnose and self-medicate based on unreliable or misunderstood online content can lead to inappropriate and costly diagnostic testing, as well as delays in receiving appropriate care. This tendency may be especially evident in publicly funded healthcare systems, such as Italy’s, where diagnostic services are largely free at the point of use. This lowers barriers for patients to request unnecessary tests and may lengthen waiting times for those with legitimate medical needs.

The objective of this study is to assess whether increased access to online health information, the “Dr Google” effect, leads to greater use of diagnostic medical services. Using a unique dataset combining medical diagnostic prescriptions and broadband coverage across Lombardy from 2013 to 2019, we estimate the causal impact of internet expansion on the volume of diagnostic prescriptions, magnetic resonance imaging scans (MRIs), tomographs, and sonograms.

A central feature of our analysis is the stratification of patients into two age groups, 25–55 years and over 65 years, in order to capture systematic differences in exposure to and use of online health information. Younger adults are more likely to be active users of broadband and are therefore more frequently exposed to digital health content, including misinformation, which can fuel precautionary demand for discretionary diagnostic procedures such as sonograms and tomographs. In contrast, previous studies show that older individuals are less likely to go on-line; nevertheless, health information seeking is increasingly common among them compared to younger individuals (Lee and Jang (2022), Di Novi et al. (2024) (Powell et al., 2011) D’Andrea et al. (2023)). By comparing two cohorts, we want to disentangle demand driven primarily by digital engagement from demand associated with age-related health needs and chronic disease management.

A further dimension of the analysis distinguishes between two broadband-related outcomes: coverage and penetration. Broadband coverage, capturing the supply-side expansion of infrastructure, is consistently associated with significant increases in diagnostic utilization. Provinces exposed to a greater growth in coverage record higher volumes of diagnostic prescriptions overall, with robust effects for both general prescriptions and, to a lesser extent, technologically intensive procedures such as MRIs, tomographs, and sonograms. These findings align with the interpretation that the structural expansion of digital infrastructure provides individuals with broader opportunities to access online health information, thereby fueling precautionary demand for medical tests. Importantly, the positive association between coverage and utilization

is evident across both age groups, though older adults show relatively stronger responses in high-tech diagnostics, consistent with their higher baseline healthcare engagement.

By contrast, broadband penetration, which reflects the demand-side uptake of internet services, produces weaker and more heterogeneous effects. Among younger adults, penetration is positively related to diagnostic prescriptions at the per-capita level, suggesting that actual internet use amplifies individual demand for general tests. However, its effects on technologically intensive procedures are limited or absent, indicating that physician discretion continues to constrain utilization in this domain. Among older adults, the penetration results are largely null, with coefficients close to zero or negative and statistically insignificant, suggesting that increased subscription rates do not broaden access to diagnostics in this group. Taken together, these findings highlight that while coverage operates as a structural driver of healthcare utilization, penetration reflects more selective behavioral responses, concentrated among younger, digitally engaged patients and mainly affecting general rather than specialized diagnostics.

The uniqueness of our dataset, linking individual-level diagnostic prescriptions to detailed information on both patients and their general practitioners (GPs), further allows us to explore heterogeneity in broadband effects across both patient- and provider-related dimensions. There is emerging evidence that being female is a significant predictor of searching for health information on the internet ([Bidmon and Terlutter \(2015\)](#), [Rice \(2006\)](#)). We examine whether the impact of broadband varies by gender, as prior literature highlights differences in health information-seeking behavior between men and women, and by GP characteristics, including physician age, gender, and the number of patients under their care.

The heterogeneity analysis indicates that broadband’s effect on diagnostic utilization is not uniform, but differs across both patient and physician characteristics. Consistently with previous studies, women appear to experience larger increases in prescriptions, particularly for sonograms, although these differences diminish once outcomes are expressed on a per-capita basis. Among physicians, gender plays little role: both male and female GPs tend to convert broadband-driven demand into higher diagnostic activity. By contrast, stronger variation emerges when age and workload are considered. Younger physicians show consistent rises across diagnostic categories, while their older counterparts exhibit larger but more erratic effects. Workload also matters: doctors with moderately sized patient panels (about 1,500–1,800 individuals) respond most strongly, whereas those managing very large lists show minimal responsiveness, suggesting that capacity constraints may limit their ability to accommodate additional demand. Taken together, these findings suggest that broadband expansion heightens patient demand, but the extent to which this translates into diagnostic use is mediated by physician characteristics, including professional experience, workload, and the institutional setting in which they practice.

This article makes several contributions to the growing literature on digital health behavior and healthcare utilization. Broadband expansion is consistently correlated with online health information seeking and subsequent healthcare use. [Di Novi et al. \(2024\)](#), using evidence from

13,829 Europeans aged 50+, shows that greater regional broadband coverage increased the probability of searching for health information online, which in turn raised doctor visits by about 6%. The study also found a dual effect: while online information seeking directly improved self-perceived health, its indirect effect through increased medical consultations often worsened health perceptions, especially among the 50–69 age group. While [Di Novi et al. \(2024\)](#) focus on survey data linking broadband access, information seeking, and perceived health outcomes, the present study provides causal evidence that broadband availability drives higher use of discretionary diagnostic services, consistent with cyberchondria mechanisms. Together, the two sets of results reinforce the conclusion that broadband availability is a structural driver of both health information seeking and higher healthcare utilization. While earlier research has documented the widespread practice of online symptom checking and self-diagnosis (see [Powell et al. \(2011\)](#)) there remains a lack of rigorous causal evidence on whether this behavior translates into increased use of medical services. In particular, concerns about “cyberchondria”, a pattern of anxiety-induced overuse of healthcare driven by online searches, have been highlighted in prior psychological and clinical studies (([Starcevic and Berle, 2013](#))[Li et al. \(2025\)](#), [Lin et al. \(2024\)](#), [Suziedelyte \(2012\)](#))).

We address this gap by applying the recent methodological framework developed by [de Chaisemartin et al. \(2024\)](#), which enables causal inference in settings with continuous treatments and no untreated units. Unlike traditional difference-in-differences (DiD) approaches that rely on binary treatment indicators and control groups, our method accommodates nonlinearities and treatment effect heterogeneity, which are essential in capturing behavioral responses to gradual broadband diffusion.

Empirically, we provide novel evidence from a large, high-income European region (Lombardy, Italy), showing that increased broadband availability leads to a significant rise in diagnostic testing, particularly in MRI, tomograph, and sonogram use. This finding supports the hypothesis that access to online health content, whether accurate or not, can meaningfully influence real-world healthcare decisions. Our results thus contribute to ongoing policy debates on the unintended consequences of digital access in healthcare and highlight the importance of interventions that improve online health literacy and mitigate overuse in publicly funded systems. The remainder of the paper is structured as follows. Section 2 describes the institutional and healthcare context of Lombardy and outlines key features of the Italian health system. Section 3 details the data sources, including broadband coverage and healthcare service records. Section 4 introduces the empirical methodology, highlighting the use of a DiD estimator for continuous treatments. Section 5 presents the main results, supported by graphical and econometric evidence. Section 6 discusses the findings in light of the behavioral mechanisms at play and concludes with policy implications and avenues for future research.

2 Institutional Background

The Italian National Health Service (NHS) guarantees universal access to healthcare system for all citizens. Established in 1978 through Law 833/1978, Italian NHS is a Beveridge-type system, founded on the principle of equitable and funded by taxation.

Since its creation, the Italian NHS has been reformed several times with the aim of improving efficiency and effectiveness. The most significant changes occurred in 1992 and 1999, when structural reforms shifted the system toward greater decentralization, granting regional governments broader autonomy in health service delivery.

Today, the NHS is organized across three levels: national, regional, and local. At the national level, the Ministry of Health defines overall policy priorities, while regions organize and manage their own regional healthcare system. Local implementation is entrusted to institutions such as the Technical-Scientific Committee, Regional Health Agencies, and Local Health Authorities (ASLs). Together, these bodies ensure oversight, control, and compliance with national standards, while adapting services to local needs.

This study focuses on Lombardy, the largest region in Italy, accounting for 16% of Italy's total population, and one of the wealthiest and best educated in Europe. With a population of 10 million, Lombardy is comparable in both size and economic competitiveness to mid-sized European countries such as Portugal or the Netherlands.

Lombardy's healthcare system is one of the largest in Italy, encompassing approximately 150 hospitals that collectively handle 1.7 million discharges annually. The region's healthcare expenditure totals around €20 billion per year, representing approximately 75% of its regional budget.

In Lombardy, as in the rest of Italy, general practitioners (GPs) are self-employed professionals contracted by the NHS. They are remunerated mainly through a capitation system per registered patient, with additional payments for specific services and performance incentives. GPs act as gatekeepers and can prescribe basic diagnostic tests; for high-cost imaging, such as MRI, computed tomography (CT), or certain specialist ultrasounds, prescriptions are also issued by GPs but are subject to national and regional appropriateness guidelines. Once an electronic prescription (dematerialized prescription) is issued, patients must book the examination through the centralized booking system (Centro Unico di Prenotazione, CUP), which enforces validity limits and priority classes established by regulation.

