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HEALTH ECONOMICS

Introduction – From Theory to Practice and Vice Versa or How Economists Contribute to Understanding and Improving the Healthcare System

Thomas Barnay* and David Crainich**

For the third time, the journal *Economie et Statistique / Economics and Statistics* and the *Collège des Économistes de la Santé*, the French learned society in health economics, are working together to promote French Annual Health Economics Conferences (in French, JESF). These yearly events are organised by the French Health Economists Association. After publishing two special issues in 2015 and 2021, respectively associated with the 35th (Barnay *et al.*, 2015) and 41th JESF (Franc, 2021), *Economie et Statistique / Economics and Statistics* is publishing a new edition compiling a selection of articles from the 44th JESF held at the University of Lille in December 2022.

Since 2006, these events have given rise to the publication of a selection of articles in a peer-reviewed generalist journal every other year. This promotion of the work carried out reflects the commitment to exploit economic expertise in a particularly complex sector where debate often arises about access to care, the remuneration of healthcare professionals, optimal patient care and the regulation of healthcare spending.

The healthcare sector is a particularly good field for economic analysis, on the one hand, and for public intervention, on the other hand. This introduction highlights the concerns held by French health economics researchers about these two aspects, and their research is represented for the occasion by the seven articles in this special issue. More specifically, we show how these articles contribute to discussions on public health policies and fit in with the traditional approach taken by economic science, which involves the interaction between theoretical models and empirical studies. These articles are summarised at the end.

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Translated from “Introduction - De la théorie à la pratique et vice versa ou comment les économistes contribuent à comprendre et à améliorer le système de santé”.

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An Ever-Evolving Sector

First of all, it is well established that the health sector is a source of wealth. From a purely accounting perspective, INSEE states that the pharmaceutical sector generates pre-tax value added of 14,438 million euros (more than the IT, electronics and optical products manufacturing sector, for instance). Moreover, health professionals accounted for 1.23 million workers in 2023. The relative weight of the healthcare and medical-social sectors is also expanding rapidly as a result of the growing need for care and support for dependent elderly people. As a result, 370,000 additional positions for doctors, nurses, home support workers and care assistants are expected to be created between now and 2030 (France Stratégie & Dares, 2022). Since Solow's exogenous growth model (Solow, 1956) was challenged in the 1980s, economic theory has argued that healthcare expenditure can be productive. Endogenous growth models show that health capital, not only as a component of Human Capital but also due to spillover effects to other sectors (such as chemistry or imaging) and intergenerational reproduction, is a source of production (Mushkin, 1962; Becker, 1964 and Grossman, 1972). At a more microeconomic level, the good health of working-age individuals ensures productivity gains and a higher likelihood of working and increasing one's income (Barnay & Jusot, 2018).

Of course, the health sector is also expensive. The ONDAM (*Objectif national de dépenses d'assurance maladie* – National Objective for Healthcare Spending), voted by Parliament every autumn and set at 254.9 billion euros for 2024, represents nearly 9% of gross domestic product. While the exceptional expenditure allocated to the health crisis was halved between 2021 and 2022 (Arnaud & Lefebvre, 2023), budget constraint remains extremely strict. The French Social Welfare Budget Bill of 2024 estimated the health insurance deficit at 9.4 billion euros in 2023. The latter is explained in particular by rising health spending fuelled by ageing population, the rise of chronic diseases and technological innovations.

Given that four-fifths of the consumption of healthcare and medical goods is covered by statutory health insurance, the public authorities are working hard to enact reforms. This work appears entirely consistent with the economic analysis which identifies numerous market failures in the health sector. One frequently cited example is the presence of externalities. Negative externalities include second-hand smoke and forest fires caused by cigarettes, which cause damage to society that is not financially compensated by smokers. In contrast, vaccination against infectious diseases brings benefits to society. On one hand, this positive externality justifies recourse to public insurance because individual risks are neither independent nor random, thereby compromising the optimal functioning of the private health insurance market; on the other hand, subsidising vaccines means they can be promoted among the most disadvantaged populations. Strong levels of information asymmetry between stakeholders and the interdependence of supply and demand for healthcare are also weaknesses that create a loss of efficiency in the healthcare system. Moreover, in his words "*recovery from disease is as unpredictable as its incidence*", the 1972 Nobel Prize winner in economics, Kenneth Arrow, in his pioneering 1963 paper underlined the high level of uncertainty characterising this highly unusual market (Arrow, 1963).

In many respects, therefore, it seems imperative to manage healthcare expenditure, in a context where rapid innovation is very costly (genetics, biomedicine, artificial intelligence) and where the need to reduce carbon emissions is becoming ever more pressing. Reforms to the healthcare system are therefore common and may have competing objectives; sometimes focusing on the efficiency of the health system, sometimes aiming at reducing social inequalities in health and access to care. The articles presented in this special edition of the journal *Economie et Statistique / Economics and Statistics* therefore stem from a context of intense reforms.

Within the Healthcare market, Public Finance uses the whole range of regulatory tools: Market price changes (contracting of sector one doctors, administered drug prices, etc.), volume regulation (number of doctors via the *numerus apertus*[1] principle), publication

1. *As part of the "My Health 2022" plan, the* numerus clausus *principle has been replaced by the* numerus apertus *one. The latter sets a minimum number of students admitted in the second year of medical school, depending on intake and places available at the University.*

of guidelines for healthcare professionals or modification of competition rules in the pharmaceutical market through patents.

On the patient side, reforms focus on protecting the most vulnerable, "empowering patients" and addressing emerging needs. On the protection side, one of the flagship reforms (inspired by Beveridge) is undoubtedly the creation of CMU coverage (*Couverture maladie universelle* – Universal Health Insurance) in 2000 making healthcare cover available to all, and CMU-C coverage (*Couverture maladie universelle complémentaire* – Complementary Universal Health Insurance) for the most disadvantaged.[2] The legislator also strives to better define and protect the rights of specific populations such as disabled people (French disabled workers act in 1987 and 2005; French act prohibiting discrimination against persons with disabilities or on health grounds in 1990), a population group that is at the core of **Thomas Blavet**'s contribution to this issue. Instead, the more coercive reforms carried out in 2008 aim to introduce deductibles and fixed contributions on boxes of medicines and paramedical services, paramedical procedures, hospital care or health transportations in order to limit the risk of overuse of care caused by an insurance policy deemed too generous (this relationship has never been rigorously demonstrated). Two decrees published in the Journal Officiel on 17 February 2024 provide for an increase in the fixed contribution and a doubling of medical deductibles. These provisions will automatically lead to an increase in patient co-payments. The work of **Florence Jusot and Adèle Lemoine** presented in this issue demonstrates, based on European data collected from people aged 50 and over, that final[3] out-of-pocket expenses undermine equity in the healthcare system.

In addition, special attention is paid to emerging needs. As the large post-war generation advances in age, France, like most developed countries, is facing an acceleration in the ageing of its population. Despite dedicated legislative measures such as the act on adapting society to an ageing population (ASV) of 1 January 2016 or specific measures (*Allocation personnalisée d'autonomie*, APA – Personal Autonomy Allowances), the model of care is mainly based on caregivers. This leads economists, such as **Quitterie Roquebert** in this issue, to question the effects of this informal care that continues to be administered even to people living in nursing homes (*Établissements d'hébergement pour personnes âgées dépendantes*, EHPADs). Special categories of workers such as the self-employed are also targeted by support schemes for older adults (PARI programme) that **Estelle Augé and Nicolas Sirven** propose to evaluate.

In terms of care services, the way in which healthcare professionals are remunerated and the way in which care is organised are being radically overhauled. Although they remain the most common, traditional remuneration methods linked to activity are being brought into question because of their inflationary nature, in favour of mixed models incorporating incentive mechanisms often linked to performance, care pathways, patient follow-up and public health objectives. Thus, performance-based payments for self-employed doctors, initially introduced on a voluntary basis with the CAPI (*Contrats d'amélioration des pratiques individuelles* – Contracts for the Improvement of Individual Practices) in 2009, have been generalised with the ROSP (*Rémunération sur objectifs de santé publique* – Remuneration Based on Public Health Objectives) since 2011. Since 1 January 2024, the share of funding allocated to medical, surgical and obstetric activities has been increased to contain the effects of activity-based payment (T2A) introduced in 2004 for hospital funding. In this issue, **Vincent Attia, Mathilde Gaini, Edouard Maugendre and Catherine Pollak** evaluate pay-for-performance schemes to support prescriptions for biosimilars delivered in towns and cities. Moreover, experiments in innovative payments are being carried out in community medicine with, for example, "lump sums per episode of care" to be distributed among the various professions involved in treating the disease, sometimes grouped together in a Multidisciplinary group practice. These new incentives also aim to combat the still very high social inequalities in health and access to care and

2. Assistance with the payment of supplementary health (ACS), granted on a resource-tested basis, was also introduced in 2005. The CMU-C and ACS were finally replaced in 2019 by the Complémentaire santé solidaire *(CSS) top-up insurance.*
3. Direct payment made by patients after public and private health insurance coverage.

medicines in France. Two million people have three disadvantages in terms of access (general practitioner, nurse or physiotherapist), three quarters of whom live in rural areas (Legendre, 2021). **Julien Silhol**'s contribution explores new factors affecting the location of doctors that are likely to lead to levers of action.

Finally, the theme of prevention runs through healthcare policies, whether in terms of the way doctors are remunerated or in terms of efforts to change patient behaviour. It is discussed in this issue from an international perspective in the study by **Pauline Kergall and Jean-Baptiste Guiffard**, which analyses the effects of the Internet on the prevention of infectious diseases and the use of prenatal care.

From Theory to Practice

Like the work carried out in all fields of economics, the complementarity between theoretical models and empirical studies underpins the advances made in health economics. In a sector beset by major societal challenges and a sustained pace of reform, health economics is unique in that it is an applied discipline, one purpose of which is to fuel public debate. The contribution of economic theory is, therefore, decisive in constructing public health policies *ex nihilo*, in that it helps to predict how healthcare system stakeholders will react following an intervention that could, for example, alter the price of care or the income of healthcare professionals.

An example of this mutual benefit comes from the United States. In order to shed light on discussions about health cost sharing, the largest American experiment ever conducted was by the RAND Corporation between 1976 and 1982, led by Joseph Newhouse. This included establishing whether or not theoretical mechanisms of *ex post* moral hazard were proven (Pauly, 1968) within the framework of an *ex post* evaluation. Patients were randomly assigned (in particular to ensure that their care needs were similar) to relatively generous health insurance contracts including a 100% cover option. The aim of this experiment was to measure the elasticity of demand for healthcare to price changes. The aim was to compare theoretical insights with the behaviour revealed by the experiment. As expected, one of the findings of this study is that the consumption of medical goods and services is negatively correlated with price, with a price elasticity of −0.2 (Newhouse *et al*., 1993; Newhouse, 1996).

This special issue of *Economie et Statistique / Economics and Statistics* illustrates the importance of this interaction between theoretical frameworks and empirical studies through some of the discipline's classic subject areas. The articles published in this issue use empirical tools to answer the various research questions they examine. However, the literature to which each of them belongs highlights the way in which the research themes they address have been inspired by economic theory or shaped by the existing dialogue between theory and empirical research.

The importance of the interaction between theoretical and empirical work in the literature on individual demand for care is highlighted in two articles in this special issue, devoted respectively to the use of medical treatment (Estelle Augé and Nicolas Sirven) and disease prevention measures (Pauline Kergall and Jean-Baptiste Guiffard).

In their contribution, Estelle Augé and Nicolas Sirven measure the effect of the PARI programme (literally: Action Plan for Independent Retirement) on the use of care for self-employed workers. The latter is significantly lower during working life, mainly because of better health and longer working hours (Augé & Sirven, 2021). The theoretical starting point for the empirical work of Estelle Augé and Nicolas Sirven is Grossman's health capital demand model (1972). In the latter, individuals inherit an initial health capital, the natural depreciation of which can be offset by an investment in the form of time devoted to health and the acquisition of market goods such as medical care, food, housing, etc. According to Grossman, individuals adjust their investment in order to reach a level of health capital deemed optimal. The benefits of this investment are twofold: over and above its intrinsic value, good health also makes it possible to increase labour productivity and generate higher income. The model is therefore particularly well suited

to the decisions made by the self-employed. It has also been widely criticised because it implies – contrary to what has been shown in the empirical literature – that the health capital depreciation rate is exogenous on the one hand, and that the demand for care and health status are positively correlated on the other hand. There are various possible reasons for this discrepancy. The reason of particular interest to us in the work of Estelle Augé and Nicolas Sirven was formulated by Wagstaff (1986), who suggests that the negative correlation observed between demand for care and health may potentially result from the fact that – contrary to what Grossman's model implies – individuals do not necessarily instantly adjust their health capital to the optimal level. Wagstaff (1993) therefore provided a new empirical formulation of the Grossman model, the results of which seem to be more in line with observed behaviours. As a result, Galama & Kapteyn (2011) proposed a theoretical extension of Grossman's model in which individuals do not instantly adjust their investment to reach their optimal level of health capital, which is instead defined as a threshold level above which individuals do not use healthcare. This would be the case for self-employed workers who, in accordance with the empirical literature, are believed to underutilize healthcare services at the beginning of their employment and then catch up during retirement. However, this one-off approach, which is only used when the patient's health has deteriorated sufficiently, is problematic. It justifies the introduction of measures to encourage workers to adopt a more proactive and forward-looking attitude. The work of Estelle Augé and Nicolas Sirven aims to evaluate the effects of one of these measures.

The article by Pauline Kergall and Jean-Baptiste Guiffard analyses the effects of developing high-speed connectivity on the use of mosquito nets, the use of antenatal care and the vaccination of children in Senegal. This article is part of the literature devoted to the determinants of disease prevention actions, the level of which is considered too low in developing countries. Dupas (2011), for example, highlighted that malaria and diarrhoea, which account for a substantial share of infant mortality in Africa, could be effectively prevented through the use of nets and chlorination of drinking water. Outside the specific context of developing countries, theoretical and empirical literature in health economics have converged to elucidate individual prevention decisions. *Ex ante* moral hazard, which refers to the lower use of prevention when the financial consequences of a claim are covered by an insurance contract, has been identified as a natural candidate to explain the limited investment in disease prevention measures (Arrow, 1963). However, the existence of this moral hazard has not been demonstrated in the empirical literature (Newhouse *et al.*, 1993). Other factors have been suggested to explain the low level of prevention against health risks. From a theoretical point of view, this literature is based on the article written by Ehrlich & Becker (1972), which provided the first model of actions that modify the characteristics of an event by reducing its probability (self-protection or, according to the terminology more commonly adopted in health economics, primary prevention) and its severity (self-insurance or secondary prevention). Ehrlich & Becker's (1972) analysis, based on the expected utility model, assumes that individuals are rational. However, empirical and experimental literature has largely shown that this is not generally the case. In the specific context of prevention, Keeney (2008), for example, highlighted the fact that individual decisions are the leading cause of death in the United States. Based on this observation, recent theoretical research has focused on how different behavioural elements could improve the understanding of prevention decisions. In particular, Baillon *et al.* (2020) show that low perception of the likelihood of illness could, by diminishing the benefits of prevention, elucidate the lack of investment in this endeavour. In the same vein, this insufficiency could be explained by loss aversion (behavioural bias whereby a loss is perceived as more severe than a gain of the same amount) that would heighten the perception of the cost of preventative effort (Bleichrodt, 2022). Finally, time preferences are also likely to influence the use of preventive actions, the cost of which is immediate and the benefit of which delayed. The link between time preferences, disease information and prevention (based on vaccination decision) is explored by Nuscheler & Roeder (2016). Based on a theoretical model validated by an empirical study, the latter show that the effect of information on the propensity to be vaccinated depends on whether or not individuals' time preferences are rational and on their awareness of their irrationality (that is, whether they are naive or sophisticated). In connection with the work of Pauline

Kergall and Jean-Baptiste Guiffard described in this issue, the analysis by Nuscheler & Roeder (2016) points out that access to medical information may not be sufficient to promote disease prevention actions.

At the intersection of the demand for care discussed in the two previous articles and the supply of care, the literature on informal care for dependent persons serves as another illustration of the interaction between theoretical models and empirical studies in health economics. Quitterie Roquebert's contribution highlights the importance of intra-family relationships, which is a very specific aspect of this literature. Since informal caregivers and claimants are often members of the same family, care may be the result of a joint decision to maximise the family's well-being, or it may result from strategic interactions between family members.

More specifically, Quitterie Roquebert analyses the effect of informal care on different health outcomes (depression or fatigue, lack of appetite and sleep disorder) for nursing homes residents. In order to address the potential endogeneity bias between informal care and health status, the author uses, as an instrumental variable, the fact that the beneficiary of informal care has at least one daughter. Dependence studies have largely shown that girls are more likely than boys to provide informal care to their parents. The question of the effects of intrafamily relationships on the provision of informal care takes on different aspects in the economic literature on care. These relate to – in addition to the effect of formal and/or informal care on the dependent person's health status discussed by Quitterie Roquebert – the distribution of the amount of formal and informal care offered, the appropriateness of placing the individual in a nursing home or of sharing accommodation between the dependent person and the caregiver, other financial decisions jointly determined with those relating to long-term care and so on. The theoretical contributions that have addressed these issues have assumed either that there was only one child in the family (Kotlikoff & Morris, 1990), or that only one child in the family made decisions about long-term care (Sloan *et al.*, 1997), or that the family constituted a single entity, in terms of both its well-being and decision-making (Hoerger *et al.*, 1996). More realistic contexts were then proposed, using game theory models which assume that decision-making results from interaction between siblings, in order to analyse the effect of formal and informal care on the health of the dependent parent (Byrne *et al.*, 2009) or on the identity of the sibling providing informal care (Engers & Stern, 2002). A second aspect of the link between intrafamilial relationships and informal care provision is what is known in the literature as intrafamily moral hazard. The latter occurs when some parents, preferring to receive informal care rather than formal care or being moved to a retirement home, influence the behaviour of their relatives by not purchasing a long-term care insurance contract (Pauly, 1990). Empirical work on the subject has led to relatively mixed conclusions: Mommaerts (2024) shows that the availability of potential informal caregivers does reduce the demand for long-term care insurance, but Coe *et al.* (2023) nuance the dynamics of intrafamily moral hazard in that they do not observe that informal care decreases when dependent persons are insured against the financial consequences of long-term care. While it is therefore theoretically a determining factor in the demand for long-term care insurance and, indirectly, in the supply of informal care, the existence of intrafamily moral hazard nevertheless needs to be more formally established by the empirical literature. The empirical conclusions of Quitterie Roquebert, which demonstrate that informal care has a limited effect on the health of dependent people, could be integrated into theoretical models describing how siblings interact to provide a combination of formal and informal care for their parents.

Agency theory, which analyses agreements between a principal who pays for the delivery of a service and an agent who delivers it, forms the theoretical basis for health economics work that studies the effects of care providers' payment structure. More specifically, contributions under this category focus on the propensity of different funding structures to incentivize providers to adopt behaviours considered desirable (providing quality care, minimising costs, not selecting patients, etc.).

The article by Vincent Attia, Mathilde Gaini, Edouard Maugendre and Catherine Pollak, which assesses the effects of a pay for performance-scheme to encourage private

practitioners and hospitals to increase their prescriptions of biosimilars dispensed in towns and cities, contributed to this literature. Empirical work highlights the relatively mixed effects of pay-for-performance on the efficiency of care (see, for example, Maynard, 2011). This highlights the importance of dialogue between theoretical and empirical contributions in order to identify the optimal structure of performance payments. The latter cover different aspects. The first concerns the very definition of performance and its observability, which forms the contractual basis of the scheme. This question is particularly complex in health economics, the quality of care being multi-dimensional and often only observable by the actual provider.[4] The level and structure of the payment (linear vs. non-linear) constitute two other aspects of the scheme. While the theoretical literature has shown, for example, that non-linear payment is more suitable in cases of high patient heterogeneity (Baron & Meyrson, 1982), a linear payment is easier to implement in practice (Chalkley *et al.,* 2020). Similarly, the trade-off between an additional payment if the target is met or a financial penalty if it is not met is another question linked to the definition of pay for performance (Chalkley *et al.*, 2020). Finally, the optimal structure of the scheme needs to be defined in the light of the objectives pursued, but also in such a way as to avoid (or at least minimise) the various undesirable effects highlighted by the empirical literature. In this regard, the pay-for-performance scheme initiated in the United Kingdom by the National Health Service in 2004 for the financing of primary care (quality and outcomes framework) has been rich in lessons learned. For instance, in the context of funding the monitoring of hypertension and diabetes indicators, Serumaga *et al.* (2011) showed that the scheme remunerated providers for actions they would have carried out in its absence, and Gravelle *et al.* (2010) suggest abuses of the scheme by providers. Other unintended effects of pay-for-performance would include incentives for providers to – where possible – exclude certain patients from the scheme (Doran *et al.,* 2008) and neglect aspects of their activity that are not directly remunerated (Campbell *et al.*, 2009). In addition to being considered in the design of performance-based remuneration for healthcare providers, these unintended effects must be compared with the beneficial effects on the quality of care. The latter are proven but, as shown by the work of Vincent Attia, Mathilde Gaini, Edouard Maugendre and Catherine Pollak, which confirms the conclusions of the British experiment (Roland & Campbell, 2014), remain below what is expected by public authorities.

The other three articles of this special issue deal with the topic of health inequalities in a broad sense (the equity of healthcare funding in the contribution by Florence Jusot and Adèle Lemoine and the distribution of doctors across the country in the contribution by Julien Silhol) or by targeting a vulnerable population (people with disabilities for Thomas Blavet). While these three articles do not systematically draw on a body of theory, the lessons taught by theoretical analysis are valuable in trying to reduce health inequalities, which are considered unfair.

It is, for example, well established that one of the tools for combating inequalities in access to health insurance is the requirement mandating the purchase of health insurance. This legal provision is rooted in the theoretical work carried out by Rothschild and Stiglitz in 1976. These authors show that in case of asymmetric information, the high-risk individuals, i.e. those in the poorest health, are more likely to take out an insurance policy than those in good health. This situation will generate very high-risk premiums, making it impossible for the poorest people to obtain insurance. The obligation to subscribe to health insurance makes it possible to pool risk by providing a broad base for funding, initially employee and employer social security contributions, but now a combination of contributions and tax.

The contributions of Florence Jusot and Adèle Lemoine identify indicators that measure the propensity of healthcare systems to meet conditions considered desirable, such as equity in the use of care or in its financing. The work measuring the equity of care financing is based on fairly old theoretical literature. The principles that have emerged

4. However, this problem is relatively limited in terms of the contribution made by Vincent Attia, Mathilde Gaini, Edouard Maugendre and Catherine Pollak given the objective laid down for prescribers.

from this process are the result of a consensus among public authorities and the general public. For example, the principles of horizontal and vertical equity, raised in the article by Florence Jusot and Adèle Lemoine, appear to be widely accepted and shared, at least in European countries (Hurst, 1992; Wagstaff *et al.*, 1992), and used into work on equity in health systems. They are found, for example, in the contributions of Wagstaff *et al.* (1999) and O'Donnell *et al.* (2008) which break down the redistributive effect of health system financing for 12 OECD countries and 13 Asian countries, respectively. Like many of the works in this literature, Florence Jusot and Adèle Lemoine use the Kakwani index (1977) to determine the extent to which health systems address vertical and horizontal equity concerns. This index was originally proposed to measure the progressiveness of tax systems, before being used to answer questions specifically raised by the evaluation of healthcare systems. O'Donnell *et al.* (2008) adapt it to measure the progressiveness of care financing by comparing the Lorenz curve for income distribution and the concentration curve for healthcare payments. The technique will then be used to highlight the effect of the different sources of financing of health systems and in particular, as proposed by Florence Jusot and Adèle Lemoine, the effect of out-of-pocket expenses on the progressive nature of the system.

Julien Silhol's contribution questions another facet of inequalities in access to care, namely the freedom for doctors to set up practice. Theoretical analysis produces knowledge that highlights the extent to which market failures linked notably to the interdependence of supply and demand and differences in medical demographics can alter the conditions of the outpatient care market (volume of care potentially created – Evans (1974) – as a result of the dominance of a fee-for-service payment, excess fees in sector two, adjustment of the consultations length and even potentially of the quality of care). Combating the shortage of doctors in certain areas therefore requires detailed knowledge of doctors' preferences at the time they set up practice and their sensitivity to the monetary and non-monetary incentives offered by the public authorities. Among the structures for access to primary care, Multidisciplinary group practice (*Maisons de santé pluriprofessionnelles*), set up mainly in medically underserved areas, seem to be gaining increasing support among young doctors. They are characterised in particular by mixed payment methods, fee-for-service and capitation payments, but also coordination payments to promote group work. The theoretical literature highlights the benefits of mixed payment through channels such as information gains, reduction of strategic behaviours (Lipman, 2000) or risk sharing (Robinson, 2001). Moreover, it provides strong arguments for promoting teamwork, which is also popular with physicians, while the complementary nature of tasks increases marginal productivity (Lazear & Shaw, 2007) and reinforces intrinsic motivations. Alongside the findings of Julien Silhol's study on the role of birth place and place of internship, promoting these schemes would undoubtedly help to combat inequalities in the geographical location of doctors.

Finally, studying a specific situation such as disability also feeds into the issue of inequalities, through the measurement of needs. Although Thomas Blavet's primary aim is to estimate the additional cost of disability in measuring household living standards in France, the issue is not so far removed from a conceptual and theoretical framework that could be very usefully applied. Guided by the data, Thomas Blavet adopts a pragmatic and standard definition of disability, i.e. limitations in activity over the last six months (the Global Activity Limitation Indicator). Beyond the specific needs created by the onset of disability in terms of care or technical aids, adopting a more societal view of disability by highlighting an alteration in opportunities or even capabilities (Sen, 1985) would undoubtedly make it possible to reconsider the public aid paid to offset the damage suffered. As such, the theory produces a particularly appropriate analytical framework for assessing the discrimination faced by people with disabilities in schools, in the labour market or on transport. Traditionally, two major theories have been advanced: the *taste-based discrimination* that underlies perfect information (Becker, 1957) and *statistical discrimination* (Arrow, 1972; Phelps, 1972). In the second case, statistical discrimination could be based on simple beliefs (Arrow) or measurement errors (Phelps), with both leading to, for example, under-employment of people with disabilities due to biased information about their productivity. Explicitly taking account of these lost

opportunities on the labour market or, more generally, of indirect costs would clearly alter the assessment of the additional cost associated with disability when measuring household living standards.

Summary of Articles

The first three contributions in this special issue on health economics are part of a topic on inequalities and vulnerability.

Julien Silhol's contribution, which opens this special issue, examines the effect of the distribution of medical interns on the geographical distribution of practice locations. It focuses on doctors who completed their internship between 2004 and 2007. During this period, the number of general medical interns doubled due to the combined effect of an increase in the *numerus clausus* and a change in the distribution of students between specialities in favour of general medicine. The data used matches different sources: INSEE databases on self-employed GPs from 2016 to 2019 who completed their internship between 2004 and 2007, the SIRENE (Système national d'Identification et du Répertoire des ENtreprises et de leurs Établissements – National Identification System and Register of Companies and their Establishments) and internship assignment decrees. The results show that, on average, an increase of one percentage point in university interns is associated with an increase of around 0.4 percentage points in the number of self-employed GPs in this cohort who set up in the region of this university. The allocation of internship positions would thus appear to be a lever for regulating doctors as they set up practice.

Thomas Blavet looks at how the statistical measure of living standards can be adapted to include the increased needs of households containing a person with a disability. In support of the French SRCV survey (Statistiques sur les ressources et conditions de vie – Statistics on Income and Living conditions) on standards of living, this methodology is applied to ordinary households residing in metropolitan France for the period 2017 to 2019. The author compares the results obtained for two standard-of-living indicators: the feeling of financial comfort and material deprivation. The handicap is defined from the GALI indicator (Global Activity Limitation Indicator). Estimates show that the additional cost of disability exceeds 30% of disposable income, regardless of the standard of living indicator considered. Taking into account this additional cost, it appears that four out of ten households with one disabled person are suffering income poverty.

The last article in this section is written by Florence Jusot and Adèle Lemoine. The authors assess the contribution of final out-of-pocket payments to vertical and horizontal equity in the financing of care for individuals aged 50 and over in Europe, using data from the SHARE (Survey of Health, Ageing and Retirement in Europe). The final out-of-pocket expenses are analysed for doctor's consultations, hospital treatment and dental care. The results indicate a lower equity in the financing of care in private insurance systems despite the presence of redistributive mechanisms. Universal health care systems seem to respect this principle better for outpatient care than for hospitalisations, thereby underlining the need to adapt these systems to their gradual privatisation by introducing exemptions for people on low incomes. Moreover, although universal health care systems appear to be more effective for medical consultations and hospitalisations, particular attention should be paid to improving dental coverage, which often remain insufficiently covered across all health systems.

Two other articles then focus on analysing changes in health care consumption and prevention behaviour in two extremely different contexts: a programme to support self-employed people in France and the effects of broadband on health prevention behaviours observed in Senegal.

The purpose of the study by Estelle Augé and Nicolas Sirven is to evaluate the causal effect of the PARI plan (*Programme d'actions pour une retraite indépendante* – Action Plan for Independent Retirement) on the consumption of care by self-employed older workers using a double difference method. The PARI programme, established in 2015 by the social system for self-employed individuals, aims to promote a comprehensive,

proactive and targeted approach, aimed at encouraging access to various social benefits for artisans and traders aged 60 to 79, with a view to preventing loss of autonomy. The identification of the effect is based on the implementation of the PARI programme in voluntary regions. The results show that the programme tends to reduce one-time care use behaviours in favour of a more regular relationship with the health system.

Based on demographic and health survey data, combined with the Afterfibre database, and using a difference of differences methodology, Pauline Kergall and Jean-Baptiste Guiffard are interested in the effect of the arrival of broadband on preventive health behaviours in Senegal. The installation of submarine fibre optic cables in 2010 introduced broadband connectivity in Senegal, including access to online medical information. The results show that broadband access is positively correlated with mosquito-net use, but with mixed results in access to antenatal care and immunisation for children. If the positive effects of Internet access were proven, then the expansion of broadband connectivity could be of paramount importance for improving health.

The last section brings together two contributions dedicated to support structures for dependent people (EHPADs) and more generally for patients (hospitals). Quitterie Roquebert estimates the causal effect of informal care provided by children on the health of EHPAD residents. She uses the French cross-sectional survey Care-Institutions (2016), which provides a representative sample of approximately 2,400 residents aged 60 and over, with children. Health is assessed in terms of depression, sleep disturbances, decreased appetite and feelings of fatigue. To correct the endogeneity of informal care, the author uses an instrumentation strategy where family help depends on the gender composition of the siblings. It turns out that informal care has little impact on health overall, and this is true regardless of gender and level of education.

Finally, the article by Vincent Attia, Mathilde Gaini, Edouard Maugendre and Catherine Pollak evaluates the effect of an incentive system to promote hospital prescriptions of biosimilars delivered in towns and cities. This system combines profit-sharing between hospitals and the health insurance fund with direct reimbursement of the incentive for prescription services. A difference-of-difference analysis method, using data from the National Health Data System (SNDS), compares the proportion of biosimilars prescribed by public hospitals benefiting from the incentive to that observed in similar non-beneficiary institutions. Between 2018 and 2021, this experience led to a significant increase in the share of biosimilars, with prescriptions for insulin glargine and etanercept increasing by 6.0 and 10.8 percentage points, respectively. From the point of view of efficiency, this measure resulted in savings, estimated at 0.5% of expenditure for insulin glargine and 0.1% for etanercept. Therefore, although the scheme has led to a significant increase in the prescription of biosimilars, savings for health insurance remain moderate, in part due to rapidly changing drug prices. □

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Geographical Distribution of Interns in General Practice: A Tool for Regulating Place of Settlement?

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Abstract – Since 2004, interns in general practice have been distributed among universities following the internship competition based on their wishes, the ranking in the competition, and the number of available positions at each university. The significant reallocation of intern posts which took place between 2004 and 2007 is used as a natural experiment to assess the effect of distribution of interns on geographical distribution of settlement. We estimate that an increase of one percentage point in the proportion of interns placed at a university is associated, on average, with an increase of 0.4 percentage points in the proportion of general practitioners in private practice resulting from these cohorts having settled in the university zone twelve years later. The study shows that place of birth is also a significant decisive factor in relation to place of settlement. Recruiting medicine students in "medical deserts" could therefore be a tool for regulating place of settlement.

JEL: J18, J48, J61
Keywords: general practitioners, medical deserts, distribution, regulation, mobility

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Since the turn of the millennium, the issue of accessibility to care has increasingly been the subject of public debate. Effectively, there are large, expanding zones in which there are known to be fewer doctors with regard to the population than in the rest of the country (Vergier & Chaput, 2017). The ageing of the population, the decrease in the ratio of doctors to inhabitants and, above all, the sharp decrease in the average labour supply of doctors are likely to have increased these imbalances (Bachelet & Anguis, 2017).

This article focuses on general practitioners in private practice, who perform 95% of general practice procedures.[1] In addition to the care they provide themselves (first-line care, chronic disease monitoring, prevention, etc.), they refer patients to all other areas of the health care system. As such, they are an essential factor in the efficiency of medical and paramedical provision (Ferrer *et al.*, 2005).

General practitioners in private practice are at liberty to choose where they practise. The public decision-maker therefore has little leverage in regulating the distribution of settlement. However, it acts upstream, by distributing intern positions among universities. Many medical students are therefore forced to move geographically when they become interns. This distribution has a significant short-term effect: as junior doctors, interns contribute to the functioning of hospitals and practices in the region in which they are placed. More interns directed towards a university therefore translates into increased care provision in the surrounding hospitals and practices.

But this distribution could also have a long-term effect. The placement system leads interns to work in regions to which they initially did not want to move. By completing their studies there, some of them may ultimately decide to settle there. Exposure to the region where they are placed is lengthy and intense, and takes place at a key moment in the doctor's life. Generally aged between 25 and 30, interns undertake various placements there for at least three years at a working pace that does not allow them to return to their home region every weekend. They receive their first wages, form their first professional network and are likely to form personal relationships. The internship experience is therefore likely to modify the perception they had of the region before being placed there. Accordingly, the distribution of intern positions appears to be a potential tool for geographical regulation of future settlement.

This article considers the effectiveness of this tool. With this aim, the geographical trajectories of the 2004 to 2007 cohorts of interns in general practice will be followed. During this period, a significant reallocation of intern positions took place. Compared to 2004, in 2007 they were less frequently attributed to universities in the largest urban areas (Paris, Lyon, Marseille, Toulouse, etc.), in favour of those located in smaller urban areas (Angers, Clermont-Ferrand, Saint-Étienne, Dijon, etc.). This reallocation can be seen as a quasi-natural experiment in so far as, upstream, the distribution of places for entry to the second year of medical studies for students in these cohorts had remained unchanged. It enables the effect of distribution of interns on distribution of place of practice to be identified.

The data used contains doctors' municipalities of birth. We use these as a proxy for where the doctor grew up, which is known to be a significant decisive factor in place of settlement. Once the places of birth are taken into account, we find that by increasing by one percentage point the proportion of interns of a cohort placed at a university, the proportion of general practitioners in private practice from this cohort who settle in the university zone increases by about 0.4 percentage points. We also find that distribution of births has an effect of similar magnitude on distribution of settlement.

This article does not specifically address the decisive factors for settlement in "medical deserts". Indeed, although a "medical desert" does not correspond to an official statistical category (Vergier & Chaput, 2017), the term refers to the idea of an area in which access to care is difficult in every respect. However, we observe a division of the country into 28 zones, each municipality being associated with the nearest university hosting interns (Figure I). These zones are very large (more than three departments on average) and therefore contain areas with different levels of accessibility to doctors. Nevertheless, the average ratio of general practitioners to population also varies greatly from one zone to another: in 2020, there were 10.7 general practitioners in private practice per 10,000 inhabitants in the zones of the universities of Marseille and Nice, but less than 7.8 in those of the universities of Reims, Rouen and Tours. A better distribution of settlement among these zones would therefore contribute to a better geographical balance in care provision. Moreover, the effect of place of

1. *Sources: National Health Data System (*Système National des Données de Santé*, SNDS) via the application https://cartosante.atlasante.fr, which contributes to the network of regional health agencies (Agences Régionales de Santé, ARS).*

birth on place of settlement, highlighted in this article can certainly be extrapolated in part to smaller geographical units.

The article is structured as follows: Section 1 provides a review of the literature on decisive factors relating to doctors' place of settlement. Background information is provided in Section 2. The data is presented in Section 3. In Section 4, we consider variations in the distribution of interns in general practice between 2004 and 2007 to identify the effect of place of internship on place of settlement. Finally, in Section 5, we adapt a competition model to put forward counterfactual simulations: we consider how settlement would have been distributed *(i)* if the distribution of interns in 2004 had been maintained in subsequent years or *(ii)* if a policy of recruitment of medicine students specifically in certain zones had been adopted.

1. Review of the Literature

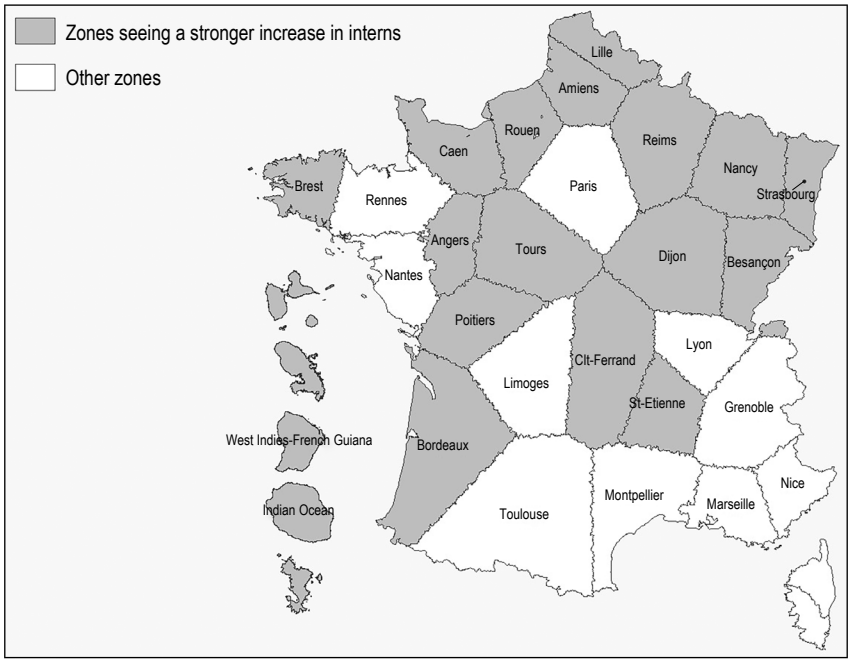
Regional inequalities in access to care are not unique to France. In many countries, rural areas and disadvantaged urban zones, in particular, may have fewer doctors. Accordingly, there is significant literature focusing on identifying the decisive factors for settlement in these types of areas. A better understanding of these decisive factors aids in developing public policies for the geographical regulation of more efficient settlement. This literature can be divided into two categories of studies.[2] The first focuses on the geographical trajectories of doctors. The second on the effects of financial incentives.

Geographical Trajectories

A first category of studies focuses on doctors' geographical origins. The principal decisive factor identified for settlement in a zone with a low density of doctors is having grown up there and, to a lesser extent, having studied there. Asghari *et al.* (2020) undertake a meta-analysis of this issue. To rectify the shortage of doctors in rural areas, the authors advocate continuity between places of recruitment of medical students, places of study, and places benefiting from settlement incentives. The expression "*rural pipeline"* has therefore emerged to characterise this geographical continuity, which appears to be a constant. This term may also describe programs to recruit medical students in rural areas and/or promote placements there, in order to increase settlement in areas of this type (Witter *et al.*, 2020). However, rural areas do not entirely overlap with the areas that have a low density of doctors. In the United States and Canada, studies also focus on identifying the decisive factors for settlement in disadvantaged urban areas where certain ethnic communities

2. Some studies highlight other local or individual decisive factors in relation to place of settlement. For example, Chevillard & Mousquès (2020) show that multidisciplinary nursing homes are attractive to doctors. We do not address studies of this type here because the places of settlement observed in this study are extensive (cf. Figure I) and, therefore, contain areas in which the presence of these decisive factors is very uneven. In addition, the dataset used contains very few individual characteristics.

Figure I – **University zones**



Notes: Each municipality is attached to the nearest university hosting interns in general medicine.

(particularly Black, Hispanic, or Native American communities) are concentrated. In line with the concept of a rural pipeline, these studies show that coming from each of these types of areas significantly increases the likelihood of settling there (Goodfellow *et al.*, 2016).

The links between places of study and places of settlement are discussed further. Using French data, Vilain & Niel (1999) and Delattre & Samson (2012) find that three quarters of doctors are based in the region where they submitted their thesis. But this high proportion could actually be linked to a rural pipeline effect, since most doctors study in the region where they grew up. There is less research aiming to disentangle the effect of the place where a doctor grew up from the place where they trained, as decisive factors in relation to their place of settlement. Xu *et al.* (1997), based on a sample of just over 2,000 doctors whose place of settlement was observed ten years after completion of their studies, show that practising in a rural zone is associated with having grown up there, but not with having completed part of their training there. A similar result is found in Easterbrook (1999). However, the effect of place of study on place of settlement, net of the place where the doctor grew up, remains the subject of discussion: it is strongly suspected to depend on the "duration of exposure" to the region concerned (Denz-Penhey *et al.*, 2005) and on when this "acculturation period" occurs (Wilkinson *et al.,* 2003). These issues are considered in this article.

Financial Incentives

The second category of studies assesses the effects of financial incentives intended to regulate place of settlement. This traditional public policy instrument consists of bonuses or tariff increases for doctors practising in low-density zones, or takes the form of funding for years of study in return for which the beneficiary students commit to practising in certain regions for a fixed period of time after graduation. Both types of financial incentives exist in France (Box).

There are few assessments of the effects of bonuses and tariff increases on settlement in certain regions, but these are consistent: the effects are generally assessed as fairly minimal. Moreover, it has been observed that the imbalances are still present in countries that used these early on (in the 1970s and 1980s in Canada and the United States). They were therefore not sufficient to attract enough doctors. Experimental economics studies carried out to document doctors' choices provide some clarification in relation to doctors' limited response to this type of mechanism. Polton *et al.* (2021) contains a review of nine studies analysing preferences expressed by doctors: income level is not seen as a significant decisive factor when doctors have to choose between various scenarios. Using French data, Delattre & Samson (2012) also show that, in order to influence doctors' preferences to the extent of changing their inter-regional distribution, bonus amounts need to be very high. In fact, a report by the Cour des comptes (Cour des comptes, 2014) states that the conventional option – a mechanism which increased the price of consultations for doctors practising in certain regions by 20%, or on average around €25,000 per doctor – only led to the arrival of 60 new general practitioners in private practice during the 2007-2010 period, some of whom might have chosen these regions without this intervention. The targeted zones were, however, quite extensive (4,500 municipalities/2.6 million inhabitants). It should also be noted that these financial incentives could have counter-productive effects. Indeed, many doctors seem to adjust their working time to the income they seek (Rizzo & Blumenthal, 1996; Chanel *et al.*, 2017). Financial incentives could lead to a reduction in the number of consultations offered, as beneficiary doctors receive part of their income from the incentive itself.

There are more studies dealing with the effects of financial assistance to students in exchange for a period of practice in a zone with a low density of doctors. The summary of 43 articles produced by Bärnighausen & Bloom (2009) shows firstly that only seven tenths of students included in these programmes meet their obligation to practise in a low-density zone after graduation – this proportion is 67% on average when the programme offers a buy-out option and 84% when this option is not available. It also appears that the periods doctors who have benefited from these programmes and meet their obligation spend practising in low density zones are variable, but are generally shorter than in the case of doctors who choose to settle there. Financial incentives alone cannot, therefore, balance out the geographical distribution of doctors.

2. Background

2.1. Placement of Interns at Different Universities

Internat (internship) is the name given to post-graduate medicine studies. Originally,

Box – **Policies for Regulating the Settlement of Doctors in France**

Freedom of settlement, i.e. the option to freely choose one's place of practice, is included in the 1927 charter written by the doctors' trade unions to establish the principles of private medical practice. This freedom has never been questioned, neither when the social security system was set up in 1945, nor in the successive medical agreements defining the relationship between health insurance bodies and doctors' representatives.

Until the mid-2000s, the policy for regulating settlement was based on a single factor: the setting of the total number of students admitted to continue medicine studies beyond the first year. This number, the *numerus clausus*, is provided each year in a ministerial order which also sets out how is it broken down for each university. However, the distribution of second-year admissions between universities is more or less stable over time (see Appendix 1) and therefore does not constitute a tool for geographical regulation of future settlement.

The evolution of the *numerus clausus* follows a U-curve. Set at 8,588 in 1972, the *numerus clausus* initially saw a downward trend until 1993 (3,500) and then increased until 2020 (9,361 students). The *numerus clausus* was abolished in 2021.

In 2004, general medicine became a medical speciality. In the past, students wishing to enter this field could complete all their studies at the same university. As of 2004, all fifth-year students sit the national ranking tests (*Épreuves Classantes Nationales*, ECN). At the end of these tests they are placed at a university to carry out their postgraduate study, the internship. The placement is made based on of their wishes, their ranking in the ECN and the number of available intern positions. By making intern positions available at universities and withdrawing them, the public decision-maker drives this distribution. The objective of this study is to measure the effect of this distribution of interns among universities on the geographical distribution of settlement.

The Act of 13 August 2004 (*loi du 13 août 2004*) amends the Social Security Code, notably by broadening the scope of negotiations in relation to medical agreements. In particular, it opens up the possibility of introducing financial incentives to settlement in zones where there are considered to be too few doctors.

The 2005 medical agreement, signed in 2007, therefore provides for an increase of up to 20% in the fees of doctors practising in zones of this type, defined by the regional health departments (*Missions Régionales de Santé*). But this tool created a windfall effect given that doctors already settled in these zones benefited from these increases. At a cost of around €20 million per year, only 60 or so new general practitioners in private practice settled in one of the 4,600 target municipalities having a total of 2.6 million inhabitants, between 2007 and 2010 (Cour des comptes, 2014).

The 2011 agreement abolished this arrangement and created the *demography option* (aimed at encouraging new doctors to settle in zones having a shortage) and the *health-solidarity option* (the purpose of which was to encourage doctors practising in other zones to come and work in zones with a shortage on a short-term basis). New zoning was implemented by the regional health agencies (*Agences Régionales de Santé*, ARS). In addition to support with settlement, *the demography option* led to a 10% increase in fees, with a cap of €20,000 per year, conditional on practising in a group practice. It only applied to newly-settled doctors.

Following the medical agreement of 2016, new zoning was carried out, based on a geostatistical indicator (the Localised Potential Accessibility indicator – *l'indicateur d'Accessibilité Potentielle Localisé*) and the local expertise of the ARS. From January 1, 2019, general practitioners in private practice who settle for at least five years in a multidisciplinary nursing home based in a Priority Intervention Zone (*Zone d'Intervention Prioritaire*, ZIP) receive a bonus based on the number of days worked during the week, which can be up to €60,000 if it is increased by the ARS.

In addition, the Act on Hospitals, Health, Patients and Regions (*loi Hôpital Santé Patient Territoire*) of 2009 offers medical students the option of receiving a monthly allowance of €1,200 if they commit to working in a shortage zone after their studies, for a period at least equal to the number of years for which this allowance was received. This public service commitment contract (*Contrat d'Engagement du Service Public*, CES) therefore constitutes a tool for regulating place of practice. Doctors covered by this study were not able to benefit from this new regulation because they completed their internship between 2004 and 2007 and the first CES were signed in 2011.

students who had completed their degree in medicine were housed in hospitals: this is from whence the terms *internat* (*internship)* and *interne (intern)* come from. Interns are placed at a university, where they attend classes. But most of their time is spent on placements that they undertake in hospital settings or practices located close to the university. They are then considered junior doctors: they enjoy a degree of autonomy (they see patients alone and are able to prescribe treatment) while being supervised and trained by senior doctors.

General practice has ranked as a medical speciality as of the 2004 cohort of interns. Previously, students could stay at the university where they had completed their first five years of study. The post-graduate period of study was then called a *residanat* rather than an *internat*. When general practice became a medical speciality, all medicine students were required to join the intern placement process.

This process is centralised. Each year, intern positions are allocated by medical speciality and

university. Students in their fifth-year of medicine take a competitive exam, officially known as the *Épreuves Classantes Nationales* (National ranking tests, ECN), better known as the *concours de l'internat* (internship competition), following which they choose an intern position in order of ranking (Billaut, 2005). Students choose, in turn, a combination of Speciality×University. When a student chooses the last intern position in medical speciality Sk available at university Uj, students with a lower ranking can no longer choose the combination Sk×Uj. Such a system causes the lowest ranked students to have only a limited choice of specialties and universities for their internships.

The university options for the internship placement available to the students ranked lowest in the ECN gradually narrowed between 2004 and 2007. According to Vanderschelden (2007), all intern places in general practice at 19 out of 28 universities were filled in 2007, meaning that they were not accessible to the lowest ranked students. This was the case for 15 universities in 2006 and only 11 in 2005. On the contrary, in 2004, the year in which this placement system was implemented, there was a degree of flexibility: universities were able to accommodate more interns than the number of positions they had available. The public decision-maker therefore controls much of the process of distributing interns. However, it does not have complete control. Indeed, the number of available positions is greater than the number of interns placed because at the end of the placement process some students retake their fifth year.[3]

2.2. Major Changes in the Distribution of Interns in General Practice Between 2004 and 2007

The number of interns in general practice doubled (+96%) between 2004 and 2007. This doubling was due to an upstream increase in the *numerus clausus* (see Appendix 1), as well as a change in the distribution of students between specialties in favour of general practice.

This doubling was not homogeneous across universities, which led to a change in the distribution of interns between universities (Table 1). Therefore, the number of interns in general practice placed at the university of Montpellier even decreased by 17% during this period, while it increased for all other universities, but in proportions ranging from +10% (Grenoble) to +400% (Saint-Étienne).

From one year to the next, the variations can be modest, or go in opposite directions, as was the case for the university of Angers where the number of interns placed initially doubled between 2004 and 2005, then dropped by 30%, then doubled again. However, a general trend emerges: by reducing the proportion of available positions in universities in the largest agglomerations (Paris, Lyon, Marseille, Nice, etc.) which are the most attractive (Vanderschelden, 2007), in favour of universities in smaller cities (Amiens, Caen, Reims, etc.), public decision-makers are causing more and more students to do their internships outside the major metropolitan areas (cf. Figure I). There are exceptions, however. The number of interns in general practice placed at universities in the agglomerations of Bordeaux, Lille, and Strasbourg is seeing slightly above average growth. One explanation could be their position, far away from other universities in the case of Bordeaux, or in regions with a low density of doctors (in the Haut-Rhin, Moselle and Vosges departments, the density of general practitioners was less than 9 general practitioners in private practice per 10,000 inhabitants in 2006, while the average density in mainland France slightly exceeded 10). Conversely, the lower than average growth in the number of interns placed at the university of Limoges (+84%) could stem from a difficulty in attracting students, even among the lowest ranked.

This reallocation of intern positions is significant: a third of the placements were reallocated among universities between 2004 and 2007. It seems to reflect the public decision-maker's desire to direct interns to the regions with the greatest shortages in general practitioners. Excluding the Paris and overseas departments and regions (DROM) zones,[4] there were 9.8 general practitioners in private practice per 10,000 inhabitants in 2006 in the university zones[5] where the number of interns more than doubled between 2004 and 2007, while this figure was 11.0 in the other zones.

2.3. Stability of the Distribution of Students Upstream of the Internship

We will use these changes in internship placements, which vary greatly from one university to the next, to identify the effect of the distribution between universities of a cohort of interns on the distribution of settlement locations of the doctors who come from that cohort. It is

3. Because they are not happy with their placement and wish to resit the ECN or because they have not fully completed their fifth year.
4. The Paris zone has a fairly low density of general practitioners (8.5 in 2006), but it has very specific features: its population is younger and the density of specialists much higher. Densities of general practitioners in the overseas departments and regions (DROM) in 2006 are not available.
5. The university zones are defined in Section 3.1.

Table 1 – **Distribution of interns in general practice among universities during the period 2004-2007**

University	2004		2005		2006		2007		Change in number (%) (between 2004 and 2007)
	Number	%	Number	%	Number	%	Number	%	
Amiens	22	1.8	17	1.2	74	3.6	77	3.2	+250
Angers	23	1.9	50	3.5	35	1.7	74	3.1	+222
West Indies-French Guiana	13	1.1	21	1.5	38	1.9	41	1.7	+215
Besançon	18	1.5	25	1.8	50	2.5	50	2.1	+178
Bordeaux	50	4.1	49	3.5	64	3.1	117	4.8	+134
Brest	26	2.1	31	2.2	44	2.2	71	2.9	+173
Caen	26	2.1	37	2.6	51	2.5	71	2.9	+173
Clermont-Ferrand	23	1.9	31	2.2	50	2.5	70	2.9	+204
Dijon	13	1.1	15	1.1	61	3.0	49	2.0	+277
Grenoble	67	5.4	69	4.9	65	3.2	74	3.1	+10
Lille	82	6.7	89	6.3	150	7.4	170	7.0	+107
Limoges	19	1.5	24	1.7	26	1.3	35	1.4	+84
Lyon	85	6.9	95	6.7	111	5.5	125	5.2	+47
Marseille	66	5.4	70	4.9	83	4.1	90	3.7	+36
Montpellier	79	6.4	39	2.8	45	2.2	65	2.7	-18
Nancy	47	3.8	53	3.7	83	4.1	121	5.0	+157
Nantes	50	4.1	60	4.2	65	3.2	75	3.1	+50
Nice	27	2.2	27	1.9	31	1.5	35	1.4	+30
Indian Ocean	9	0.7	15	1.1	17	0.8	25	1.0	+178
Paris	209	17.0	292	20.6	380	18.7	372	15.4	+78
Poitiers	21	1.7	46	3.2	63	3.1	101	4.2	+381
Reims	16	1.3	18	1.3	51	2.5	54	2.2	+238
Rennes	65	5.3	52	3.7	60	3.0	73	3.0	+12
Rouen	30	2.4	29	2.0	65	3.2	77	3.2	+157
Saint-Étienne	11	0.9	22	1.6	50	2.5	55	2.3	+400
Strasbourg	50	4.1	70	4.9	84	4.1	108	4.5	+116
Toulouse	60	4.9	48	3.4	63	3.1	80	3.3	+33
Tours	26	2.1	24	1.7	73	3.6	59	2.4	+127
Total	1,233	*100*	1,418	*100*	2,032	*100*	2,414	100	+96

Reading note: 22 interns in general practice were placed at the university of Amiens in 2004, which represented 1.8% of interns in general practice. 77 were placed there in 2007 (3.2%): the change is +250%.
Source: Intern placement orders.

important to note that while the distribution of interns varied greatly between 2004 and 2007, this was not the case, upstream, for their distribution as undergraduate students. Changes in the distribution of these students could have been a confounding factor. Students placed on internships between 2004 and 2007 began their second year of medicine between September 1999 and September 2002. The distribution of students admitted to the second year, fixed by ministerial orders, remained stable during those four years (see Appendix 1).

3. Data

3.1. Zones of Birth, Internship, Settlement

In order to establish the links between the places of birth, internship, and practice of doctors, we divide up the area by attaching each municipality to the nearest university. For this we use the criterion of the shortest distance (as the crow flies) between the centroid of the municipality in question and the centroids of the municipalities where the universities hosting the interns are located (cf. Figure I). We assume that interns placed at a university carry out most of their placements in the zone thus obtained.[6] The geographical unit of observation is therefore identical for these three points in the doctor's life. Therefore, a doctor born in Mulhouse, who settled in Colmar after having been an intern at the university of Strasbourg, is counted among doctors who were born, did their internship and settle in the Strasbourg zone.

6. With a few exceptions. For example, for historical reasons, interns placed at Lyon can do a placement in the René Sabran hospital in the municipality of Giens, which is attached to the Hospices Civils de Lyon.

3.2. Cross-Referencing Three Sources

The database used in this study has been produced by matching the self-employed databases (produced by INSEE[7]), the *Sirene directory,* and the internship placement ministerial orders.

We extract the general practitioners in private practice, the municipalities where they practise, their sex and their *SIREN* number from each annual self-employed database from 2016 to 2019. The business register identification system (*Système national d'identification et du répertoire des entreprises et de leurs établissements*, Sirene) assigns a SIREN number to companies, organisations and associations. Registration is compulsory. This Sirene directory makes possible *(i)* to lift anonymity of the doctors present in the self-employed databases,[8] which enables them to be matched with the internship placement ministerial orders, *(ii)* to access the municipality of birth of the doctors, information that appears in the Sirene directory.

Finally, placement ministerial orders contain the list of interns, the speciality in which they practise and the university where they are placed. We only include students placed in internships in general practice. These orders also indicate the ECN ranking. Some names appear in several orders from different years. They correspond to students who resat the ECN. As a result, we do not match the raw placement orders, but first remove from the order for year t all the names that reappear in the orders for years $t+1$ or $t+2$. Matching is done by surname, first names, sex and year of birth, except for the order for 2006 which does not contain the year of birth.

We only include general practitioners in private practice born in France and having done their internship between 2004 and 2007. Using this period allows us to observe the place of settlement twelve years after the beginning of the internship, or around eight years after the thesis. The place of practice twelve years after the beginning of the internship is more permanent than the place of practice just after thesis acceptance.[9]

This data is not exhaustive: registration in the Sirene directory does not necessarily mean that the information contained therein will be made available. In addition, we exclude doctors for whom the municipality of birth or the municipality of practice is not provided.

Of the 5,048 general practitioners in private practice who sat the internship competition between 2004 and 2007 that we identify at least once in the self-employed databases, we only include those observed as working on a private basis twelve years after the beginning of their internship in our analyses. The municipality of practice of the general practitioner twelve years after the beginning of their internship is considered as their municipality of settlement in this article. For the 2004 cohort (respectively 2005, 2006, 2007), the municipality considered is, therefore, the one where the general practitioner practises in 2016 (respectively 2017, 2018, 2019). General practitioners who have only been in private practice for a short time (a few locum posts at the start of their careers for example) and have then been employed are therefore not included in our analyses. The final number is 3,798 general practitioners in private practice. We consider the resulting database to be representative (see Appendix 2). We observe:

- the zone of birth (the municipalities of birth are aggregated at the university zone level, see Section 3.1),

- the university where the student was placed on internship,

- the settlement zone (cf. Section 3.1) twelve years after the beginning of the internship,

- the sex of the doctor and their ECN ranking: as the cohorts are of different sizes, this ranking is standardised.

It is important to bear in mind that the data only concerns general practitioners working on a private basis. The data is indeed constructed using the SIREN numbers of general practitioners in private practice. This article therefore provides information on the link between the distribution of interns in general practice and the distribution of general practitioners in private practice.

3.3. Descriptive Statistics

Twelve years after the start of their internship, more than two thirds (68%) of general practitioners in private practice are practising in the zone where they did their internship. We therefore find an important link, already documented, between place of internship and place of settlement (Vilain & Niel, 2007; Delattre & Samson, 2012). More interestingly, we observe a correlation between the increase in the number

7. The French National Institute of Statistics and Economic Studies.
8. The Sirene directory enable access to the surname and first names of doctors in private practice using their SIREN number.
9. We are also limited by the year 2004 (before 2004, general practice was not recognised as a medical speciality and was not included in the internship placement orders). In 2008, the placement of interns did not give rise to a named order. We therefore do not know the distribution of this cohort among universities.

of interns at a university between 2004 and 2007 and the increase in the settlement of doctors from these cohorts in the university zone (Figure II).

Place of birth is also a significant decisive factor in relation to place of settlement. About half (46%) of the doctors practise in the zone (see Figure I) in which they were born and one third (32.6%) in their department of birth. We also observe that half of the doctors practise less than 85 km (as the crow flies) from their municipality of birth.

4. Effects of Place of Birth and Place of Internship on Place of Settlement

Place of birth and place of internship are both decisive factors in relation to place of settlement. However, these effects are intertwined, since a significant proportion of doctors undertake an internship in the zone in which they were born. We intend to separate these two effects here.

The data allows for calculation of the proportions of general practitioners in private practice, from these cohorts, settled in each zone. We calculate these proportions using the places of practice observed twelve years after the beginning of the internship. For example, 1.4% of general practitioners in private practice who started their internship in 2004 work in the Amiens zone in 2016. This proportion increased for interns in the 2005, 2006 and 2007 cohorts (respectively of 2.7%, 2.6% and 2.5%) whose places of settlement were observed in 2017, 2018 and 2019 respectively.

Finally, the data allows for calculation of the proportions of general practitioners in private practice born in each zone.

It is therefore possible to compare the proportions of births, internships and settlement: we consider the panel model (1), in which t indexes the cohorts and j indexes universities or university zones.

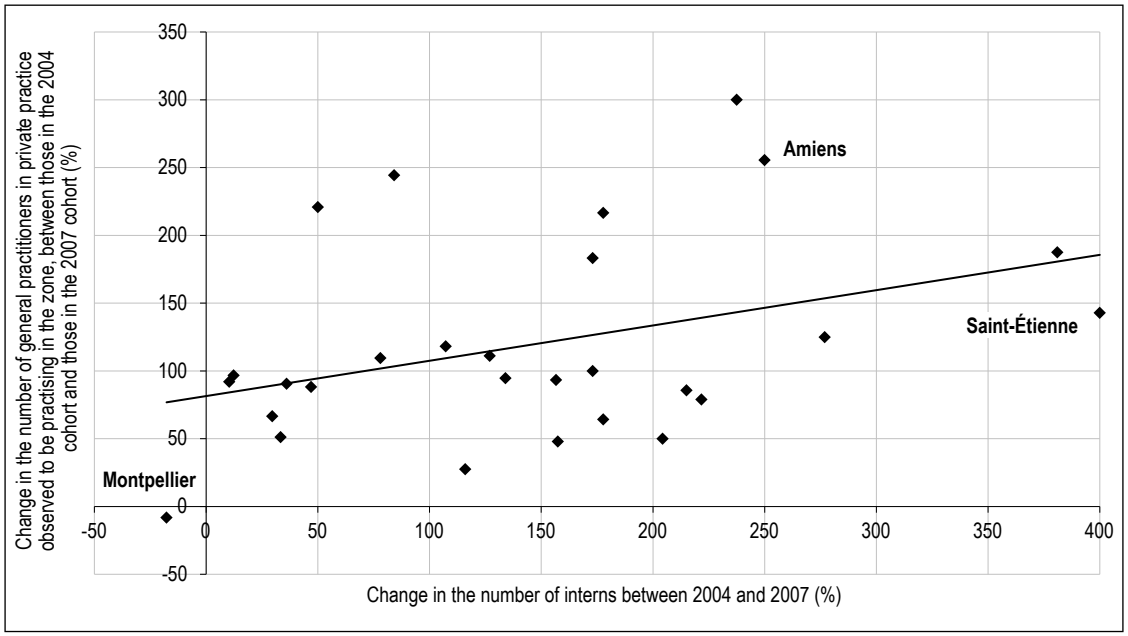
$$S_{jt}^{Installations} = \alpha_1 S_{jt}^{Internes} + \alpha_2 S_{jt}^{Naissances} + \beta_j + \gamma_t + \varepsilon_{jt} \quad (1)$$

with $j \in \{1;2;\ldots;28\}$ and $t \in \{2004;\ldots;2007\}$

where:

- $S_{jt}^{Installations}$ is the proportion of general practitioners in private practice from the cohort t practising in zone j in $t+12$,
- $S_{jt}^{Internes}$ is the proportion of interns from cohort t placed at university j,
- $S_{jt}^{Naissances}$ is the proportion of general practitioners in private practice from cohort t who were born in zone j,
- β_j and γ_t are fixed effects of zone and date respectively.

Figure II – **Correlation between the change in the number of interns at a university and the change in the number of doctors settling in its zone**



Notes: The place of settlement is observed 12 years after the beginning of the internship. The slope of the least squares line shown in the figure is 0.26.
Reading note: Between 2004 and 2007, the number of interns placed at the university of Amiens increased by 250%. The number of general practitioners in private practice from the 2007 cohort settled in the Amiens zone is 256% higher than the number of general practitioners in private practice from the 2004 cohort settled in this zone.
Source and coverage: Internship placement orders and self-employed database (INSEE). General practitioners in private practice who started their internship in 2004 or 2007.

Intuitively, it can be expected that the proportion of doctors practising in zone *j* will depend heavily on its attractiveness. For example, the average number of days of sunshine per year is identified in Delattre & Samson (2012) as having an influence on doctors' choice of settlement place. This type of attractiveness factor and all such factors that are invariant over time are controlled by the fixed effect β_j.

The proportion of students admitted to the second year at each university four years earlier is not introduced as a control variable in this model since it is constant over time (see Appendix 1).

We also test the addition of two control variables:

- The proportion of women among the interns of cohort *t* placed at university *j*,
- The proportion of students with low ranking in the internship competition. More precisely, within each group of interns placed at university *j* in year *t*, we use the proportion of those whose ranking in the internship competition (ECN) is in the lowest 20%.

The estimated coefficients are shown in Table 2.[10] Appendix 3 provides robustness checks for these estimates.

Without taking place of birth into account, we find that, on average, a one percentage point (pp) increase in the proportion of general practice interns placed at a university is associated with a 0.44 pp increase in the proportion of general practitioners in private practice who settle in this zone. The estimated effect is lower (0.35 pp), but the difference is not statistically significant at the usual thresholds. We find that the distribution of place of birth has an effect of the same order of magnitude (0.37 pp). The place where the doctor grew up is known to be a decisive factor in settlement place decision. In this article, doctor place of birth is used, in the absence of any more reliable information, to represent the place where he grew up. If, for example, we knew the distribution of places where the baccalaureate was awarded, we would undoubtedly find that this distribution has an even greater effect on place of settlement, perhaps to the detriment of that associated with the distribution of interns. Adding the control variables does not significantly change these results.

Paris is an atypical zone where a fifth of all intern positions are based. The link between place of internship and place of settlement is more significant, regardless of the specification, when we repeat the estimates excluding the interns placed at universities in this zone (see the three right-hand columns of Table 2), with no significant disparities. These slightly higher estimates could reflect the increased opportunities for salaried employment in the Paris region or a residential trajectory of young doctors similar to that of many young professionals, from the Paris region to the rest of France.

Our estimates therefore show that the distribution of place of internship has a significant effect on that of place of settlement, and the distribution of place of birth has an effect of the same magnitude.

The estimated effect of distribution of place of birth clearly reduces the effect of the distribution

10. We find a variance inflation index equal to 8.5, which reflects a situation in which correlations between the proportions of births, internships and settlement are moderate. Standard practice is to take problems related to multicollinearity into account when this index exceeds 10.

Table 2 – **Effect of intern distribution on settlement distribution**

	All zones			All zones except Paris		
	(1)	(2)	(3)	(1)	(2)	(3)
Proportion of interns	0.44***	0.35***	0.40***	0.52***	0.42***	0.45***
	(0.07)	(0.07)	(0.10)	(0.08)	(0.08)	(0.10)
Proportion of births	-	0.37***	0.35***	-	0.38***	0.38***
		(0.09)	(0.10)		(0.10)	(0.10)
Controls (ECN ranking and proportion of wom-en)	No	No	Yes	No	No	Yes
R^2	0.96	0.97	0.97	0.88	0.89	0.93
Observations	28 x 4	28 x 4	28 x 4	27 x 4	27 x 4	27 x 4

Notes: The settlement of each cohort of interns is observed twelve years after the beginning of the internship. *** corresponds to the significance threshold at 1%, ** at 5%, and * at 10%.
Reading note: On average, a one percentage point increase in the proportion of interns placed at a university is associated with a 0.44 percentage point increase in the proportion of private doctors settling in the university zone when place of birth is not taken into account.
Source and coverage: internship placement orders, self-employed database (INSEE) and Sirene directory (INSEE). General practitioners in private practice who started their internship between 2004 and 2007.

of places where doctors grew up. Therefore, in line with the rural pipeline programmes (cf. Section 1), our estimates show that to increase the number of doctors in a region, a policy consisting of encouraging secondary school students in this region to engage in medical studies, and providing them with support, could contribute to a better geographical distribution of settlement.

5. Modification of the Distribution of Settlement Following a Reallocation of Intern Positions or Places for Entry to the Second Year

To what extent did the distribution of interns in 2007 lead to a distribution of settlement very different to that which would have occurred if the distribution of interns in 2004 had been maintained?

What distribution of settlement could be expected if a policy was put in place aiming to recruit medical students in zones with a shortage of doctors?

In this section, we suggest the simulation of counterfactual situations in order to address these questions.

5.1. Econometric Specifications

In order to simulate counterfactual situations, we adapt a competition model introduced by Berry (1994), basing our approach on Silhol & Wilner (2023). In this model, potential consumers face a number of differentiated products and purchase the one that maximizes their utility; they may also decide not to purchase at all. When the consumer opts for one of the products, he "reveals" a level of utility of that product (its hedonic price). This model can be transposed to young doctors who have to choose one of the 28 zones in which to settle as a general practitioner in private practice, therefore revealing their level of utility for the zone. To complete the transposition, interns who do not settle as private practitioners (because they are employed, not working or practising abroad) play the role of consumers who decide not to buy.

The adaptation of the model leads to the estimation of equation (2) in which δ_{jt} represents the level of attractiveness exerted by zone j on the general practitioners from cohort t ($t \in \{2004;\ldots;2007\}$ and $j \in \{1;2;\ldots;28\}$). The attractiveness of each zone depends on its specific features, considered constant over time and captured by the fixed effect β_j. It also depends on the proportion $S_{jt}^{Internes}$ of interns who have been placed there: the greater the number of interns creating links with this zone during their internship, the more attractive the zone is to the cohort. Finally, it depends on the proportion of births, $S_{jt}^{Naissances}$, doctors having a strong propensity to settle where they grew up.

$$\delta_{jt} = \alpha_1 S_{jt}^{Internes} + \alpha_2 S_{jt}^{Naissances} + \beta_j + \gamma_t + \varepsilon_{jt} \qquad (2)$$

Berry (1994) used a measure of attractiveness δ_{jt} ($j \in \{1;2;\ldots;28\}$) in the form $\delta_{jt} = logs_{jt} - logs_{0t}$, where s_{jt} is the proportion of interns settled in private practice in zone j of all interns in cohort t, and s_{0t} is the proportion of interns who are not observed as practising on a private basis twelve years after the beginning of the internship. δ_{0t} denotes the attractiveness associated with the decision not to practise on a private basis in France. This measure enables an expression of s_{jt} which depends only on δ_{jt} given that the nullity of δ_{0t} ensures the equivalence of equalities (3) and (4):

$$\delta_{jt} = logs_{jt} - logs_{0t} \qquad (3)$$

$$s_{jt} = \frac{e^{\delta_{jt}}}{\sum_{k=0}^{28} e^{\delta_{jt}}} \qquad (4)$$

The coefficients of model (2) are estimated by ordinary least squares, based on the data used in the previous section. These then enable the levels of attractiveness $\hat{\delta}_{jt}$ of each of the zones to be estimated, corresponding to given distributions of interns in universities ($S_{jt}^{Internes}$) and of births in the zones ($S_{jt}^{Naissances}$). The equality (4) then enables an estimate to be made of the corresponding distribution of place of settlement (s_{jt}).

Models (1) (Section 4) and (2) (Section 5) are, therefore, complementary. The coefficients estimated in model (1) are interpreted directly as an effect on the proportion of settlement in a zone, which model (2) does not allow, due to the form of the variable explained. Conversely, model (2) enables a direct estimate to be obtained (via equality (4)) of the distribution of place of settlement for given distributions of place of birth and place of internship, which model (1) does not allow.[11]

Table 3 provides estimates of coefficients α_1 and α_2 of model (2).[12]

11. Model (1) does not allow counterfactual situations to be simulated. If distributions of interns in universities and of places of birth were chosen, model 1 would give proportions of settlement that do not amount to 100 and could in some cases be negative.

12. As models (1) and (2) are not the same, since the variables explained are different, it is unsurprising that the estimates in Table 3 are different from those in Table 2.

Table 3 – **Estimates of model for choice of place of settlement (model 2)**

	All zones			All zones except Paris		
	(1)	(2)	(3)	(1)	(2)	(3)
Proportion of interns	0.12***	0.09***	0.09***	0.15***	0.12***	0.13***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Proportion of births	-	0.11***	0.11***	-	0.13***	0.13***
		(0.04)	(0.04)		(0.04)	(0.04)
Controls (ECN ranking and proportion of women)	No	No	Yes	No	No	Yes
R^2	0.92	0.92	0.93	0.90	0.91	0.92
Observations	28 x 4	28 x 4	28 x 4	27 x 4	27 x 4	27 x 4

Notes: Settlement of each cohort of interns is observed twelve years after the beginning of the internship. *** corresponds to the significance threshold at 1%, ** at 5% and * at 10%.
Source and coverage: Internship placement orders, self-employed database (INSEE) and Sirene directory (INSEE). General practitioners in private practice who started their internship between 2004 and 2007.

5.2. Aggregation Into Two Types of Zones

Estimates are made at the level *jt* (with $j \geq 1$) as described above. But the results are presented after the zones are aggregated into two groups, according to whether they saw a particular increase in interns (i.e. the number of interns more than doubled between 2004 and 2007) or not (cf. Figure I). This aggregation allows for a clearer representation of public policy, which has involved an increase in the number of interns in general practice at 18 universities in particular, to the detriment of the other 10. It also enables more robust results to be presented.

The proportions of births, internships and settlement in these two types of zones are presented in Figure III. By construction, the curves are symmetrical (the sum of the two parts is 100%[13]). The doctors from the 2004 and 2005 cohorts, whose places of settlement are observed respectively in 2016 and 2017, mostly settled in zones that did not see a particular increase in interns. For the 2006 and 2007 cohorts, the distribution of settlement is more balanced between the two types of zones. This change must be compared to the distribution of these doctors in internships, twelve years earlier, and perhaps also to the distribution of their places of birth. The proportions of doctors from the 2006 and 2007 cohorts born in zones seeing a particular increase in interns are slightly higher than those from the 2004 and 2005 cohorts.

5.3. Simulation of the Absence of Change in the Distribution of Interns Among Universities

From equation (2), we obtain an estimate of the average levels of attractiveness of each zone in 2005, 2006 or 2007 assuming the 2004 distribution is maintained by:

$$\hat{\delta}_{jt}^{R_{2004}} = \hat{\delta}_{jt} - \hat{\alpha}_1 \left(s_{jt}^{Internes} - s_{j2004}^{Internes} \right)$$
$$\forall t \in \{2005; 2006; 2007\}$$

Simulated market shares are obtained through equality (4): $\hat{s}_{jt}^{R_{2004}} = \frac{e^{\hat{\delta}_{jt}^{R_{2004}}}}{\sum_{k=0}^{28} e^{\hat{\delta}_{jt}^{R_{2004}}}}$

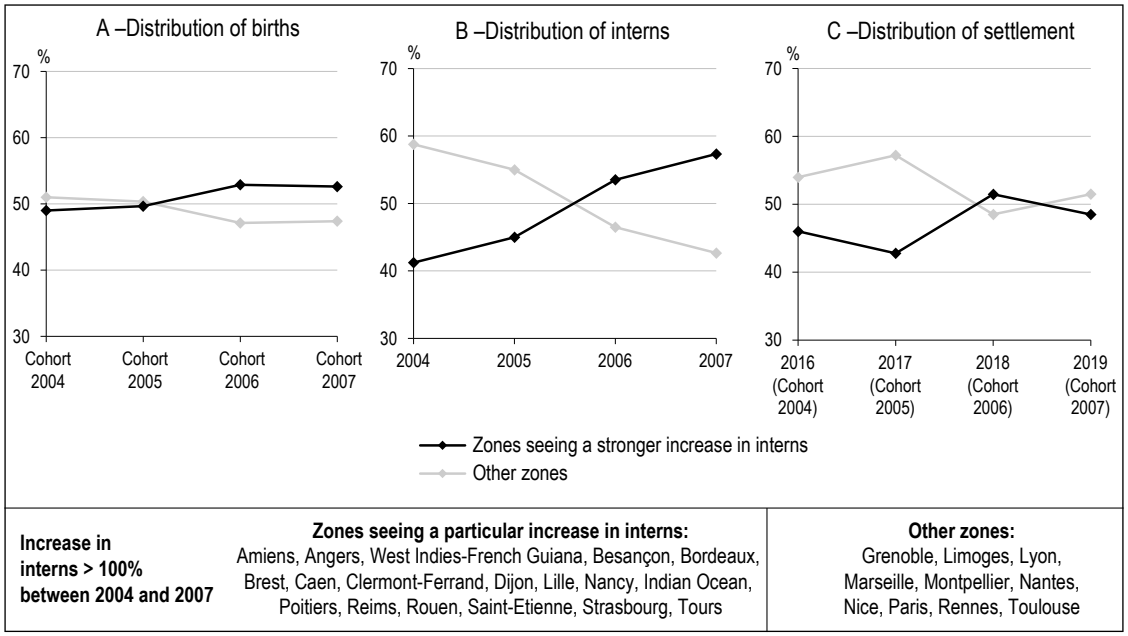
They are then added up by types of zone and represented in Figure IV.