3 Internet Diffusion in Italy

The diffusion of internet connection (broadband and ultra-broadband) in Italy has been characterized by significant regional and temporal disparities, reflecting broader structural and institutional inequality within the country. At the beginning, in the early 2000s, broadband access was primarily based on Digital Subscriber Line (DSL) technologies, which operated over

the traditional copper telephone network, with speeds of up to 20 Mbps. Later, ultra-broadband connection was developed, more sophisticated technologies capable of delivering much higher speeds. These include Fiber to the Cabinet (FTTC), Fiber to the Home (FTTH), and Very-high-bit-rate DSL (VDSL), with FTTH providing speeds exceeding 1 Gbps.¹ Coverage, indicated by the variable “broadband availability,” refers to the extent of infrastructure deployment, typically measured by the number of broadband lines installed in a given area. In contrast, penetration, captured by the variable “broadband usage,” reflects the degree to which these services are utilized, measured by the number of active broadband connections. Coverage and adoption were limited in the early years, and by 2013 broadband penetration remained below 50% in several provinces, especially in southern and rural areas. Coverage and adoption were limited in the early years, and by 2013, broadband penetration remained below 50% in several provinces, especially in southern and rural areas.

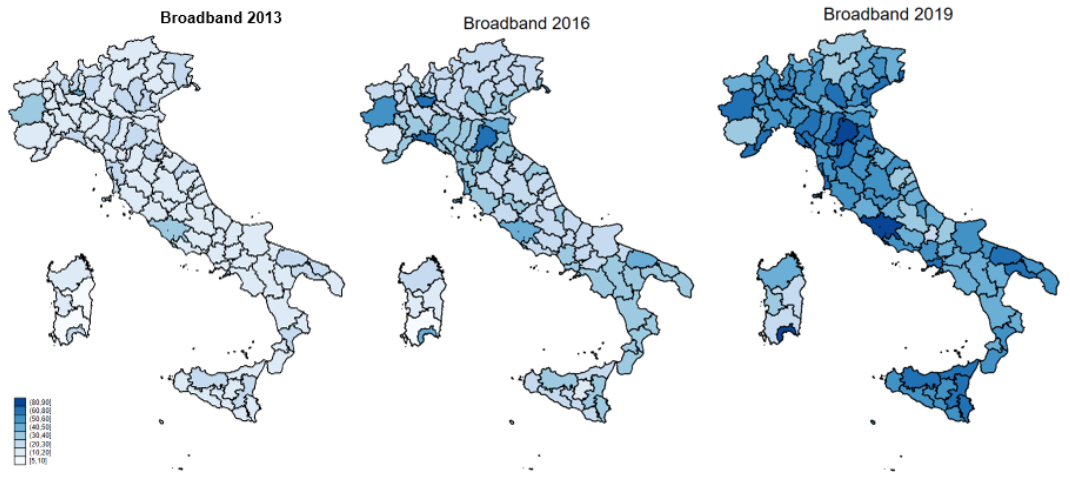


Figure 1. Broadband coverage in Italian provinces (2013,2016,2019)

Figure 1 shows the evolution of broadband coverage over the period under study, focusing on three benchmark years: 2013, 2016, and 2019. The maps highlight a marked expansion in coverage across Italian regions. In 2013, access was generally limited, with many areas remaining below 50%. By 2016, substantial progress had been achieved, particularly in the northern and central regions. By 2019, coverage levels were high across most of the country, with several regions surpassing 85–90%.

In response to concerns over this uneven development, Italy launched the *National Ultra-*

¹In more detail, the several technologies for internet connection are: *I)* DSL (ADSL): technology using the traditional copper telephone line from the central office to the user; distance strongly affects the speeds of connection. *II)* VDSL: an evolution of DSL that still based on copper but achieves higher performance, frequently combined with fiber up to the street cabinet. *III)* Fiber to the Cabinet (FTTC): fiber arrive at the street cabinet, while the final stretch to the home is copper; provides intermediate speeds. *IV)* Fiber to the Building (FTTB): fiber reaches the building, then internal cabling distributes the connection to individual apartments. *V)* Fiber to the Home (FTTH): fiber arrive directly inside the home, offering very high connection speeds. *VI)* Fiber to the Premises (FTTP): a general term covering all fiber connections up to the customer premises, including FTTH and FTTB.

Broadband Strategy in 2015, followed by the *Italia a 1 Giga* plan in 2021, with the objective of ensuring gigabit connectivity nationwide by 2026. These initiatives, supported by significant public investments, including €6.7 billion from the National Recovery and Resilience Plan (PNRR), targeted underserved areas through programs such as the *White Areas Plan*, which focused on municipalities with no commercial broadband infrastructure.

Despite this progress, disparities remain: as of mid-2020, while 99.6% of households had access to at least one fixed broadband network, only 33.7% had access to FTTP (Fiber to the Premises), and just 8.4% in rural areas. These uneven developments reflect the broader institutional framework of Italy’s decentralized governance. Following the devolution reforms, 21 regional health systems emerged, each responsible for service provision, funding, and infrastructure—including digital infrastructure needed to support telemedicine and health care innovation. Differences in regional governance capacity, income levels, and investment priorities have led to a fragmented digital landscape, with significant variation in both technological endowment and access. Despite the recent acceleration in coverage and investment, Italy’s experience demonstrates that infrastructure expansion alone is insufficient to ensure equitable digital diffusion without addressing underlying territorial and institutional imbalances.

3.1 Broadband and Ultra-Broadband Development in Lombardy (2013–2019)

In Lombardy, broadband and ultra-broadband diffusion between 2013 and 2019 was characterized by marked disparities across provinces and over time, but overall the region consistently outperformed the national average. In 2013, average broadband coverage reached about 47% of the population, with most provinces already surpassing 60% household coverage. Nevertheless, the gap between the least connected territories, barely 4% coverage in some mountain areas, and the best-performing ones, close to 87%, was striking. Penetration was equally uneven, with a regional average of 22%, ranging from just above 2% to nearly 34%. Between 2013 and 2016, substantial improvements were recorded, driven by private investment in metropolitan provinces such as Milan, Brescia, and Bergamo, and by targeted public programs supporting peripheral municipalities. By 2017, the regional average coverage exceeded 68%, with many provinces approaching or surpassing 80%. Yet, heterogeneity persisted: some territories still reported coverage below 15%, especially in rural and mountainous zones. By 2019, broadband coverage in Lombardy had reached nearly universal levels, with ultra-broadband (networks enabling speeds above 30 Mbps, increasingly FTTC and FTTP) available to over 85% of households, and fixed broadband coverage above 95%. At the same time, ultra-broadband access at gigabit speeds remained limited, with penetration around 13.9%. Adoption rates also grew markedly, supported by high income levels, dense urbanization, and strong demand from households and firms in advanced manufacturing and business services. Still, within-region disparities persisted. Urban centers, particularly Milan and provincial capitals, benefited from early deployment of FTTP, while smaller municipalities in mountain valleys (e.g. in Bergamo, Como, Lecco, and Sondrio) continued to face slower adoption and weaker infrastructure competition. This unevenness was also visible in the implementation of the regional White Areas Plan: while municipalities such as

Almenno San Salvatore or Alzano Lombardo in Bergamo province exceeded 95% coverage, others, like Aviatice or Clusone, remained only partially covered or not yet connected. Similar heterogeneities were observable in rural areas of Brescia (e.g. Bedizzole, Ghedi, Cologne, Desenzano del Garda) and in peripheral municipalities of Pavia and Como. Overall, the period 2013–2019 saw Lombardy achieve very high levels of broadband coverage (above 95% for basic broadband, and over 85% for ultra-broadband), with penetration rising steadily as well. However, the pronounced provincial variability, separating urban and peri-urban centers from rural and mountain areas, demonstrates that even in Italy’s most industrialized region, the path toward a truly homogeneous diffusion of ultra-fast connectivity remains incomplete, reflecting the combined influence of geography, infrastructure investment patterns, and demand-side constraints.

4 Data

4.1 Broadband Data

For our analysis, we draw on data provided by Agcom (Autorità per le Garanzie nelle Comunicazioni) regarding broadband and ultrabroadband coverage across all provinces in Lombardy from 2013 to 2019. Evaluating the digital divide within a country requires considering both the availability of broadband infrastructure and the actual uptake of services.

Although high coverage indicates the presence of infrastructure, it does not necessarily imply widespread usage, which may depend on socio-economic factors, digital skills, and affordability. For this reason, we focus on broadband coverage, measured as the number of broadband and ultrabroadband lines available per capita (“broadband coverage (%)”). Specifically, we gather data on the total number of DSL, VDSL, FTTC, and FTTH lines, aggregating them to provide a comprehensive view of connectivity in each province. Consistent with prior studies ([Campante et al., 2018](#)), we use broadband coverage as our main explanatory variable. This choice is justified by the fact that broadband penetration is intrinsically endogenous, as it depends on individual decisions to adopt the technology.

4.2 Healthcare Data

The dataset consists of detailed records of outpatient services provided to all Lombardy citizens from 2013 to 2019. Each record corresponds to a single outpatient service performed, and each year more than 150 millions of prescriptions are delivered.

For each service, the dataset records the patient’s unique identifier, the date of provision, and the specific outpatient procedure performed. Additional information includes the number of services delivered, their associated cost, and details on both the provider organization and the facility where the service was carried out. In addition, the amount of patient co-payment is also recorded.

The focus of this paper is on the analysis of tomographs, MRI, and ultrasounds, identified

through service descriptions, as these procedures are considered to be most subject to discretion by both patients and GPs.

From the original data, two datasets were constructed: one at the individual level, containing demographic characteristics alongside the annual number of tomographs, ultrasounds, MRIs, and total ambulatory services per patient; the second one includes the aggregation at the provincial level per year, summing the counts of the same procedures to allow for area-level analyses.

The analysis was conducted on two age groups: 25–55 years and over 65 years. The younger group was selected based on the assumption that individuals in this range are more likely to be active users of broadband services, and therefore potentially more exposed to online misinformation, including health-related fake news, which could lead to an unjustified increase in the use of discretionary diagnostic procedures. The older group was included because individuals over 65 typically have a higher prevalence of chronic conditions and greater utilization of healthcare services, making it possible to observe patterns of ambulatory care use more clearly. Additionally, studying this group allows for evaluation of how age-related differences in exposure to and understanding of online information, as well as the presence of disease-related exemptions, may influence diagnostic behavior. Particular attention was given to the distribution and frequency of exemption codes to ensure appropriate identification of patient subgroups, including those with rare disease exemptions. This rich administrative data source enables a detailed analysis of ambulatory care utilization patterns across both segments of the study population.

Finally, information on GPs is available, collecting data on gender, age, and workload for every GP in Lombardy. GPs is the first gate to the healthcare service that usually citizens use when they are sick or suspect to be.

5 Methods

Recent methodological advances in causal inference have addressed the limitations of traditional DiD estimators in settings involving continuous treatments and the absence of untreated or “stayer” units ([de Chaisemartin et al., 2024](#)).

In this context, [de Chaisemartin et al. \(2024\)](#) introduced a DiD framework specifically designed for continuous treatments, where treatment levels change for all units over time. Traditional two-way fixed effects (TWFE) models often perform poorly in such settings because they assume linear treatment effects and require untreated comparison groups, which can produce biased estimates in the presence of heterogeneous effects. The new framework overcomes these limitations by exploiting the presence of “quasi-stayers” units whose treatment levels change only minimally between periods. This approach, based on a weighted average of marginal treatment effects accommodates both nonlinear and heterogeneous responses to treatment. This innovation is particularly valuable for applied research in fields such as environmental economics, public health, and taxation, where policy variables like temperature, pollution, or tax rates are

continuous and vary universally over time.

In our study, we apply this framework to estimate the effects of broadband coverage and penetration across Lombardy’s provinces between 2013 and 2019. We treat broadband coverage as a continuous variable, noting that all provinces experienced some degree of change during this period, so there are no untreated units or “stayers.” This context fits well with the assumptions of the estimator, which is explicitly designed for settings with continuous treatments and universal variation. By exploiting differences in the intensity of broadband availability and conditioning on quasi-stayers—provinces where coverage changed only slightly—we are able to compute a weighted average of marginal treatment effects. This approach not only captures heterogeneous treatment effects but also avoids the biases typical of standard fixed-effects estimators when interventions are nonlinear and continuous. As a result, our implementation provides credible evidence of the causal impact of broadband expansion on diagnostic utilization at the provincial level.

Our empirical strategy is formulated following [de Chaisemartin et al. \(2024\)](#). We assume the representative unit is observed for $T \geq 2$ periods, from 2013 to 2019 so that $T = 7$. Let $(D_1, \dots, D_T)$ denote the unit’s treatments and let $\mathcal{D}_t = \text{Supp}(D_t)$ for all $t \in \{1, \dots, 7\}$. For any $t \in \{1, \dots, 7\}$, and for any $d \in \bigcup_{t=1}^T \mathcal{D}_t$, let $Y_t(D_d)$ denote the unit’s potential outcome at period t with treatment d , while Y_t denotes the observed outcome at period t . Define $\Delta D_{it} = D_{it} - D_{i,t-1}$ as the change in treatment between periods t and $t - 1$.

This setup allows us to define our main estimator based on treatment changes over time:

$$Y_{i,t} - Y_{i,t-1} = \alpha + \beta_1 D_{i,t-1} + \beta_2 \Delta D_{it} + \beta_3 D_{i,t-1} \Delta D_{it} + \beta_4 (\Delta D_{it})^2 + \varepsilon_{it}, \quad (1)$$

where the interaction term $D_{i,t-1} \Delta D_{it}$ and the quadratic term $(\Delta D_{it})^2$ allow the effect of treatment change to depend on the initial level of treatment and to capture potential nonlinearities in the treatment response.

After estimating equation (1), we can identify the causal effect of the treatment on the outcome. To this end, we introduce the estimator θ , defined as:

$$\theta = \frac{E[\text{sgn}(\Delta D_{it})(Y_{it}(D_{it}) - Y_{it}(D_{i,t-1}))]}{E(|\Delta D_{it}|)}, \quad (2)$$

where the numerator corresponds to the expected change in the potential outcome associated with a unit increase in treatment, and the denominator corresponds to the expected change in treatment.

By definition, $\text{sgn}(\Delta D_{it}) = 1$ if $\Delta D_{it} > 0$ and -1 otherwise. Hence, the estimator θ is a weighted average of the slopes of units’ potential-outcome functions across treatment changes from period $t - 1$ to t . This measure is also referred to as WAOSS in [de Chaisemartin et al. \(2024\)](#).

In this paper, Y_{it} represents one of the four outcomes of interest—number of prescriptions, sonograms, tomographs, and MRIs—for province i in period t , while D_{it} measures the extent of broadband availability in province i and period t . In our empirical application, we focus on the change between the first and last periods (2013 and 2019), effectively using $\Delta D_{i,T} = D_{i,2019} - D_{i,2013}$ and $\Delta Y_{i,T} = Y_{i,2019} - Y_{i,2013}$ to compute the estimator θ .

As previously discussed, our setting corresponds to a DiD design with continuous treatments in a two-period panel. All units are treated to varying degrees, and there are no untreated (“stayer”) units. This implies that

$$\Pr(\Delta D = 0) = 0 \quad \text{or} \quad \Pr(|\Delta D| < \eta) > 0 \quad \forall \eta > 0,$$

which aligns with Assumption 4 in [de Chaisemartin et al. \(2024\)](#).

We stratify the analysis by two age groups, 25–55 years and over 65 years, to capture differences in both exposure to and use of online health information. Younger adults are more likely to be active broadband users and thus more frequently exposed to digital content, including health-related misinformation, which can fuel precautionary demand for discretionary diagnostic procedures (([Starcevic and Berle, 2013](#)),([Powell et al., 2011](#)), [D’Andrea et al. \(2023\)](#),[Di Novi et al. \(2024\)](#)). By contrast, older adults typically present a higher prevalence of chronic conditions and interact more often with the healthcare system, making them a key group for assessing whether broadband access amplifies utilization among populations already at elevated risk ([Powell et al., 2011](#)). Examining these two cohorts separately allows us to disentangle demand driven by digital engagement from demand linked to health status and age-related needs.

We also distinguish between two broadband-related outcomes, coverage and penetration. This distinction matters because they capture different mechanisms. Coverage reflects the supply-side expansion of infrastructure, the availability of broadband lines in a given area, primarily determined by public and private investment decisions ([Campante et al., 2018](#)). Penetration, instead, measures demand-side uptake, i.e., the number of active subscriptions, and is inherently more endogenous since it depends on household decisions shaped by socio-economic status, digital literacy, and affordability ([Eurostat, 2025](#)). While coverage provides an exogenous proxy for the potential to access online health information, penetration better reflects actual usage and the resulting behavioral responses, such as information seeking and cyberchondria ([Starcevic and Berle, 2013](#)). By analyzing both, we can separate the structural effect of infrastructure expansion from the behavioral effect of broadband adoption, offering a more comprehensive assessment of how internet access influences healthcare demand.

The uniqueness of our dataset, which links individual-level diagnostic prescriptions with detailed information on both patients and their GPs, allows us to conduct a rich heterogeneity analysis. By patient age group and by broadband outcomes (coverage and penetration), we further examine whether the broadband effect varies across gender and GP characteristics, including physician age, gender, and number of patients. This is an important extension since earlier studies

emphasize that patient–doctor interactions are shaped not only by patients’ characteristics but also by physicians’ attributes and practice constraints (Powell et al., 2011; Starcevic and Berle, 2013).

Patients number, in particular, represents a relevant source of variation. On the one hand, GPs with a larger number of patients tend to be more experienced and may therefore be better equipped to resist patient-driven demand for unnecessary diagnostics. On the other hand, high patients numbers can weaken oversight from regional health authorities regarding compliance with appropriateness guidelines, and more experienced physicians may also be more skilled in justifying deviations when they exceed diagnostic prescription targets (Berta et al., 2010, 2019). As a result, higher patients numbers could either reduce or amplify the likelihood that broadband access translates into higher diagnostic utilization. Exploring these dimensions enables us to capture how digital health information interacts not only with patient behavior but also with physician-level incentives and constraints.

6 Descriptive Statistics

Table 1 presents descriptive statistics for coverage and penetration. Coverage consistently exceeds penetration, indicating that not all active lines are in use. Both variables show substantial variability, as reflected in the large standard deviations relative to the means. The median values, lower than the means, suggest a right-skewed distribution for both coverage and penetration, with some very high values stretching the upper range.

Table 1. Descriptive statistics for coverage and penetration

Variable	Observations	Mean	Std. Dev.	Min	Max	Median
Coverage	84	677,526.3	928,792	74,374	4,505,961	362720.5
Penetration	84	250,582	303,110.6	34,084	1,332,486	162961

The two variables are highly correlated ($r = 0.96$), indicating that areas with higher numbers of active lines also tend to have higher numbers of lines in use.

Figure 2 shows a scatterplot of coverage versus penetration. The plot illustrates the strong positive relationship between the two variables, consistent with the high correlation ($r = 0.96$). Most points follow a linear trend, although some extreme values are visible at the upper range.

7 Results

In this section, we present the results separately for the two population groups: individuals aged 25–55 and those over 65. For each group, we report analysis based on both coverage and penetration, providing overall outcomes as well as per-capita outcomes.