According to this modelling, maintaining the 2004 distribution of interns would have led to settlement of a smaller proportion of doctors in zones seeing an increase in 2006 and 2007. In other words, the reallocation of interns carried out between 2004 and 2007 seems to have led to a reallocation of settlements. More specifically, the disparity between actual and simulated settlement in the two types of regions is 6.4 percentage points for the 2006 cohort and 2.7 percentage points for the 2007 cohort. Extrapolating these disparities to all general practitioners from these two cohorts of interns (those observed to be in private practice and others), we estimate that the change in the distribution of interns led around 200 general practitioners (in private practice or employed) to practise in zones seeing a particular increase in interns rather than in other zones.[14]

13. The model gives the proportion s_{0t} of interns who do not work on a private basis twelve years after the beginning of the internship and the proportions s_{jt} of doctors in private practice settled in each of the zones j, all these proportions being compared with all interns from cohort t. Figure III-C conversely represents the proportion of doctors in private practice settled in a type of zone compared solely with general practitioners in private practice.

14. In 2020, about 48,000 general practitioners (in private practice, employed, or mixed) practised in zones seeing a particular increase in interns and about 52,000 in other zones.

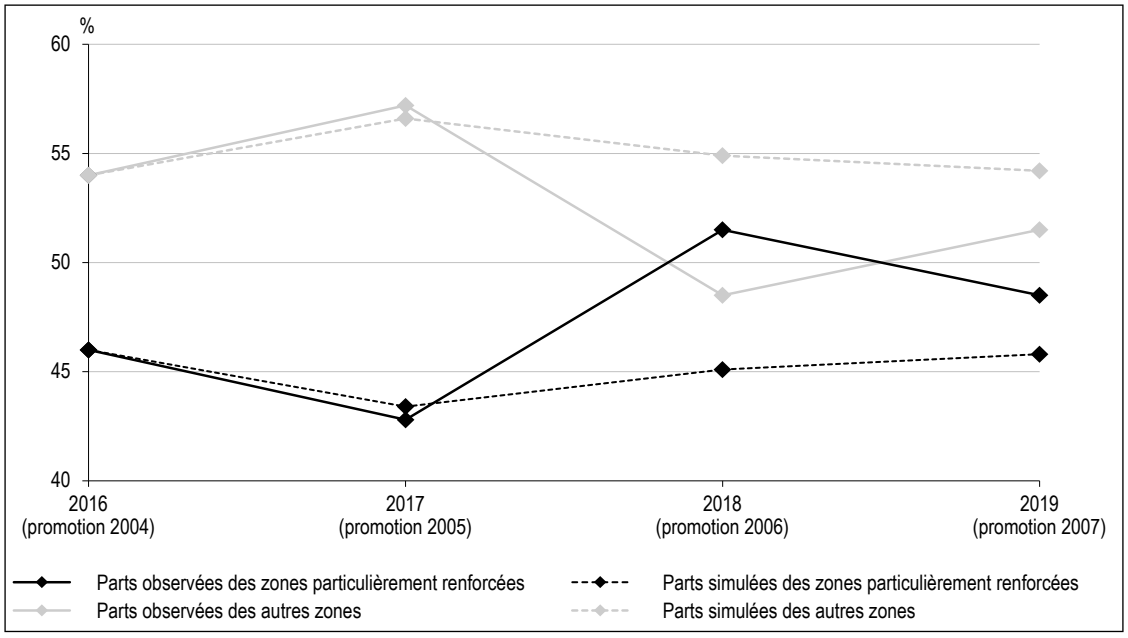
Figure III – **Changes in place of birth, of internship and of settlement according to the types of zones**



Increase in interns > 100% between 2004 and 2007	**Zones seeing a particular increase in interns:** Amiens, Angers, West Indies-French Guiana, Besançon, Bordeaux, Brest, Caen, Clermont-Ferrand, Dijon, Lille, Nancy, Indian Ocean, Poitiers, Reims, Rouen, Saint-Etienne, Strasbourg, Tours	**Other zones:** Grenoble, Limoges, Lyon, Marseille, Montpellier, Nantes, Nice, Paris, Rennes, Toulouse

Notes: The municipality of settlement observed is where the doctors are practising twelve years after the beginning of the internship.
Reading note: Of general practitioners in private practice who started their internship in 2004, 49% were born in a zone seeing a stronger increase in interns, 41% did their internship there and 46% settled there.
Source and coverage: Self-employed database (INSEE), Sirene directory (INSEE) and internship placement orders. General practitioners in private practice who started their internship between 2004 and 2007.

Figure IV – **Simulation of distribution of settlement if the 2004 distribution had been maintained**



Notes: The municipality of settlement observed is where the doctors are practising twelve years after the beginning of the internship.
Reading note: Of general practitioners in private practice who started their internship in 2007, 48.5% are observed to have settled in a zone seeing a particular increase in interns. The proportion of settlement of this type, if the distribution of interns of 2004 had been maintained, is estimated at 41.6%.
Source: Self-employed database (INSEE), Sirene directory (INSEE) and internship placement orders. General practitioners in private practice who started their internship between 2004 and 2007.

5.4. Simulation of the Recruitment of Local Students

At each university, students enrolled in the first year sit exams and are ranked in order of their results. During the period we are interested in, the number admitted to the second year was fixed centrally, by the *numerus clausus* and its breakdown by university. Those admitted to the second year then continued their studies at the same university.

Interns from the 2004 to 2007 cohorts were admitted to the second year of medicine between 1999 and 2002. During those years, the distribution of those admitted to the second year changed very little (see Appendix 1). Here, we simulate a reform of the distribution of admissions to the second year of medical studies for the years 1999 to 2002 which would have consisted of admitting more students to universities in zones seeing a particular increase in interns.[15] (as defined in Section 5.2). To simulate this reform with the data used in this article, we assume that it results in a change in the distribution of doctors' places of birth. The underlying assumption is that undergraduate students enrolled at a university were born in the zone of that university.

In this paragraph, we suggest the simulation of a reform of the distribution of students admitted to the second year which would have consisted of increasing by 10 percentage points the proportion of students admitted to the second year in universities in zones seeing the highest increases in interns. We assume that this reform results in a proportion of doctors born in zones seeing a particular increase in interns which is 10 percentage points higher in actuality.[16] This reallocation of places of birth is made to the detriment of other universities and pro rata to the births actually observed in each zone.

The attractiveness associated with settlement in each of the zones, for each of the cohorts, is estimated by:

$$\hat{\delta}_{jt}^{Simulation-naiss} = \hat{\delta}_{jt} - \hat{\alpha}_2 \left(s_{jt}^{Naissances} - s_{jt}^{Naissances-simulées} \right)$$
$$\forall t \in \{2004;...;2007\}$$

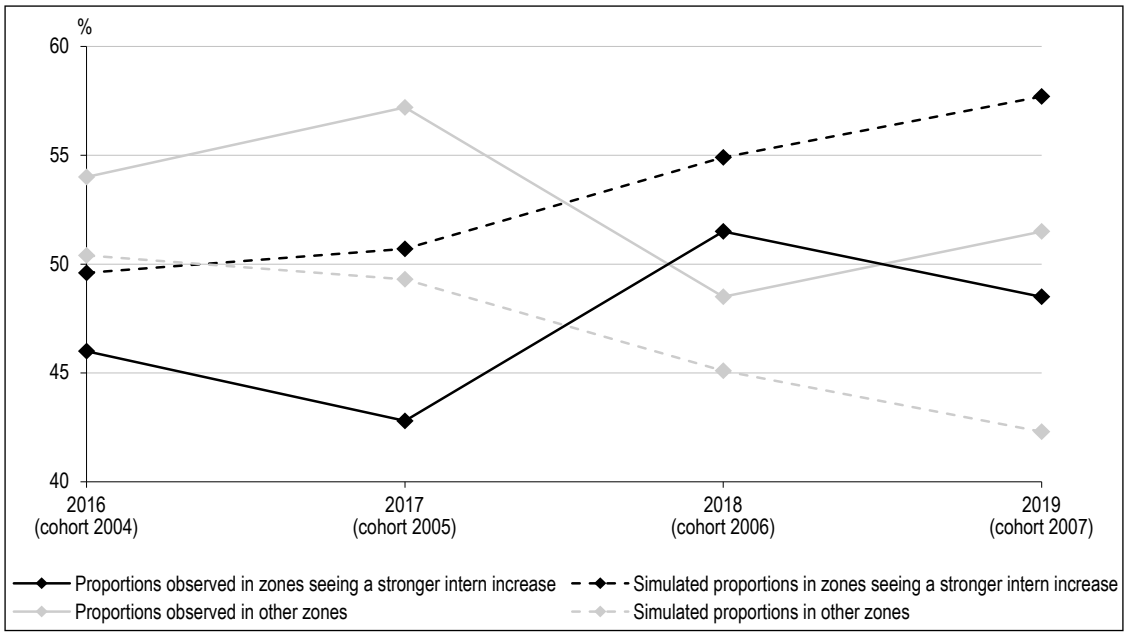
The proportions of settlement simulated in each of the zones and for each cohort are calculated using equality (4) and then aggregated according to the two types of zones (Figure V).

Using the same approach as in Section 5.3, we extrapolate the estimated disparities in settlement between the two types of zone to all general practitioners (in private practice, employed and mixed). The increase in settlement in favour of zones seeing a particular increase in doctors to the detriment of other zones, associated with the change to the distribution of students admitted to the second year, is around 450 general practitioners for the four cohorts considered, including around 300 for the 2006 and 2007 cohorts alone.

In Section 5.3, we estimated the increase in general practitioners practising in zones seeing

15. For example, the Angers zone is one of the zones seeing the highest increases in interns (Section 5.2). Each year between 1999 and 2002, it received 2.0% of those admitted to the second year (see Appendix 1). The reform simulated here would have involved an increase in this proportion.
16. This increase of 10% corresponds to a proportion of reallocation of places of birth similar to the proportion of intern positions reallocated between 2004 and 2007.

Figure V – **Simulation of distribution of settlement if the proportion of doctors born in zones seeing a particular increase in interns had been 10 percentage points higher**



Notes: The municipality of settlement observed is where the doctors are practising twelve years after the beginning of the internship.
Reading note: Of general practitioners in private practice who started their internship in 2007, 48.5% are observed to have settled in a zone seeing a stronger increase in interns. The proportion of this settlement, if an additional 10 percentage points of interns from the 2007 cohort were born in these zones, is estimated at 57.7%.
Source and coverage: Self-employed database (INSEE), Sirene directory (INSEE) and internship placement orders General practitioners in private practice who started their internship between 2004 and 2007.

a particular increase in interns associated with changes in the distribution of interns from these two cohorts at around 200. Compared to the distribution of interns in 2004, the 2006 distribution corresponds to a relocation of 12% of placements, and the 2007 distribution to a relocation of 16% (Figure V). It therefore appears that a more moderate rise (+10%) in students coming from zones seeing a particular increase in interns would produce a higher increase. However, the disparity between the increases in settlement obtained with the two simulations should be interpreted with caution. These increases are calculated using an estimate of the coefficients of model (2), and a method based on fairly strong assumptions.

* *
*

The analyses set out above are based on individual data relating to around 3,800 general practitioners in private practice who started their postgraduate medicine studies (internship) between 2004 and 2007. The combined presence, in the dataset, of places of birth, internship and settlement enables to shed light on some aspects of doctor settlement behaviours. In particular, we have been able disentangle the effects place of internship from place of birth on place of settlement.

We find that the geographical distribution of interns has a significant effect on the geographical distribution of their places of settlement. On average, we find that an increase of one percentage point in the proportion of interns placed at a university is associated with an increase of around 0.4 percentage points in the proportion of general practitioners in private practice, from these cohorts, who settle in the university zone. Therefore, the reallocation of intern positions carried out between 2004 and 2007 acted as a tool for regulating place of settlement. The distribution of place of birth has an effect of comparable magnitude.

Place of internship and place of birth are not the only factors that can influence the settlement choices of young doctors. In particular, future research could explore how these factors relate to other factors known to be decisive in relation to place of settlement, such as spouse's profession and origin where applicable, or the role of certain regional amenities such as multidisciplinary nursing homes (Chevillard & Mousquès, 2020). These regional analyses will undoubtedly benefit from being based on a more detailed geographical breakdown than the 28-zone approach used in our study. Lastly, it would be interesting to obtain information on the choice of location of doctors who do not work on a private basis, to broaden the scope of our results.

Our results suggest conclusively that a policy based on local recruitment of medical students from secondary school students in the regions needing more doctors could be effective. It would be a question of building on the fact that a number of doctors wish to settle near the places where they grew up. Such a policy could address the unequal distribution of training capacity in the region, for instance by building on inter-hospital type arrangements, allowing an intern to carry out certain placements in hospitals outside the zone of the university where they are placed. □

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APPENDIX 1

STABILITY OF THE DISTRIBUTION OF STUDENTS ADMITTED TO THE SECOND YEAR OF MEDICINE STUDIES

The scope of this study consists of general practitioners in private practice who started their internships in the 2004 to 2007 academic years. They began their second year of medicine between 2000 and 2003. The number of students admitted to continue their medical studies at the end of the first year was fixed by ministerial order for each university.

The total number of students admitted to continue their medicine studies beyond the first year grew between 2000 and 2003 (increase in *numerus clausus*), but their distribution among universities remained stable (Table A1).

Table A1 – **Distribution of second-year medicine students**

	2000-2001		2001-2002		2002-2003		2003-2004	
	%	#	%	#	%	#	%	#
Amiens	2.3	*89*	2.4	*98*	2.4	*112*	2.4	*122*
Angers	2.0	*77*	2.0	*81*	2.0	*93*	2.0	*101*
Besançon	2.1	*79*	2.1	*86*	2.1	*98*	2.1	*106*
Bordeaux	5.4	*208*	5.3	*218*	5.1	*242*	5.1	*262*
Brest	1.9	*72*	1.9	*78*	1.9	*89*	1.9	*96*
Caen	2.2	*85*	2.3	*93*	2.3	*107*	2.3	*117*
Clermont-Ferrand	2.3	*88*	2.3	*96*	2.3	*110*	2.3	*119*
Dijon	2.4	*94*	2.5	*102*	2.5	*117*	2.5	*127*
Grenoble	2.4	*92*	2.4	*98*	2.4	*112*	2.4	*121*
Lille	7.3	*281*	7.2	*294*	7.2	*337*	7.1	*364*
Limoges	1.8	*69*	1.8	*75*	1.8	*86*	1.8	*93*
Lyon	6.4	*248*	6.3	*257*	6.0	*283*	6.0	*306*
Marseille	5.2	*200*	5.1	*211*	5.1	*242*	5.1	*261*
Montpellier-Nîmes	3.3	*125*	3.3	*135*	3.3	*155*	3.3	*168*
Nancy	3.8	*146*	3.8	*156*	3.8	*179*	3.8	*193*
Nantes	2.7	*102*	2.6	*108*	2.6	*124*	2.6	*134*
Nice	1.9	*73*	1.9	*79*	1.9	*90*	1.9	*98*
Paris	23.4	*900*	23.2	*950*	23.4	*1,098*	23.3	*1,187*
Pointe-à-Pitre	0.4	*15*	0.4	*15*	0.5	*25*	0.6	*32*
Poitiers	2.2	*83*	2.2	*91*	2.2	*104*	2.3	*115*
Reims	2.3	*90*	2.4	*98*	2.4	*112*	2.4	*121*
Rennes	2.5	*96*	2.4	*100*	2.4	*115*	2.5	*125*
Rouen	2.7	*105*	2.7	*112*	2.7	*128*	2.7	*139*
Saint-Étienne	1.6	*63*	1.6	*65*	1.7	*80*	1.7	*87*
Saint-Denis de La Réunion	0.0	*0*	0.1	*6*	0.1	*7*	0.2	*10*
Strasbourg	3.4	*131*	3.4	*140*	3.4	*160*	3.4	*173*
Toulouse	3.7	*142*	3.7	*152*	3.7	*174*	3.7	*189*
Tours	2.5	*97*	2.6	*106*	2.6	*121*	2.6	*132*
Total	*100*	*3,850*	*100*	*4,100*	*100*	*4,700*	*100*	*5,098*

Notes: Medicine students in their second year in the 2000-2001 academic year sat the internship competition in 2004.
Reading note: In the 2000-2001 academic year, 2.3% of second-year medicine students were enrolled at the university of Amiens.
Source: Ministerial orders setting the number of first-year undergraduate medicine students authorised to continue their medicine studies following the final examinations of the academic year.

APPENDIX 2

REPRESENTATIVENESS OF THE DATABASE

The Direction de la Recherche, des Études, de l'Évaluation et des Statistiques (DREES) publishes, by five-year age groups, the distributions of general practitioners working on a private basis by region of practice and sex. We use the 2017 distribution for the 35-39 year old age group as a comparator. 93.3% of the doctors to whom the data used in this study relates were aged between 34 and 41 in 2017.

The regional distribution of general practitioners in private practice in our data is consistent with the distribution of all general practitioners in private practice (Table A2). The higher proportion of women in our data undoubtedly stems from the fact that our data and the DREES distributions have slightly different coverage. Our data does not include general practitioners in private practice born abroad (whether they qualified in France or abroad).

Foreign-born general practitioners in private practice is a not well documented population. Le Breton-Lerouvillois *et al.* (2015) states that in the early 2010s, doctors who qualified abroad accounted for 10% of all doctors and that this group is 63% male. Further, they seem to be unevenly distributed across the country, with a particular concentration in Île-de-France, Auvergne-Rhône-Alpes and PACA. These are precisely the regions where the rate of women is higher in our data than in the comprehensive data.

Table A2 – **Comparison of distribution by region and sex of doctors in the data used for all doctors, for the 35–39 year old age group, in 2017**

	Breakdown by region				Proportion of women		
	Data		All				
Region	%	#	%	*CI 95*	Data	All	*CI 95*
Bourgogne-Franche-Comté	4.4	*144*	4.1	*[2.4; 5.9]*	63.9	57.5	*[49.1; 65.8]*
Brittany	7.0	*231*	6.4	*[4.6; 8.1]*	67.1	59.2	*[52.6; 65.7]*
Centre-Val-de-Loire	3.1	*102*	2.9	*[1.1; 4.6]*	61.8	60.1	*[50.2; 70.0]*
Corsica	0.3	*9*	0.2	*[-1.5; 2.0]*	22.2	45.7	*[12.4; 79.0]*
DROM	2.8	*93*	3.4	*[1.65; 5.15]*	51.6	64.1	*[53.7; 74.5]*
Grand-Est	8.0	*262*	7.8	*[6.1; 9.6]*	61.1	55.6	*[49.4; 61.7]*
Hauts-de-France	7.9	*259*	8.0	*[6.3; 9.7]*	47.5	44.1	*[37.9; 50.3]*
Île-de-France	12.6	*414*	13.8	*[12.0; 15.5]*	68.4	62.4	*[57.4; 67.3]*
Nouvelle-Aquitaine	9.2	*303*	10.1	*[8.4; 11.9]*	54.5	51.2	*[45.4; 56.9]*
Normandy	5.1	*166*	4.9	*[3.2; 6.7]*	63.3	58.9	*[51.1; 66.7]*
Occitanie	9.9	*325*	9.5	*[7.8; 11.3]*	66.2	63.5	*[58.0; 69.1]*
PACA	6.5	*214*	7.6	*[5.8; 9.3]*	59.8	56.0	*[49.2; 62.8]*
Pays de la Loire	7.3	*240*	6.5	*[4.8; 8.3]*	69.6	63.1	*[56.6; 69.6]*
Rhône-Alpes	15.7	*517*	14.8	*[13.0; 16.5]*	60.7	56.5	*[52.1; 60.9]*
Total	100	*3,279*	100		61.6	58.8	*[57.1; 60.5]*

Notes: (1) For doctors in the study data, the enrolment region is considered to be the region of registration in the SIREN directory. For national data, it is registration with the college of Physician (*Conseil de l'ordre des médecins*). These two approaches go hand in hand. (2) By construction, doctors born abroad are not included in our data. This may explain the differences observed, at least partially.
(3) To make this comparison, we include all doctors from our data practising in 2017 rather than all doctors in private practice twelve years after the beginning of the internship: the total number (3,279) is therefore not identical to that in the other tables.
Reading note: 4.4% of the doctors in our data aged 35 to 39 in 2017 practised in the Bourgogne-Franche-Comté region in 2017. This was the case for 4.1% of all general practitioners in private practice in this age group in 2017.
Coverage: General practitioners in private practice aged between 35 and 39 in 2017.

APPENDIX 3

ROBUSTNESS CHECKS

Table A3 below presents the estimates for the model in Section 4 :

1) By dividing up the country based on the administrative regions that existed before the 2015 territorial reform (robustness 1),

2) By calculating the proportions of interns on the sole basis of the doctors in our database identified as working on a private basis twelve years after the internship, rather than on the basis of placement orders.

The estimated coefficients are not significantly different from those in Table 2.

Table A3 – **Effect of distribution of interns on distribution of settlement – Robustness Checks**

	Robustness 1 The division of the country corresponds to the administrative regions in force before 2015				**Robustness 2** The proportions of interns are calculated on the basis of doctors working on a private basis 12 years after the internship			
	All zones		All zones except Paris		All zones		All zones except Paris	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Proportion of interns	0.38***	0.28***	0.43***	0.31***	0.54***	0.46***	0.57***	0.50***
	(0.07)	(0.07)	(0.08)	(0.07)	(0.06)	(0.07)	(0.06)	(0.07)
Proportion of births	-	0.52**	-	0.55***	-	0.24**	-	0.21***
		(0.10)		(0.11)		(0.09)		(0.10)
Controls (ECN ranking and proportion of women)	No	No	No	No	No	No	No	No
R^2	0.97	0.98	0.96	0.97	0.97	0.97	0.93	0.94
Observations	23 x 4	23 x 4	22 x 4	22 x 4	28 x 4	28 x 4	27 x 4	27 x 4

Notes: Settlement of each cohort of interns is observed twelve years after the beginning of the internship. The PACA and Corsica regions are grouped together. The DROM are grouped together, as West Indies-French Guiana and Indian Ocean. *** corresponds to significance thresholds at 1%, ** at 5%, and * at 10%.
Source and coverage: Internship placement orders, self-employed database (INSEE) and Sirene directory (INSEE). General practitioners in private practice who started their internship between 2004 and 2007.

How Can the Additional Cost Due to Disability Be Taken Into Account When Measuring the Standard of Living of Households in France?

Thomas Blavet*

Abstract – We study how to adapt the statistical measurement of standard of living in France to take into account the additional needs of households in which a disabled person lives. We use the standard of living approach developed by Berthoud *et al.* (1993) and expanded upon by Zaidi & Burchardt (2005). Using the French *Statistiques sur les ressources et les conditions de vie* (SRCV) survey on income and living conditions, this approach is applied to ordinary households living in metropolitan France from 2017 to 2019. We compare two indicators of standard of living, the feeling of financial well-being and the number of material deprivations, and we assess disability based on the Global Activity Limitation Indicator (GALI). The additional cost due to disability is estimated to be more than 30% of disposable income, regardless of the standard of living indicator. If this additional cost were taken into account, four households out of ten in which a disabled person lives would be in a situation of monetary poverty.

JEL: D12, I31, J14
Keywords: cost of disability, standard of living, poverty

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The concept of "standard of living" is intended to determine the material well-being that a household derives from its income. It depends on both the household's income and its needs. The standard of living is usually measured statistically by comparing the household's disposable income to its number of consumption units.

INSEE defines disposable income as the income available to households for consumption and saving. It includes income from employment net of social security contributions, unemployment benefits, retirement benefits and pensions, capital income and other social benefits received, net of direct taxes.

The number of consumption units is the weight assigned to each household to reflect the fact that needs vary according to household composition, given that living together allows for some economies of scale, such as housing costs. It is calculated using what is known as an equivalence scale. Thus, in Europe, the statistical measure of standard of living is generally based on the so-called "OECD-modified" equivalence scale, which assigns 1 consumption unit to the reference person in the household, 0.5 consumption units for each additional person aged 14 years or over and 0.3 consumption units for each additional person under 14 years of age. The OECD, for its part, uses the square root of the number of people in the household as the number of consumption units.

Taking household needs into account in the statistical measurement of standard of living thus begins with the number of household members, possibly taking into account their age. Recent studies propose improving these calculations so that the statistical measurement of standard of living better reflects the variety of needs in accordance with family circumstances, starting with the fact that single-parent families are likely to face specific additional costs related to their isolation (lack of a spouse to share childcare, lower economies of scale for a single parent with one child than for a couple with no children, etc.) (Martin, 2017; Martin & Périvier, 2018; Pinel *et al.*, 2023).

Following on from these considerations, it seems essential to also question the statistical measurement of standard of living in the case where a person with a disability lives in the household. With a given family composition, those households may indeed face specific additional costs, as we will explore. For those households that may be economically vulnerable, in so far as people with disabilities[1] face greater difficulty on the labour market, it is important to have a fair view of their situation in order to provide greater clarity regarding needs for public assistance.

The notion of disability is used here within the meaning of French Law No 2005-102 of 11 February 2005 on equal rights and opportunities, the participation and citizenship of disabled people, which defines it more precisely as: "any limitation of activity or restriction of participation in life in society suffered in their environment by a person due to a substantial, lasting or permanent alteration of one or more physical, sensory, mental, cognitive or psychic functions, multiple disabilities or a disabling health disorder".

A disabled person, according to this definition, may have specific needs likely to result in additional expenses. For example, to acquire technical aids (manual or motorised wheelchair, optical or hearing aid, etc.), to make alterations to the home (bathroom alterations, installation of a suitable shower, widening of doorways, installation of a lifting platform, etc.), to make vehicle alterations (installation of a pivoting car seat, alterations to the vehicle to allow driving, etc.), to purchase a support animal (a guide dog or assistance dog) or to pay for human support (housekeeper, nursing care, etc.). Disabled people are also likely to use healthcare more frequently (consultations, pharmacy expenses and hospitalisations). In particular, their health spending increases sharply when they need human support. Penneau *et al.* (2019) estimated for France that in 2008 their additional healthcare spending amounted to between 5,000 and 17,000 euros per year on average, depending on the level of help needed, and that the amount payable after medical cover was 800 euros per year on average, whatever the amount of human support needed. The amount payable after medical cover was also higher for people aged 60 or over than for those aged under 60, despite an equivalent level of expenditure, due to different patterns of care consumption and types of exemption.

If the specific needs of disabled people are fully covered by public aid, this need not be taken into account in the statistical measurement of standard of living. However, if they are not fully covered, ignoring them can lead to overestimating the standard of living of disabled people and underestimating their monetary

1. *In the rest of the article, we will use the term "disabled people".*

poverty rate. Levieil (2017) also mentions that the specific needs of disabled people can not only lead to additional expenses, but can also limit the economies of scale generated by living together, as these specific expenses are not easy to pool.

In France, the public authorities have put in place benefits to increase the monetary resources of disabled people (Box 1), in particular through the allowance for disabled adults (*allocation aux adultes handicapés*, AAH), and in-kind benefits to compensate for part of the expenses due to disability, through the personalised autonomy allowance (*allocation personnalisée d'autonomie*, APA) and the disability compensation benefit (*prestation de compensation du handicap*, PCH). Benefits that increase monetary resources are taken into account in the statistical measurement of standard of living via disposable income. However, in-kind benefits such as the APA and the PCH are not. The aim here is to assess the extent to which specific additional costs due to disability persist despite these benefits and, if they do, how taking them into account could change the assessment of the standard of living of disabled people.

One difficulty in performing this analysis is the statistical identification of the disabled population. Several criteria can be used, which do not overlap, leading to different counts, depending on whether a single criterion is used, whether a broad approach is adopted based on one criterion or another or whether a restrictive approach is adopted based on the cross-referencing of criteria (Bellamy, 2023). Depending on the available data, two criteria are often used: reporting a severe limitation in a physical, sensory or cognitive function and reporting a severe overall restriction in activities, for at least the past six months, because of a health problem, in relation to activities people usually do. This second criterion, known as the Global Activity Limitation Indicator (GALI), increasingly tends to be used in more general surveys, in so far as it makes it possible to address four constituent elements of disability in a single question: its chronic aspect, its medical causes, the fact that the aim is to measure impact on activities, and that it is positioned in a given social context (Dauphin & Eideliman, 2021). A third criterion often used when using administrative data is administrative recognition of a disability or loss of autonomy. Finally, some studies use information on limitations in the activities of daily living (dressing, washing, etc.) and in the instrumental activities of daily living (cleaning or laundry, taking medication, etc.).

The *Vie quotidienne et santé* survey, carried out in 2021 by DREES, makes it possible to compare the counts of disabled people identified according to the first two criteria: the reporting of a severe limitation in a physical, sensory or cognitive function and the GALI. In 2021, in France, among people aged 15 and over living in ordinary dwellings, 12.5% were disabled according to the first criterion, 6.2% according to the second criterion, 4.7% according to both criteria and 14.0% were disabled according to at least one of the two criteria (Rey, 2023).

In the first part of this article, we set out the various approaches envisaged in international studies to take into account the additional cost due to disability in the statistical measurement of standard of living. The question that we propose to examine is not specific to France, although the results naturally depend on the situation in each country in terms of public aid to disabled people. In particular, we set out the approach we prefer in this article, the so-called "standard of living" approach developed by Berthoud *et al.* (1993) and expanded upon by Zaidi & Burchardt (2005), as well as a literature review of the articles in line with their approach. This method is based on the modelling of indicators of the standard of living of individuals, such as their opinion on their greater or lesser financial well-being or the number of deprivations of certain consumer goods that they report. We then present the statistical source, the standard of living indicators and the disability measurement chosen to apply this approach to France. Given the available data, we are using the GALI, i.e. reporting a severe overall restriction in activity for at least the past six months, because of a health problem, in relation to activities people usually do.

In the second part, we present the estimates of the additional cost due to disability obtained and the impact of their inclusion on the assessment of inequalities in standard of living and monetary poverty. These estimates are made for all households and for the main family configurations (single people, couples with or without children and single-parent families), taking into account the age of the reference person and their spouse, if any. We make sure to distinguish between family configurations, because a disabled person who lives in a couple may require the services of professional caregivers less frequently because of the support provided by their spouse. We also distinguish between people aged 60 and over and those aged under 60, because specific purchases of disability-related goods and services are

Box 1 – **Disability Benefits in France**

Disability is managed in France through several benefits schemes. First of all, there are social security benefits to ensure a minimum amount of resources for the disabled person, namely the *allocation aux adultes handicapés* (allowance for disabled adults, AAH). The amounts paid under the AAH are included in the household's disposable income.

In addition to compulsory health insurance, there are benefits systems in France to partially compensate for the cost of disability through the *prestation de compensation du handicap* (disability compensation benefit, PCH) and the *allocation personnalisée d'autonomie* (personalised autonomy allowance, APA). These benefits are used to compensate for expenses due to disability and are cash transfers to the recipient households to reimburse them for purchases of goods and services. Consequently, a part of the additional costs incurred by households in which a disabled person lives is covered by these benefits systems. Household disposable income does not include benefits paid under the PCH and the APA. However, these benefits impact the estimated economic cost due to disability and will lead to a lower estimate of this economic cost than in the absence of these benefits systems.

The *allocation aux adultes handicapés*

The AAH is financial support paid by the *Caisses d'Allocations Familiales* (family benefit offices, CAF) or the offices of the *Mutualité Sociale Agricole* (farmers' and agricultural workers' social security, MSA) and granted by a decision of the *Commission des droits et de l'autonomie des personnes handicapées* (commission on the rights and independence of disabled people, CDAPH) in accordance with disability, age, residence and resource criteria. This financial support ensures a minimum amount of resources for the disabled person.

To receive the AAH, the person must have a disability rate of at least 80% or between 50% and 79% with a substantial and lasting restriction on access to employment. To be eligible, people must be at least 20 years old (or at least 16 years old if the person is no longer in the care of their parents). Finally, a residence criterion and resource criterion are applied, taking into account the resources of the person's spouse, if they have one. As of 1 October 2023, the AAH reform to disregard any spouse's income changed the method used to calculate the allowance. From that point on, only the personal resources of the disabled person are taken into account in the calculation of the benefit.

The *allocation personnalisée d'autonomie*

The APA is financial support paid by the French *départements* in accordance with criteria relating to the degree of loss of autonomy, age and residence. This financial support makes it possible to pay, in full or in part, for the expenses necessary to stay at home (in the case of APA at home) or to cover part of the dependency fee set by the nursing homes (in the case of APA in institutions).

To receive the APA, the person must be at least 60 years old and be in a situation of loss of autonomy, that is to say, they must need help to perform activities of daily living. The amount of the APA is determined according to the loss of autonomy measured using the AGGIR scale defining different degrees of loss of autonomy, ranging from GIR 1 to GIR 6. Only people classified in GIR 1 to GIR 4 can receive the APA. A residence criterion is also applied.

In 2023, people with monthly resources above 864.60 euros and below 3,184.11 euros have an out-of-pocket amount after cover which varies progressively from 0% to 90% of the amount of the support plan. For higher monthly resource levels, the out-of-pocket amount after cover is equal to 90% of the amount of the support plan used.

The *prestation de compensation du handicap*

The PCH is financial support paid by the French *départements*, granted by a decision of the CDAPH in accordance with criteria relating to the degree of loss of autonomy, age, residence and resources. This financial support makes it possible to reimburse people for expenses incurred due to loss of autonomy and includes human support, technical support, home alteration, transport support and, finally, specific or exceptional support.

To receive the PCH, the person must be unable to perform an essential activity of daily living or face serious difficulty in performing at least two essential activities of daily living. To be eligible, the person must be under 60 years of age. In the case of children or adolescents, they must be under 20 years old and receive the *allocation d'éducation de l'enfant handicapé* (disabled children's education allowance, AEEH). The support is granted without any conditions regarding resources but the amount varies in accordance with the resources, with the maximum rate of support being between 80% and 100% depending on the resources. Finally, a residence criterion is applied.

There is an exemption to the age limit of 60 for people whose disability met the PCH eligibility criteria before they reached the age of 60 and those who are still engaged in a professional activity and whose disability meets the eligibility criteria when they apply.

The PCH cannot be combined with the APA: from the age of 60, people who meet the conditions to claim the APA can choose between retaining the PCH or receiving the APA when renewing their entitlement.

partly covered by the PCH and the APA, and the PCH is mainly aimed at disabled people under the age of 60, while the APA is intended for people aged 60 or over with disabilities or loss of autonomy. We also present estimates of the additional cost for households in which a person lives who has reported a restriction for at least the past six months, because of a health problem, in relation to activities that people usually do, distinguishing between whether the

person reports a "severe" restriction or a "mild" restriction.

In the third part, we analyse the results and compare them with those in the international literature. Finally, we discuss the limitations, in particular the sensitivity of the results to the measurement of disability.

1. Methodology and Data

To measure the additional cost due to disability, we aim to estimate the additional income needed by a household in which a person is disabled in order to have the same standard of living as a household with similar characteristics, but in which there is no disabled person.

There are several methods for making such an estimate and each has its advantages and limitations (Box 2). We use the approach that we consider to have the fewest limitations, namely the so-called "standard of living" approach developed by Berthoud *et al.* (1993) and expanded upon by Zaidi & Burchardt (2005). It allows the measurement of the additional cost due to disability by using a latent standard of living variable.

1.1. The Standard of Living Approach

We illustrate the method under the basic assumption, in which the standard of living increases linearly with income for given household characteristics (Figure I). To achieve a standard of living S^*, a household of given characteristics in which there is no disabled person (straight black line) needs an income equal to Y, whereas a household with the same characteristics with a disabled person (straight grey line) needs an income of $Y1$, higher than Y. Thus, with given characteristics, $Y1 - Y$ corresponds to the additional cost faced by a household in which a disabled person lives.

Algebraically, the standard of living method involves estimating the following equation:

Box 2 – **Approaches Allowing the Measurement of the Additional Cost Due to Disability**

Several approaches allow the measurement of the additional cost due to disability. The advantages and disadvantages of the various approaches have been summed up by several authors including Tibble (2005) and Morciano *et al.* (2015).

A first approach is based on the examination of consumption patterns and the fact that budget structure can be a good indicator of standard of living. In particular, to study the additional cost due to the presence of a child, Engel (1857) started from the assumption that the proportion of expenditure devoted to food, essential expenditure, tended to decrease with the standard of living. He therefore modelled that proportion in accordance with income and various household characteristics to deduce the impact of the presence of a child on the standard of living. Rothbarth (1943) assumes that expenditure on goods consumed exclusively by adults, such as adult clothing, tobacco and alcohol, can be used. The more a household spends a significant proportion of its budget on such purchases, the higher the standard of living it is expected to have. This approach has been used by Jones & O'Donnell (1995) and Mitra *et al.* (2009) to measure the additional cost due to disability. However, this approach is criticised as it is the statistician who defines what type of expenditure (food, clothing, etc.) they consider to be a good indicator of standard of living. However, there is no real basis for validating the choice of the type of expenditure chosen. In addition, the budget structure may also reflect personal preferences (Martin, 2017). These preferences and lifestyle choices may change depending on household size or certain vulnerabilities, reducing the consumption of some adult goods, without that being linked to a decline in standard of living.

A second approach is to interview a group of experts to assess the additional costs due to disability or to directly ask disabled people about their estimate of the additional costs they face. The difficulty with this approach is that the additional costs due to disability may depend not only on the nature of the limitations that people face because of their disability, but also on other characteristics of their household. As a result, this method is difficult to implement, since it requires the definition of many typical cases. It is also subject to the choice made by experts regarding the basket of additional goods and services to be taken into account. For their part, disabled people may have difficulty considering and assessing the counterfactual situation in which they would not have a disability. Despite these obstacles and limitations, it was used by Martin & White (1988), Thompson *et al.* (1990) and Smith *et al.* (2004).