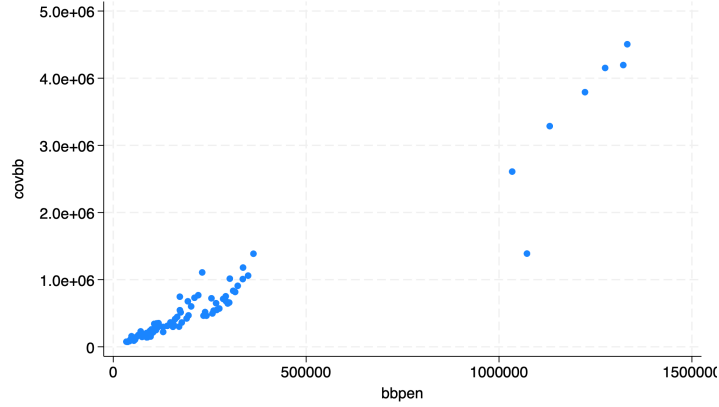


Figure 2. Scatterplot of coverage vs. penetration

7.1 Coverage results for individuals aged between 25 and 55

Figures 3 to 6 present boxplots illustrating the distribution of four diagnostic services—sonograms, tomographs, MRIs, and overall diagnostic prescriptions—by year and quartile of broadband coverage. These visualizations support the hypothesis that increased broadband coverage is associated with higher utilization of healthcare services, potentially due to behavioral responses induced by online health information seeking.

In particular, Figure 3 shows the distribution of sonograms per year across quartiles of broadband coverage. A clear upward shift is observable across quartiles, particularly in the upper quartiles (Q3 and Q4), indicating that areas with higher broadband availability consistently exhibit higher median and inter-quartile ranges of sonogram usage. This suggests a potential behavioral channel: greater internet access may increase awareness or concern about health conditions, leading to more frequent requests for non-invasive imaging.

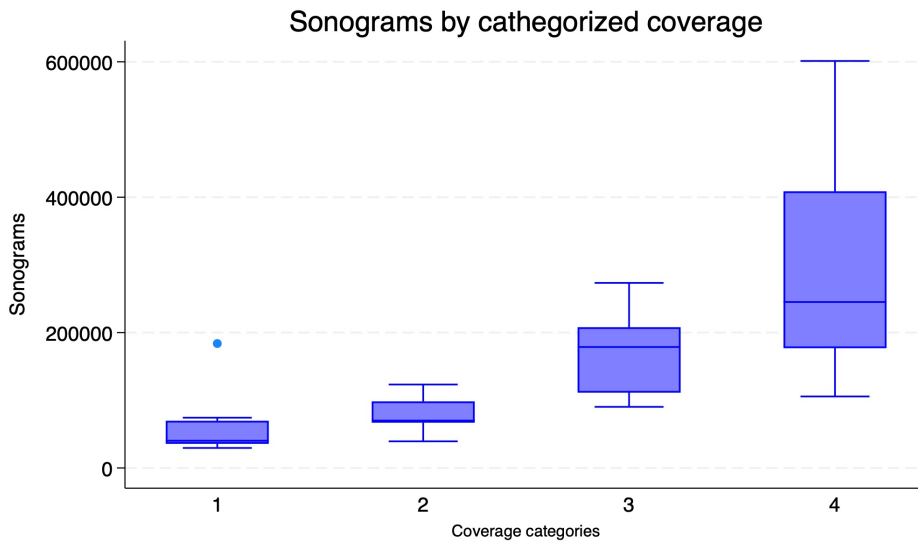


Figure 3. Distribution of sonograms by quartile of coverage

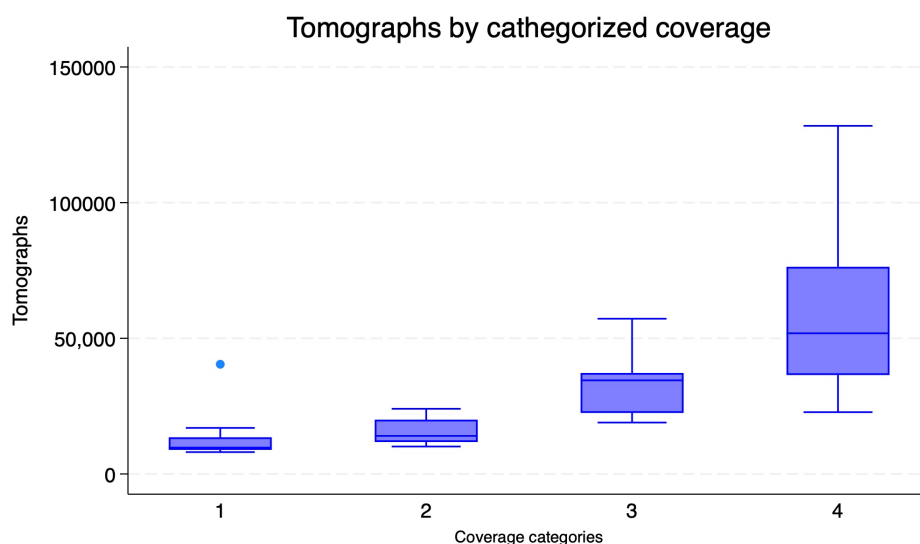


Figure 4. Distribution of tomographs by quartile of coverage

Figure 4 depicts the annual distribution of tomographs across broadband coverage quartiles. Similar to sonograms, the distribution is positively skewed with a clear gradient—higher quartiles display higher medians and broader distributions. This pattern is especially pronounced in Q4, which also shows the highest variability. This may reflect the discretionary nature of tomographic procedures, which are more likely to be pursued in response to heightened health anxiety or consumer-driven demand triggered by online information.

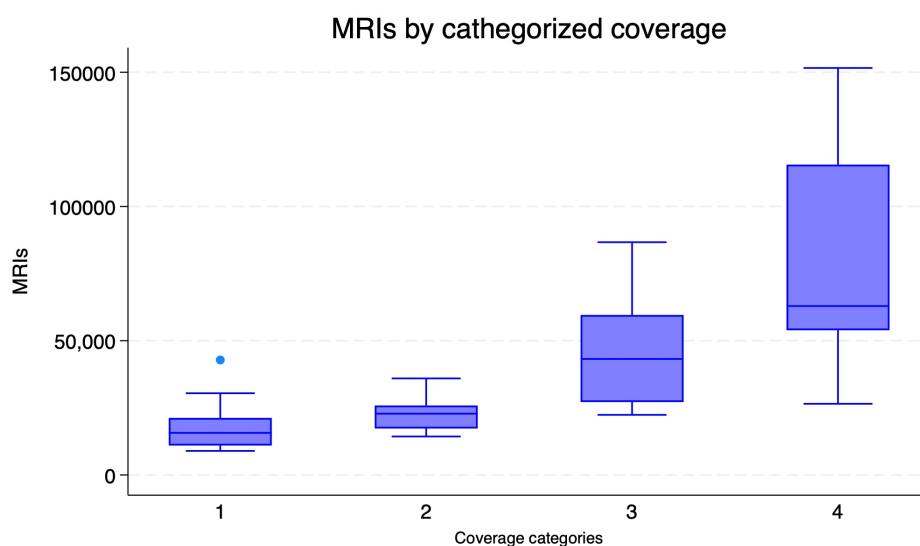


Figure 5. Distribution of MRIs by quartile of coverage

Figure 5 focuses on MRIs, showing a similar, though slightly less pronounced, trend. Median values and spread increase with broadband coverage quartiles. Notably, Q4 exhibits both a higher median and a wider range, suggesting that broadband may enable access not only to more

information but also to more costly or intensive diagnostics, likely mediated by patient-initiated demand.

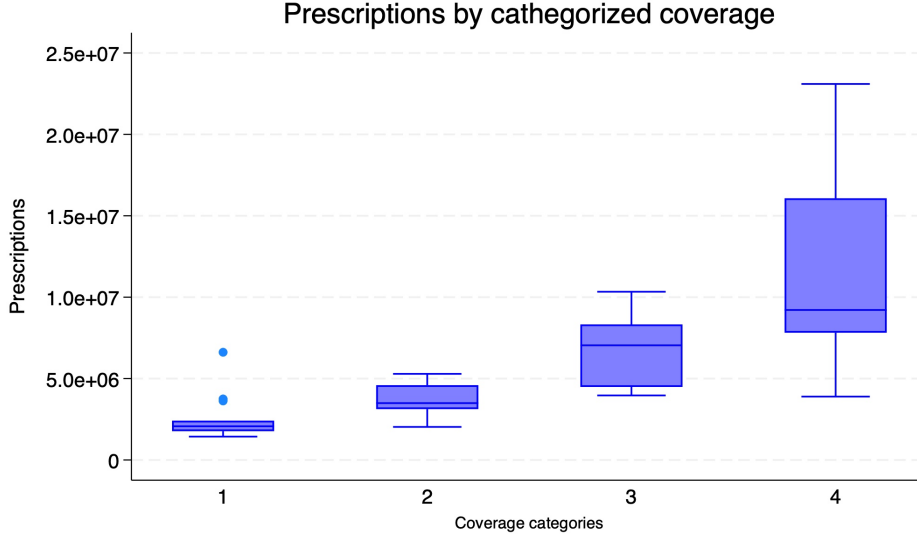


Figure 6. Distribution of diagnostic procedures by quartile of coverage

Finally, Figure 6, covering total diagnostic prescriptions for people aged 25-55, displays the most dramatic differences across quartiles. The scale of the y-axis (ranging into the millions) reflects the aggregated nature of the outcome, and again, higher coverage is associated with higher volume. The steep jump in both median and variability from Q1 to Q4 supports the notion that broadband access has systemic implications for the overall intensity of healthcare service utilization.

Taken together, these figures provide strong visual evidence of a positive association between broadband coverage and healthcare service usage across diagnostic categories. While not causal on their own, these distributions reinforce the main hypothesis tested in the econometric analysis: that broadband-induced access to health information online may lead to heightened precautionary behavior, increased patient anxiety (e.g., cyberchondria), and ultimately, higher consumption of diagnostic services—even in the absence of underlying health changes.

Table 2 reports the estimates of the Weighted Average of Slopes of Switchers (WAOSS) for several healthcare-related outcomes, under the hypothesis that increased broadband availability leads to greater exposure to health-related information online. The table follows a structure that will be repeated throughout the paper. The first column reports the type of diagnostic service under study (all the diagnostic procedures in our dataset, MRIs, tomographs, and sonograms), the second presents the estimated causal effect on the number of services performed, and the remaining columns provide the standard error together with the bounds of the 95% confidence interval. Each row corresponds to an estimated model.

This behavioral mechanism identified in each type of diagnostic procedure suggests that individ-

uals with better internet access are more likely to seek medical content—including news and discussions about symptoms and diseases—which can trigger health anxiety or precautionary behavior. As a result, they may increase their demand for medical services even in the absence of objective health changes.

	Estimate	SE	LB CI	UB CI
Diagnostic procedure	2.784	0.532	1.742	3.827
MRI	0.029	0.013	0.004	0.055
Tomographs	0.014	0.003	0.007	0.020
Sonograms	0.077	0.013	0.052	0.103

Table 2. WAOSS Estimation for coverage on the yearly amount of: overall diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55

Consistent with this hypothesis, our findings reveal a large and statistically significant effect of broadband expansion on the overall volume of diagnostic prescriptions (95% CI: [1.742, 3.827]). In provinces with greater broadband growth, individuals appear to have engaged more intensively with the healthcare system, likely reflecting heightened concerns or perceived risks triggered by online information.

Smaller, yet still statistically significant, effects emerge for specific diagnostic technologies. Broadband growth is associated with increases in MRI use (95% CI: [0.004, 0.055]), tomographs (95% CI: [0.007, 0.020]), and sonograms (95% CI: [0.052, 0.103]). These results suggest that the impact of digital access is not confined to general check-ups, but extends to technologically intensive procedures as well.

All the findings in table 2 are consistent with a behavioral response whereby broadband-induced access to medical information—and potentially sensational or alarming content—increases health awareness or anxiety, thereby driving individuals to seek more diagnostic services.

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	0.618	0.118	0.386	0.850
MRI	0.000	0.000	-0.001	0.001
Tomographs	0.000	0.000	-0.000	0.001
Sonograms	0.002	0.002	-0.002	0.005

Table 3. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55

Table 3 reports the WAOSS estimates for the same set of healthcare outcomes analyzed previously, but scaled at the per capita level. This transformation allows for a more precise interpretation of how broadband expansion affects individual-level behavior, rather than aggregate changes which may be driven by population size or other macro-level dynamics. For interpretability, broadband coverage has been rescaled by dividing by 100,000; therefore, the coefficients should be read as the effect of an increase of one broadband line per 100,000 inhabitants.

Compared to the results in Table 2, the per capita effects are markedly smaller in magnitude, as expected given the unit of measurement. Nonetheless, the coefficient for diagnostic prescriptions per capita remains positive and statistically significant (95% CI: [0.386, 0.850]), reinforcing the idea that improved broadband access translates into greater individual-level engagement with healthcare services. In practical terms, this implies that an additional broadband line per 100,000 inhabitants is associated with an increase of 0.618 diagnostic prescriptions per capita. This provides further support for the behavioral mechanism suggested earlier: increased access to online medical information may lead individuals to request more diagnostic procedures, even in the absence of new medical needs.

By contrast, the per capita estimates for MRI, tomographs, and sonograms are no longer statistically significant, with confidence intervals that include zero. This suggests that while broadband availability might influence general diagnostic activity at the individual level, its effect on high-tech or costlier procedures may be more concentrated or driven by specific subgroups, and may not be strong enough to detect when normalized by population.

Tables 2 and 3 suggest that the observed increase in diagnostic activity is not merely an artifact of population growth or aggregation, but reflects a genuine per capita increase in medical engagement, particularly for general diagnostic prescriptions.

7.2 Penetration results for individuals aged between 25 and 55

When focusing on broadband penetration, the estimates reveal a different picture compared to those obtained with coverage. At the aggregate level (Table 4), penetration appears to be negatively associated with the overall number of MRI procedures, with a statistically significant coefficient. This suggests that, as broadband adoption increases, there may be a relative substitution away from more resource-intensive diagnostic procedures such as MRIs. However, the coefficients for total diagnostic prescriptions, tomographs, and sonograms are not statistically significant, indicating that the aggregate relationship between penetration and overall diagnostic activity is weak.

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	-162.451	173.317	-502.152	177.250
MRI	-8.209	3.337	-14.750	-1.668
Tomographs	-0.662	0.732	-2.097	0.774
Sonograms	-3.041	3.714	-10.320	4.238

Table 4. WAOSS Estimation for penetration of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55

By contrast, at the per capita level (Table 5), penetration exhibits a positive and statistically significant effect on diagnostic prescriptions, with a point estimate of 71.061 (95% CI: [7.533, 134.589]). This finding is consistent with the idea that active broadband use fosters greater individual-level engagement with healthcare services, particularly in the form of requesting

diagnostic tests. Importantly, while infrastructure availability (coverage) already showed positive associations with diagnostic demand, the penetration results suggest that it is the effective utilization of broadband—rather than its mere potential availability—that drives behavioral changes at the individual level.

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	71.061	32.412	7.533	134.589
MRI	-0.033	0.079	-0.188	0.122
Tomographs	-0.043	0.057	-0.155	0.068
Sonograms	-0.220	0.302	-0.812	0.371

Table 5. WAOSS Estimation for penetration of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55

Taken together, these results underscore a crucial distinction: broadband coverage and penetration capture two related but conceptually different mechanisms. Coverage reflects supply-side factors linked to infrastructure expansion, while penetration measures actual take-up and therefore better approximates demand-side behavioral responses. The evidence that penetration is positively related to diagnostic prescriptions per capita but not to more technologically advanced procedures (MRI, tomographs, sonograms) suggests that individuals empowered by internet access may tend to demand a higher number of general diagnostic tests, while more complex or specialized procedures remain largely driven by medical discretion rather than patient initiative.

7.3 Coverage results for individuals aged over 65

Table 6 reports WAOSS estimates for healthcare utilization among individuals aged 65 and over. The results show a statistically significant increase in diagnostic prescriptions (95% CI: [1.650, 15.319]) in provinces with higher broadband growth, suggesting substantial engagement with healthcare services. MRI, tomographs, and sonograms also exhibit positive estimates (95% CI: MRI [-0.004, 0.056]; tomographs [0.021, 0.154]; sonograms [0.044, 0.188]), with tomographs and sonograms reaching statistical significance, indicating uptake of technologically intensive procedures, albeit smaller in magnitude than for prescriptions.

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	8.484	3.487	1.650	15.319
MRI	0.026	0.015	-0.004	0.056
Tomographs	0.088	0.034	0.021	0.154
Sonograms	0.116	0.037	0.044	0.188

Table 6. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 65 and over

Table 7 presents the same outcomes at the per capita level. The effect on diagnostic prescriptions per capita is positive but not statistically significant (95% CI: [-0.057, 1.401]). Tomographs and

sonograms show small yet statistically significant increases, highlighting that while broadband availability affects individual engagement with high-tech procedures, the absolute magnitude of these effects is limited.

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	0.672	0.372	-0.057	1.401
MRI	0.002	0.002	-0.001	0.005
Tomographs	0.007	0.003	0.0004	0.014
Sonograms	0.010	0.004	0.001	0.019

Table 7. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 65 and over

Overall, the results indicate that higher broadband availability is associated with a meaningful increase in healthcare utilization among older adults, particularly for general diagnostic prescriptions, while the impact on high-tech procedures is present but quantitatively modest.

Compared to the younger population (25–55), the effects observed among individuals aged 65 and over are generally larger in magnitude, particularly for technologically intensive procedures. While in the younger cohort per capita increases were essentially limited to diagnostic prescriptions, older adults exhibit significant uptake of tomographs and sonograms even at the individual level, albeit small in absolute terms. This pattern suggests that broadband-induced access to health information may translate into more pronounced behavioral responses among older individuals, who are both more frequent users of healthcare services and potentially more responsive to health-related content online.

Several factors may help explain these age-related differences. Older adults often have lower digital literacy and may find it difficult to navigate online resources independently, so the observed effects likely reflect the behavior of a subset who are either more digitally capable or supported by caregivers. At the same time, their greater health risks and more frequent interactions with the healthcare system may heighten their attentiveness to online health information, amplifying their responsiveness.

In practical terms, the results reveal a clear age gradient. Broadband expansion increases healthcare engagement across all age groups, but its impact on technologically intensive diagnostic procedures is more pronounced among older adults. These findings underscore the importance of considering age-specific behavioral responses and barriers to digital access when assessing the broader effects of online health information on healthcare utilization.

7.4 Penetration results for individuals aged over 65

Tables 8 and 9 report WAOSS estimates for the penetration of diagnostic procedures among individuals aged 65 and over, both in aggregate and per capita terms. Unlike the coverage measures, the coefficients for diagnostic prescriptions, MRI, tomographs, and sonograms are all negative or close to zero and not statistically significant (95% CIs include zero in all cases).