A third approach is based on the link established by individuals between income and standard of living, for example by proposing different amounts of income and asking them to indicate the standard of living that it would allow them to achieve using a satisfaction scale or, conversely, by asking them to estimate the amount of income needed to achieve that level of satisfaction compared with their income. Such an approach was used by Kapteyn & van Praag (1978) who used it to deduce equivalence scales between households of different characteristics. The problem with this approach is that the link established by individuals depends on their own income.

A fourth approach, known as the "standard of living approach", was developed by Berthoud *et al.* (1993) and expanded upon by Zaidi & Burchardt (2005). This approach is detailed in the article.

$$S = \alpha Y + \beta D + \gamma X + k + \varepsilon, \quad (1)$$

with S is an indicator of the household's standard of living, Y is the household's disposable income, D is an indicator of the presence of a disabled person in the household, X corresponding to the characteristics of the household and its reference person while α, β, γ, k are the parameters to be estimated.

Note that E is the additional cost due to disability, that is, a household with the characteristics X in which there is a disabled person needs an income of $Y + E$ to achieve the same standard of living as a household with the same characteristics X without a disabled person and with an income of Y. This gives us :

$$\alpha(Y + E) + \beta(1) + \gamma X + k = \alpha Y + \beta(0) + \gamma X + k. \quad (2)$$

By solving (2), we obtain:

$$E = \frac{dY}{dD} = -\frac{\beta}{\alpha} \quad (3)$$

However, the usual assumptions about the relationship between disposable income and standard of living are that returns are decreasing between standard of living and disposable income, that is, a given amount of extra income improves the standard of living of a modest household more than that of a wealthy household, and that the additional cost due to disability increases with income; in other words, disability-related needs cost more for a wealthy household than for a modest household if they want to compensate for its deterioration in standard of living. These assumptions are supported by several studies. In particular, Zaidi & Burchardt (2005) and Morris & Zaidi (2020) concluded that the best adjustment for the data was not to use disposable income for Y but to instead use its logarithm (Figure II). It is this form of equation that we will favour in this article.

Algebraically, it is a case of estimating the following equation:

$$S = \alpha \ln Y + \beta D + \gamma X + k + \varepsilon \quad (4)$$

We then determine the λ factor by which Y must be multiplied for a household in which a disabled person lives to achieve the same standard of living as a household with the same characteristics X without a disabled person, which amounts to solving:

$$\alpha \ln(\lambda Y) + \beta(1) + \gamma X + k = \alpha \ln(Y) + \beta(0) + \gamma X + k \quad (5)$$

By solving (5), we obtain:

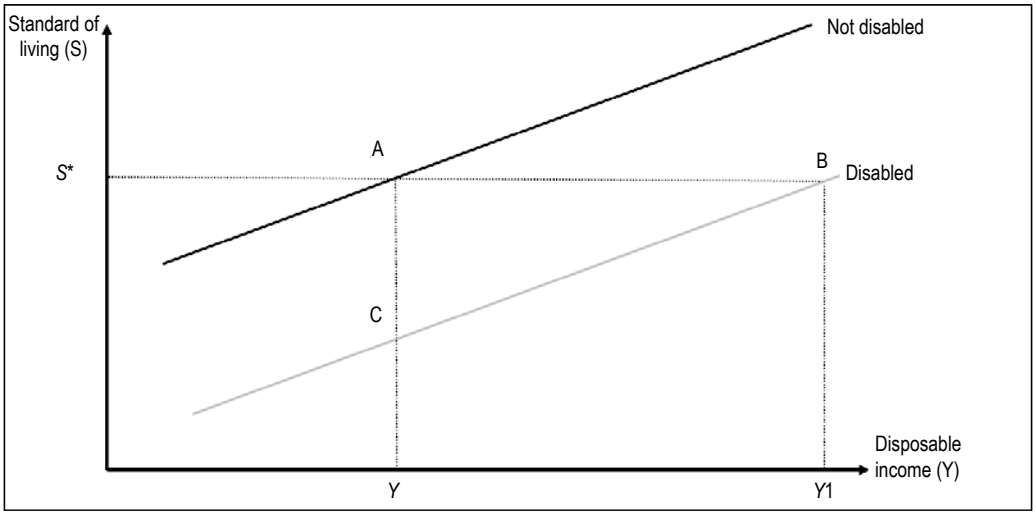
$$\lambda = \exp\left(-\frac{\beta}{\alpha}\right) = \exp(E) \quad (6)$$

Starting from the approximation $\exp(E) = 1 + E$ in the vicinity of zero, the authors then interpret E as the percentage of additional disposable income needed by a household in which there is a disabled person to achieve the same standard of living as a household with the same characteristics in which there is no disabled person.

What effect does public aid have on E?

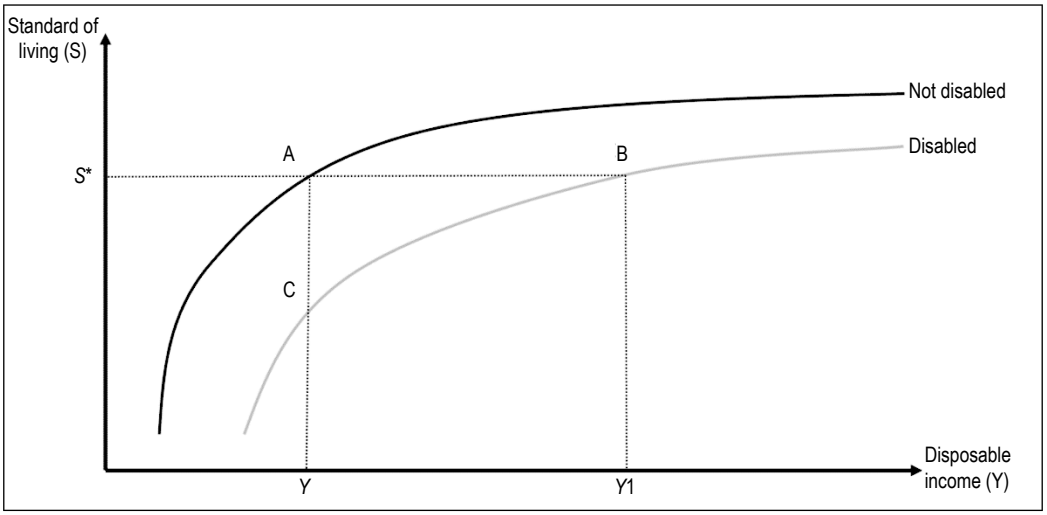
There are two types of public aid to support disabled people. The first type of aid consists of income paid independently of the specific expenses incurred by households, such as in the form of an allowance. This type of aid increases disposable income and, therefore, the standard of living, without changing the gap between the two curves (movement along the grey curve).

Figure I – **Linear relationship between disposable income and standard of living**



Sources: graph from Morris & Zaidi (2020).

Figure II – **Logarithmic relationship between disposable income and standard of living**



Sources: graph from Morris & Zaidi (2020).

It therefore does not change E. The second type of aid consists of partial or full compensation for expenses due to disability. This type of aid reduces the gap between the two curves (movement of the grey curve upwards). It therefore changes E.

The standard of living approach therefore consists in estimating Equation (4), linking the household's standard of living to the logarithm of its disposable income, the presence or absence of a disabled person in the household and the different characteristics of the household.

1.2. Studies Using the Standard of Living Approach

The standard of living approach has been used to measure the additional cost due to disability in several countries, including in the United Kingdom by Zaidi & Burchardt (2005), in China by Loyalka *et al.* (2014) and in Turkey by Ipek (2020). Recently, the method was adopted by Morris & Zaidi (2020) to estimate the additional cost due to disability for adults aged between 50 and 65 in fifteen European countries using data from the Survey of Health, Ageing and Retirement in Europe (SHARE).

Mitra *et al.* (2017) conducted a literature review based on twenty articles estimating the additional cost due to disability using various approaches. Table S1 in the Online Appendix (link at the end of the article) presents a review of various articles using the standard of living approach to measure the additional cost due to disability.

Unlike Zaidi & Burchardt (2005) and Morris & Zaidi (2020), who use subjective indicators of standard of living, such as household perceptions of their financial situation, the other authors use objective indicators that take into account, for example, deprivations relating to certain durable consumer goods, taking holidays over the last two years or holding savings. This is the case, in particular, for Cullinan *et al.* (2011), Loyalka *et al.* (2014) or, more recently, Schuelke *et al.* (2022).

Concerning the measurement of disability used, some authors rely on limitations in the essential or instrumental activities of daily living, as is the case for Ipek (2020), or on limitations in working life, as is the case for Morris & Zaidi (2020) and She & Livermore (2007). Other authors rely on functional limitations (physical, sensory or cognitive), such as Cullinan *et al.* (2011; 2013), Loyalka *et al.* (2014), Minh *et al.* (2015) or Mont & Cuong (2011).

Cullinan *et al.* (2011) expanded the standard of living approach of Zaidi & Burchardt (2005) to apply it to a panel of households. This method makes it possible to control the unobserved heterogeneity of households (for example, their culture, preferences or habits) as well as disability and previous incomes. In addition, that method makes it possible to distinguish between the short-term and long-term costs of disability. In their work, the authors use the Living In Ireland Survey (LII), which makes it possible to follow a representative panel of Irish households from 1995 to 2011. That survey was the Irish version of the European Community Household Panel (ECHP), which has since been replaced by the Statistics on Income and Living Conditions (EU-SILC). From that point on, it is no longer a panel of households that is followed

but instead a panel of individuals, meaning that it is no longer possible to apply the method of Cullinan *et al.* (2011).

Lastly, Morciano *et al.* (2015) adopt the standard of living approach by allowing the latent nature of the standard of living and disability to be taken into account, using nine difficulties and limitations to describe the severity of the disability.

For our part, we propose applying the method of Zaidi & Burchardt (2005) to France, adapting it by family configuration. First, the conditions of public aid for disabled people vary from one country to another, depending on its social security system. However, the additional cost due to disability that can be estimated using this method is a cost net of direct public support covering certain expenses. It makes it possible to correct the statistical measurement of standard of living based on the household's disposable income and to better assess inequalities in the standard of living by taking into account all public aid, both that which directly covers expenses and that which increases disposable income. Secondly, it is important to take into account the family configuration of the household: the additional cost due to disability may indeed differ depending on whether the disabled person lives alone or with others. For example, a disabled person who does not live alone can benefit from the informal care of people living with them, which can reduce the additional cost due to disability. Adults living alone are more likely not to receive informal care and to turn to professional assistance, where such services are available (Burchardt *et al.,* 2018).

1.3. The Data

We use data from the *Statistiques sur les ressources et les conditions de vie* (SRCV) survey, the French version of the EU-SILC. The survey is carried out each year on around 12,000 households representative of ordinary households living in metropolitan France. It is then matched with tax data from the *Direction générale des finances publiques* (Directorate-General for public finance, DGFiP) and, since 2009, with social security data from the *Caisse nationale des allocations familiales* (national family benefits fund, CNAF), the *Caisse centrale de mutualité sociale agricole* (farmers' and agricultural workers' social security, CCMSA) and the *Caisse nationale d'assurance vieillesse* (national pension fund, CNAV). That matching allows for reliable information on household resources and the accurate measurement of their disposable income. This includes income from activity or replacement income (retirement pensions and unemployment benefits, in particular), capital income, transfers from other households, social security benefits and statutory minimum incomes (including the AAH), net of direct taxes. In contrast, the household's disposable income does not include the PCH and APA allowances, which are not considered resources, but compensation for expenses (cf. Box 1). Those benefits do not increase resources, but reduce needs: the estimated cost is net of this support.

We stacked three survey waves, 2017, 2018 and 2019, to ensure that we have sufficient observations in the structural cross-referencing of the analysis (modalities for the standard of living and presence of a disabled person). Estimates for all households are thus based on around 33,000 observations (see Table S3 in the Online Appendix).

To determine the standard of living, there are two indicators available in the SRCV survey. The first is the subjective financial situation of the household. That is determined through the following question: "currently, (for the household,) would you say that your financial situation is more:" The answer options are as follows: "you are unable to make ends meet without incurring debts", "you struggle to make ends meet", "it is okay, but you have to be careful", "it is okay", "you are fairly comfortable" and "you are very comfortable". Zaidi & Burchardt (2005) and Morris & Zaidi (2020) also used a household financial situation satisfaction variable to make their estimates (see Table S1 in the Online Appendix). The work carried out in France to estimate equivalence scales for standard of living according to family configuration often uses this question, which also features in the French *Budget de famille* survey on family finances (Hourriez & Olier, 1997; Martin, 2017; Martin & Périvier (2018) and Pinel *et al.*, 2023).

The second indicator used to determine the standard of living is constructed from questions about material deprivations caused by a lack of monetary resources. Several studies on the cost of disability use a variable of this type (see Table S1 in the Online Appendix). To construct this indicator, we use the European indicator of material deprivation (Guio *et al.,* 2016). This is defined by the absence, due to a lack of monetary resources, of at least three of the following nine items: ability to cope with unforeseen expenses of a significant amount (equal to the poverty line); ability to pay rent

or mortgage repayments, current bills, consumer loan repayments on time; ability to pay for a one-week holiday per year; ability to keep the home at a comfortable temperature; ability to have a meal with meat or an equivalent at least one day in two; having a washing machine; having a colour tv; having a telephone; having a car. As an indicator of standard of living, we use the number of material deprivations, on the basis that the greater the number of material deprivations, the lower the standard of living. We use four answer options: 0, 1, 2 and 3 or more (households considered to be in a situation of material deprivation due to lack of monetary resources). From 2020, the material deprivation indicator was replaced by the material and social deprivation indicator to study the risk of poverty and social exclusion. The latter aims to improve the material deprivation indicator and is based on thirteen elements, six of which are shared with the old indicator. However, we preferred to use the old indicator to allow us to pool several survey waves and have a larger sample size.

To determine whether there is a disabled person in the household, we use the question used to calculate the GALI: "For at least the past six months, to what extent have you been limited because of a health problem in activities people usually do?" and the answer options are as follows: "yes, severely limited", "yes, limited but not severely" and "no, not limited at all".[2] This is indeed the only information we have, but multiple studies validate the use of this indicator. For example, Berger *et al*. (2015) show that the GALI is closely linked to the measurement of disability based on limitations in the essential and instrumental activities of daily living, as well as of disability based on functional limitations. Cabrero-García *et al*. (2020) show that it is also closely linked to a measurement based on working limitations. The level of overall restriction in activity (mild or severe) is also closely related to the number of limitations in activities of daily living and their level of severity (Van Oyen *et al.,* 2006).

More precisely, we use a variable equal to 1 if the reference person[3] and/or their spouse reports that they are severely limited, in the sense of the GALI question, and 0 otherwise. This question is asked only to household members aged 16 or older. Disabled children under 16 in a household are therefore not identified in the survey. This is why we include only the disability of the reference person and her spouse, if any, in our study. According to this indicator, 13.9% of households included a disabled person for the period 2017 to 2019 (see Table S3 in the Online Appendix).

1.4. Estimation Method: Ordinal Logistic Models on Pooled Data

To carry out the estimates, we successively use, as a latent variable of the standard of living (S_j), two qualitative variables with more than two hierarchically ordered answer options, satisfaction with one's financial situation and the indicator of material deprivation. In practice, ordinal logistic models are therefore used on pooled data from 2017 to 2019. The two main explanatory variables are the logarithm of disposable income, in constant 2019 euros ($\ln(Y_j)$), of the household j and an indicator equal to 1 if the reference person and/or their spouse report being severely restricted within the meaning of the GALI question (D_j).

$$S_j = \gamma_0 + \alpha \ln(Y_j) + \beta D_j + \boldsymbol{\gamma_1 Occupation_j} + \boldsymbol{\gamma_2 Tuu_j} + \gamma_3 Adulte_j + \gamma_4 Enfant_j + \boldsymbol{\gamma_5 Age_j^{PR}} + \gamma_6 Genre_j^{PR} + \boldsymbol{\gamma_7 Diplôme_j^{PR}} + \boldsymbol{\gamma_8 Nationalité_j^{PR}} + \gamma_9 2017 + \gamma_{10} 2018 + \varepsilon_j$$

Finally, estimates are performed controlling for the occupancy status of the dwelling ($\boldsymbol{Occupation_j}$), the location based on the size of the urban unit ($\boldsymbol{Tuu_j}$), the number of adults ($Adulte_j$) and the number of children ($Enfant_j$) in the household, the age of the reference person ($\boldsymbol{Age_j^{PR}}$), their gender ($Genre_j^{PR}$), their highest qualification obtained ($\boldsymbol{Diplôme_j^{PR}}$) and their nationality ($\boldsymbol{Nationalité_j^{PR}}$). Finally, we added year fixed effects. The description of the variables used can be found in Table S2 in the Online Appendix.

1.5. Descriptive Statistics

Households in which the reference person or their spouse, if any, is disabled report more material deprivations (Table 1). In fact, among households where the reference person or their spouse is disabled, 16.4% report two material deprivations and 18.8% report three, compared with 10.9% and 10.1%, respectively, among other households. Households in which the reference person or their spouse, if any, is disabled also have a lower opinion of their financial situation. In fact, among households where the reference person or their spouse is disabled, 21.6% report struggling to make ends meet and 5.6% report being unable to make ends meet

2. We use the term severe overall restriction in activity for the first option and mild overall restriction in activity for the second option.

3. The reference person in the household is the person who provides the most resources. When there are multiple primary resource providers, the reference person is the active person, the retired person, and then the inactive person, in that order; all other things being equal, the reference person is the oldest person.

without incurring debts, compared with 12.0% and 3.4%, respectively, among other households.

39.5% of households in which the reference person or their spouse, if any, is disabled are couples without children, compared to 24.6% of other households (Table 2). This characteristic is partly explained by the higher age of disabled people, who include those who are dependent and in loss of autonomy: 30.1% of the reference people in a household with a disabled person are aged between 60 and 74, and 34.2% are aged 75 or over, compared with 24.9% and 12.2% of other households, respectively. Their median disposable income is also lower, 27,514 euros compared to 32,545 euros. Finally, households in which the reference person or their spouse, if any, is disabled more commonly own their dwelling, which can again be explained by the older age of their members.

2. Results of the Estimation of the Additional Cost Due to Disability and Overall Activity Restrictions

2.1. Estimation of the Additional Cost Due to Disability and Impact on the Assessment of Inequalities in Standard of Living

In this section, we present estimates of the additional cost due to disability for people living in ordinary households in metropolitan France for the 2017-2019 period.

2.1.1. All Households

For all households, if the standard of living is measured by the assessment of the financial situation, the additional cost due to disability is estimated at 36% (Table 3). In other words, with other comparable characteristics, a household in which the reference person or their spouse is disabled, in the sense that they report being severely limited in response to the GALI question, would need a disposable income 36% higher to achieve the same standard of living as a household in which neither person is disabled.

By measuring the standard of living based on the number of material deprivations, the additional cost due to disability is estimated at 38%, which is very close to the previous estimate. In both cases, the confidence interval at the 95% threshold is plus or minus 6 percentage points: a broadest estimate of between 30% and 44% is obtained at this threshold.

We can now study how taking into account the additional cost due to disability alters the assessment of inequalities in standard of living. Without it being taken into account, households in which there is a severely limited person, in the sense of the GALI, are over-represented in the first half of the standard of living distribution (Figure III). In particular, 14.8% of households with a disabled person are in the second decile of the standard of living distribution and 14.3% are in the third decile. The first four deciles of the standard of living distribution thus account for 53% of households in which a disabled person lives.[4] The concentration of these households in the first deciles

4. In the Revenus fiscaux et sociaux *survey (ERFS), a reference survey for studying poverty, in 2019, among households in which a severely limited person, in the sense of the GALI question, aged 15 to 59 lives, 57% belong to the first four deciles of the standard of living distribution (Leroux, 2022).*

Table 1 – **Standard of living depending on the presence of a disabled person in the household (reference person or their spouse)**

	Absence of a disabled person	Presence of a disabled person	All households
Number of observations	28,033	4,901	32,934
Number of material deprivations (%)			
0 deprivations	63.1	47.2	60.8
1 deprivation	15.9	17.6	16.2
2 deprivations	10.9	16.4	11.7
3 or more deprivations	10.1	18.8	11.3
Assessment of the financial situation (%)			
You are very comfortable	2.4	0.9	2.2
You are fairly comfortable	13.8	7.4	12.9
It is okay	29.6	21.6	28.5
It is okay, but you have to be careful	38.7	42.8	39.2
You struggle to make ends meet	12.0	21.6	13.4
You are unable to make ends meet without incurring debts	3.4	5.6	3.7

Reading note: 21.6% of households in which the reference person or their spouse, if any, is disabled report having difficulty making ends meet, compared to 13.4% of all households.
Sources and coverage: INSEE, *Statistiques sur les ressources et conditions de vie* survey, 2017-2019. All ordinary households living in metropolitan France.

Table 2 – **Independent variables depending on the presence of a disabled person in the household (reference person or their spouse)**

	Absence of a disabled person	Presence of a disabled person	All households
Number of observations	28,033	4,901	32,934
Type of household (%)			
Single person	37.2	36.2	37.1
Couple with children	27.2	17.0	25.8
Couple without children	24.6	39.5	26.7
Single-parent family	9.1	5.6	8.6
Complex household	1.9	1.7	1.9
Mean annual disposable income	39,604	32,279	38,584
Median annual disposable income	32,545	27,514	31,807
Number of adults	1.55	1.60	1.56
Number of children	0.65	0.39	0.62
Home occupancy status (%)			
Homeowner	36.1	50.2	38.1
Homeowner with mortgage	25.4	11.3	23.4
Tenant at market price	20.1	21.8	20.3
Tenant at below market price	15.4	14.1	15.2
Housed free of charge	3.0	2.6	3.0
Size of urban unit (%)			
Rural municipality	21.4	24.1	21.8
Fewer than 20,000 inhabitants	17.3	20.7	17.8
From 20,000 to fewer than 100,000 inhabitants	13.0	15.5	13.3
More than 100,000 inhabitants	31.7	29.5	31.4
Paris agglomeration	16.6	10.3	15.7
Sociodemographic characteristics of the reference person			
Gender (%)			
Male	59.4	58.7	59.3
Female	40.6	41.3	40.7
Age (%)			
Aged 16–29	10.2	2.1	9.1
Aged 30–44	25.3	11.4	23.3
Aged 45–59	27.4	22.2	26.7
Aged 60–74	24.9	30.1	25.7
Aged 75 or over	12.2	34.2	15.3
Highest qualification obtained (%)			
No degree/qualification or primary school certificate (CEP)	19.7	39.3	22.5
CAP or BEP	31.7	37.8	32.6
BAC or BAC + 2 years of higher education	27.2	14.8	25.4
BAC + 3 or more years of higher education	21.4	8.1	19.5
Nationality (%)			
French by birth	91.1	90.9	91.0
French by naturalisation	4.6	5.3	4.7
Foreign	4.3	3.8	4.2

Reading note: 39.5% of households in which the reference person or their spouse, if any, is disabled are couples without children, compared to 26.7% of all households.
Sources and coverage: INSEE, *Statistiques sur les ressources et conditions de vie* survey, 2017-2019. All ordinary households living in metropolitan France.

of the standard of living distribution will explain, as will be seen, the very high sensitivity of their poverty rate to an adjustment to disposable income.

This is mainly explained by the difficulties in accessing employment that disabled people may encounter, or even the consequences of the family situation on the professional activity of spouses, and by the more specific profile of those whose response to the GALI question is that they are severely limited, compared to other possible approaches to disability (Levieil, 2017; Baradji *et al.*, 2021; Dauphin & Eideliman, 2021).

Table 3 – **Estimates of the additional cost due to disability, 2017–2019**

Standard of living indicator	Assessment of the financial situation	Number of material deprivations
All households		
Disposable income (log)	1.596*** (0.047)	1.802*** (0.061)
Severe overall activity restriction	−0.575*** (0.044)	−0.686*** (0.048)
Estimated additional cost (*E*)	0.361 (0.031) [0.300; 0.421]	0.381 (0.031) [0.320; 0.441]
Pseudo R^2	0.120	0.181
Number of observations	32,934	32,934
Single people under 60 years old		
Disposable income (log)	1.215*** (0.106)	1.438*** (0.132)
Severe overall activity restriction	−0.635*** (0.126)	−0.648*** (0.124)
Estimated additional cost (*E*)	0.523 (0.116) [0.296; 0.750]	0.451 (0.098) [0.260; 0.642]
Pseudo R^2	0.102	0.143
Number of observations	4,458	4,458
Single people aged 60 or over		
Disposable income (log)	1.845*** (0.116)	2.355*** (0.149)
Severe overall activity restriction	−0.530*** (0.099)	−0.575*** (0.090)
Estimated additional cost (*E*)	0.287 (0.061) [0.168; 0.406]	0.244 (0.043) [0.159; 0.329]
Pseudo R^2	0.122	0.163
Number of observations	6,172	6,172
Couples in which both spouses are under 60 years old		
Disposable income (log)	1.972*** (0.077)	2.009*** (0.105)
Severe overall activity restriction	−0.763*** (0.082)	−0.874*** (0.096)
Estimated additional cost (*E*)	0.387 (0.045) [0.299; 0.475]	0.435 (0.054) [0.329; 0.541]
Pseudo R^2	0.122	0.182
Number of observations	10,711	10,711
Childless couples in which both spouses are aged 60 or over		
Disposable income (log)	2.093*** (0.134)	2.242*** (0.189)
Severe overall activity restriction	−0.411*** (0.077)	−0.592*** (0.094)
Estimated additional cost (*E*)	0.196 (0.041) [0.117; 0.276]	0.264 (0.051) [0.164; 0.364]
Pseudo R^2	0.141	0.181
Number of observations	6,076	6,076
Single-parent families for which the reference person is under 60 years old		
Disposable income (log)	0.975*** (0.147)	1.351*** (0.170)
Severe overall activity restriction	−0.862*** (0.163)	−1.024*** (0.196)
Estimated additional cost (*E*)	0.884 (0.233) [0.428; 1.341]	0.758 (0.174) [0.417; 1.099]
Pseudo R^2	0.070	0.145
Number of observations	2,532	2,532
Single-parent families and single people for which the reference person is under 60 years old		
Disposable income (log)	1.130*** (0.087)	1.377*** (0.105)
Severe overall activity restriction	−0.701*** (0.102)	−0.750*** (0.106)
Estimated additional cost (*E*)	0.620 (0.106) [0.412; 0.829]	0.544 (0.090) [0.367; 0.721]
Pseudo R^2	0.100	0.146
Number of observations	6,990	6,990

Notes: ***p-value < 1%; **p-value < 5%; *p-value < 10%. Results of the ordinal logistic models on pooled data to assess the additional cost due to disability for all households and for the main family configurations. The confidence interval for the estimated additional cost was calculated at the 95% level using the Delta method. The models include the following controls: home occupancy status, location, number of adults and number of children (except for some configurations with the same number of adults or no children in the household), age, gender, qualifications, nationality of the reference person and year.
Reading note: Using the assessment of the financial situation of the household as a standard of living indicator, the estimated additional cost due to disability for a single person under 60 years of age is equal to 52.3% of disposable income.
Sources and coverage: INSEE, *Statistiques sur les ressources et conditions de vie* survey, 2017-2019. All ordinary households living in metropolitan France.

Table 4 shows the rates of monetary poverty in 2019 with and without the cost of disability, as estimated by the dependent variable of satisfaction with one's financial situation. Without taking into account the cost of disability, the poverty rate is 17.2% for households in which there is a severely limited person, in the sense of the GALI, compared to 12.8% for all households. Once the cost of disability is taken into account, it is 44.4%, compared to 15.4% for all households. The adjustment to the standard of living of disabled people[5] affects the median standard of living and the monetary poverty line, which are revised downwards. As a result, all monetary poverty rates are changed, including that of households without a disabled person, from 12.1% to 10.7%.

The very high impact on the monetary poverty rate of taking into account the additional cost due to disability is explained by the fact that households in which a person is severely limited, in the sense of the GALI, are strongly overrepresented in the first deciles of the standard of living distribution, below and just above the monetary poverty line. The adjustment to their standard of living causes many of them to fall below the monetary poverty line. After the adjustment to the monetary standard of living, 54% of households in which a disabled person lives are in the first two deciles of the standard of living distribution, compared to 28% before the adjustment.

2.1.2. Heterogeneity by Household Category

For single people aged under 60, the additional cost is estimated at 52% using the assessment of the financial situation and 45% using the number of material deprivations. For those aged 60 or over, the estimated cost is 29% and 24% respectively. The additional cost due to disability, beyond the expenses covered by public aid, is therefore higher for single people under the age of 60. The difference is statistically significant

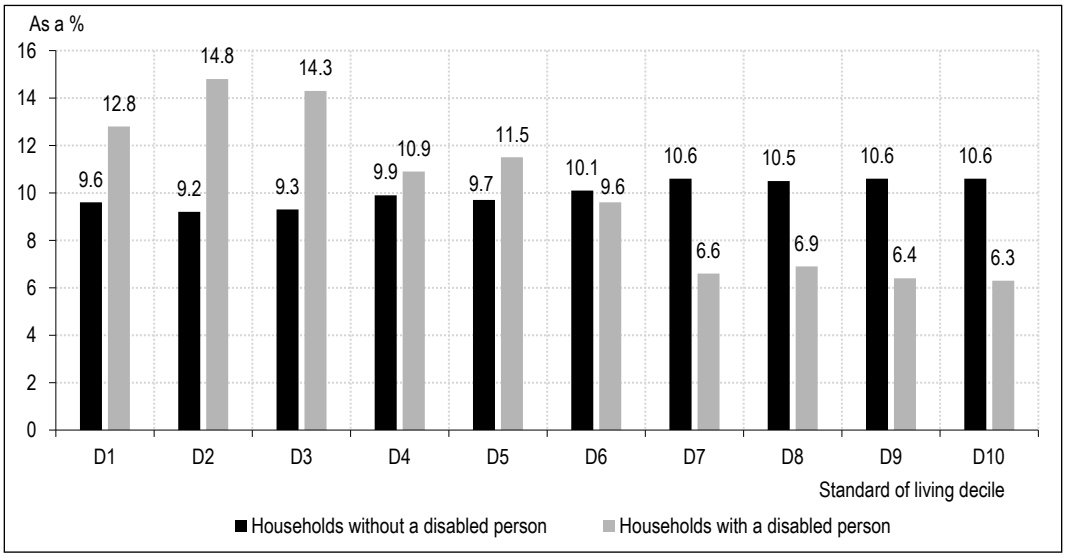
5. *To calculate the monetary standard of living of disabled people, we apply the following formula:* $Y^{*} = Y / \exp(0.361)$.

Table 4 – **Proportion of poor households**

	Household without a disabled person	Household with a disabled person	All households
Poverty rate (%)	12.1	17.2	12.8
Poverty rate after taking into account the cost of disability (%)	10.7 [10.6; 10.8]	44.4 [38.4; 49.5]	15.4 [14.7; 16.0]

Reading note: 12.1% of households in which there are no disabled people are in a situation of monetary poverty (at the threshold of 60% of the median standard of living).
Sources and coverage: INSEE, *Statistiques sur les ressources et conditions de vie* survey, 2019. All ordinary households living in metropolitan France.

Figure III – **Distribution of households by standard of living decile depending on the presence of a disabled person**



Reading note: 12.8% of households in which a disabled person lives are in the first standard of living decile, compared to 9.6% of households where no disabled person lives.
Sources and coverage: INSEE, *Statistiques sur les ressources et conditions de vie* survey, 2019. All ordinary households living in metropolitan France.

at the 95% threshold when considering the number of material deprivations and at the 90% threshold when considering the assessment of the financial situation.

For couples who are both under the age of 60, estimates of the additional cost due to disability vary slightly depending on the variable used: 39% with the assessment of the financial situation and 44% with the number of material deprivations. For childless couples who are both aged 60 or over, the estimated cost is 20% and 26% lower, respectively. We thus find the same hierarchy as for single people. The difference is statistically significant at the 95% threshold for both standard of living variables.

For single-parent families whose reference person is under 60 years old, the additional cost varies more significantly depending on the variable used: 88% with the assessment of the financial situation and 76% with the number of material deprivations. This is the family configuration for which the additional cost appears to be the highest. Nevertheless, the estimates are particularly imprecise given the low number of households (2,532 households, 200 of which have a disabled reference person).

2.1.3. The Additional Cost Depends on Whether the Person Is in a Couple or Not

These results suggest that the additional cost due to disability may be higher for disabled people living alone than for those living in a couple. For people aged 60 or over, the differences between single people and those in a childless couple with a spouse of the same age are not significant. For people under the age of 60, Table 3 shows the results of estimating the additional cost due to disability for single people and those leading a single-parent family. The additional cost due to disability is estimated at 62% using the assessment of the financial situation and 54% using the number of material deprivations. These results are comparable with those of couples, with or without children, under the age of 60. The differences are still not significant when considering the number of material deprivations as the dependent variable. In contrast, they are significant at the 95% threshold when the assessment of the financial situation is considered as the dependent variable. This result is in line with the findings of Zaidi & Burchardt (2005) who find that the additional cost due to disability is higher for single people than for couples, concerning both pensioners and non-pensioners in the UK.

2.2. Estimation of the Additional Cost Due to Overall Activity Restrictions

We now include people with a mild overall activity restriction[6] with disabled people, differentiating between them and those people with a severe overall activity restriction. For all households (Table 5), the estimates indicate an additional cost associated with a mild overall activity restriction of 24% using the assessment of the financial situation as the dependent variable and 26% using the number of material deprivations as the dependent variable. The results for the main family configurations can be found in Table S4 in the Online Appendix. They also reveal an additional cost for households in which the reference person or their spouse, if any, reports a mild overall activity restriction.

The additional cost due to a severe overall activity restriction is slightly higher than that estimated in the previous section: 41.4% compared with 36.1% for the assessment of the financial situation; and 44.3% compared with 38.1% for the number of material deprivations. This is due to the fact that the reference category has changed and now includes only people with no overall activity restrictions (i.e., those who answered “no, not limited” to the GALI question).

3. Discussion

3.1. Analysis of the Results

It is estimated that the additional cost due to disability is greater when the disabled person is under 60 years old than when they are aged 60 or over, regardless of family configuration. There are several possible explanations for this result. The first is that the benefits to cover expenses due to disability better cover the needs and services of disabled people aged 60 or over through the APA than those of disabled people under 60 years old through the PCH. Changes to the eligibility requirements for the PCH were introduced on 1 January 2023 to make people with deafblindness eligible for human help. Other eligibility criteria could be revised to better cover the needs of this population. The second explanation is that the types of disability and therefore the needs are different for disabled people under 60 years old and for older people, including people with a loss of autonomy. Disabled people under the age of 60 may have compensation needs involving more use of technical support, while those aged 60

6. *People answering “yes, limited but not severely” to the GALI question.*

Table 5 – **Estimates of the additional cost due to overall activity restrictions, 2017-2019**

Standard of living indicator	Assessment of the financial situation	Number of material deprivations
All households		
Disposable income (log)	1.578*** (0.047)	1.785*** (0.060)
Severe overall activity restriction	−0.653*** (0.044)	−0.790*** (0.048)
Mild overall activity restriction	−0.379*** (0.033)	−0.461*** (0.037)
Estimated cost of a severe overall activity restriction	0.414 (0.032) [0.351; 0.477]	0.443 (0.033) [0.379; 0.507]
Estimated cost of a mild overall activity restriction	0.240 (0.022) [0.197; 0.283]	0.258 (0.023) [0.214; 0.303]
Pseudo R^2	0.122	0.185
Number of observations	32,934	32,934

Notes: ***p-value < 1%; **p-value < 5%; *p-value < 10%. Results of the ordinal logistic models on pooled data to assess the additional cost due to overall activity restrictions for all households. The confidence interval for the estimated additional cost was calculated at the 95% level using the Delta method. The models include the same control variables as in Table 3.
Reading note: Using the assessment of the financial situation of the household as a standard of living indicator, the additional cost due to a severe overall activity restriction is estimated to be 41.4% of disposable income for all households, compared to 24.0% for a mild overall activity restriction.
Sources and coverage: INSEE, *Statistiques sur les ressources et conditions de vie* survey, 2017-2019. All ordinary households living in metropolitan France.

or over may have greater human support needs. This human support may consist of support with activities of daily living, which may be partly provided by friends and family acting as caregivers, thereby reducing the estimated additional cost. A third possible explanation is that the transition to retirement further lowers the income and standard of living of people who are not disabled compared to those who are disabled.

Moreover, for people under 60 years old, with or without children, the additional cost due to disability would be higher when they live without a spouse than when they live with a spouse of the same age. Disabled people in couples may require professional caregivers less frequently because of the support provided by their spouse. However, this support is not without consequences for friends and family acting as caregivers, such as on their professional situation. These friends and family have a lower likelihood of being employed (Carmichael *et al.,* 2010; Nguyen & Connelly, 2014). This support can have consequences on their physical (Pinquart & Sörensen, 2007) and psychological (Pinquart & Sörensen, 2003) health, with informal caregivers reporting stress and depression more often.

This result may also reflect differences in the nature of the disability of single people compared to couples. Indeed, depending on the limitations and their degree of severity, the percentage of disabled people living alone differs. According to Levieil (2017), in 2010, among people aged 15 to 64 living in metropolitan France, 17% of those with a mobility limitation lived alone (18% in the case of severe mobility limitation), as did 19% of people with a mental limitation (26% in the case of severe mental limitation), compared with 13% of people with no limitations. People with multiple limitations also live alone more often (24% and 30% of people with multiple severe limitations).

3.2. Comparison of the Results with International Literature

The additional cost due to disability estimated using the approach of Zaidi & Burchardt (2005) depends on the types of public aid for disabled people and the social security system of each country. In addition, international studies use different standard of living indicators and indicators to identify disabled people (see Table S1 in the Online Appendix). Therefore, it is difficult to compare our results with earlier work. Nevertheless, we propose a comparison with the studies relating to Europe to compare orders of magnitude.

Morris & Zaidi (2020) use data from the SHARE to estimate the additional cost due to disability for adults aged 50 to 65 in fifteen European countries. They identify four groups of countries: “social democrats” (Switzerland and Denmark), “Eastern Europe” (Estonia and Slovenia), “conservative system” (Australia, Germany, the Netherlands, Switzerland, Belgium and Luxembourg) and “Mediterranean system” (Spain, Italy, Israel and France). In the case of households with adults aged 50 to 65, the estimated additional cost due to disability (health problems limiting paid work) is higher for the social democratic countries (62%) and Eastern Europe (66%) than for the conservative (40%) and Mediterranean (41%) system countries, including France.