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	-136.626	121.898	-375.547	102.295
MRI	-0.255	0.428	-1.094	0.583
Tomographs	-1.112	1.077	-3.223	0.999
Sonograms	-1.750	1.333	-4.362	0.863

Table 8. WAOSS Estimation for penetration of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 65 and over

	Estimate	SE	LB CI	UB CI
Diagnostic prescriptions	-9.430	9.681	-28.405	9.544
MRI	-0.036	0.038	-0.111	0.0398
Tomographs	-0.055	0.094	-0.238	0.129
Sonograms	-0.092	0.12	-0.329	0.145

Table 9. WAOSS Estimation for penetration of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 65 and over

These findings suggest that broadband availability does not substantially affect the overall penetration of medical procedures among older adults. In other words, while expansion of coverage appears to raise utilization among those already engaged with the healthcare system, it does not significantly increase the proportion of older individuals receiving such services. This indicates that behavioral responses to online health information are concentrated among existing users rather than drawing new patients into the system.

At the per capita level, the effects are small and statistically indistinguishable from zero, reinforcing the view that broadband primarily intensifies use among current patients rather than broadening participation. Taken together, the results point to an important nuance: online access can increase demand for technologically intensive procedures, but its broader influence on penetration is limited. Structural and access barriers—particularly low digital literacy and mobility challenges among older adults—likely constrain these effects.

Importantly, the patterns observed for penetration are consistent with those for the younger population (25–55), where broadband also did not significantly affect the share of individuals receiving procedures. This suggests that, across age groups, the main impact of broadband is on the intensity of use among existing healthcare users rather than on expanding the population’s participation in medical services.

8 Heterogeneity analysis on broadband coverage for individuals aged between 25 and 55

In this section and in the following one, we conduct several heterogeneity analyses focusing on broadband coverage. First, we examine differences between female and male patients to determine whether broadband coverage has distinct effects by gender. We then repeat the

analyses to assess whether the effects vary according to certain characteristics of the GPs. Specifically, we evaluate differences between male and female GPs, between physicians over and under 55 years of age, and based on their workload. For this last comparison, we consider three groups: GPs treating up to 1500 patients (theoretically the workload limit according to national and regional guidelines), those treating between 1500 and 1800 patients (corresponding to the third quartile of the workload distribution), and those with more than 1800 patients. All heterogeneity analyses are conducted using broadband coverage as the outcome variable, which is completely exogenous to the outcomes if compared to the broadband penetration that can be in several ways endogenous to the considered outcomes.

The results based on per capita outcomes are reported in Appendix.

8.1 Heterogeneity analysis comparing male and female patients

For individuals aged 25–55, the WAOSS estimates show notable differences between females and males in coverage, both in total and per-capita outcomes, which are presented in tables 10 and A1 respectively. Diagnostic prescriptions exhibit the largest gap: females present an overall coverage of 5.88 procedures compared to 3.46 for males, while the aggregated estimate is 2.78. However, when examining per-capita outcomes, the confidence intervals for both females (0.42, 95% CI: -0.16–0.99) and males (0.23, 95% CI: -0.17–0.64) include zero, suggesting that the differences are not statistically significant at the 5% level despite the higher point estimates for females.

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	5.882	2.613	0.760	11.003
MRI	0.025	0.012	0.002	0.048
Tomographs	0.021	0.015	-0.008	0.050
Sonograms	0.179	0.093	-0.004	0.361
Males				
Diagnostic prescriptions	3.460	1.672	0.184	6.736
MRI	0.022	0.013	-0.003	0.047
Tomographs	0.013	0.012	-0.011	0.038
Sonograms	0.047	0.014	0.019	0.075

Table 10. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals males and females aged 25-55

For MRI and tomographs, overall coverage differences between genders are small (MRI: 0.025 vs. 0.022; tomographs: 0.021 vs. 0.013), indicating that sex differences in these procedures are negligible. Differently, sonograms show a more pronounced sex difference (0.179 for females vs. 0.047 for males) and in per-capita outcomes (0.015 for females vs. 0.005 for males). In addition, the confidence interval for females per capita (-0.005 to 0.035) marginally includes zero, implying that while the trend is clear, statistical significance is limited to males.

Overall, the data suggest that sex differences are most pronounced for diagnostic prescriptions and sonograms, whereas MRI and tomograph use appear more evenly distributed, but per-capita estimates in table A1 indicate that many differences are not statistically significant, highlighting the importance of considering uncertainty in individual-level utilization patterns.

8.2 Heterogeneity analysis comparing gender of GPs

When stratifying coverage by physician sex, WAOSS estimates reveal some differences between female and male physicians, both in overall (see table 11) and per-capita outcomes (see table A2) .

For the overall diagnostic prescriptions, the broadband coverage for patients managed by female GPs has an estimated impact of 3.21, compared to 3.66 for patients managed by male GPs. Both these effects are statistically significant (female physicians: 1.13—5.28; male physicians: 0.65—6.66).

Even when we observe MRI, tomographs, and sonograms the effect of the broadband coverage is similar comparing GPs by sex, with slightly higher estimates for male physicians (MRI: 0.018–0.015; tomographs: 0.017–0.018; sonograms: 0.075–0.086).

The similarity of these results with the overall analysis seem to confirm that the gender of GPs does not change what we observed overall.

	Estimate	SE	LB CI	UB CI
Female GPs				
Diagnostic prescriptions	3.209	1.059	1.134	5.284
MRI	0.015	0.004	0.008	0.022
Tomographs	0.018	0.007	0.004	0.031
Sonograms	0.075	0.026	0.025	0.125
Male GPs				
Diagnostic prescriptions	3.655	1.533	0.651	6.658
MRI	0.018	0.008	0.003	0.033
Tomographs	0.017	0.011	-0.004	0.038
Sonograms	0.086	0.036	0.014	0.157

Table 11. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Comparison by gender of GPs for individuals aged 25-55.

8.3 Heterogeneity analysis comparing age of GPs

In this heterogeneity analysis we compare GPs under 55yo with those older than 55 years.

Table 12 show that for the overall diagnostic prescriptions, patients treated by GPs under 55 years old show a statistically significant coverage effect equal to 3.06 (95% CI: 1.53–4.60), whereas patients of physicians over 55 have a higher but not significant effect.

A similar pattern is observed for the other procedures (MRI, tomographs, and sonograms): total coverage tends to be higher but not significant for older physicians.

This means that broadband coverage has an effect on younger physicians, who may appear to be more accommodating or more easily influenced in their prescribing behavior compared with more experienced doctors.

	Estimate	SE	LB CI	UB CI
GPs under 55yo				
Diagnostic prescriptions	3.064	0.781	1.533	4.596
Tomographs	0.013	0.002	0.009	0.017
MRI	0.020	0.005	0.010	0.031
Sonograms	0.076	0.019	0.038	0.114
GPs over 55yo				
Diagnostic prescriptions	6.277	3.580	-0.739	13.294
Tomographs	0.034	0.023	-0.011	0.078
MRI	0.013	0.023	-0.032	0.059
Sonograms	0.149	0.090	-0.028	0.326

Table 12. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55 and GPs under 55yo vs GPs over 55yo

8.4 Heterogeneity analysis comparing workload of GPs

The heterogeneity analysis based on the workload are summarized in tables 13 and A4. On the overall diagnostic prescriptions, the impact of an increase of broadband coverage generate 4.18 (95% CI: -0.51–8.87) more prescription, which is not statistically significant. GPs with 1500–1800 patients show a similar effect of 4.395 (95% CI: 1.36–7.43), which is statistically significant, while GPs managing more than 1800 patients have an effect of 0.76 (95% CI: 0.065–1.46), also statistically significant but much smaller.

Results suggest that broadband coverage has no statistically significant effect among physicians with a desirable workloads (lower than 1500 patients), while the impact becomes significant for those with medium workloads (between 1500 and 1800 patients. Similarly, the effect of the broadband coverage increase positively affects MRIs, tomographs, and sonograms. Among GPs in the highest workload quartile, broadband expansion significantly increases only general diagnostic procedures and sonogram use.

It is worth noting that GPs whose patient loads align closely with guideline recommendations appear to manage their work most effectively, at least in terms of influence by “Dr Google”. Those with slightly larger workload show smaller gains, possibly reflecting stress or organizational inefficiencies. Among physicians with very high patient loads, the effect on total coverage remains positive but is markedly reduced, pointing to diminishing returns once workloads become excessive.

Outcome	Estimate	SE	LB CI	UB CI
Patients load under 1500				
Diagnostic prescriptions	4.182	2.392	-0.507	8.871
Tomographs	0.022	0.016	-0.009	0.053
MRI	0.006	0.014	-0.023	0.034
Sonograms	0.104	0.060	-0.015	0.222
Patients load 1500–1800				
Diagnostic prescriptions	4.395	1.548	1.395	7.428
Tomographs	0.022	0.007	0.008	0.035
MRI	0.024	0.011	0.002	0.046
Sonograms	0.103	0.040	0.025	0.182
Patients load over 1800				
Diagnostic prescriptions	0.764	0.356	0.065	1.462
Tomographs	0.003	0.002	-0.001	0.007
MRI	0.004	0.002	-0.000	0.009
Sonograms	0.020	0.008	0.004	0.035

Table 13. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55 and GPs comparison for three level of workload

9 Heterogeneity analysis on broadband coverage for individuals aged over 65

Similarly to the previous section, we are now performing a heterogeneity analysis to check whether the effect of broadband coverage is different by patients’ gender and comparing subgroups of GPs (by sex, age, and workload).

9.1 Heterogeneity analysis comparing male and female patients aged over 65

Tables 14 and A5 report heterogeneity estimates by sex for individuals aged 65 and over. The overall pattern is consistent across genders, with positive and statistically significant effects on diagnostic prescriptions, tomographs, and sonograms. For women, the broadband coverage increases the amount of the overall diagnostic prescriptions by 4.57 (95% CI: 0.92–8.22), while for men the effect is slightly smaller at 3.91 (95% CI: 0.73–7.10). In both groups, tomographs and sonograms show robust positive effects, with negligible differences by gender. MRI effects is statistically insignificant for both sexes.