For all households in the United Kingdom between 2016 and 2017, Schuelke *et al.* (2022) obtained an additional cost due to disability of 53% for households with at least one disabled person. For all Irish households, for the period 1995 to 2001, Cullinan *et al.* (2011) obtained an additional cost of 23% for households with at least one disabled person and 33% if the disabled person has a severe limitation. For all households in France, we estimate the additional cost due to disability at 36% using the assessment of the financial situation as the standard of living variable (38% using material deprivations). Our results for France therefore are between Ireland and the United Kingdom.

For households in the United Kingdom with men aged 65 or over and women aged 60 or over, between 2007 and 2008, Morciano *et al.* (2015) obtained an additional cost of more than 60% for households with an adult with a median disability score. For Irish households with members aged 65 or over, in 2001, Cullinan *et al.* (2013) obtained an additional cost of 49% for households with a disabled person. In France, in the case of disabled people aged 60 or over, we estimate the additional cost due to disability at 29% using the assessment of the financial situation (24% using material deprivations) for a single person and 20% for couples in which there is at least one disabled adult (26% using material deprivations).

This comparison shows that the additional cost due to disability estimated in this article for France is of the same magnitude as those estimated in other European countries, particularly in Ireland and the United Kingdom.

3.3. Limitations of the Study

In this article, we used the GALI, the only indicator available in the SRCV survey to identify disabled people. Consequently, a person who responds that they are not limited is considered in the estimates to have no disability, even though they may have official recognition of a disability or have severe physical, sensory or cognitive limitations. Having these three criteria available in the SRCV survey would make it possible to refine the measurement of the cost of disability by including an independent variable in the estimates indicating the presence of a person considered disabled under one of the three criteria. More detailed information on physical limitations (walking 500 metres on flat ground, climbing stairs, etc.), sensory limitations (hearing or visual difficulties even when using aids) or cognitive limitations (being understood by others, concentrating for more than 10 minutes, etc.) would also make it possible to assess which limitations entail the most additional cost.

The second limitation of this study is that it only considers a disabled person to be present in the household if it is the reference person or their spouse, if any, who reports being severely limited in response to the GALI question. The question is not actually asked to individuals under the age of 16 in the household. If this information were available, we would be able to assess the additional cost due to a child's disability.

Finally, the APA and the PCH are considered in-kind benefits to compensate for expenses due to disability. As a result, the amounts paid are not included in disposable income (Levieil, 2017). Nevertheless, they make it possible to reduce the additional cost of disability estimated using the standard of living approach: without those benefits, that cost would be higher. However, the additional cost estimated in this article is an average cost for both those receiving benefits and those not receiving benefits. Having information on the amounts received by the household in respect of the APA and PCH would make it possible to estimate the additional cost according to whether or not these benefits are received.

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In this article, we have estimated the additional cost due to disability for ordinary households living in metropolitan France for a typology of family configurations. To do this, we have applied the standard of living approach developed by Berthoud *et al.* (1993) and expanded upon by Zaidi & Burchardt (2005) to data from the SRCV survey. To compensate for the low number of households, several waves of the survey were pooled.

For all ordinary households living in metropolitan France, for the 2017-2019 period, the estimates conclude that the additional cost due to disability is at least 30% on average, regardless of the standard of living variable used.

These initial results would need to be refined and consolidated. They already seem to us to support the need to refine the measurement of inequalities in the standard of living to take into account the greater needs of households in which a disabled person lives. To go further, it would

be valuable to be able to collect more data, for example through a specific module on disability and an oversample of disabled people added to the SRCV survey in a given year. These initial results may also encourage people to question the conditions for the State covering expenses due to disability for households in which the disabled person is under 60 years of age, for which the additional cost of disability appears to be higher. □

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/8186098/ES542_Blavet_OnlineAppendix.pdf

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Do Out-Of-Pockets Undermine Equity in Healthcare Financing? A Comparison of Healthcare Systems in Europe

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Abstract – In order to guarantee equal access to healthcare, it must be funded in an equitable manner to ensure that people are not forced to forgo healthcare and to prevent healthcare from becoming too large a financial burden for patients. This is achieved by ensuring that healthcare received by the poorest people is subsidised by wealthier people, while also ensuring that patients suffering poor health are not burdened with excessive costs for a given income. In practice, patients are required to cover some of their healthcare costs across all European healthcare systems. Since out-of-pockets are only paid by healthcare consumers, their existence may compromise equity in healthcare financing. In this article, we evaluate how out-of-pockets contribute to vertical and horizontal equity in healthcare financing for people aged 50 and over in Europe. Using concentration indices, we demonstrate that equity in financing is not respected, particularly in healthcare systems where out-of-pockets are the least regulated.

JEL: D63, I14
Keywords: out-of-pocket, equity, healthcare financing, healthcare systems

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With a view to fostering responsibility among consumers of healthcare, all European healthcare systems have introduced schemes whereby patients pay a share of their healthcare costs. In other words, all of these systems apply out-of-pockets. However, the existence of out-of-pockets can undermine equal access to healthcare if it is a contributing factor in patients forgoing healthcare or if such out-of-pockets present too great a financial burden for some individuals.

In order to guarantee access to healthcare for all, healthcare systems must ensure that they are financed in an equitable manner (Daniels, 1982; 1985; Wagstaff & Van Doorslaer, 2000; Fleurbaey & Schokkaert, 2009; Rochaix & Tubeuf, 2009). They must therefore respect the principle of vertical equity for financing, according to which healthcare of the poorest is subsidised by the wealthiest (Wagstaff & Van Doorslaer, 2000; Rochaix & Tubeuf, 2009; Jusot *et al.*, 2016). This principle demands that financial contributions to the healthcare system increase at least in proportion to income, regardless of risk or how much the healthcare system is actually used. The aim is twofold: promoting access to healthcare and ensuring that healthcare financing does not require a higher proportion of disposable income among the poorest than among the wealthiest. The idea is to ensure that accessing healthcare does not contribute to inequality in disposable income.

Guaranteeing universal access to healthcare also means not subjecting the sickest patients very high expenditure, also called "catastrophic" payments, or forcing them to forgo healthcare for financial reasons. The literature shows that the majority of individuals faced with high expenditure for healthcare are elderly individuals with health conditions requiring numerous treatments, some of which are not well covered (e.g. dental care prosthetics, etc.), as well as vulnerable hospital inpatients (Franc & Pierre, 2016; Perronnin, 2018). Therefore, vertical equity in healthcare financing is combined with the objective of achieving horizontal equity in healthcare financing, a principle that demands equal contributions to the system based on equivalent ability to pay, regardless of how much the healthcare system is used. Horizontal equity in the financing of healthcare therefore ensures that individuals are not financially responsible for their healthcare needs.

Regarding contributions to the public health insurance system, both of these principles can easily be fulfilled, since contribution amounts can be based solely on income levels, without any link to health status. Compliance with these social justice principles is less clear in cases where patients are required to cover a portion of their healthcare costs. Indeed, out-of-pockets are not only based on patients' ability to pay, but also on their actual healthcare consumption (Wagstaff & Van Doorslaer, 2000). In France, compulsory health insurance contributions have a positive effect on redistribution from the wealthiest to the poorest, while health insurance premiums and final out-of-pockets run counter to solidarity between high and low incomes (Jusot *et al.*, 2016). Using survey data from Tajikistan, Pellet (2020) also demonstrates that out-of-pockets have a negative impact on vertical equity in the financing of healthcare due to their regressive nature; in other words, they do not increase in proportion to income.

This article provides an insight into how final out-of-pockets, i.e. amounts that are not covered by public nor private health insurance, contribute to equity in healthcare financing. We assess how out-of-pockets contribute to both vertical and horizontal equity in healthcare financing, a question that has not yet been explored in the literature to our knowledge. As Europe is home to a number of different types of healthcare system, we conduct this study from a comparative perspective among European countries. We would expect out-of-pockets to have a greater negative impact on equity in insurance-based systems, where the share of private financing is greater, except if these systems implement redistributive instruments that limit direct payments based on financial resources (vertical equity) or health condition regardless of income (horizontal equity). For this reason, we explore the extent to which out-of-pockets contribute to equity in financing in several European countries for three different types of healthcare for which costs are covered differently, depending on healthcare systems: doctor visits, dental care and hospital stays. We use data from the Survey of Health, Ageing and Retirement in Europe (SHARE), which surveys Europeans aged 50 and over, a population with important healthcare needs. This survey provides harmonized information on final out-of-pockets paid by patients for these three types of healthcare across countries. In order to assess the contribution of out-of-pockets to vertical equity in financing, we use the concentration index method (O'Donnell *et al.*, 2007), which defines whether out-of-pockets increase, decrease or is constant with income, and the progressivity index, known as the "Kakwani

index" (Kakwani, 1977), which indicates the regressivity, progressivity or proportionality of out-of-pockets in relation to income. For the horizontal equity analysis, we measure differences in contributions to the healthcare system between individuals with equivalent income but with differences in health status. To this aim, we compute the concentration index for out-of-pockets in a population ranked by health status with indirect standardisation of income.

We demonstrate that out-of-pockets negatively contribute to vertical equity in financing for the three types of healthcare. For outpatient care (i.e. doctor visits and dental care), out-of-pockets are the least regressive in countries in which such healthcare is largely covered by the public system. It is the most regressive in Switzerland, where the healthcare system is largely financed by households. Out-of-pockets for hospital stays is even more regressive than out-of-pockets for outpatient care. In spite of having a healthcare system based on the universal model, Denmark and Sweden exhibit the most regressive hospital out-of-pockets among all countries in our study: this is symptomatic of a growing privatisation due to long waiting lists in the public sector (Chambaretaud & Lequet-Slama, 2003). For a given income, out-of-pockets for doctor visits and hospital stays are more concentrated among the sickest in almost all countries, which suggests that healthcare systems are not providing adequate coverage for the sickest who then become financially responsible for their poor health, which is at odds with the principle of horizontal equity. For dental care, out-of-pockets are less concentrated among those requiring more care, particularly in Czechia, where basic dental care is not subject to out-of-pockets.

The remainder of this article is structured as follows. Section 1 describes the financing of healthcare systems in Europe. Section 2 defines the concepts of vertical and horizontal equity healthcare financing and describes the methodology. Section 3 presents the data, the variables used for our analyses and the sample of interest. Results are presented in Section 4.

1. Healthcare Financing in Europe

All healthcare systems are funded by a combination of public (i.e. taxes and public insurance contributions) and private sources (i.e. private insurance premiums and out-of-pockets paid directly by households). Although European healthcare systems are largely publicly funded, they differ in terms of funding sources and healthcare provision organization. In insurance-based systems, also known as Bismarck systems, healthcare is funded by mandatory health insurance contributions from workers and dispensed by public and private service providers, while systems inspired from the assistance-based model, also referred to as the Beveridge model, are characterised by a universal healthcare system funded through taxation and healthcare dispensed by public service providers or providers under contract with the public system (Badel & Pujolar, 2008; Chambaretaud & Hartmann, 2009; Nezosi, 2021). Table 1 shows the different types of healthcare funding in the studied countries.

In insurance-based systems, healthcare expenses are usually paid by patients and are only partially reimbursed by public health insurance.[1] Cost-sharing instruments (co-payment, beneficiary co-payment and lump-sum payment) exist in all countries sharing this type of system for all three types of healthcare. However, schemes aimed at exempting patients from paying out-of-pockets or capping such out-of-pockets are based on financial resources (in Germany, Austria, Belgium, France and Czechia), health condition (in Germany, Austria, Belgium, France and Switzerland) or based on the proportion of the out-of-pocket to income, referred to as the "expenditure to income ratio", as is the case in Germany and Austria, where out-of-pockets are capped at 2% of gross annual household income. In Czechia, annual out-of-pockets are capped at an absolute threshold (Paris *et al.*, 2016; Tikkanen *et al.*, 2020). Since patients have to cover a part of their healthcare costs in these systems, the private supplementary health insurance market is particularly well developed in these countries (Figure I). In some cases, individuals are covered by their employers, which goes some way to explaining the systematic difference in coverage rates between workers (i.e. those in employment) and non-workers (i.e. those who are retired, unemployed or unable to work due to disability) revealed by the SHARE survey data. Supplementary insurance coverage rates are high in Bismarck-type systems, such as Switzerland (>75%), Belgium (>80%) and France particularly (>95%). Coverage rates are lower in other countries with a system based

1. Nowadays, the majority of systems that were initially insurance-based are now considered as hybrid systems since they also borrow characteristics from the universal model. For example, in France, the healthcare system was originally based on the Bismarck model but now also provides assistance schemes (e.g. Complémentaire Santé Solidaire, *CSS) and is also partly financed by social security contributions (i.e.* Contribution Sociale Généralisée, *CSG). Similarly, so-called assistance-based systems have an insurance-based component, since some healthcare services, such as dental care, are not included in the universal basket.*

on this model, such as Germany (<35%), Austria (<25%) and Czechia (≤10%). In Czechia, this could be explained by the fact that some types of healthcare are not subject to out-of-pockets, such as basic healthcare, which is fully covered.

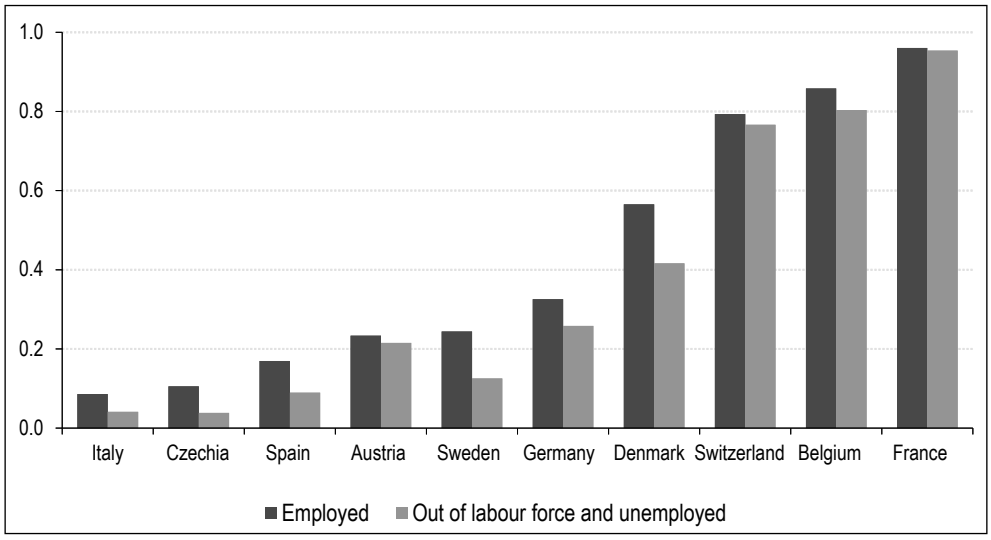
In assistance-based systems, the universal basket of healthcare services is dispensed by national health services and is generally universally accessible – in some cases, it is even free of charge – regardless of ability to pay. For this reason, doctor visits and hospital stays are not subject to cost-sharing in Denmark, Spain or Italy (Sweden is an exception among universal systems). However, private healthcare and dental care are not included in the universal basket of healthcare. Therefore, they are paid by patients in all countries and may be covered by voluntary private insurance. The use of private supplementary health insurance is far less widespread in these systems, particularly in Italy (4% among the unemployed, otherwise 9%) and Spain (9% and 17%, respectively). However, it is more common in Sweden (13% and 24%, respectively) and Denmark (42% and 57%, respectively) where the standard of living is higher. Except from Italy, systems based on the universal model do not provide any regulation towards out-of-pockets for the poorest. Exemptions for

Table 1 – **Characteristics of healthcare systems**

Country	System type		Co-payment, beneficiary co-payment and lump-sum payment			Exemption or cap for:		
	Insurance	Assistance	Doctor visits	Dental care	Hospital stays	financial resources	disease	out-of-pocket amount
Germany	X		X	X	X	E	C	C
Austria	X		X	X	X	E	E	C
Belgium	X		X	X	X	C	C	
Denmark		X		X			E	
Spain		X		X				
France	X		X	X	X	E	E	
Italy		X		X		E	E	
Czechia	X		X	X	X	E		C
Sweden		X	X	X	X		E	C
Switzerland	X		X	X	X		C	

Notes: E = exemption, C = cap.

Figure I – **Supplementary health insurance coverage in Europe**



Notes: The coverage rate is the proportion of individuals with a supplementary health insurance at the time of the survey. It is calculated for the employed on one hand, for the unemployed and those out of labour market, i.e. retirees, those seeking employment or those unable to work due to disability, on another hand.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

chronic diseases are provided for in Denmark, Italy and Sweden, but not in Spain. Lastly, the annual out-of-pocket is capped in Sweden for doctor visits for all individuals and for hospital stays for patients aged over 85 (Paris *et al.*, 2016; Tikkanen *et al.*, 2020).

Beyond this typology, healthcare systems differ according to the weight out-of-pockets represent in the overall healthcare system's funding. Figure II shows the proportion of each funding source for each country (OCDE, 2024). Among all countries, Switzerland's healthcare system has the highest share of private funding: 46% of its funding comes from households, among which 27% come from private supplementary insurance and 19% from out-of-pockets. Like Denmark and Sweden, Spanish and Italian healthcare systems are based on the universal model. However, the share of private funding is greater in those countries. In Spain and Italy, funding from households accounts for 42% and 39% of total funding respectively and out-of-pockets making up a similar proportion as observed in Switzerland (18% and 19%, respectively). In Denmark and Sweden, the share of healthcare system funding that comes from households is 25% and 26%, respectively, 12% and 13% of which comes from out-of-pockets. Among the studied countries, France's healthcare system is the least dependent on out-of-pockets, which account for 8% of total funding, due to the key role of private supplementary insurance.

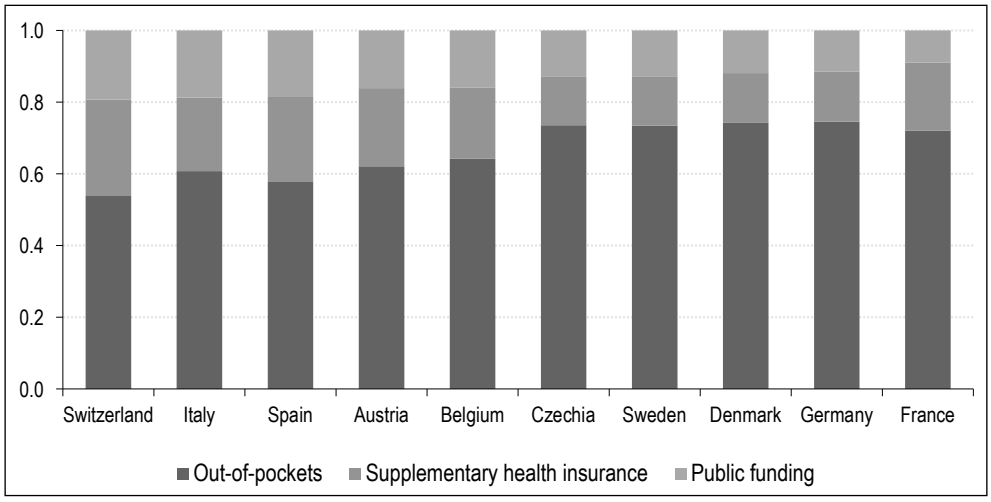
Out-of-pockets account for a different share of households' budget depending on the country. On average, 3% of households' consumption is allocated to healthcare out-of-pockets in OECD countries, with dental care being among the top sources of healthcare expenditure (Berchet & Morgan, 2018). Given that healthcare expenditure increases with age due to higher needs, out-of-pockets for people aged over 50 may be higher than for the general population, unless the healthcare system provides redistribution from the healthiest to the least healthy. By aggregating annual out-of-pockets for doctor visits, dental care and hospital stays to be paid by patients over the age of 50 in the SHARE survey, we estimate that out-of-pockets account for a proportion of individual income ranging from 1% in Denmark to 6.4% in Italy (Figure III). In all countries, dental care generates the greatest out-of-pockets, followed by hospital stays and then doctor visits, with the exception of Italy where hospital out-of-pockets represent the smallest share of total out-of-pockets. However, these statistics cannot be used to assess the equity of healthcare financing in these countries. This point is further discussed in the following section.

2. Methodology

2.1. Vertical Equity in Healthcare Financing

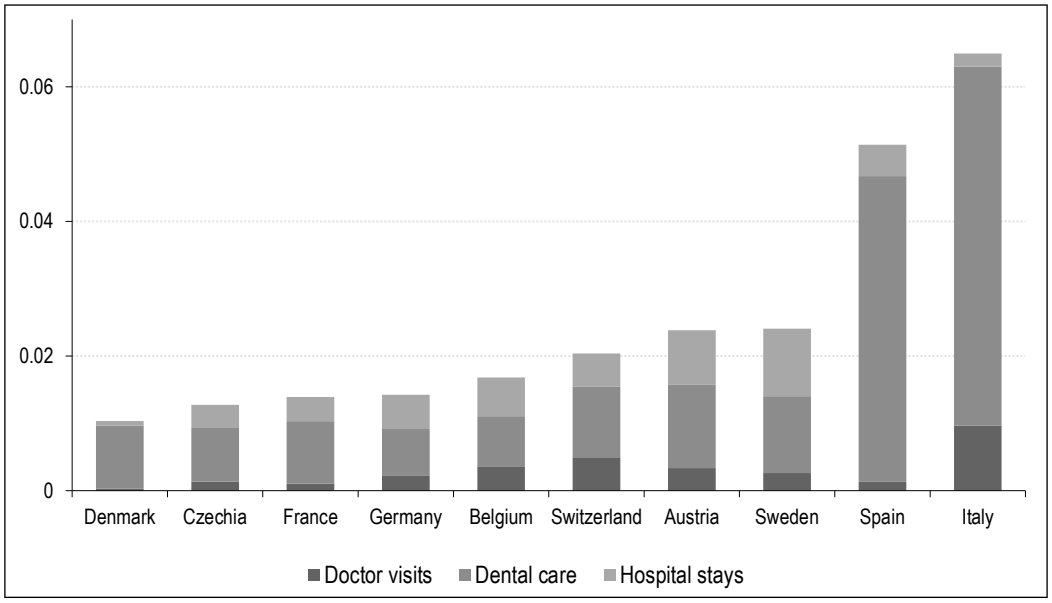
The concept of vertical equity requires unequal treatment of unequal situations. Vertical equity in healthcare financing involves that individuals contributes in line with their ability to pay: financing increases at least in proportion to a person's contributive capacity (Wagstaff *et al.*, 1989; Wagstaff & Van Doorslaer, 2000; Rochaix & Tubeuf, 2009).

Figure II – **Composition of healthcare systems' funding in Europe**



Notes: Public funding includes public insurance contributions and taxes. Each source of funding is interpreted as the percentage of total costs of the healthcare system.
Source: OECD, *Dépenses de santé et financement: Indicateurs des dépenses de santé, 2023* (Healthcare expenditure and financing: healthcare expenditure indicators, 2023).

Figure III – **Composition of average annual out-of-pockets in Europe**



Notes: The ratio of annual out-of-pockets on total annual income is broken down into the following three types of healthcare: doctor visits (dark grey), dental care (medium-grey) and hospital stays (light grey).
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

2.1.1. Concentration Curve

From a graphical point of view, it is possible to show the distribution of out-of-pockets within the population ranked by income using a concentration curve (O'Donnell *et al.*, 2007). Concentration curves show the cumulative proportion of out-of-pockets based on income percentile, ranked from the lowest to the highest income on the x-axis. The concentration curve for out-of-pockets is compared with the "perfect equality" situation, represented by the diagonal line,[2] where all individuals pay the same out-of-pocket amount, regardless of income. If the concentration curve does not differ significantly from the diagonal, this means that the out-of-pockets' distribution reflects perfect equality. If the concentration curve is above (or below) the diagonal, this means that out-of-pockets are more concentrated among the poorest (or wealthiest) people.

2.1.2. Concentration Index

In order to know if concentration curves are significantly different from the diagonal, we calculate the concentration index (CI) for out-of-pockets (O'Donnell *et al.*, 2007). Inspired from the Gini index, it is equal to twice the area contained between the diagonal and the concentration curve for out-of-pockets, i.e.:

$$CI = \frac{2cov\left(y_j, x\right)}{\mu_{y_j}} \quad ,$$

where y_j is the amount of the out-of-pockets for healthcare type j, x is the rank within the population ranked by income and μ_{y_j} is the average amount of out-of-pockets for healthcare type j in the whole population. The concentration index ranges between −1 and 1, with a positive (or negative) value indicating that out-of-pockets are more concentrated among the wealthiest (or poorest) people. The absolute value of the concentration index increases with the distance between the diagonal and the concentration curve. A null index suggests that out-of-pockets are distributed equally across the population. As the population is ranked by income level, standard errors are corrected for autocorrelation of errors at the income level.

2.1.3. Progressivity Index

In order to conclude on the contribution of out-of-pockets to vertical equity in financing, the degree of progressivity of out-of-pockets is assessed by comparing the concentration curve for out-of-pockets with the Lorenz curve, i.e. the concentration curve for income levels. In other words, it determines whether out-of-pockets contribute to inequalities in standards of living. If the concentration curve for out-of-pockets is the same as the Lorenz curve, out-of-pockets increase in proportion to income and are neutral in terms of contribution to income inequality. If the

2. In a graph with population ranked by income on the x-axis and the cumulative proportion of out-of-pockets on the y-axis, the diagonal line contains all points where x% of the population pays x% of total out-of-pockets in the population.

concentration curve for out-of-pockets is above (or below) the Lorenz curve, out-of-pockets increase less (or more) when compared with income, meaning that out-of-pockets are regressive (or progressive) and increase (or decrease) income inequality. The degree of progressivity is measured by the progressivity index, also known as the Kakwani index (Kakwani, 1977), which, in our case, measures the area between the concentration curve for out-of-pockets and the Lorenz curve. Concretely, this is the difference between the concentration index (CI) and the Gini index (GI), which indicates the degree of income inequality in the population (i.e. the concentration index of the Lorenz curve), i.e.:

$$KI = CI - GI = \frac{2cov\left(y_j, x\right)}{\mu_{y_j}} - \frac{2cov\left(r, x\right)}{\mu_r},$$

where r is income and μ_r its average value in the population. The Gini index ranges from 0 to 1, with 0 indicating no income inequality in the population. The Kakwani index (KI) can therefore range from −2 to 1, with a positive (or negative) value indicating that out-of-pockets are progressive (or regressive) with respect to income and a null value indicating that out-of-pockets increase exactly in proportion with income.

2.1.4. Barriers to Accessing Healthcare

Regarding out-of-pockets, the issue of vertical equity in healthcare financing needs to be tackled in the light of access to healthcare. Indeed, if there are barriers to healthcare access for the poorest, a higher concentration of out-of-pockets among the wealthiest people could be attributable to greater use of healthcare. In this case, under-concentration of out-of-pockets among the poorest cannot (solely) be attributed to a redistributive instrument (*Complémentaire santé solidaire* in France), but may also be explained by the fact that the poorest consume less healthcare than their health status needs it. If there were no barrier to healthcare access, the concentration curve for out-of-pockets would be further away from the Lorenz curve, making out-of-pockets more regressive, and all the more so with healthcare inequality. In other words, where barriers to healthcare access exist, the degree of out-of-pocket's regressivity is probably underestimated. In order to discuss the underestimation of our findings with respect to vertical equity for each type of healthcare, we explore the existence of access barriers by evaluating horizontal equity in healthcare use (Wagstaff & Van Doorslaer, 2000; O'Donnell *et al.*, 2007; Fleurbaey & Schokkaert, 2009). We check whether or not wealthier people are more likely to access healthcare for a given need. In this regard, we use the indirect standardisation method[3] to correct healthcare use for differences in needs for healthcare. Healthcare use is defined as the probability of having consumed a type of healthcare at least once during the last 12 months and the need for healthcare is measured by a health status score.[4] Findings regarding vertical equity in the financing of each type of healthcare are presented in Section 4.1 and are discussed in the light of barriers to healthcare access.

2.2. Horizontal Equity in Healthcare Financing

The fact that vertical equity in the healthcare financing is respected is not a guarantee of equity among individuals with the same income. In other words, even if financial contribution increases with income, two individuals with the same income level may be paying different contributions, thereby violating horizontal equity in healthcare financing according to which equal individuals must be treated equally (Wagstaff & Van Doorslaer, 2000). In principle, there is no horizontal inequity in public insurance contributions since they are based solely on income and do not depend on health status (although age is taken into account in some systems). Regarding out-of-pockets, differences in amounts for a given income should be expected given potential differences in individuals' health status for the same income, unless we assume that public health insurance compensates for these differences by paying more for the sickest (exemption from co-payment in the case of a chronic illness in France or capping of annual out-of-pockets via a safety net in Belgium, for example).

Out-of-pockets contribute to horizontal equity in healthcare financing if, for a given income, the amount of out-of-pockets does not change based on any other criterion, e.g. health status. It therefore implies exploring the concentration of out-of-pockets within the population ranked from the worst to the best health status for a given income (see Section 3.2.3). To do so, we use the indirect standardisation method to correct out-of-pocket amounts for differences in income, i.e. compute out-of-pockets paid by individuals if they were treated as individuals with the same income (O'Donnell *et al.*, 2007). It is also possible to use direct standardisation, which involves correcting out-of-pockets for differences in income by income sub-group.

3. This method is also used to analyse horizontal equity in financing and is described in Section 2.2.
4. The structure of the health score is described in detail in Section 3.2.3.

Since the indirect standardisation method can be used on individual data rather than aggregated data, it is preferred over the direct method that provides a less precise standardisation (Wagstaff & Van Doorslaer, 2000). Standardised out-of-pockets paid by individual i for each healthcare type j, denoted as y_{ij}^{s}, is calculated as follows:

$$y_{ij}^{s} = y_{ij} - \hat{y}_{ij} + \overline{y}_{j},$$

where y_{ij} is the observed out-of-pocket amount, $\hat{y}_{ij}$ is the predicted out-of-pocket amount on income and $\overline{y}_{j}$ is the average out-of-pocket. Then, we compute a concentration index with this standardised out-of-pocket measure in the population ranked by health status. Standard errors of concentration indices are corrected for autocorrelation of errors at the health status score level.

If the concentration curve for standardised out-of-pockets does not diverge significantly from the diagonal, the distribution of out-of-pockets is perfectly equal, which means that all individuals pay the same amount regardless of their health status for a given income. This situation fulfils the principle of horizontal equity in healthcare financing. If the concentration curve for out-of-pockets is above the diagonal (i.e. positive concentration index), this means that out-of-pockets are more concentrated among the sickest for a given income. This corresponds to a situation of great horizontal inequity in financing as the sickest patients are required to pay out-of-pockets to meet their healthcare needs even though they have the same ability to pay as other individuals with the same income. If the concentration curve for out-of-pockets is below the diagonal (i.e. negative concentration index), this means that out-of-pockets are more concentrated among people in better health. This situation is conceivable in the context of preventative care since they avoid the deterioration of health.

3. Data

3.1. The Survey of Health, Ageing and Retirement in Europe (SHARE)

This study is based on data from the SHARE survey (Börsch-Supan *et al.*, 2013),[5] which provides information regarding employment, living conditions and the health status of individuals aged 50 and over in 27 European countries. Only data from Waves 5, 6 and 7[6] (conducted between 2013 and 2017) are used since questions regarding healthcare costs asked in the previous waves are not comparable. By restricting our sample to respondents who answered all of the questions that we are interested in, we obtain a total sample of 89,079 observations for 50,336 individuals living in 10 European countries: Austria, Belgium, Czechia, Denmark, France, Germany, Italy, Spain, Sweden and Switzerland.

3.2. Variables of Interest

3.2.1. Out-of-Pockets

The SHARE survey provides information regarding out-of-pockets after public and private healthcare insurance coverage for three types of healthcare: doctor visits (including visits to a general practitioner, a specialist and/or outpatient and emergency consultations at the hospital), dental care and hospital stays. For each type of healthcare, the question providing the out-of-pocket amounts is as follows: "*Overall, how much did you pay yourself during the last twelve months for [healthcare type], that is how much did you pay without getting reimbursed? Only include the amount you were ultimately required to pay out of pocket.*" The amount of out-of-pocket is a continuous variable with a minimum value of 0 for individuals who have not declared any out-of-pocket (cost of healthcare covered in full or no consumption of healthcare).

Where the amount of out-of-pocket represents an important share of income, it is considered a "catastrophic" expenditure. The literature generally applies a threshold of 10% of total income or 40% of disposable income (i.e. income without expenditure that cannot be reduced, or "ability to pay") to define a catastrophic amount (O'Donnell *et al.*, 2007; Cylus *et al.*,

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5. This paper uses data from SHARE Waves 5, 6 and 7 (10.6103/SHARE.w5.800, 10.6103/SHARE.w6.800, 10.6103/SHARE.w7.800, 10.6103). See Börsch-Supan et al. *(2013) for methodological details. The SHARE data collection has been funded by the European Commission, DG RTD through FP5 (QLK6-CT-2001-00360), FP6 (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857, SHARELIFE: CIT4-CT-2006-028812), FP7 (SHARE-PREP: GA N°211909, SHARE-LEAP: GA N°227822, SHARE M4: GA N°261982, DASISH: GA N°283646) and Horizon 2020 (SHARE-DEV3: GA N°676536, SHARE-COHESION: GA N°870628, SERISS: GA N°654221, SSHOC: GA N°823782, SHARE-COVID19: GA N°101015924) and by DG Employment, Social Affairs & Inclusion through VS 2015/0195, VS 2016/0135, VS 2018/0285, VS 2019/0332, and VS 2020/0313. Additional funding from the German Ministry of Education and Research, the Max Planck Society for the Advancement of Science, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064, HHSN271201300071C, RAG052527A) and from various national funding sources is gratefully acknowledged (see www.share-project.org).*

6. Wave 7 is based around two sub-surveys: the main questionnaire, submitted to all longitudinal participants in the survey, and the SHARELIFE retrospective questionnaire, which gathers data from participants regarding their life trajectories. Two types of participant were involved in this second questionnaire: new entrants in Wave 7 and former participants who did not participate in the previous version of this questionnaire in Wave 3. We exclude these two categories of respondents from the sample of interest because the main questionnaire they were asked to complete was adapted to limit the total duration of the survey and does not include information regarding out-of-pockets.

2018; Wagstaff, 2019). Based on the available information in SHARE, we calculate the expenditure to income ratio by comparing healthcare expenditure with total income and therefore use the 10% threshold to draw a conclusion as to the catastrophic nature of out-of-pockets. For each country, the expenditure to income ratio for each quartile is shown in the Appendix and discussed in Section 3.3.

It is worth noting that the use of declared out-of-pockets may induce some bias. More specifically, there may be a memory bias related to healthcare consumption, but the direction of this bias is not clear. On one hand, we can expect that individuals who consume a lot of healthcare may forget some costs. Knowing that healthcare consumption is positively correlated with income, it could be the case that the wealthiest people underestimate their out-of-pocket amounts. Ultimately, out-of-pockets may appear less concentrated among the wealthiest than they actually are and could therefore look less favourable to vertical equity than they should be. On the other hand, it could be assumed that less frequent consumers underestimate their out-of-pockets if they are less accustomed to monitoring their healthcare expenditures. In this case, out-of-pockets would seem more favourable to vertical equity than it should be. Since healthcare consumption is also correlated with health status, out-of-pockets may also be underestimated among the sickest (resp. least sick) if people with high (resp. low) out-of-pockets underestimate the amount. Thus, the distribution of out-of-pockets is artificially more (resp. less) horizontally equitable. In the end, it is impossible to establish the impact of memory bias on the estimation of out-of-pockets' contribution to equity in healthcare financing. Nevertheless, declared out-of-pockets from the SHARE survey are the best measure we can use for the purposes of this analysis. First, there is no administrative data source allowing to observe final out-of-pockets (i.e. after all coverage tools) for a representative sample of people aged 50 and over. Secondly, since the objective of this study is to compare the contribution of out-of-pockets to equity in healthcare financing across European healthcare systems, a harmonised measure of out-of-pockets across European countries is necessary.

3.2.2. Contributive Capacity

Data from the SHARE survey provide detailed information regarding different categories of household income (wages and other income). We use the household's standard of living, calculated by dividing the total annual household income (total of all sources of income reported by the household) by the number of consumption units. The number of consumption units is measured as follows: the first member of the household counts as 1 unit and all other members of the household count as 0.5 (Hourriez & Olier, 1998). Vertical equity analyses are performed using the percentiles of this continuous standard of living variable as a ranking variable. The mean standard of living and its distribution in quartiles are shown for the overall sample in Table 2 and are available for each country within the sample in Online Appendix S2 (see Tables S2-1 to S2-10 – link to the Online Appendix at the end of the article).

3.2.3. Health Status

In order to analyse horizontal equity in healthcare financing, a continuous health status variable is required in order to rank the population according to health status on a precise scale, in this case percentiles (Wagstaff & Van Doorslaer, 1994). We achieve this by constructing a continuous score by predicting the individual's perceived health status with various reported health status indicators and socio-demographic characteristics. Our selection of health indicators is based on health status measurement tools developed by The EuroQol Group (EuroQol Research Foundation, 2018). Their indicator, referred to as EQ-5D, includes several health-related dimensions: mobility, self-care, daily activities, pain/discomfort and anxiety/depression.

SHARE data provide information regarding limitations in daily activities, particularly in terms of mobility and self-care. More specifically, each respondent states whether or not she has difficulties with bathing, dressing, using the bathroom, transferring, maintaining continence and eating. This measure of limitations in daily activities therefore covers the first three dimensions used in EQ-5D. Respondents are also asked about whether or not they are experiencing pain. Mental health status is approximated using a standard European measure, the EURO-D, which is based on the responses to questions concerning depression, pessimism, suicidality, guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment, and tearfulness (Prince *et al.*, 1999). Lastly, we include a variable that counts the number of chronic illnesses diagnosed by a doctor, which is often used in the literature to approximate health status (Perronnin *et al.*, 2006; Devaux *et al.*, 2008; Pellet, 2020).

Perceived health is predicted by these health-related dimensions using a linear model,

estimated using the ordinary least squares method:

$$Y_{it} = \alpha + \beta_1 AVQ_{it} + \beta_2 MC_{it} + \beta_3 EUROD_{it} + \beta_4 Pain_{it} + \beta_5 X'_{it} + \partial_t + \varepsilon_{it}$$

where Y_{it} is the general health status reported by individual *i* during period *t* on a scale from 1 to 5, with 1 indicating a poor health status and 5 an excellent one; AVQ_{it} is a variable indicating the number of functional limitations in the activities mentioned above (0 to 6); MC_{it} is a variable indicating the number of chronic illnesses; $EUROD_{it}$ is a mental health variable with values from 0 to 12 (1 point for each affected mental health characteristic reported by the individual); $Pain_{it}$ is a binary variable that takes the value of 1 if the individual reports experiencing pain or 0 if not; X'_{it} is the vector of socio-demographic characteristics that are predictive of perceived health (i.e. age, gender); ∂_t is an effect specific to year *t* in which the individual is observed; ε_{it} is a normally distributed error term. Coefficients, standard errors and predicted averages for perceived general health by country are available in Online Appendix S1 (see Table S1-1).

3.3. Description of the Population

All countries included, the total population has more women (55%) than men. The average age of individuals is 67 years, 26% of the population is employed and the average annual income is 27,722 euros (Table 2). 35% of individuals are covered by supplementary private health insurance and 32% report a poor or acceptable health status, 38% report a good health status and 30% a very good or excellent one. The predicted health status score (see Section 3.2.3) is between 3 and 5 on average. Access to healthcare, i.e. consumption of a given type of care at least once during the year, is highest for doctor visits (89%), followed by dental care (57%) and then hospital stays (9%). The proportion of healthcare consumers who have null annual out-of-pockets, in other words, whose healthcare expenditure is covered in full by the public system and/or supplementary private insurance, is higher for hospital stays (66%) than for doctor visits (57%) and dental care (26%). On average, doctor visits generate the lowest out-of-pocket (83 euros). It is higher for hospital stays (138 euros) and dental care (376 euros).

In the sample as a whole and when each country is taken separately, individuals in the first income quartiles are older, are less likely to be employed, are in worse health. Those income groups also contain more women than other quartiles (see Online Appendix S2, Tables S2-1 to S2-10 for the detailed breakdown by country). The poorest people are less likely to be covered by supplementary health insurance than the wealthiest and income-based differences are particularly high in Austria, Belgium, Denmark and Germany, where coverage rates for people falling into the first income quartile are at least 20 percentage points lower than for those in the last quartile. In addition, coverage rate varies widely from one country to the other and between healthcare system types. France, Belgium and Switzerland, which have insurance-based systems, have the highest coverage rates of the sample with 96%, 81% and 77% of individuals having a supplementary health insurance, respectively. Conversely, in countries with a universal healthcare system, supplementary insurance is not as necessary for covering healthcare expenditure and rates are broadly lower, with 5% of the population covered in Italy, 10% in Spain and 16% in Sweden.

At least 85% of individuals have visited a doctor at least once in the last 12 months. Among healthcare consumers, the poorest are more likely to report a null out-of-pocket than the wealthiest, with the exception of Denmark, where the proportion of individuals reporting an out-of-pocket is 95% across all income quartiles. The average out-of-pocket amount among healthcare consumers decreases with income, except in Sweden and Czechia, where individuals falling into the first and last quartiles report a higher annual out-of-pocket than those in the middle quartiles. However, out-of-pockets represent a greater financial burden for the poorest individuals since the out-of-pocket to income ratio decreases with income, with the exception of the two countries with a Beveridge-type universal system: Denmark and Spain (see Appendix, Figures A-I to A-III). In all countries, no income group reaches the 10% threshold that determines whether an out-of-pocket is considered as a catastrophic amount. The out-of-pocket to income ratio for doctor visits represents a maximum of 2% of income for all income groups.

In all countries, dental care use increases with income, even though the population with the lowest income is older and in poorer health. Dental care therefore appears to be particularly prone to barriers to healthcare access. The proportion of individuals reporting full coverage of expenses for dental care is 26% on average across the sample, but this proportion varies widely between countries. In Denmark, Italy, Sweden and Switzerland, it is below 10%,

Table 2 – **Descriptive statistics**

	1st quartile	2nd quartile	3rd quartile	4th quartile	Total
Individual characteristics					
Women	0.59	0.55	0.53	0.52	0.55
Age	69.57	68.72	66.30	64.71	67.36
Workers	0.14	0.18	0.30	0.41	0.26
Income per consumption unit (in €)	9,678	15,770	21,895	64,641	27,722
Supplementary health insurance	0.28	0.33	0.37	0.42	0.35
Health status					
Poor	0.12	0.09	0.06	0.05	0.08
Moderate	0.31	0.27	0.22	0.18	0.24
Good	0.36	0.39	0.40	0.38	0.38
Very good	0.15	0.18	0.23	0.27	0.20
Excellent	0.06	0.07	0.10	0.13	0.10
Predicted score	2.83	2.95	3.07	3.16	3.00
Healthcare use					
Doctor visits	0.89	0.90	0.89	0.88	0.89
Dental care	0.46	0.55	0.61	0.65	0.57
Hospital stays	0.10	0.10	0.08	0.07	0.09
Null out-of-pocket					
Doctor visits	0.65	0.62	0.60	0.59	0.61
Dental care	0.67	0.59	0.54	0.51	0.58
Hospital stays	0.97	0.97	0.97	0.98	0.97
Null out-of-pocket if healthcare is used					
Doctor visits	0.61	0.58	0.55	0.53	0.57
Dental care	0.29	0.26	0.24	0.25	0.26
Hospital stays	0.69	0.64	0.65	0.66	0.66
Average annual out-of-pocket (in €)					
Doctor visits	56.76	69.11	79.69	90.24	73.74
Dental care	147.13	186.07	251.87	269.89	212.83
Hospital stays	14.53	8.63	9.10	10.02	10.59
Average annual out-of-pocket if healthcare is used (in €)					
Doctor visits	63.93	76.76	89.65	102.98	83.00
Dental care	320.24	338.74	414.68	414.58	376.33
Hospital stays	165.24	101.99	138.36	150.66	138.46
Number of observations	22,765	22,607	21,818	21,889	89,079

Notes: The average value of each variable for the first (second, third, fourth) income quartile is reported in column 1, (2, 3, 4). The predicted health score ranges between 1 and 5.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over, all countries.

while it reaches 64% in France. The expenditure to income ratio for dental care decreases with income in all countries. In Italy and Spain, out-of-pockets for dental care represent 12% and 13% of the income of individuals in the first quartile, respectively, which means that dental care out-ok-pocket meets the catastrophic threshold for the poorest individuals

In universal healthcare systems, such as those found in Denmark, Italy and Spain, the proportion of full coverage among individuals who stayed at the hospital during the year is close to 100%. However, the Swedish system, which is based on the same model, presents the lowest proportion of null out-of-pockets (23%). The link between annual out-of-pocket amounts and income is less homogeneous between countries for hospital stays than for dental care or doctor visits. In Belgium, Denmark and Germany, the average out-of-pocket decreases in line with income, whereas it increases in France, Spain and Switzerland. In the remaining countries, the average out-of-pocket is higher in the first and last quartiles. The threshold for catastrophic out-of-pockets is not reached for hospital expenditure.

4. Results

4.1. Vertical Equity in Healthcare Financing

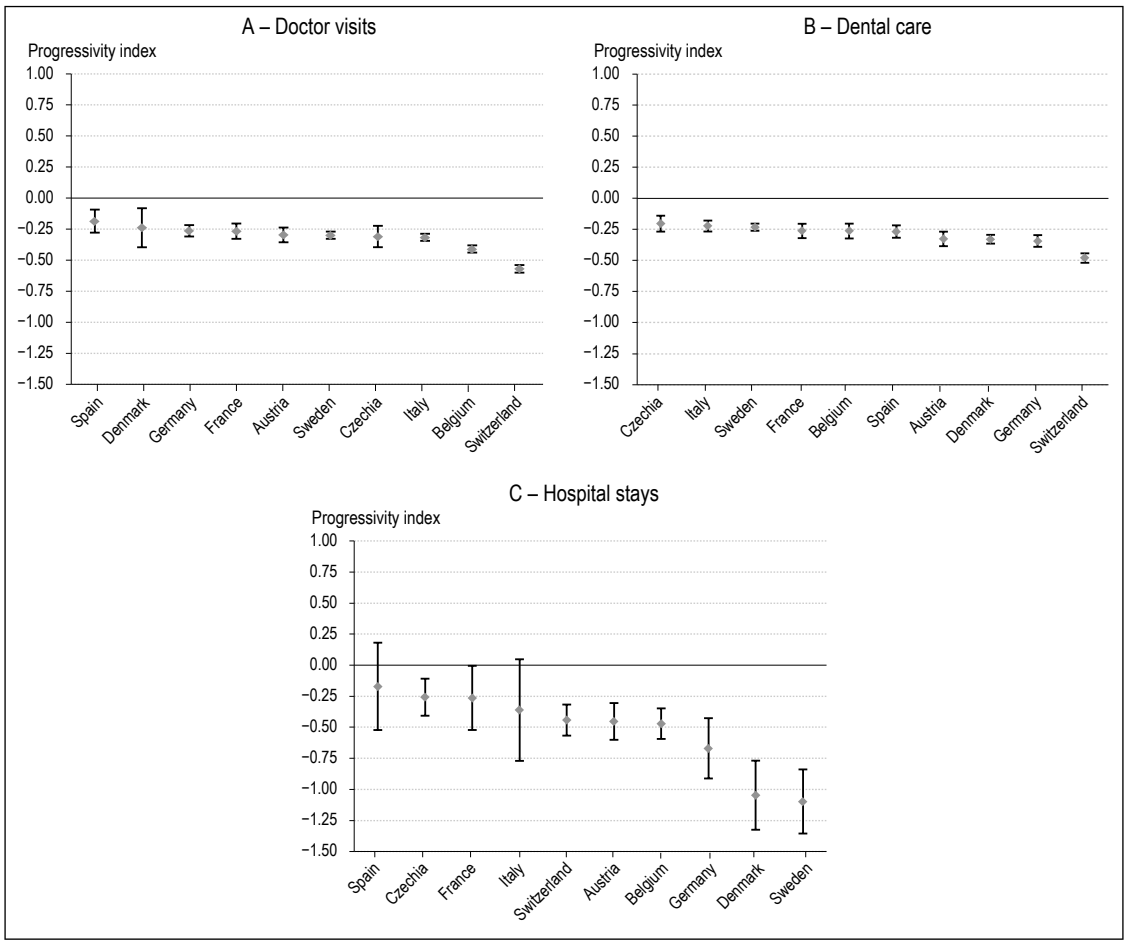
Results regarding the vertical equity analysis are summarised in Figure IV. Concentration curves

are presented in the Appendix (see Figures A-IV to A-VI). For each country, the progressivity index is represented along with 95% confidence intervals. Figure IV-a (or IV-B, IV-C) shows the progressivity index of the out-of-pocket for doctor visits (or dental care, or hospital stays). The concentration index for out-of-pockets for each healthcare type, the Gini index and the progressivity index are available in Online Appendix S3 (see Table S3-1). We comment our findings from the point of view of access to healthcare. Concentration indices for healthcare use with standardisation on the need for healthcare can also be found in Online Appendix S3 (see Table S3-2).

4.1.1. Doctor Visits

In Czechia, Sweden and Denmark, the concentration curve for doctor visits' out-of-pockets does not deviate significantly from the diagonal. Concentration indices are not far from 0 at the 5% level, which means that out-of-pockets do not change with income. Concentration indices for the other countries are positive and deviate significantly from 0, at least at the 5% level. Conversely, the concentration curve crosses the diagonal in Austria, Spain and Switzerland which compromises the interpretation of concentration indices. Only Belgium, France, Germany and Italy have concentration curves that sit significantly below the diagonal without crossing it, demonstrating that out-of-pockets are more concentrated among the wealthiest, particularly in France and Germany (concentration index >0.2). However, although out-of-pockets are more concentrated among the wealthiest individuals in some countries, this does not confirm vertical equity in financing since the progressivity index for out-of-pockets for doctor visits is negative and significant in all countries, which suggests a regressive structure of out-of-pockets. In other words, although out-of-pockets are more concentrated among the wealthiest people, they represent a greater burden among the poorest. Figure IV-A shows that Switzerland, where healthcare financing is more largely based on private sources, is the country in which out-of-pockets are the most regressive (progressivity index <−0.5), while the lowest levels of regressivity are observed in Spain (−0.2 <progressivity index<0) and Denmark (−0.3 <progressivity index <−0.2),

Figure IV – **Vertical equity in healthcare financing**



where healthcare systems are based on a universal model. The level of regressivity of out-of-pockets also appears to be underestimated, as the wealthiest individuals are greater consumers of healthcare than the poorest among those in need of a particular type of healthcare across all countries, with the exception of Denmark, Germany and Spain.

4.1.2. Dental Care

Regarding dental care, the concentration index for out-of-pockets is positive in all countries (at the 1% level), which indicates greater concentration of out-of-pockets among those with the highest incomes. From a graphical point of view, the concentration curve for out-of-pockets is below the diagonal, except in Austria, Switzerland and Belgium, where the concentration curve crosses it. As is the case for doctor visits, concentration of out-of-pockets among the wealthiest people is no guarantee of vertical equity in the healthcare financing since dental out-of-pockets are regressive. In all countries, the progressivity index is negative and deviates significantly from 0, revealing that out-of-pockets do not increase in proportion to income. Out-of-pockets for dental care therefore contribute to the inequity in healthcare financing, particularly in Switzerland (progressivity index = 0.488). The regressivity of dental care out-of-pockets also appears to be underestimated, since concentration indices for standardised healthcare use are positive and even more so than for doctor visits. With equal need for healthcare, the use of healthcare is more concentrated among the wealthiest people, particularly in Italy and Spain (concentration index >0.1). Dental out-of-pockets would therefore represent a heavier burden on the budgets of the poorest if they were to consume as much care as their health status demands.

4.1.3. Hospital Stays

In all countries, the concentration index for hospital out-of-pockets does not deviate significantly from 0 (95% confidence interval). This finding suggests that out-of-pockets for hospital stays are equally distributed along the income distribution, which means that the annual amount of out-of-pocket is independent of income. However, this does not show vertical equity in financing, since this not only requires that the amount of the out-of-pocket increases with income, but also that the share of income allocated to out-of-pockets increases with ability to pay. Figure IV-C shows that, with the exception of Spain and Italy, out-of-pockets for hospital stays are regressive, since the progressivity index is significantly negative (at the 5% level). It is the most regressive in Sweden and Denmark (progressivity index <−1) and the least regressive in Czechia and France (−0.3 <progressivity index <0). The regressive structure of out-of-pockets once again appears to be underestimated in view of the higher concentration of use for a given level of healthcare need among the wealthiest people in Austria (at the 1% level), but appears to be overestimated in Sweden (at the 1% level) and in Germany (at the 5% level) where use is more concentrated among the poorest for a given need.

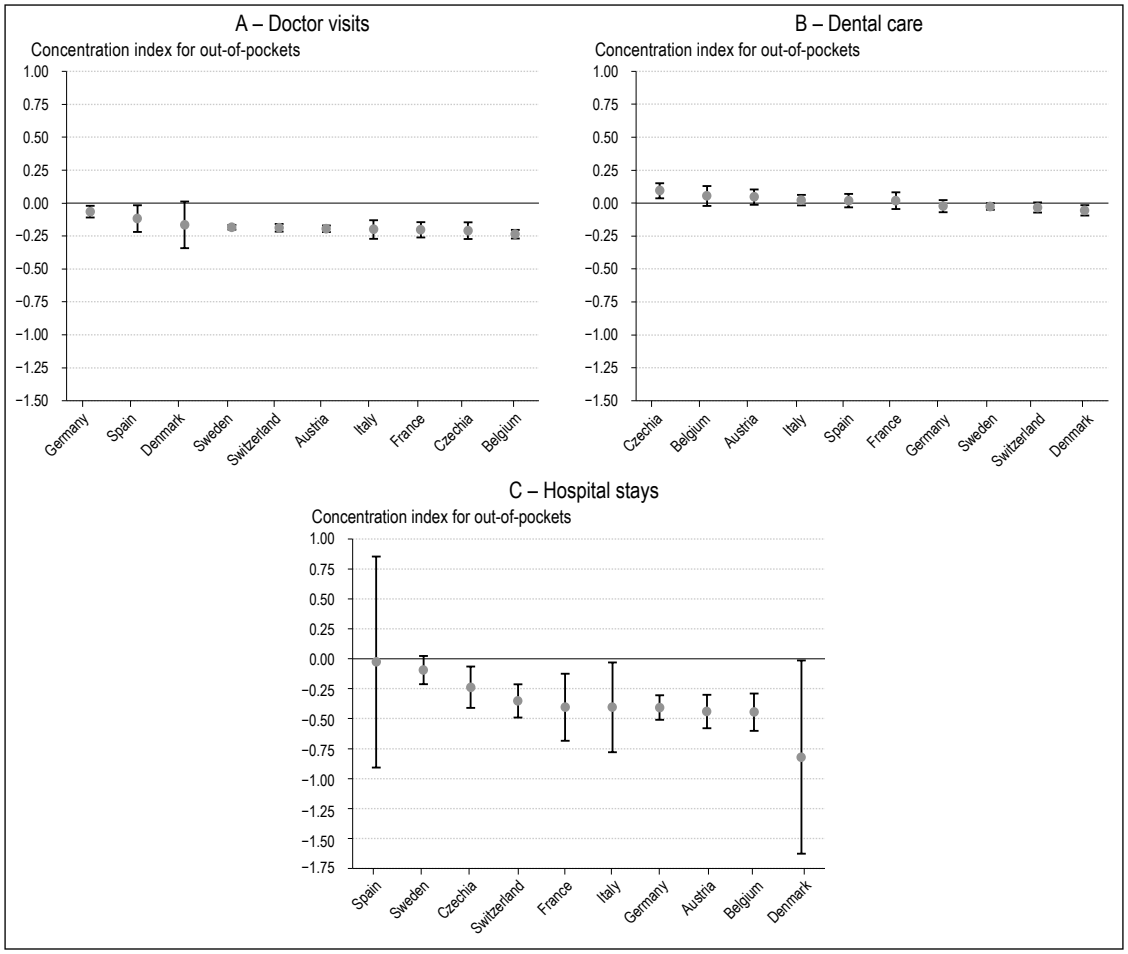
4.2. Horizontal Equity in Healthcare Financing

Results regarding the horizontal equity analysis are summarised in Figure V. For each country, concentration indices for out-of-pockets according to health status with standardisation on income are shown along with 95% confidence intervals. Figure V-A (or V-B, or V-C) shows concentration indices of doctor visits' out-of-pockets (or dental care, or hospital stays). Standardised concentration indices for each healthcare type can be found in Online Appendix S3 (see Table S3-3). The corresponding concentration curves are presented in the Appendix (see Figures A-VII to A-IX).

4.2.1. Doctor Visits

For a given income, the concentration index for doctor visits out-of-pockets according to health status is negative and deviates significantly from 0 at the 5% level in all countries except Denmark (1% level). From a graphical point of view, we observe that the concentration curve of the out-of-pocket crosses the diagonal in Germany and Denmark, giving non-interpretable results for these countries. For the remaining countries, a negative concentration index means that out-of-pockets for doctor visits are more concentrated among the sickest and therefore contribute negatively to horizontal equity in healthcare financing. This finding suggests that the sickest are offered inadequate financial healthcare coverage. Indeed, inequity is the most pronounced in Bismarck-type insurance-based systems, such as Austria, France, Czechia and Belgium where the concentration index is below −0.2, in spite of the existence of exemption schemes or a disease-based cap. In Spain, Sweden and Italy, where healthcare systems are based on a Beveridge-type universal model, inequity is less prevalent (−0.2< concentration index <−0.1). It is also the case as in Switzerland where the healthcare system is predominately based on private insurance.

Figure V – **Horizontal equity in healthcare financing**



4.2.2. Dental Care

Concerning dental care, out-of-pockets are more concentrated among the sickest in Denmark (at the 5% level), Sweden (at the 5% level) and Switzerland (at the 10% level), while they are more concentrated among the healthiest in Czechia (at the 5% level) for a given income. However, concentration indices can only be interpreted in Denmark and Czechia as they are the only countries in which the concentration curve does not cross the diagonal. In Denmark, the sickest patients are more heavily exposed to the financial burden associated with their dental care. In the case of Czechia, the concentration of out-of-pockets among the healthiest for a given income could suggest redistribution from the healthiest to the sickest by the system. However, we cannot ignore the existence of other potential channels, such as prioritisation of other healthcare types by the sickest patients to the detriment of dental care with a given budget, or lower use of preventative dental care among the sickest because of the positive correlation between health status and preventative behaviours.

4.2.3. Hospital Stays

Out-of-pockets for hospital stays are more concentrated among the sickest (at least at the 5% level) in all countries, with the exception of Spain and Sweden, where the concentration index for out-of-pockets does not deviate significantly from 0. In the case of hospital stays, the concentration index has higher values than for other healthcare types, which indicates greater horizontal inequity. This difference can be explained by the fact that hospital stays are more likely to involve individuals in poor health than other types of healthcare, since they are essentially curative, while consultations with doctors and dental care may have a prevention component. For that reason, hospital out-of-pockets contribute more heavily to horizontal inequity in healthcare financing. As for dental care, inequity is the most pronounced in Denmark (concentration index <-0.8) and the least pronounced in Czechia ($-0.4 <$ concentration index <-0.3).

5. Discussion

For individuals aged 50 and over, out-of-pockets for doctor visits have a regressive structure,

suggesting that expenditure coming out of patients' pockets does not increase in proportion with income. This means that, although out-of-pockets are more heavily concentrated among the wealthiest people, doctor visits expenditure to income ratio remains higher for the poorest, which means that out-of-pockets contribute negatively to vertical equity in healthcare financing. The regressivity of out-of-pockets is the least pronounced in Spain and Denmark, where doctor visits are included in the basket of universal healthcare. It is more pronounced in Sweden, where cost-sharing is implemented for this type of healthcare without any exemptions based on financial resources, and in Italy, where coverage from supplementary insurance is very poor. Switzerland, where healthcare financing relies heavily on private sources and in the absence of exemptions subject to financial resources, is the country in which out-of-pockets contribute the most to vertical inequity in healthcare financing. Out-of-pockets for dental care are also regressive in all countries, especially in Switzerland. Czechia is the only country considered in this study that does not implement co-payment for basic dental care, which could explain why out-of-pockets take on a less regressive structure there than in other countries. However, it is important to note that the use of dental care is more concentrated among the wealthiest individuals for a given healthcare need. This finding implies that the regressivity observed for out-of-pockets is underestimated, i.e. that out-of-pockets for dental care should represent a larger proportion of the poorest individuals' income if they consume as much dental care as their health status needs it. Regarding hospital stays, out-of-pockets contribute negatively to vertical equity in healthcare financing in all countries except from Spain and Italy. Despite their universal system, Sweden and Denmark have a highly regressive out-of-pocket structure. This finding is consistent with a "two-speed" system created by excessive waiting lists in public hospitals and a growing privatisation of the system without exemptions based on financial resources (Chambaretaud & Lequet-Slama, 2003). In Sweden, the safety net provided for old age individuals at the hospital does not allow to meet vertical equity since the cap is not based on income.

For a given income, out-of-pockets for doctor visits and for hospital stays are more concentrated among the sickest in almost all countries, with some exceptions, which casts doubt on the existence of horizontal equity in healthcare financing. In Spain and Sweden, out-of-pockets for hospital stays is not more concentrated among the sickest, which could suggest that their healthcare systems cover healthcare costs of the sickest to ensure that they are not financially responsible for their poor health status (e.g. health shield for hospital out-of-pockets for patients aged over 85). The same is true for doctor visits in Denmark, where the distribution of out-of-pockets standardised on income does not differ from perfect equality. In the other countries, tools such as out-of-pockets exemption for the sickest could be considered or improved in order to reduce horizontal inequity in healthcare financing. In the case of dental care, out-of-pockets are more concentrated among the sickest in Denmark. In Czechia, they are more concentrated among healthier people for a given income, suggesting a potential redistribution of healthcare financing from the healthiest to the sickest individuals. However, it is important to consider other potential factors such as greater avoidance of dental care among individuals in poor health who already have an important expenditure to income ratio for other healthcare types, or a lower dental care use among the sickest patients due to the positive correlation between health status and prevention behaviours.

This study has some limitations. First, the use of self-declare out-of-pockets could induce a source of bias for the vertical equity analysis if out-of-pockets are systematically misreported for some individuals (e.g. those who make very little use of healthcare or, on the opposite, heavy healthcare consumers). Nevertheless, the data allows us to observe final out-of-pockets in a harmonized way, between European countries, unlike administrative data. Next, horizontal equity in healthcare financing could incorrectly give the impression of being respected if people in good (or poor) health over-use (or under-use) healthcare due to the positive correlation between health status and preference for health. In this case, out-of-pockets could even be more concentrated among healthier people. In the same way as the existence of barriers to healthcare access among the poorest individuals tends to result in the overestimation of vertical equity healthcare financing, failure to observe preferences for health would result in overestimating horizontal equity. Lastly, the sickest individuals might be less well represented in the sample if they are not in a position to respond (e.g. in hospital or an institution, etc.). As a result, individuals in better health, whose annual out-of-pocket amount is expected lower, are over-represented in the sample. This selection limits the external validity of our findings, since

equity measures are performed on a population in better health than the overall population of individuals aged 50 and over.

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This study's findings suggest that vertical equity in financing is less respected in insurance-based healthcare systems compared to universal-type systems despite the existence of redistributive tools. In universal systems, vertical equity in financing appears to be fulfilled for outpatient care but less for hospital stays, which illustrates the need for these systems to adapt to their gradual privatisation by offering exemption schemes for the poorest individuals. Regarding horizontal inequity in healthcare financing, universal systems appear to perform better for doctor visits and hospital stays. However, this is not systematically the case for dental care, which suggests that additional efforts should be concentrated on this type of care, which is usually poorly covered, in the ten European systems that we analysed. □

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/8186100/ES542_Jusot-Lemoine_OnlineAppendix.pdf

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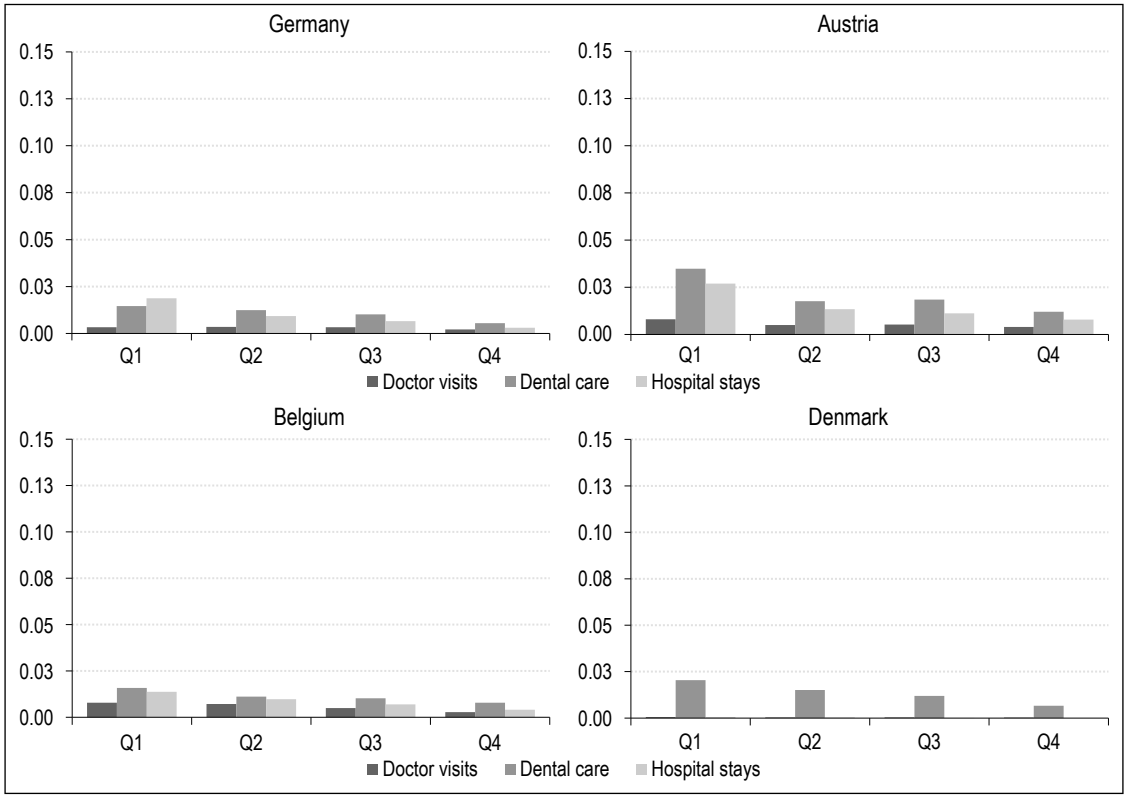
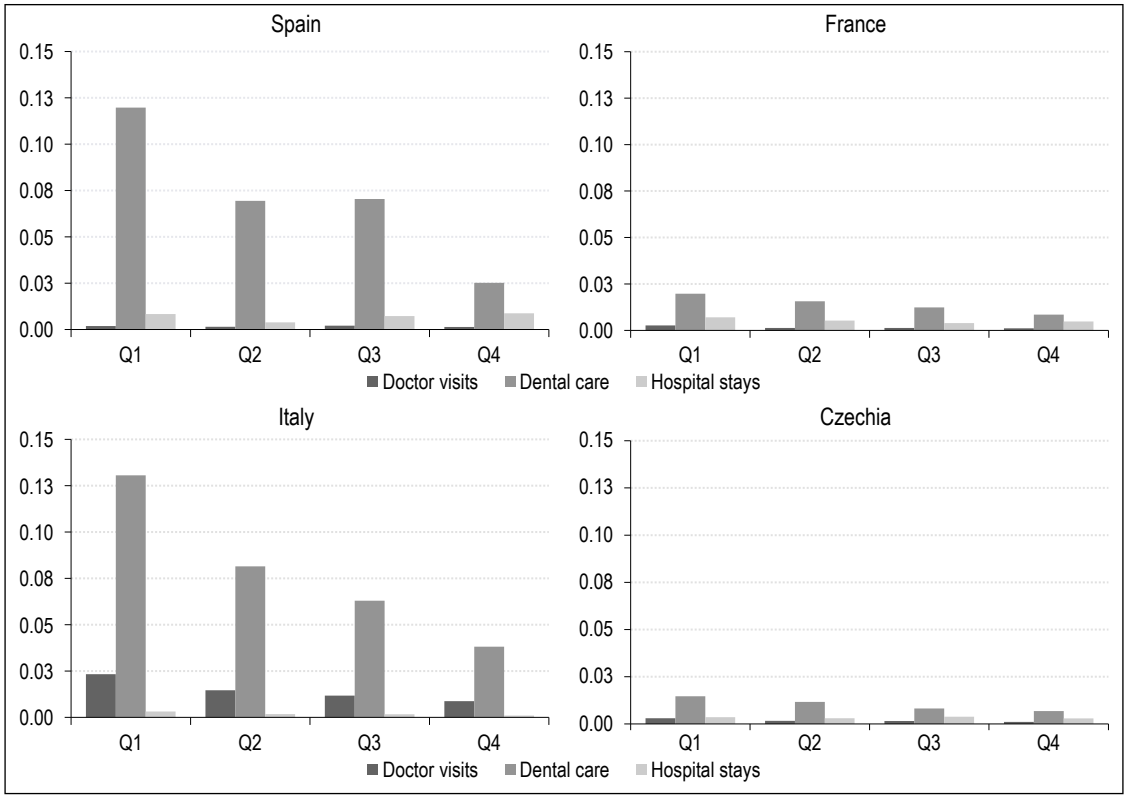
APPENDIX

Figure A-I – **Out-of-pockets to income ratio by income quartile – Germany, Austria, Belgium and Denmark**



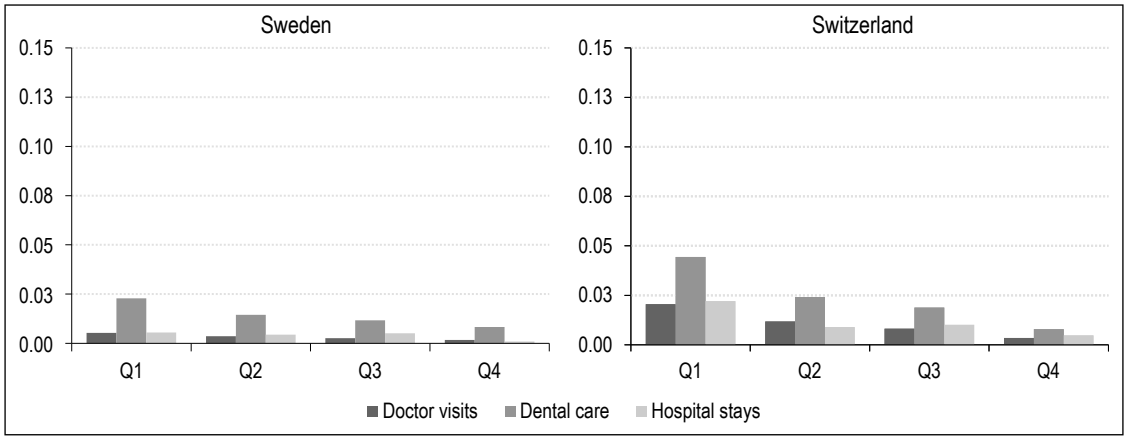
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-II – **Out-of-pockets to income ratio by income quartile – Spain, France, Italy, Czechia**



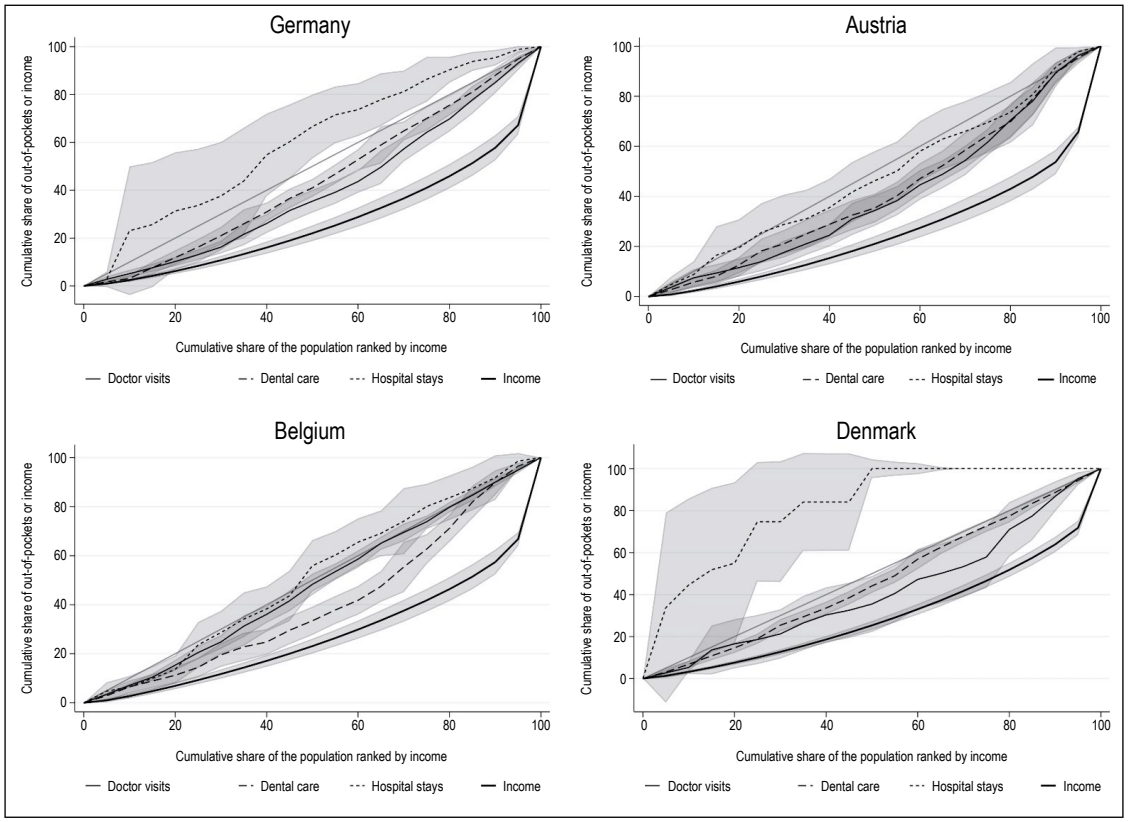
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-III – **Out-of-pockets to income ratio by income quartile – Sweden and Switzerland**



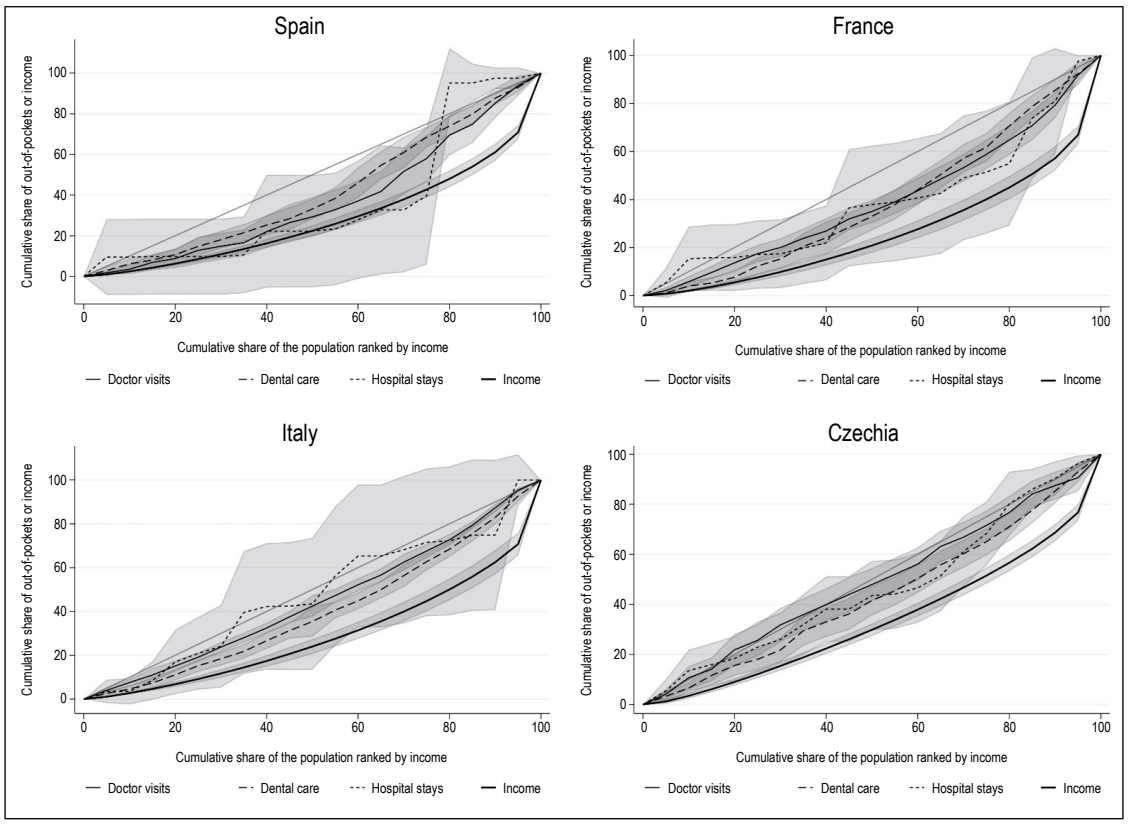
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-IV – **Concentration curves for out-of-pockets and Lorenz curve within the population ranked by income – Germany, Austria, Belgium and Denmark**