Overall, these findings indicate that the positive association between broadband expansion and healthcare utilization among older adults is not driven by one gender alone but is relatively homogeneous across sexes. The slightly larger coefficients observed among females (particularly for sonograms) are consistent with the higher baseline utilization rates typically observed among

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	4.573	1.862	0.923	8.223
Tomographs	0.045	0.017	0.011	0.079
MRI	0.014	0.009	-0.003	0.031
Sonograms	0.065	0.020	0.026	0.105
Males				
Diagnostic prescriptions	3.911	1.626	0.725	7.097
Tomographs	0.043	0.017	0.010	0.075
MRI	0.012	0.007	-0.001	0.025
Sonograms	0.050	0.017	0.018	0.083

Table 14. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals males and females aged 65 and over

women in this age group.

9.2 Heterogeneity analysis comparing gender of GPs for patients aged over 65 years

Tables 15 and A6 report WAOSS estimates for the heterogeneity by physician gender among individuals aged 65 and over. The results show positive and statistically significant effects across all major outcomes when physicians are female. For aggregate measures, the increase in diagnostic prescriptions is 2.36 (95% CI: [1.10, 3.62]), with tomographs, MRI, and sonograms also displaying positive and significant effects, the largest being for sonograms (0.037, 95% CI: [0.022, 0.052]). At the per capita level, all outcomes remain statistically significant, although the magnitudes are very small, suggesting that the impact primarily reflects increased service intensity rather than a broad expansion of coverage.

For male physicians, the pattern is similar: broadband expansion is associated with significant increases in diagnostic prescriptions (2.82, 95% CI: [0.73, 4.92]) and sonograms (0.043, 95% CI: [0.020, 0.065]), while MRI estimates lose statistical significance in aggregate and per capita terms. Tomographs remain positive and significant in both specifications, though the effect sizes are modest.

Overall, the differences between female and male physicians are quantitatively small, and the confidence intervals largely overlap, indicating no strong evidence of heterogeneity by physician gender. If anything, female physicians show slightly smaller aggregate coefficients for prescriptions and sonograms compared to male physicians but slightly more consistent significance at the per capita level, particularly for MRI. These findings suggest that the influence of broadband on healthcare utilization among older adults does not meaningfully depend on physician gender.

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	2.361	0.644	1.099	3.623
Tomographs	0.0233	0.00546	0.0126	0.0340
MRI	0.00923	0.00314	0.00307	0.01539
Sonograms	0.03688	0.00747	0.02223	0.05153
Males				
Diagnostic prescriptions	2.824	1.067	0.733	4.916
Tomographs	0.02832	0.00920	0.01028	0.04636
MRI	0.00961	0.00509	-0.00036	0.01959
Sonograms	0.04255	0.01152	0.01998	0.06513

Table 15. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Comparison by gender of GPs for individuals over 65 years old.

9.3 Heterogeneity analysis comparing age of GPs for patients older than 65 years

Tables 16 and A7 present the estimates stratified by physician age (under and over 55). Among GPs younger than 55, broadband expansion is associated with positive and statistically significant effects across all outcomes, both in aggregate and per capita terms. Diagnostic prescriptions show an increase of 1.97 (95% CI: 1.20–2.73), while tomographs, MRI, and sonograms also exhibit robust and significant effects, with the largest effect observed for sonograms (0.033, 95% CI: 0.022–0.043).

Considering the GPs aged 55 and over, the results are more heterogeneous, but always higher than those observed for younger GPs. The effects for diagnostic prescriptions (6.52, 95% CI: 0.37–12.67) and sonograms (0.083, 95% CI: 0.020–0.146) are positive and statistically significant, while tomographs show a smaller but still positive and significant effect (0.068, 95% CI: 0.006–0.129). The effect on MRI, in contrast, is not statistically different from zero.

Overall, these findings point to an important interaction between broadband availability and physician age. Younger physicians exhibit consistent and moderate increases across all outcomes, whereas older physicians display a larger effect. This suggests that younger physicians when manage older patients may integrate digital resources into routine practice and showing less susceptibility to the influence of “Dr Google”. Conversely, among older physicians, broadband may trigger selective increases, potentially driven by specific types of care or patient demand dynamics.

Conversely, older physicians, who may have more established clinical routines and greater confidence in their diagnostic judgment, appear less influenced by patient-driven demands. This could explain why aggregate effects for older doctors are more variable and why per capita effects remain insignificant: any broadband-induced pressure may only translate into increased

	Estimate	SE	LB CI	UB CI
GPs under 55yo				
Diagnostic prescriptions	1.9657	0.3886	1.2040	2.7273
Tomographs	0.02012	0.00323	0.01378	0.02645
MRI	0.00830	0.00221	0.00398	0.01262
Sonograms	0.03273	0.00540	0.02216	0.04330
GPs over 55yo				
Diagnostic prescriptions	6.5186	3.1390	0.3661	12.6711
Tomographs	0.06759	0.03123	0.00638	0.12880
MRI	0.01790	0.01327	-0.00811	0.04392
Sonograms	0.08288	0.03231	0.01955	0.14621

Table 16. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged over 65 and GPs under 55yo vs GPs over 55yo

procedures for a narrow subset of patients, rather than a widespread behavioral shift.

9.4 Heterogeneity analysis comparing workload of GPs for patients older than 65 years

The results in table 17 reveal a clear heterogeneity in the responsiveness to broadband expansion when stratifying physicians by patient panel size. Among practitioners managing up to 1,500 patients, the effect on the total number of procedures is relatively large (e.g., 4.8 prescriptions, 95% CI 0.51–9.18). This pattern suggests that these physicians—likely less time constrained—can accommodate increased demand by expanding overall service provision, without substantially altering the distribution of procedures across individual patients.

GPs managing 1,500–1,800 patients display strong and statistically significant effects but slightly reduced if compared with the previous group. These GPs appear to operate in a capacity range that allows them to translate patient requests, potentially amplified by broadband-enabled access to health information, into additional diagnostic procedures, including technologically intensive ones.

Finally, among physicians with more than 1,800 patients, the estimated effects are virtually zero. This finding is consistent with a capacity saturation mechanism, whereby heavily loaded physicians cannot increase service supply regardless of changes in patient behavior.

Taken together, these results suggest that the interaction between digital access and healthcare utilization is mediated not only by patient characteristics but also by physician constraints, with workload acting as a binding limit on the capacity to respond to digitally informed demand.

Outcome	Estimate	SE	LB CI	UB CI
Patients load under 1500				
Diagnostic prescriptions	4.8451	2.2127	0.5083	9.1820
Tomographs	0.05434	0.02339	0.00851	0.10018
MRI	0.01275	0.00941	-0.00570	0.03120
Sonograms	0.06220	0.02239	0.01832	0.10608
Patients load 1500–1800				
Diagnostic prescriptions	3.1469	0.9718	1.2421	5.0517
Tomographs	0.02859	0.00750	0.01390	0.04328
MRI	0.01149	0.00448	0.00272	0.02027
Sonograms	0.04557	0.01066	0.02468	0.06646
Patients load over 1800				
Diagnostic prescriptions	0.49226	0.31694	-0.12895	1.11347
Tomographs	0.004776	0.003307	-0.001705	0.011256
MRI	0.001955	0.001536	-0.001055	0.004966
Sonograms	0.007840	0.003863	0.0002683	0.015412

Table 17. WAOSS Estimation for coverage of the yearly amount of procedures for the overall amount of diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals over 65 and GPs comparison for three level of workload

10 Discussion and Conclusion

This study investigates the impact of broadband diffusion on healthcare utilization in Lombardy, Italy, between 2013 and 2019. Leveraging a DiD estimator for continuous treatments, as developed by [de Chaisemartin et al. \(2024\)](#), we identify the causal effects of increased broadband coverage on the consumption of diagnostic services, including prescriptions, MRIs, tomographs, and sonograms.

Our results show a statistically significant increase across all outcomes examined following broadband expansion. The strongest effect is found for general diagnostic prescriptions, with smaller yet significant increases also observed for technologically intensive procedures. These patterns support the behavioral hypothesis that greater internet access encourages individuals to seek health information online, heightening concerns about symptoms and, in turn, driving demand for medical evaluations even in the absence of clear clinical indications.

The distribution of utilization across broadband coverage quartiles reinforces this interpretation. Provinces in the highest quartile consistently display both higher and more variable use of diagnostic services, suggesting that online health content can stimulate precautionary or anxiety-driven healthcare consumption.

Although access to information can empower patients and improve decision-making, our findings also point to inefficiencies: overuse of diagnostic resources, higher healthcare costs, and mounting pressure on publicly funded systems. In this sense, the “Dr Google” effect operates as a double-

edged sword—enhancing patient engagement while at the same time contributing to unnecessary medical demand.

Future research should explore individual-level psychological responses to online health content and assess the role of digital literacy in mitigating unintended consequences. As part of our robustness checks, we will conduct sensitivity analyses by age—including older adults—and by sex, and we will also examine differences in average per-capita service utilization to further characterize heterogeneity in treatment effects.

Policymakers may also consider interventions such as verified health information platforms or digital health education to guide online behavior and promote more appropriate healthcare use in the digital age.

Appendix

A Heterogeneity analysis of broadband coverage effect on per capita outcomes

In this appendix, we present the tables reporting the analysis of the effect of broadband coverage on the outcomes evaluated on a per capita basis.

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	0.420	0.294	-0.157	0.997
MRI	0.002	0.001	-0.001	0.004
Tomographs	0.002	0.002	-0.002	0.005
Sonograms	0.015	0.010	-0.005	0.035
Males				
Diagnostic prescriptions	0.235	0.205	-0.167	0.637
MRI	0.001	0.001	-0.001	0.004
Tomographs	0.001	0.002	-0.002	0.004
Sonograms	0.005	0.002	0.000	0.009

Table A1. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals males and females aged 25-55

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	0.203	0.105	-0.003	0.410
MRI	0.001	0.000	0.001	0.002
Tomographs	0.001	0.001	-0.000	0.003
Sonograms	0.005	0.003	-0.001	0.010
Males				
Diagnostic prescriptions	0.239	0.155	-0.064	0.542
MRI	0.001	0.001	0.000	0.003
Tomographs	0.001	0.001	-0.001	0.004
Sonograms	0.007	0.004	-0.001	0.014

Table A2. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55 and male physicians

	Estimate	SE	LB CI	UB CI
GPs under 55yo				
Diagnostic prescriptions	0.240	0.075	0.093	0.388
MRI	0.001	0.000	0.001	0.002
Tomographs	0.002	0.001	0.001	0.003
Sonograms	0.006	0.002	0.002	0.010
GPs over 55yo				
Diagnostic prescriptions	0.415	0.438	-0.443	1.272
Tomographs	0.002	0.002	-0.003	0.007
MRI	0.001	0.003	-0.004	0.007
Sonograms	0.014	0.010	-0.007	0.034

Table A3. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55 and GPs under 55yo vs GPs over 55yo

Outcome	Estimate	SE	LB CI	UB CI
Patients load under 1500				
Diagnostic prescriptions	0.316	0.303	-0.278	0.909
Tomographs	0.002	0.002	-0.002	0.005
MRI	0.001	0.002	-0.003	0.005
Sonograms	0.012	0.007	-0.002	0.026
Patients load 1500–1800				
Diagnostic prescriptions	0.298	0.166	-0.027	0.624
Tomographs	0.002	0.001	0.000	0.003
MRI	0.002	0.001	-0.001	0.004
Sonograms	0.007	0.004	-0.002	0.015
Patients load over 1800				
Diagnostic prescriptions	0.042	0.035	-0.028	0.111
Tomographs	0.00013	0.00023	-0.00032	0.00059
MRI	0.00019	0.00027	-0.00034	0.00072
Sonograms	0.00129	0.00086	-0.00038	0.00297

Table A4. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged 25-55 and GPs comparison for three level of workload

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	0.365	0.200	-0.027	0.757
Tomographs	0.00381	0.00175	0.00038	0.00723
MRI	0.00117	0.00096	-0.00070	0.00305
Sonograms	0.00568	0.00238	0.00103	0.01034
Males				
Diagnostic prescriptions	0.307	0.172	-0.030	0.645
Tomographs	0.00333	0.00167	0.00005	0.00661
MRI	0.00105	0.00070	-0.00032	0.00242
Sonograms	0.00428	0.00205	0.00026	0.00830

Table A5. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals males and females aged 65 and over

	Estimate	SE	LB CI	UB CI
Females				
Diagnostic prescriptions	0.2058	0.0746	0.0596	0.3520
Tomographs	0.00231	0.00065	0.00105	0.00358
MRI	0.00087	0.00036	0.00015	0.00158
Sonograms	0.00336	0.00093	0.00154	0.00518
Males				
Diagnostic prescriptions	0.1981	0.1000	0.00214	0.3941
Tomographs	0.00237	0.00087	0.00066	0.00408
MRI	0.000656	0.000481	-0.000287	0.001599
Sonograms	0.003693	0.001291	0.001163	0.006223

Table A6. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Comparison by gender of GPs for individuals over 65 years old.

	Estimate	SE	LB CI	UB CI
GPs under 55yo				
Diagnostic prescriptions	0.1763	0.0494	0.07941	0.27322
Tomographs	0.001960	0.000465	0.001050	0.002871
MRI	0.000689	0.000213	0.000272	0.001106
Sonograms	0.003053	0.000737	0.001608	0.004498
GPs over 55yo				
Diagnostic prescriptions	0.49581	0.34219	-0.17488	1.16651
Tomographs	0.005175	0.003186	-0.001069	0.011418
MRI	0.001532	0.001470	-0.001349	0.004412
Sonograms	0.006912	0.003978	-0.000885	0.014709

Table A7. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals aged over 65 and GPs under 55yo vs GPs over 55yo

Outcome	Estimate	SE	LB CI	UB CI
Patients load under 1500				
Diagnostic prescriptions	0.45115	0.24793	-0.03480	0.93710
Tomographs	0.004946	0.002402	0.000238	0.009653
MRI	0.001454	0.001093	-0.000688	0.003596
Sonograms	0.006023	0.002786	0.000563	0.011482
Patients load 1500–1800				
Diagnostic prescriptions	0.21588	0.10286	0.01428	0.41749
Tomographs	0.002124	0.000797	0.000562	0.003685
MRI	0.000783	0.000459	-0.000117	0.001682
Sonograms	0.003706	0.001339	0.001081	0.006331
Patients load over 1800				
Diagnostic prescriptions	0.005093	0.033076	-0.059735	0.069922
Tomographs	0.000066	0.000394	-0.000706	0.000838
MRI	-0.000016	0.000174	-0.000357	0.000326
Sonograms	0.000236	0.000377	-0.000502	0.000975

Table A8. WAOSS Estimation for coverage of the yearly amount of procedures per capita for diagnostic prescriptions, MRI, Tomographs, and Sonograms. Individuals over 65 and GPs comparison for three level of workload

References

- Berta, P., G. Callea, G. Martini, and G. Vittadini (2019). General practitioners' behaviour and practice styles: Evidence from administrative data in Italy. *Social Science & Medicine* 224, 52–62.
- Berta, P., C. Seghieri, and G. Vittadini (2010). The impact of general practitioners' characteristics on their practice activity: Evidence from Italy. *Health Policy* 95(2-3), 212–219.
- Bidmon, S. and R. Terlutter (2015). Gender differences in searching for health information on the internet and the virtual patient-physician relationship in Germany: Exploratory results on how men and women differ and why. *Journal of Medical Internet Research* 17(6), e156.
- Bussey, L. G. and E. Sillence (2019). The role of internet resources in health decision-making: a qualitative study. *Digital Health* 5, 2055207619888073.
- Campante, F., R. Durante, and F. Sobbrío (2018). Politics 2.0: The multifaceted effect of broadband internet on political participation. *Journal of the European Economic Association* 16(4), 1094–1136.
- de Chaisemartin, C., X. d'Haultfœuille, and G. Vazquez-Bare (2024). Difference-in-difference estimators with continuous treatments and no stayers. In *AEA Papers and Proceedings*, Volume 114, pp. 610–613. American Economic Association 2014 Broadway, Suite 305, Nashville, TN 37203.

- Di Novi, C., M. Kovacic, and C. E. Orso (2024). Online health information seeking behavior, healthcare access, and health status during exceptional times. Journal of Economic Behavior & Organization 220, 675–690.
- D’Andrea, A., P. Grifoni, and F. Ferri (2023). Online health information seeking: An italian case study for analyzing citizens’ behavior and perception. International Journal of Environmental Research and Public Health 20(2), 1076.
- Eligibility.com (2019). 89% of americans google their symptoms before seeing a doctor.
- Eurostat (2025). Internet use: individuals — indicator tin00101. <https://ec.europa.eu/eurostat/databrowser/view/tin00101/default/table?lang=en>. Accessed: 27 August 2025.
- Insights, H. (2022). 43% of americans misdiagnose themselves online before seeing a doctor.
- Jungmann, S. M., S. Brand, J. Kolb, and M. Witthöft (2020). Do dr. google and health apps have (comparable) side effects? an experimental study. Clinical Psychological Science 8(2), 306–317.
- Lee, H. Y. and S.-N. Jang (2022). Have changes in internet use during the covid-19 pandemic affected older adults’ self-rated health? a cross-sectional study of young-old and old-old populations in korea. International Journal of Environmental Research and Public Health 19(19), 12335.
- Li, X. et al. (2025). Online health information seeking and outpatient service utilization: Evidence from the chinese general social survey. Journal of Medical Internet Research 27, e66683.
- Lin, Y. et al. (2024). Mobile internet use, self-medication, and health-seeking behavior: Evidence from china. Frontiers in Public Health 12, 1403877.
- Link, E., M. Rosset, and A. Freytag (2022). Patterns of online information seeking and avoidance about sars-cov-2 and covid-19. European Journal of Health Communication 3(1), 53–75.
- McMullan, R. D., D. Berle, S. Arnáez, and V. Starcevic (2019). The relationships between health anxiety, online health information seeking, and cyberchondria: Systematic review and meta-analysis. Journal of Affective Disorders 245, 270–278.
- Powell, J., N. Inglis, J. Ronnie, and S. Large (2011). The characteristics and motivations of online health information seekers. Journal of Medical Internet Research 13(1), e20.
- Rice, R. E. (2006). Influences, usage, and outcomes of internet health information searching: multivariate results from the pew surveys. International Journal of Medical Informatics 75(1), 8–28.
- Starcevic, V. and D. Berle (2013). Cyberchondria: Towards a better understanding of excessive health-related internet use. Expert Review of Neurotherapeutics 13(2), 205–213.

Suziedelyte, A. (2012). Does searching for health information on the internet increase medical care utilization? Social Science & Medicine 75(10), 1828–1835.