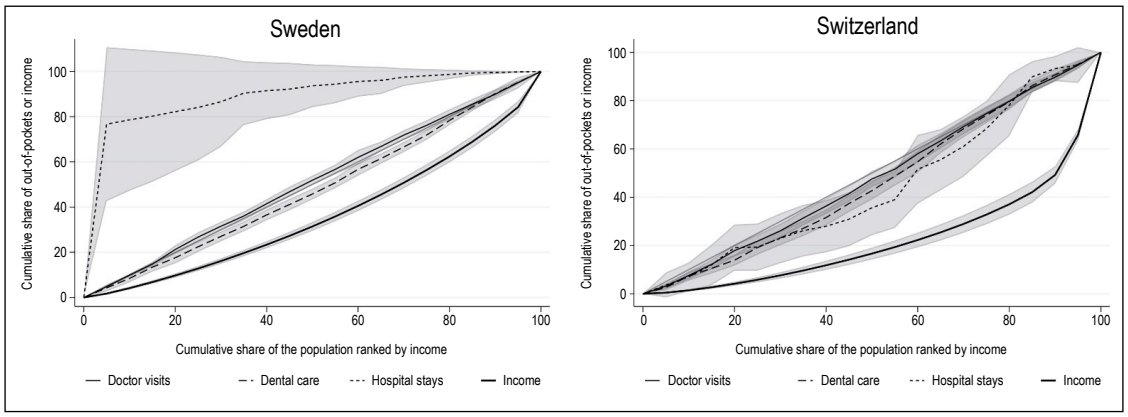
Notes: For each healthcare type, the concentration curve represents the cumulative share of out-of-pockets for each percentile of the population ranked by income from the lowest to the highest. The grey areas represent confidence intervals at 95%.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-V – **Concentration curves for out-of-pockets and Lorenz curve within the population ranked by income (Spain, France, Italy and Czechia)**



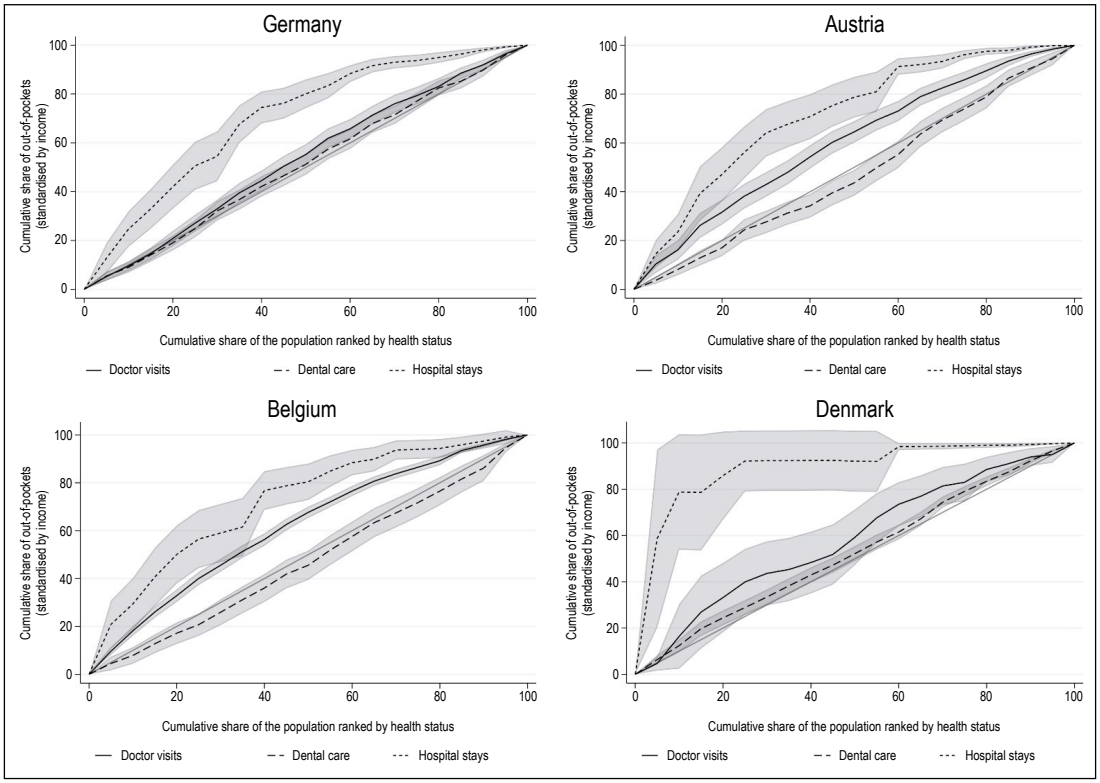
Notes: For each healthcare type, the concentration curve represents the cumulative share of out-of-pockets for each percentile of the population ranked by income from the lowest to the highest. The grey areas represent confidence intervals at 95%.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-VI – **Concentration curves for out-of-pockets and Lorenz curve within the population ranked by income – Sweden and Switzerland**



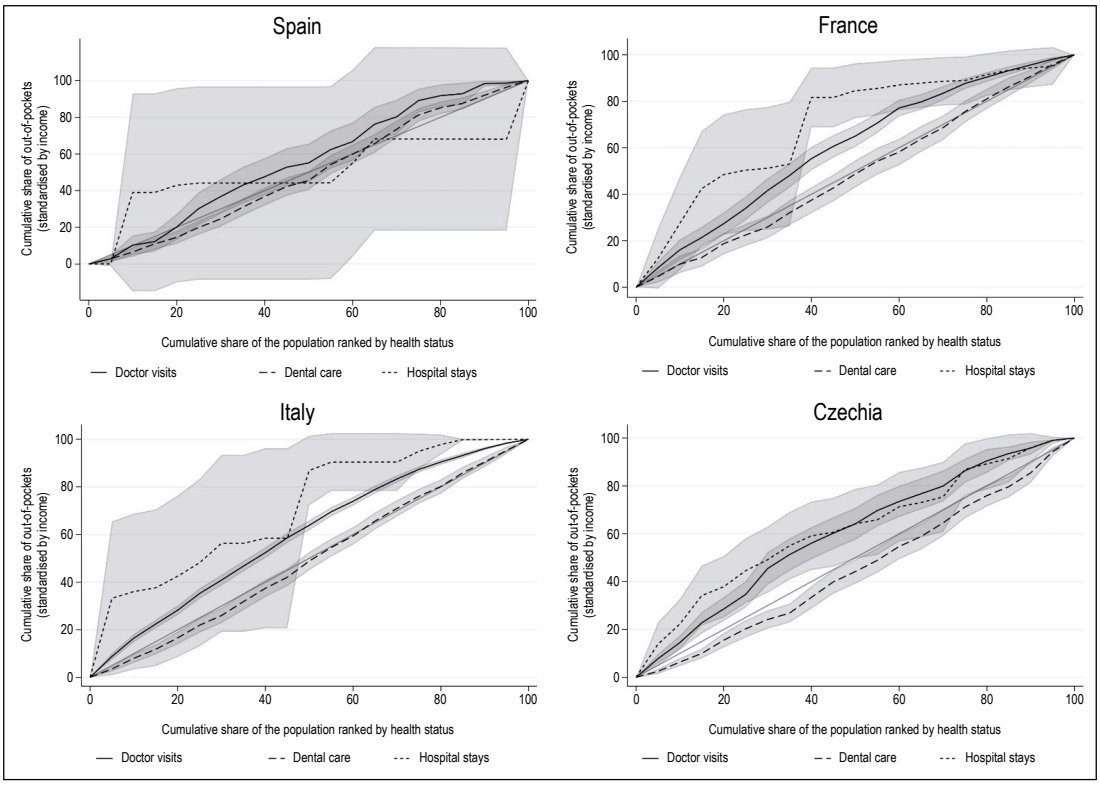
Notes: For each healthcare type, the concentration curve represents the cumulative share of out-of-pockets for each percentile of the population ranked by income from the lowest to the highest. The grey areas represent confidence intervals at 95%.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-VII – **Concentration curves for out-of-pockets within the population ranked by health status for a given income – Germany, Austria, Belgium and Denmark**



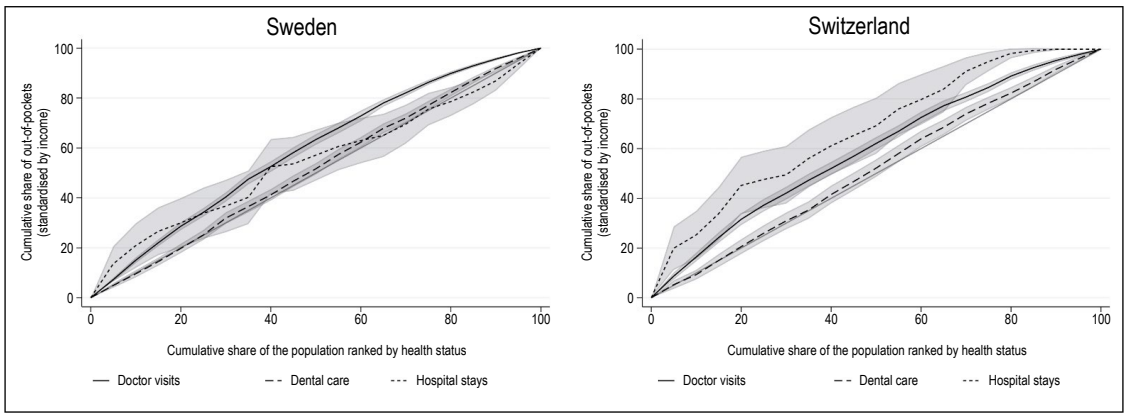
Notes: For each healthcare type, the concentration curve represents the cumulative share of out-of-pockets for each percentile of the population ranked by health status from the poorest to the best. The grey areas represent confidence intervals at 95%.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-VIII – **Concentration curves for out-of-pockets within the population ranked by health status for a given income – Spain, France, Italy and Czechia**



Notes: For each healthcare type, the concentration curve represents the cumulative share of out-of-pockets for each percentile of the population ranked by health status from the poorest to the best. The grey areas represent confidence intervals at 95%.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

Figure A-IX – **Concentration curves for out-of-pockets within the population ranked by health status for a given income – Sweden and Switzerland**



Notes: For each healthcare type, the concentration curve represents the cumulative share of out-of-pockets for each percentile of the population ranked by health status from the poorest to the best. The grey areas represent confidence intervals at 95%.
Source and sample: *Survey of Health, Ageing and Retirement in Europe*, 2013-2017, individuals aged 50 and over.

The Impact of a Social Programme on the Healthcare Consumption of Elderly Self-Employed Workers in France

Estelle Augé* and Nicolas Sirven**

Abstract – The aim of the *Programme d'Actions pour une Retraite Indépendante* (PARI), launched in 2015 by the *Régime Social des Indépendants* (Social security scheme for self-employed workers – RSI), is to propose a threefold, global, proactive and targeted approach to promote the use of various social assistance by craftsmen and merchants aged 60 to 79 with a view to preventing loss of autonomy. The central assumption is that the elasticity of demand for medical goods and services is sensitive to social assistance. The aim of this work is to assess the causal impact of the PARI programme on the healthcare consumption of elderly self-employed workers using a difference-in-differences method. The identification of the effect is based on the implementation of the PARI programme in volunteers' regions. The results indicate that the programme reduces one-off healthcare behaviours in favour of a more regular relationship with the healthcare system.

JEL: I12, I18, I14
Keywords: demand for healthcare, social assistance, difference-in-differences

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The law relating to the adaptation of society to ageing (*loi relative à l'adaptation de la société au vieillissement* – ASV) of 1 January 2016 aims to respond to the challenges of demographic change in France by mobilising all public policies: transport, urban development, housing and, of course, social protection. The actions undertaken in this framework are based on two main pillars: support for loss of autonomy, which in particular has led to a reform of the *Allocation personnalisée d'autonomie* (Personal autonomy allowance – APA) for home care (Bozio *et al.*, 2016) and the change in rates for EHPADs[1] (Xing-Bongioanni, 2021); and upstream prevention of loss of autonomy which has contributed to the development of numerous programmes aimed at vulnerable people carried out by the various social protection schemes. By way of example, the *Programme d'Actions pour une Retraite Indépendante* (PARI), started by the *Régime Social des Indépendants* (Social security scheme for self-employed workers – RSI) in 2015 among craftsmen and merchants aged 60 to 79, is a model.[2] What are the specific needs of this subpopulation and how does this programme aim to meet them?

Self-employed workers are generally in better health (Sewdas *et al.,* 2018; Algava *et al.*, 2013; Stephan & Roesler, 2010). The health demand model (Grossman, 1972) predicts in this case that greater prevention efforts are made because the time required for prevention activities (when in good health) is higher. However, since self-employment requires more working hours than salaried work (Hyytinen & Ruuskanen, 2007), working time eats into time dedicated to prevention. Nonetheless, self-employment is more stressful (Lewin-Epstein & Yuchtman-Yaar, 1991), causes emotional fatigue (Jamal, 2007) and leads to specific health problems (Park *et al.*, 2019). Self-employment leads to a greater depreciation of health capital, especially among craftsmen and merchants (Crasset, 2022).

In the classic framework of the Karasek model (1979), self-employment is "active employment" (Nikolova, 2019; Hessels *et al.*, 2017; Stephan & Roesler, 2010) that contrasts very demanding working conditions with a high degree of control, given its inherent autonomy, flexibility and use of a variety of skills (Hundley, 2001). Karasek's model of work stress (1979) analyses the relationship between demand (psychological pressure) and control (autonomy to carry out tasks and the opportunity to develop new skills). An imbalance between demand and control leads to four specific situations: low demand and low control (passive employment), high demand and high control (active employment), low demand and high control (low stress job), and low control and high demand (high stress job). A stressful work situation places individuals at risk of health problems (Askenazy *et al.*, 2011; Kuper & Marmot, 2003), while "active employment" has positive effects on health (Tsutsumi *et al.*, 2006; Amick *et al.*, 2002; Rosvall *et al.*, 2002). The faster depreciation of health capital invalidates the assumption that "active employment" has health benefits in favour of an alternative assumption. Herber *et al.* (2020) and Rietveld *et al.* (2015) therefore show that the better health of self-employed workers is the result of a selection effect, i.e. these workers have a better initial health condition when they become self-employed.

Contrary to the predictions of the health demand model, we do not observe an instantaneous increase in the demand for healthcare: studies show that, with the same healthcare need, self-employed workers consume less healthcare than other socio-professional categories (Gruber & Kiesel, 2010; Riphahn *et al.*, 2003), especially during their working lives (Pfeifer, 2013) with a catch-up effect at the time of retirement (Augé & Sirven, 2021; Lucifora & Vigani, 2018; Bíró, 2016; Boaz & Muller, 1989). The assumption is that the higher workload of self-employed people also affects the time they dedicate to healthcare (for an adaptation of the Grossman model in this context, see Galama & Kapteyn, 2011).[3] The catch-up effect that seems to characterise elderly self-employed people is problematic on two levels. First, massive and sudden healthcare consumption in retirement may not have the same impact on health as regular use of health services. Second, the catch-up approach

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1. Établissements d'hébergement pour personnes âgées dépendantes *(Residential establishments for dependent elderly people – EHPADs) are nursing homes with private bedrooms. EHPADs are generally aimed at elderly people who need healthcare and assistance on a daily basis.*

2. The Prix de l'Innovation et du Développement Durable *(Innovation and Sustainable Development Prize), which is now known as the* Grand prix de l'innovation *(Grand Prize for Innovation), is awarded by the* Union des caisses nationales de Sécurité sociale *(Union of National Social Security Funds – UCANSS) every year. In 2017, the PARI programme shared first place in the "Innovation to optimise public performance" category with the* Caisse nationale de l'Assurance Maladie *(National Health Insurance Scheme), which was recognised for setting up regional observatories for vulnerability.*

3. Galama & Kapteyn (2011) propose an adaptation of the Grossman model which makes it possible to understand the health behaviours of self-employed workers in two periods. Self-employed workers consume less healthcare during the first years of their working lives thanks to their better initial health condition, which reflects the non-instantaneous adjustment of health capital to its optimal value. Once a minimum health threshold is reached, their healthcare consumption increases with age due to the accelerating depreciation of health capital and the increasing opportunity cost of working time. In France, the work of Augé & Sirven (2021) showed that at the end of their careers, in particular at the time of retirement, self-employed workers increase their healthcare consumption and catch up with employees.

leads self-employed workers to seek acute, one-off healthcare, which is far removed from early detection and prevention.

This public health issue raises questions among economists regarding incentives that could be implemented to modify the health behaviours of self-employed workers upon retirement, particularly with regard to more regular use of health services. The PARI programme takes an ambitious approach based on facilitating access to a comprehensive range of social assistance, whether legal (under the national solidarity scheme) or extra-legal (i.e. specific to the RSI), for vulnerable elderly people benefiting from the RSI. The central assumption is that the elasticity of demand for medical goods and services is sensitive to social assistance. First, improving supplementary coverage – by means of the *Aide pour une complémentaire santé* (Assistance for supplementary health insurance – ACS) and *Couverture maladie universelle complémentaire* (Supplementary universal health coverage – CMU-C) (which merged to become the *Complémentaire santé solidaire*, CSS, in 2019) – generates a price effect such that the demand for health increases (Jusot *et al.*, 2019; Jess, 2015) in a health system where the absence of health coverage exposes individuals to high financial risks (Geoffard, 2016). This effect could be even more significant at the time of retirement when health insurance policies are often renegotiated. Second, social grants such as the *Revenu de solidarité active* (Active solidarity income – RSA), financial assistance and housing benefits generate an income effect favouring the demand for superior goods, such as health. In addition to the quantity effect, the income effect can also improve the relevance of healthcare and modify the structure of healthcare consumption for a better healthcare pathway. For example, Rapp *et al.* (2015) show that social assistance, such as the APA, reduces the use of emergency services in France, and Costa-Font *et al.* (2018) make the same observation in the Spanish context.

In order to improve the effectiveness of the PARI programme, the RSI devised a threefold approach, which is global, proactive, and targets people at risk. Targeting means limiting the self-selection effect, which results in an over-representation of healthy individuals in prevention programmes (Buchmueller, 2009), and only offering the intervention to a sample of people who are exposed to known, previously defined risks. Therefore, it is possible for the RSI to contact those targeted directly, without waiting for them to approach the scheme themselves. This is a proactive approach, which aims to maximise the use of social assistance by those potentially in greatest need, by reducing the cost associated with the complex administrative procedures that must be followed in order to find and apply for the different social benefits available. Even if craftsmen and merchants are protected by the RSI, their recourse to different social benefits may be limited for various reasons: *(i)* a lack of information, particularly regarding eligibility; *(ii)* the benefits of the assistance don't outweigh the cost to the beneficiary (stigma, transaction costs – including opportunity cost mainly present among self-employed workers (Janssen, 1992; Boaz & Muller, 1989)); and *(iii)* preferences (specifically among self-employed workers, see Ekelund *et al.*, 2005) and psychological barriers such as procrastination and psychological aversion to administrative procedures. Finally, the PARI programme takes a global approach (Lautman, 2013) based on a personalised offer of all existing (legal and extra-legal) benefits, which is made possible through the coordination of a multitude of health and social care stakeholders within the RSI and the region. This method of coordination, which is made possible by different social protection schemes working together, is a major challenge for the efficiency of health systems in developed countries like France (Fraser *et al.*, 2018; Nolte & Pichforth, 2014). The literature shows two main ways in which the RSI's PARI programme can address the lack of recourse to social benefits: dissemination of information and assistance. First, providing information, in a letter for example (here, the PARI self-questionnaire), can change the way people assess the advantages and disadvantages of the assistance available (Chareyron *et al.*, 2018). Second, the personalised assistance provided by the programme could influence the choices of individuals by making the programme more attractive.

The aim of this work is to assess the causal impact of the PARI programme on the healthcare consumption of elderly self-employed workers. The effect is identified based on the implementation of the PARI programme in a few pilot regions governed by voluntary (experimental) local RSI agencies in 2015, before it was generalised in France in January 2017. We used RSI administrative data from 2014 to 2016 to avoid the effect linked to the nationwide generalisation. We rely on a difference-in-differences approach to estimate the effect of the PARI programme, using fixed-effects panel models. Since the estimate of individual risk for targeting purposes was carried out on the entire population, the control group was made up of individuals at

risk from the eighteen non-experimental regional agencies, and the treatment group was made up of individuals with the same level of risk from the ten experimental regional agencies.

The PARI programme makes it possible to reduce one-off healthcare behaviours in favour of a more regular relationship with the healthcare system. PARI is designed to help vulnerable elderly people stay in their own homes in so far as the structure of healthcare consumed by the treatment group is modified in favour of an increase in consumption of pharmaceuticals and medical equipment, which could be linked to preventing or compensating for loss of autonomy. PARI appears to be a promising example of a loss of autonomy prevention programme as envisaged by the ASV law of 2016.

Our research contributes to the existing literature in several ways: *(i)* it supplements the rapidly growing literature on the health and healthcare consumption of self-employed workers in Europe; *(ii)* it is aligned with the growing literature which shows that social assistance improves the healthcare pathway; *(iii)* it suggests that a prevention programme based on a threefold, global, proactive and targeted approach has a greater chance of success with populations reluctant to engage in preventative behaviours. Section 1 of this study provides a detailed presentation of the targeting and treatment phases of the PARI programme. Section 2 discusses methodological issues related to the econometric models and data used. The results are presented in Section 3, then we conclude.

1. The PARI Programme

1.1. Targeting the Reference Population

The *Régime Social des Indépendants* (Social security scheme for self-employed workers – RSI) set up the *Programme d'Actions pour une Retraite Indépendante* (PARI) in 2015 to promote the prevention of loss of autonomy. It is innovative because it does not follow the traditional principles of disease-related prevention. The reference population is defined using two selection criteria. First, these are individuals aged 60 to 79 – who are retired, active, or active retirees – who are health's beneficiaries of the scheme (only the insured persons) and have paid the majority of their contributions to the RSI for a certain number of quarters. Since retirees from liberal professions are managed by another scheme, the *Caisse Nationale d'Assurance Vieillesse des Professions Libérales* (CNAVPL), the scope of the PARI programme is restricted to the professions of craftsmen and merchants. Second, targeting was carried out among these individuals in order to identify those with a high, but unproven, risk of loss of autonomy. The risk score was developed by a multidisciplinary team on the basis of expert opinion, using data from the RSI's medical-administrative databases.[4]

The variables used to determine an individual risk score are grouped into three main areas:

- "Individual": age, activity (active, active retired, retired), impairment (inability to work and disability);
- "Medical": (1) medical consumption (hospitalisations lasting more than eight days, at least one nursing or physiotherapy act, at least two GP consultations, the number of dental and ophthalmological services, the consumption of psychotropic drugs and the difference in consumption between two 6-month periods) (2) *Affections de Longue Durée* (Long-term illness – ALD) situations (3) sick pay. These criteria are taken into account over a prior period of 12 to 36 months;
- "Social": (1) the extra-legal subsidies grant by the *Action Sanitaire et Sociale* (Health and social welfare – ASS) of the RSI, comprising aids for social contributions, financial assistance, and assistance for dependency, and (2) the legal subsidies , based on economic criteria, which any French resident can claim, including the *Couverture Maladie Universelle* (Universal health coverage – CMU), *Allocation de Solidarité aux Personnes Agées* (Solidarity allowance for the elderly – ASPA), *Revenu de Solidarité Active* (Active solidarity income – RSA) and exemption from the *contribution sociale généralisée* (Generalised social contribution – CSG) / *Contribution au remboursement sur la dette sociale* (the Contribution for the reimbursement of the social debt – CRDS).

The variables described above in each of these three IMS (Individual, Medical, Social) data groups are "primary indicators" which are combined according to a "scoring" method: each criterion gives a certain number of points which are then added together. A technical committee chose these weightings based on a review of the scientific literature on the determinants of vulnerability among the elderly. It is therefore an "expert opinion" method. We then apply the chosen decision rule in order to obtain "intermediate composite indicators" in each of the areas I,

4. It should be noted that the RSI was a single organisation that managed all personal insurance contributions for health, maternity, disability, death, retirement, etc. This structure promotes targeted and global healthcare.

M and S, which classify the individuals into four risk categories: (1) low (2) medium (3) high and (4) proven. At this stage, three areas (I, M and S) are associated with each individual.

In order to summarise the information from the three "composite indicators" and obtain a single criterion, the PARI score, the following decision rule is applied: PARI 1 – each of the three composite indicators (IMS) is below 3; PARI 2 – only one of the three composite indicators (IMS) is below 3; PARI 3 – at least two composite indicators (IMS) are equal to 3; PARI 4 – at least one composite indicator (IMS) is equal to 4. This decision rule makes it possible to obtain an individual PARI score of 1, 2, 3 or 4, whereby the higher the score, the greater the risk of loss of autonomy. In addition to this decision rule, there is an exceptional "forcing" rule that enables individuals who would initially be classified elsewhere to be classified in PARI 3, on the basis of certain specific criteria, for example due to certain medical conditions (stroke, cystic fibrosis, serious chronic respiratory disease, etc.), disabilities or functional limitations (as determined using the Iso-Resource Group, GIR), or because they benefit from social assistance (RSA, ASPA, APA) but are unknown to the ASS. Ultimately, individuals with a PARI 3 score constitute the population targeted by the programme.[5] Figure I details the targeting procedure. A detailed presentation of the PARI class targeting method was proposed and an initial evaluation of the effectiveness of the targeting was also provided (Sirven, 2017).

1.2. Procedure of the Intervention

The overall approach of the PARI programme involves: *(i)* identifying, within the population benefiting from health coverage under the RSI, elderly people who meet one or more vulnerability criteria that contribute to a risk of reversible loss of autonomy, i.e. the PARI 3s; *(ii)* assessing their health and/or medicosocial needs; *(iii)* implementing, depending on the proven risk of loss of autonomy, appropriate monitoring and support activities, responsibility for which is shared between the RSI and the attending physicians and/or other healthcare and support stakeholders; and *(iv)* finally, working in partnership with the attending physicians to offer the individuals concerned personalised solutions, which are provided either by the RSI or by other providers that operate in the geographical area near their homes and are able to meet their individual needs.

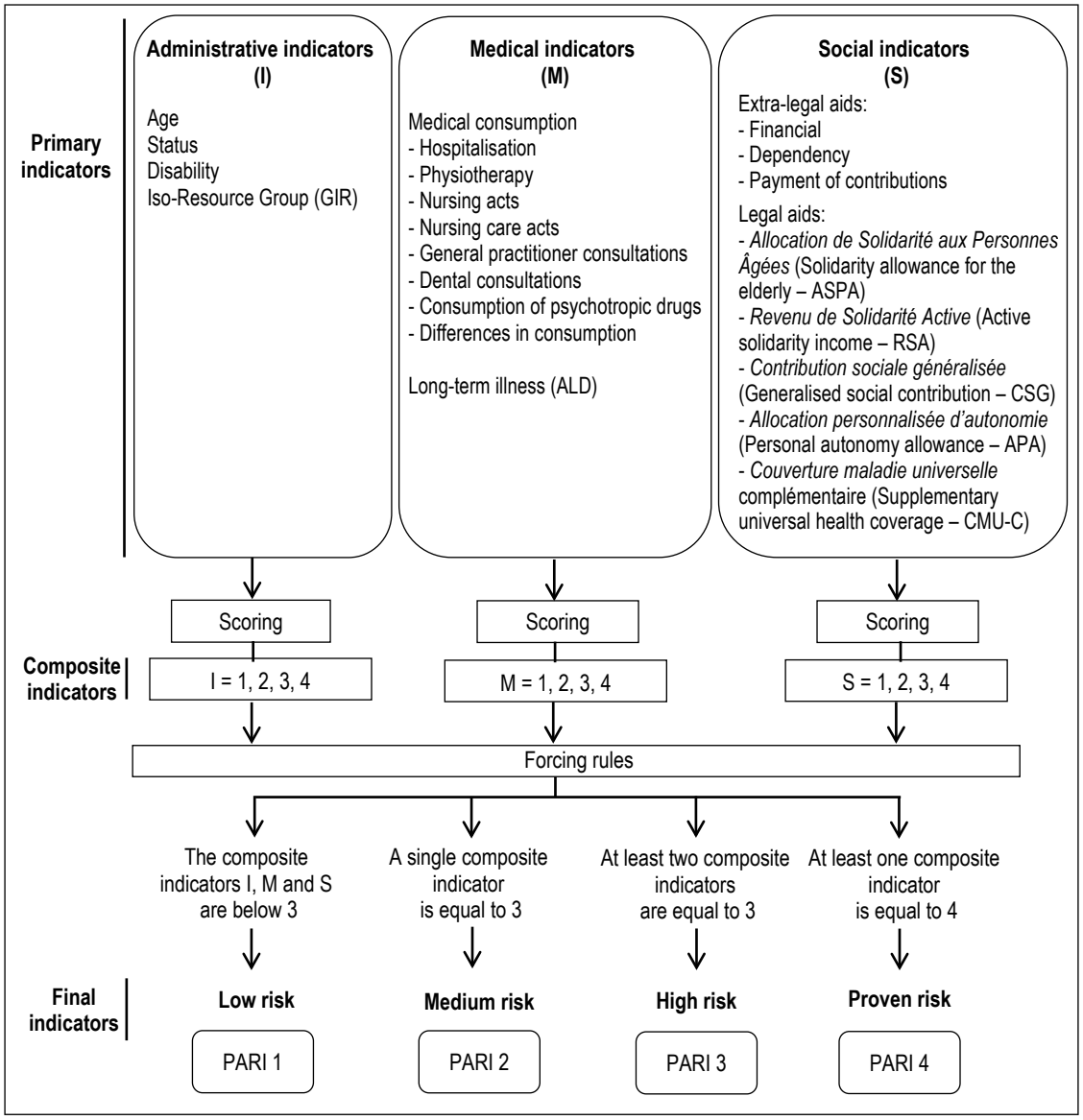
Once the PARI 3 population has been identified at national level, a two-stage approach based on a selection relating to managing the loss of autonomy is taken. Individuals in PARI 3 are excluded from the treatment group if they have died or if they already benefit from *(i)* a range of services offered by the RSI within the framework of measures to prevent the loss of autonomy (Retirement Health Check, *préparation des doses à administrer* – preparation of doses to be administered, PDA) or *(ii)* an *évaluation globale des besoins à domicile* (comprehensive assessment of home needs – EGBD) carried out recently (within the past 24 months) by a provider at the request of the RSI.

First, an individual self-questionnaire is sent by post to people at risk of loss of autonomy identified as PARI 3, who are covered by the ten volunteer experimental agencies, along with a freepost envelope. The self-questionnaire informs individuals of the aims of the programme and obtains their consent to participate. The self-questionnaires are sent back to the respective agencies of the insured parties, and generally to the prevention department. Data is entered locally, as it is received, in a tool called ARIAN. The questionnaire provides more detailed information on the economic, social and health characteristics of individuals. This data supplements the IMS administrative data from the RSI's databases. Completing the self-questionnaire is optional. Respondents will be subject to an analysis of their individual situation based on the answers provided. If necessary, additional information may be obtained as part of an *évaluation globale des besoins à domicile*. People who do not respond will be contacted again, but if they do not return the questionnaire before the deadline or do not make themselves known to the services offered by the RSI, no specific assistance proposal, as envisaged within the framework of the PARI programme, will be offered to them. However, they will be able to continue to benefit from legal and extra-legal assistance should they request it, as is the case for everyone covered by the RSI.

Second, only the PARI 3 individuals who have returned the self-questionnaire will be offered

5. A priori, the populations which benefit from the allocation personnalisée d'autonomie *(Personal autonomy allowance – APA) are by definition in GIR <5 and their PARI score is 4. However, certain people included in the initial sample were able to benefit from the APA without that information being reported to the RSI before the PARI scores were created. This information was subsequently collected by means of a self-administered questionnaire. This self-questionnaire is offered to individuals with a PARI 3 score; the answers provided supplement the data already collected for the individual concerned and thus make it possible to better identify personal needs in order to offer a personalised healthcare pathway. However, no action is taken for individuals who do not respond to the questionnaire, except in a few rare cases. In addition, disparities between French departments in terms of accessing the APA could place people who do not have a GIR below 5 into PARI 4 in departments where there is more APA funding.*

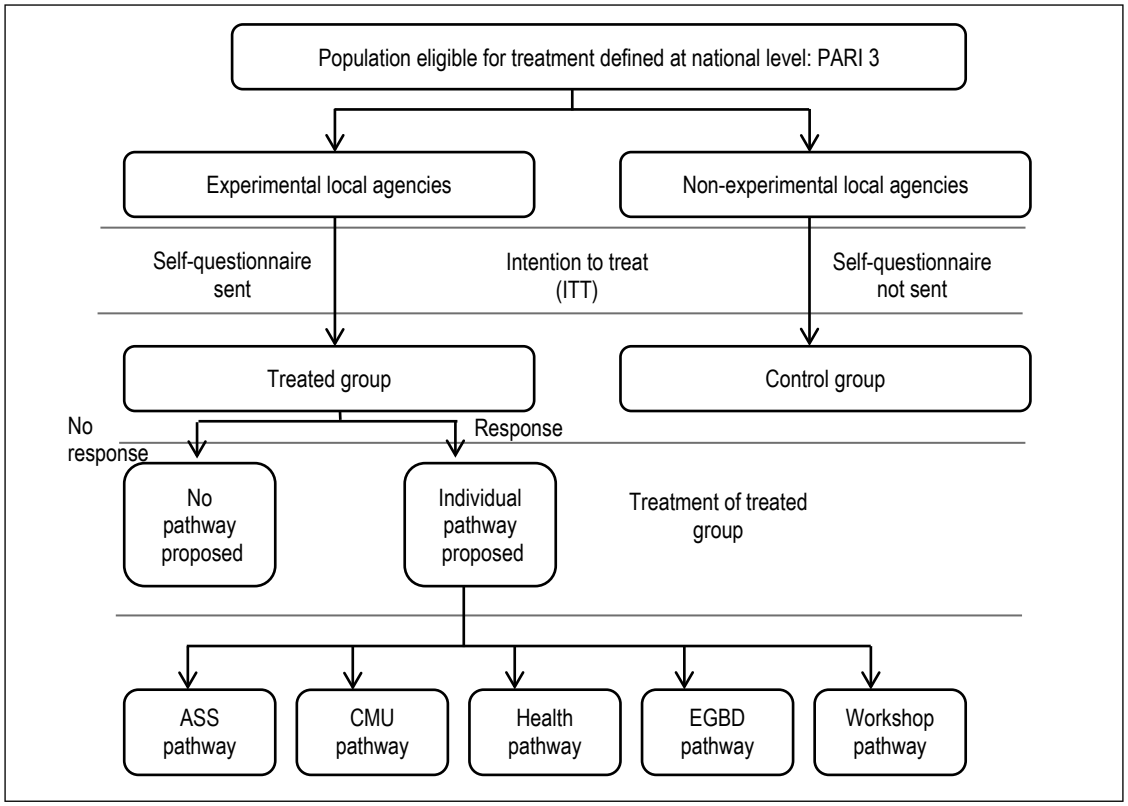
Figure I – **The construction of individual scores of the PARI programme**



Source: Sirven (2017) and RSI.

a healthcare pathway adapted to the needs they have expressed. The ARIAN tool will first predetermine a pathway. This pathway will then be rejected or confirmed by a multidisciplinary unit. The multidisciplinary unit is made up of three experts who will analyse the questionnaires according to their speciality: an *Action Sanitaire et Sociale* (Health and social welfare – ASS) expert who makes proposals based on financial means and on assistance that may already have been requested; the CMU service which identifies whether individuals not benefiting from the CMU could claim it (an area of social welfare which is generally managed by the ASS); the health service, i.e. the medical advisor, who has access to the questionnaire as well as to the individual's medical records to decide on their needs from a medical point of view, namely a check-up with a general practitioner and/or a dentist. Where applicable, if an insured person's request is not clearly expressed, a comprehensive assessment of home needs (EGBD) may be carried out by an external service provider in order to provide a very detailed analysis of the individual and their environment. In addition, group workshops on ageing may also be offered. Figure II sets out the intervention. Assistance is thus divided into five pathways: an ASS pathway, a CMU pathway, a prevention pathway (GP and dental check-up), an EGBD pathway and a workshop pathway. In principle, GP and dental check-up fees are paid directly by the RSI scheme. Once completed, each check-up report is returned to the RSI scheme's medical advisor responsible for prevention in a freepost envelope. The proposed pathways should therefore not directly increase health spending.

Figure II – **PARI intervention during the experimental phase**



1.3. The Terms of the Intervention

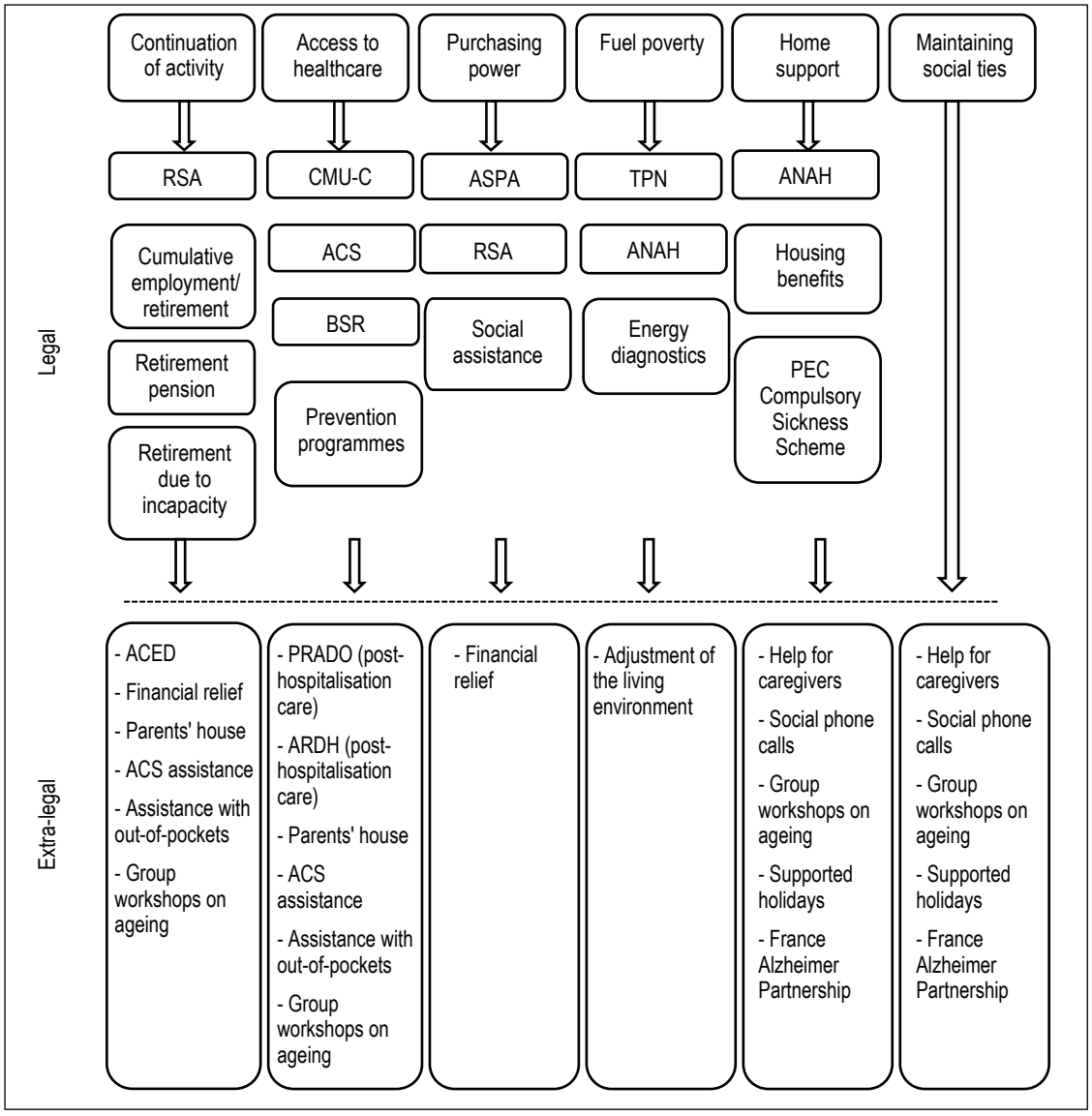
The range of services proposed by the RSI includes two main fields: healthcare and social. It is individually adapted to the needs defined by the multidisciplinary unit. Healthcare services enable beneficiaries to access medical or dental check-ups when they need them. As far as possible, social services are directed towards legal assistance schemes and then towards extra-legal assistance. If the individuals concerned already benefit from social assistance, treatment will result either in the maintenance of the existing support if it is considered adequate, or in a new support proposal if the current support is insufficient. The payment of benefits not covered by the protection scheme for self-employed workers is in the extra-legal field and falls under the ASS. Legal and extra-legal social assistance meets the following needs: continuation of activity, access to healthcare, purchasing power, fuel poverty, home support and maintaining social ties, participation in workshops (on how to avoid falls, for example) (Figure III). This assistance involves different resources, namely technical, human and financial. Among the individuals who returned the self-questionnaire, 49.7% benefited from a health pathway, 40.1% benefited from an ASS pathway, 22% benefited from an EGBD pathway, 12.1% benefited from a CMU pathway and 5.6% benefited from a workshop pathway (an individual may be offered several pathways).

1.4. Experimentation and Generalisation Phases of the Programme

The PARI implementation began in 2015 with an experimentation phase involving ten RSI agencies, which volunteered to test the programme. The other eighteen agencies form the control group, giving a total of twenty-eight regional agencies. In 2014, PARI 3 individuals were identified as the target population for this 2015 campaign, throughout France. The campaign began in June 2015, when the self-questionnaire was sent out to the experimental agencies for pathways to be offered from late 2015 and early 2016. Individual monitoring is carried out until the person has opted for a pathway. However, short-term follow-up takes place when the person benefits from a health pathway as the health professional (dentist or general practitioner) seen returns a check-up report to the medical and/or prevention service of the insured person's regional health insurance scheme. The same applies during an EGBD as the external service provider will provide more precise information on the needs of the individual.[6]

6. Specific ASS assistance measures automatically involve an EGBD, such as household assistance measures.

Figure III – **Assistance under the PARI programme (non-exhaustive)**



Source: RSI.

This programme was then gradually generalised with the implementation, in 2017, of a random experimentation initiative for everyone covered by the RSI. However, on 28 September 2017, the government announced that the RSI would be scrapped in its social security financing bill. As of 1 January 2020, the RSI became part of the General Scheme. This announcement marked the end of the PARI programme managed by the RSI. The 2018 campaign took place. For the 2019 campaign, only agencies that had the necessary human resources participated in the programme.

2. Assessment Methodology

2.1. Sources and Sample

We used medical-administrative data from 2014 to 2016 from the management of the RSI's PARI programme. The sample comprised 20,328 individuals who received health coverage under the RSI, were classified as PARI 3 in 2014, and were monitored in 2015 (when the intervention began) and 2016 (not deceased during targeting). This is a balanced panel of 60,984 observations. Classification as PARI 1, 2, 3 or 4 was carried out on 396,048 individual RSI beneficiaries (not deceased during targeting) on the basis of primary indicators recorded over the preceding 36 months, except for the variables relating to social assistance provided by the RSI under the ASS which related to only 27 months, from 1 January 2013 to 31 March 2015. The extraction of this data, which was required for the PARI classification, was carried out on 31 March 2015.

Table 1 shows the distribution of individuals classified as PARI 3 in the regional RSI agencies.

Ten regional RSI agencies, comprising 44% of the sample, volunteered to implement the PARI programme in 2015 (which entailed sending self-questionnaires and treating respondents). These were experimental agencies. It should be noted that the average effect is borne by 38.6% of the PARI 3 individuals in the experimental agencies who returned the self-questionnaire, as we are evaluating the effect of the programme proposal (sending the self-questionnaire) on the use of ambulatory care.

2.2. Strategy for Identifying the Effect

We estimate the causal impact of the PARI programme on access to ambulatory care and the total amount of ambulatory care consumed (in €). We investigated whether the programme proposal had an effect on ambulatory care use, i.e., the intention-to-treat (ITT) effect. Assignment to treatment was based on the voluntary participation of some of the regional agencies, which produced two groups – a treatment group and a control group. Identifying the effect of the treatment consisted in comparing different healthcare expenditure indicators between the experimental local agencies (treatment group) and the non-experimental local agencies (control group) before and after the introduction of the programme in 2015. This difference-in-differences (DD) approach with fixed-effect panel models is regularly used in public policy evaluation to estimate the treatment effect within the theoretical framework of the Neyman-Rubin causal model (Holland, 1986). Formally:

$$y_{it} = \gamma_t T_i \times d_t + c_i + d_t + \varepsilon_{it} \quad (1)$$

where y_{it} represents the consumption of ambulatory care (in terms of access and amount) of the individual i on the date t. d_t represents the temporal fixed effect and c_i represents the individual fixed effect, which disappears during estimation (by difference from the individual average over the period). The term T_i represents a binary treatment variable (whether or not the individual belongs to one of the experimental agencies) and the cross-referencing term $T_i \times d_t$ makes it possible to identify the effect of the PARI treatment in the experimental agencies compared to the non-experimental agencies (control group). The average intention-to-treat (ITT) effect is given by the value of the parameter γ_{2016}, under the fundamental assumption of parallel trends.

The estimate of equation (1) was carried out with linear probability models, which were applied to the binary dependent variable, the probability of exceeding different ambulatory expenditure

Table 1 – **Sample of eligible individuals (classified as PARI 3)**

PARI experimental agencies					Non-experimental agencies		
Local agencies	Number of individuals	%	Number of participants	%	Local agencies	Number of individuals	%
1. Alpes	843	9.41	274	32.50	1. Alsace	379	3.33
2. Auvergne	824	9.20	361	43.81	2. Antilles-Guyane	119	1.05
3. Bretagne	1,194	13.33	440	36.85	3. Aquitaine	1,552	13.65
4. Corse	195	2.18	91	46.67	4. Basse-Normandie	534	4.70
5. Languedoc-Roussillon	1,360	15.18	512	37.65	5. Bourgogne	722	6.35
6. Limousin	388	4.33	234	60.31	6. Centre	774	6.81
7. Midi-Pyrénées	1,072	11.97	324	30.22	7. Champagne-Ardenne	291	2.56
8. Nord-Pas-de-Calais	1,215	13.56	516	42.47	8. Côte d'Azur	974	8.57
9. Pays-de-Loire	1,137	12.69	430	37.82	9. Franche-Comté	428	3.76
10. Poitou-Charentes	730	8.15	276	37.81	10. Haute-Normandie	549	4.83
					11. Île-de-France-Centre	664	5.84
					12. Île-de-France-Est	585	5.15
					13. Île-de-France-Ouest	474	4.17
					14. Lorraine	675	5.94
					15. Picardie	526	4.63
					16. Provence-Alpes	961	8.45
					17. Rhône	1,093	9.61
					18. Réunion	70	0.62
Subtotal	8,958	100	3,458	38.60		11,370	100
Total		44.07					55.93

Notes: Number of participants = number of individuals who returned the PARI questionnaire.
Source: PARI (2014–2016).

thresholds, to measure the effects on access to ambulatory care and amounts of ambulatory care consumed. This estimate uses ordinary least squares after centring the explanatory variables by their individual average over the period (time-demeaning). Robust variance is estimated at individual level. Strictly speaking, a conditional logit model would have been more efficient, but estimation using a linear probability model makes it possible to directly obtain marginal effects and therefore compare estimates more easily.

In our case, we note that treatment has an effect on access to healthcare (see below), it is therefore not possible to estimate equation (1) only for people having access to healthcare (intensive margin): the composition of the treatment group which had access to healthcare can therefore no longer be considered comparable to that of the control group which had access to healthcare (Angrist, 2001; Angrist & Pischke, 2009). In this case, Angrist & Pischke (2009) advise estimating the causal effect on the entire sample by adopting, for the dependent variables, indicators that are higher than the different thresholds. The analysis therefore focuses on the probability of exceeding a certain threshold, which can be defined by percentiles of distribution (see, for example, Gruber *et al.*, 2020), by latent classes, or by symbolic values as we have chosen to do here (e.g. €10, €20, €50, €100, etc.). The comparison of the different estimates should make it possible to attribute the causal effect of PARI primarily to the patient for low threshold values (access) or primarily to the physician for higher values (amount). In order to also identify a possible effect of modifying the composition of the healthcare package at given amounts (primarily attributable to the physician), the analysis will focus on the amount spent per ambulatory expenditure item (general practitioner, specialist, dentist, nurse, physiotherapist, other care providers, biology, pharmaceuticals, medical equipment, optical services, prosthetics and transport).

Finally, we tested the assumption of parallel trends graphically (event analysis) and via a parametric test of pre-existing differences in results trends (placebo test), through the regression specified in equation (1). In this specification, an insignificant coefficient on the interaction term γ_t before 2016 indicates that the average treatment trajectory of individuals before the programme was implemented is identical between the two groups, i.e., the slopes are parallel for unbiased estimates. The validity of this assumption still needs to be qualified given that the pre-treatment period is relatively short.

2.3. Robustness Checks

We carried out several checks to evaluate the robustness of our approach. First, we took into account the serial correlation of regression errors ε_i following the recommendations of Bertrand *et al.* (2004) and Cameron & Miller (2015), and grouped the standard errors at regional agencies level. In addition, due to the small number of groups, we followed Cameron & Miller (2015) and adjusted the degrees of freedom of the t-statistic to G-1, where G denotes the number of groups (28). This gives critical values of t = 1.70 for a 10% confidence level, t = 2.05 for a 5% confidence level, and t = 2.77 for a 1% confidence level.

Second, we explored the assumption of comparability of the treatment group and the control group by employing a difference-in-differences model with kernel propensity score weighting. In this approach, the treatment group and the control group are balanced using a set of decisive determinants (demographic characteristics (age and sex), professional status (craftsmen, active-retired, retiree); variables relating to the medical records (iso-resource group, GIR; long-term illness, ALD); variables relating to the PARI programme management process (forcing rules and not being known to the ASS)). Weightings were constructed using a logistic regression that predicts group assignment; weighting individuals by the inverse probability of treatment creates a synthetic sample in which assignment to treatment is independent of baseline covariates (see Table A1 in the Appendix, which shows the descriptive statistics of the treatment and control groups). Identifying treatment effects that differ significantly from the main model would be problematic since the groups would not be comparable given their compositional differences.

3. Results

3.1. Different Subsamples

Table 2 shows the differences in the characteristics of individuals between the experimental and non-experimental agencies. The individuals in the experimental agencies are older (69.6 years on average, compared to 69.2 years for the control group), are mainly craftsmen (52% compared to 48% for the control group), are retired, and more often have an attending physician. In addition, the experimental agencies used the forcing rules less. These differences in characteristics observed confirm the interest of using a model with individual fixed effects in order to control for constant individual effects over the observation period (whether observed or not).

Figure A1 in the Appendix compares the distribution of health expenditure between the experimental and non-experimental agencies in 2014. The visual adjustment is very similar between the agencies despite the differences in sample composition, as shown in Table 2. Table 3 corroborates this result for 2014 and 2015 with regard to access to healthcare and the total amount consumed, but suggests that, in 2016, the experimental agencies had greater access to healthcare while the amounts consumed remained similar (statistically insignificant despite an average decrease of €183).

Table 4 breaks down access to healthcare and consumption levels (in €) by period according to the initial characteristics of the individuals. All things being equal, we observe that before the treatment, the experimental agencies offer the same access to healthcare, but their average expenditure is slightly lower. This changes after the treatment since access to healthcare is greater for the experimental agencies in 2016 while the amounts consumed lose statistical significance. Below we will assess whether these effects are potentially due to the treatment.

3.2. PARI Programme Beneficiaries Have Better Access to Healthcare

Figure IV shows the comparison of the experimental agencies in each period using the logarithm of expenditure +1 (those with no consumption are therefore taken into account). The descriptive statistics results in the figure indicate *(i)* a general downward trend in health expenditure for both groups, which could be explained by the fact that individuals are classified as PARI 3 partly based on high levels of healthcare consumption in 2014, with the result that, after a phase of (acute) care, consumption levels reduce as healthcare needs have been met; *(ii)* a parallel slope between 2014 and 2015 between the control group and the treatment group, which suggests that the treatment group would behave like the control group if untreated; and *(iii)* a difference in the healthcare consumption trend after the treatment, where we observe that individuals from treatment agencies display less of a reduction in consumption (in terms of access and amounts combined). This final observation suggests that treated individuals remain in contact with the health system.

Table 5 measures the causal impact of the PARI programme on ambulatory expenditure in ITT.[7] The results indicate that the PARI programme increases access to healthcare by 1.1%. The impact is concentrated on access to the general practitioner, pharmaceuticals and medical equipment, expenditure items which are quite typical of people losing their autonomy. Following the

7. Despite the short pre-treatment period, the estimates verified that the pre-existing trends in the two groups were identical, which suggests that the effects observed in 2016 are related to the introduction of the programme.

Table 2 – **Characteristics of eligible individuals (classified as PARI 3)**

Variables	Total	By type of agencies		
		Experimental	Non-experimental	Difference
Demographic characteristics				
Age in 2014 (59–78 years)	69.40	69.62	69.22	0.40***
Men	78.97	79.44	78.61	0.83
Women	21.03	20.56	21.39	−0.83
Professional status				
Craftsmen	49.51	51.83	47.69	4.14***
Merchants	50.49	48.17	52.31	−4.14***
In employment	12.65	11.88	13.25	−1.38***
In employment-retired	5.77	4.41	6.83	−2.42***
Retired	81.59	83.71	79.91	3.80***
Medical records				
GIR 5 or 6	4.63	4.87	4.44	0.43
CMU or ACS beneficiary	17.10	17.08	17.12	−0.04
ALD	67.41	67.16	67.61	−0.45
Attending physician	97.40	97.79	97.10	0.69***
Case management				
Forcing rule	29.32	26.89	31.23	−4.34***
Unknown of the ASS	86.87	86.77	86.95	−0.18

Notes: Tests of difference of means. Percentages (unless otherwise specified) Significance threshold: * p< .10; ** p< .05; *** p< .01.
Source: PARI (2014–2016).

Table 3 – **Evolution of healthcare consumption by type of agencies**

Variable/Year	Experimental	Non-experimental	Difference	Stat. (1)	p-value
Access to healthcare (%)					
2014	98.5	98.3	0.175	−0.973	0.330
2015	98.6	98.4	0.205	−1.171	0.242
2016	97.0	95.7	1.283	−4.807	0.000
Average expenditure (€)					
2014	2,898.2	3,124.9	−226.7	1.381	0.167
2015	2,996.1	3,218.8	−222.7	1.406	0.160
2016	3,048.6	3,231.7	−183.0	0.418	0.676

Notes: (1) Access to healthcare: proportions test; Expenditure: Wilcoxon test.
Source: PARI (2014–2016).

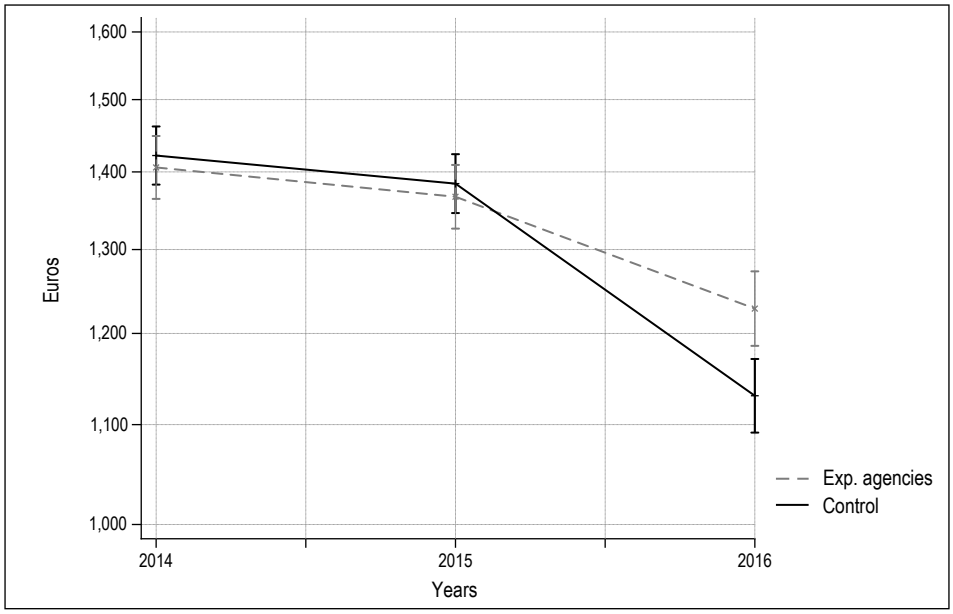
Table 4 – **Determinants of access to healthcare and amounts consumed per period**

Dependent variable	2014		2015		2016	
	Access to healthcare (OR)	Amount (€)	Access to healthcare (OR)	Amount (€)	Access to healthcare (OR)	Amount (€)
Type of regional agencies						
Experimental	0.939	−154.753***	1.074	−177.791***	1.389***	−101.864*
Non-experimental	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Demographic characteristics						
Age in 2014 (59–78 years)	0.991	−27.594***	0.972**	−14.220***	0.983**	−9.229
Men	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Women	1.166	264.874***	1.003	86.833	1.162	13.114
Professional status						
Merchants	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Craftsmen	1.259*	5.496	1.148	−78.628	1.087	−27.425
In employment	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
In employment-retired	5.071***	586.607***	2.091*	223.635	1.429*	290.954*
Retired	1.415	882.674***	0.888	716.502***	1.127	747.138***
Medical records						
GIR 5 or 6	2.678	370.158**	1.381	397.041**	1.208	500.866***
CMU or ACS beneficiary	3.358***	−572.928***	1.784***	−480.704***	1.058	−465.829***
ALD	8.630***	3,193.625***	5.824***	3,436.425***	1.122	3,078.889***
Attending physician	10.653***	1,086.029***	8.706***	945.774***	4,972***	805.855***
Case management						
Forcing rule	0.142***	−31.055	0.228***	190.348***	0.547***	275.474***
Unknown of the ASS	0.723	−409.039***	0.562*	−556.512***	1.331**	−414.253***
Observations	20,328	20,328	20,328	20,328	20,328	20,328
Pseudo R^2 (McFadden)	0.261		0.176		0.037	
Chi-squared (p-value)	771.2***		563.9***		315.2***	
% correctly classified	98.52		98.45		96.29	
ROC	0.851		0.791		0.628	

Notes: Access to healthcare was estimated using logit models and ambulatory expenditure was estimated using generalised linear models, with: * p< .10; ** p< .05; *** p< .01. OR stands for odds ratio.
Source: PARI (2014–2016).

advice of Angrist & Pischke (2009), we extend the descriptive statistics results in Figure IV by separating: *(i)* the causal effect of the programme resulting from the patient's use of healthcare, and *(ii)* the leverage effect of the physician which modifies the type and amount of healthcare consumed. Two main effects stand out. A primary prevention effect associated with medical consultations which put the individual in contact with the health system. Significant ambulatory expenditure thresholds of between €10 and €150 correspond to expenditure items linked to pharmaceuticals. The programme therefore seems to have particularly affected vulnerable people. It should be noted that the literature often links pharmaceutical consumption to

Figure IV – **Evolution of ambulatory expenses of eligible individuals (classified as PARI 3)**



Notes: This figure shows changes in ambulatory expense trends for eligible individuals classified as PARI 3 by period for both experimental agencies (dotted line) and non-experimental agencies (solid line). Here, ambulatory expenses were expressed as the logarithm of expenses +1 (in order to take into account those with no healthcare consumption) and transformed back into euro.

vulnerability in elderly people, although this is generally associated with a negative effect due to polypharmacy (Herr *et al.*, 2018). A secondary or even tertiary prevention effect appears at ambulatory expenditure thresholds around €600, primarily linked to biology and prosthetics expenses, and €1,500, corresponding mainly to pharmaceutical and prosthetics expenses. The latter assumes that, following the implementation of PARI, the general practitioner will have a positive impact in supporting people found to have vulnerabilities and/or chronic illnesses.

3.3. The Effect Is Heterogeneous

Since the PARI population was heterogeneous, we measured the effect on different subgroups (Table 6). The heterogeneity by gender shows that the effect is mainly seen in men and we cannot see any effect in women. There are two potential explanations for this: better preventative behaviours of women (Wardle *et al.*, 2004; Dean, 1989) and/or gender-based differences in health condition. The distinction according to the category of worker (craftsmen and merchants) suggests that the average effect of the PARI programme in ITT increases access to healthcare for craftsmen and merchants (coeff = 0.009*** for craftsmen and coeff = 0.014*** for merchants).

The differentiation between retirees and non-retirees shows that the average effect of the PARI programme in ITT results in an improvement in the use of healthcare for these two categories. However, the effect on access to healthcare is greater among working people. This observation reinforces our assumption that the elasticity of demand for medical goods and services is sensitive to social assistance, mainly among active self-employed workers. The PARI programme seems to play an essential role in maintaining the link between these workers and the healthcare system, particularly when self-employed workers increase their consumption to catch-up with employees before retirement. In addition, we observe a greater impact among retirees when it comes to high ambulatory expenses. These expenses could just as easily be attributed to vulnerabilities, chronic illnesses, or even end-of-life needs.

3.4. Results of Robustness Checks

In order to draw conclusions on the internal validity of this assessment, we must perform a robustness analysis on the results. Table A2 in the Appendix provides a sensitivity analysis of the results. Column 2 takes into account the serial correlation of the regression errors and shows that the results are robust due to the absence of differences in the significance of the results after grouping by regional RSI agencies and adjusting the degrees of freedom of the t distribution to G-1. Our second check (column 3), which applies kernel propensity score weighting to the main model, shows similar effects.

Table 5 – **Impact (ITT) of the PARI programme on outpatient expenditure**

Dep. var. / Type of expenditure		Total	GP	Specialist	Dentist	Nurse	Physio.	Other care providers	Biology	Pharma.	Material	Optics	Prosthesis	Transport
Access		0.011***	0.009**	0.006	0.000	0.010	0.004	0.002	0.006	0.013***	0.017**	0.002	0.007	0.013*
Consumption > Threshold														
Amounts (€)	Percentile [1] (%)													
10	2.5	0.011***	0.009**	0.004	0.001	0.007	0.005	0.002	0.007	0.012***	0.013	0.000	0.006	0.012*
20		0.013***	0.007	0.010	0.005	−0.003	0.003	0.001	0.004	0.011***	0.011	0.001	0.006	0.011
35	3	0.013***	0.002	0.009	0.005	0.004	0.002	0.000	0.008	0.013***	0.009	−0.001**	0.008	0.011
50		0.013***	0.003	0.000	0.007	0.004	0.001	0.001	0.008	0.014***	0.009	−0.001**	0.006	0.009
85	4	0.012***	0.007	−0.004	0.004	0.008	−0.003	0.003	0.012	0.011**	0.007	−0.000	0.006	0.006
100		0.010***	0.001	−0.008	0.003	0.009	−0.001	0.003	0.012	0.009**	0.004	−0.000	0.005	0.007
130	5	0.011***	−0.001	−0.001	−0.001	0.012**	0.003	0.003	0.010	0.009**	0.005	−0.000	0.008*	0.009
150		0.008**	−0.005	0.002	−0.001	0.010**	0.005	0.001	0.007	0.009*	0.003	−0.000	0.004	0.009
200		0.004	−0.004	−0.002	−0.000	0.010**	0.005	−0.000	0.002	0.010**	0.002	-	0.003	0.011*
250		0.004	−0.005	−0.004	−0.001	0.007*	0.003	0.001	0.002	0.007	0.002	-	0.003	0.011**
300	10	0.005	−0.003	−0.004	−0.003	0.007*	0.003	0.001	0.004	0.008	0.004	-	0.003	0.009*
600	20	0.013**	−0.001	−0.002	0.001	0.005	0.005	0.001	0.008**	0.000	0.001	-	0.004**	0.008*
900	30	0.008	−0.001*	−0.001	0.001	0.003	0.001	0.002	0.005*	−0.001	0.001	-	0.002	0.003
1,200	40	0.003	−0.001*	−0.000	0.000	0.002	0.001	0.003**	0.001	0.013**	0.001	-	0.002**	0.001
1,500	50	0.011	0.000	−0.000	0.000	0.002	0.002	0.001	0.002	0.012**	0.001	-	0.002**	0.000
2,000	60	0.015**	0.000	0.000	0.000	0.002	0.004**	0.001	0.000	0.003	0.001	-	0.001*	−0.001
2,600	70	0.011*	0.000	−0.000	0.000**	0.001	0.003**	0.001	0.000	0.005	−0.000	-	0.001	0.001
3,700	80	0.011**	-	−0.000	0.000*	−0.001	0.000	0.000	−0.001	0.004	0.001	-	0.001	−0.001
6,500	90	0.004	-	-	-	−0.001	0.000	−0.000	−0.000	0.002	−0.001	-	0.000	0.001
10,000	95	0.002	-	-	-	−0.001	0.000	0.000	−0.000	0.002	−0.000	-	0.000	−0.001
26,000	99	0.000	-	-	-	−0.000	-	-	-	−0.000	−0.000	-	-	0.001

Notes: Linear probability fixed-effect panel models. * p< .10; ** p< .05; *** p< .01. [1] Nearest percentile value for total health expenditure distribution, including zeros. The entire population of 60,984 individuals was considered for the estimates.
Source: PARI (2014–2016).

* *
*

The aim of the *Programme d'Actions pour une Retraite Indépendante* (PARI), launched in 2015, is to offer a threefold, global, proactive and targeted approach aimed at promoting the use of various social assistance by craftsmen and merchants aged 60 to 79 and living in France, with a view to preventing loss of autonomy. The effectiveness of the programme lies in its ability to address a specific population. We recall that self-employed workers have one-off and acute health demands due to increased working time which eats into the time dedicated to prevention and healthcare. During their working lives, they draw on a stock of health capital that is higher at the start of the period (selection effect), but which depreciates more rapidly than that of employees. A catch-up effect in healthcare consumption is, however, observed at the time of retirement, but suggests that the self-employed have a sporadic relationship with the healthcare system, which is far removed from the logic of early detection and prevention.

PARI's targeting strategy makes it possible to identify this catch-up phenomenon when individuals are characterised by high levels of health expenditure. Indeed, in the control group, we observe a rapid decrease in the two years after targeting. On the other hand, the treatment group shows a smaller reduction in healthcare consumption which we interpret as a reflection of continued contact with the healthcare system, which is favourable to the prevention of loss of autonomy, in particular because this allows for early diagnosis of disabling diseases and prevention in general. Specifically, our results indicate that this additional healthcare consumption in the treatment group corresponds to both greater access to healthcare (the probability of positive healthcare consumption increases) and a leverage effect of the general practitioner which modifies both the type of healthcare consumed, namely more medical equipment and pharmaceuticals, which could be linked to preventing or compensating for loss of autonomy, and the total amount of ambulatory care consumed. PARI is thus part of an approach promoting support for vulnerable elderly people.

Table 6 – **Impact (ITT) of the PARI programme on ambulatory expenditure – heterogeneity**

Dep. var. / Heterogeneity		Gender		Category of workers		Professional status	
		Female	Male	Craftsmen	Merchants	Retired	In employment
Access		0.003	0.013***	0.009**	0.014***	0.009***	0.031***
Consumption > Threshold							
Amounts (€)	Percentile [1] (%)						
10	2.5	0.005	0.013***	0.009**	0.014***	0.009***	0.030***
20		0.008	0.014***	0.009**	0.017***	0.009***	0.037***
35	3	0.005	0.015***	0.010***	0.016***	0.010***	0.037***
50		0.007	0.015***	0.010***	0.016***	0.009***	0.041***
85	4	0.005	0.014***	0.012***	0.012***	0.008***	0.043***
100		0.000	0.013***	0.013***	0.009*	0.007**	0.036**
130	5	0.003	0.014***	0.013***	0.011**	0.008**	0.040**
150		−0.000	0.011***	0.012**	0.006	0.007**	0.027*
200		−0.012	0.008*	0.010*	−0.001	0.003	0.020
250		−0.015*	0.009*	0.010*	−0.002	0.004	0.010
300	10	−0.011	0.010**	0.010	0.002	0.005	0.014
600	20	−0.004	0.017***	0.019**	0.008	0.010*	0.042**
900	30	−0.001	0.01	0.016*	0.002	0.009	0.010
1,200	40	−0.002	0.003	0.011	−0.004	0.001	0.021
1,500	50	0.017	0.009	0.017*	0.005	0.009	0.030*
2,000	60	0.007	0.017**	0.015	0.015*	0.016**	0.012
2,600	70	−0.003	0.014**	0.021**	0.001	0.013**	−0.004
3,700	80	−0.004	0.015**	0.016**	0.006	0.012**	0.002
6,500	90	−0.008	0.007	0.007	0.000	0.005	−0.007
10,000	95	0.001	0.002	0.002	0.001	0.003	−0.010
26,000	99	−0.000	0.000	0.001	−0.001	−0.000	0.004
Observations		12,822	48,162	25,552	35,432	53,271	7,713

Notes: Linear probability fixed-effect panel models. * p< .10; ** p< .05; *** p< .01. [1] Nearest percentile value for the total health expenditure distribution, including zeros.

Our results support the central assumption that social assistance improves the healthcare consumption of elderly self-employed people in a specific manner. However, more research needs to be carried out in at least four areas. First, our study does not offer an in-depth analysis of the specific mechanisms linked to the price and income effect which contribute to being able to meet healthcare demand. However, this area will be explored in more depth in future research. Second, our study only considers the effect of PARI on ambulatory care, which is more conducive to prevention. It only provides a partial picture and omits *(i)* the possible effects of reducing acute hospital use over time, and *(ii)* prevention practices in hospitals, particularly in geriatrics and gerontology departments, with regard to evaluating the vulnerability of the elderly and implementing, in conjunction with the attending physician, individual strategies to prevent loss of autonomy. Third, our study focuses only on a specific population of self-employed workers – craftsmen and merchants – identified as being at risk (PARI 3) and therefore raises the question of external validity on other populations of traditional self-employed workers, such as liberal professionals, and non-traditional self-employed workers whose work relates to the "Uberisation" of society. Fourth, our study is limited to potential effects only one year after the intervention, in order to avoid the effect linked to the generalisation of PARI. Assurance Maladie, the French health insurance scheme, is currently developing approaches that are quite similar to the PARI methodology for its beneficiaries (which now include self-employed workers), which represents a new opportunity for public policy evaluation in the years to come, with a view to making it more comprehensive and long-term. □

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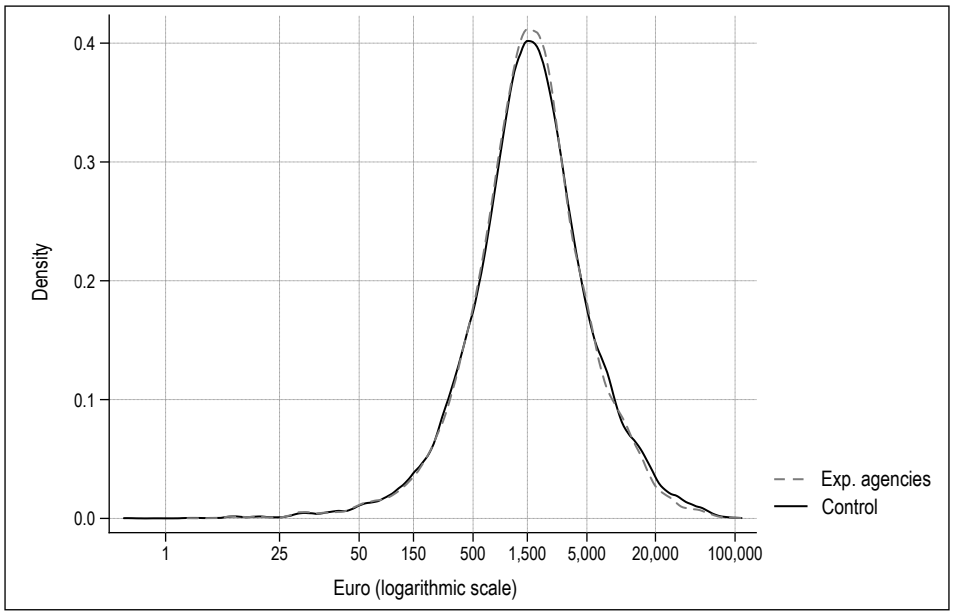
APPENDIX

Figure A1 – **Ambulatory expenses of eligible individuals (classified as PARI 3) in 2014**



Source: PARI (2014–2016).

Table A1 – **Descriptive statistics of treatment and control groups after propensity score matching**

Variables	Average			t-test	
	Treatment	Control	% bias	t	P>|t|
Age	69.618	69.404	3.7	2.48	0.013
Female	0.20563	0.21472	−2.2	−1.49	0.135
Craftsmen	0.51831	0.48607	6.5	4.32	0.000
In employment-retired	0.04409	0.03338	4.7	3.72	0.000
Retired	0.83713	0.83917	−0.5	−0.37	0.711
GIR 5 or 6	0.04867	0.04463	1.9	1.28	0.200
CMU or ACS beneficiary	0.1708	0.16957	0.3	0.22	0.827
ALD	0.67158	0.67549	−0.8	−0.56	0.577
Attending physician	0.9779	0.97874	−0.5	−0.39	0.698
Forcing rule	0.26892	0.29157	−5.0	−3.38	0.001
Unknown of the ASS	0.86772	0.86952	−0.5	−0.36	0.721

Notes: Population of eligible individuals classified as PARI 3.
Source: PARI (2014–2016).

Table A2 – **Estimates with robustness checks**

Dependent variable		Main model	Sensitivity model with robust standard errors clustered	Sensitivity model: DID kernel propensity score weighting
		(1)	(2)	(3)
Access		0.011***	0.011***	0.012***
Consumption > Threshold				
Amounts (€)	Percentile (%)			
10	2.5	0.011***	0.011***	0.012***
20		0.013***	0.013***	0.013***
35	3	0.013***	0.013***	0.014***
50		0.013***	0.013***	0.014***
85	4	0.012***	0.012***	0.013***
100		0.010***	0.010***	0.011***
130	5	0.011***	0.011***	0.013***
150		0.008**	0.008*	0.010***
200		0.004	0.004	0.005
250		0.004	0.004	0.005
300	10	0.005	0.005	0.007
600	20	0.013**	0.013*	0.015***
900	30	0.008	0.008*	0.010
1,200	40	0.003	0.003	0.004
1,500	50	0.011	0.011*	0.012*
2,000	60	0.015**	0.015**	0.015**
2,600	70	0.011*	0.011*	0.011*
3,700	80	0.011**	0.011	0.011**
6,500	90	0.004	0.004	0.003
10,000	95	0.002	0.002	0.001
26,000	99	0.000	0.000	0.000

Notes: Population of eligible individuals classified as PARI 3. (1) Main model: linear probability fixed-effects panel. (2) Sensitivity model: linear probability fixed-effects panel with robust standard errors clustered at the level of ”local agencies” and adjustment of the degrees of freedom of the distribution function t to G-1, where G corresponds to the number of groups (G = 28). (3) Sensitivity model. The control and treatment groups are the same; observations from each group are weighted using propensity scores.
* p< .10; ** p< .05; *** p< .01.
Source: PARI (2014–2016).

Impact of Broadband Internet on Preventive Healthcare Behaviors in Senegal

Pauline Kergall* and Jean-Baptiste Guiffard**

Abstract – In Sub-Saharan African (SSA) countries the main channels of morbidity and mortality are preventable and treatable diseases. Yet, SSA countries invest little in preventive healthcare. Literature has shown that providing health information can have an impact on health behaviors. The arrival of optic fiber submarine cables in 2010 brought broadband connectivity to Senegal, allowing access to healthcare information online. Using the Demographic and Health Surveys datasets combined with the Afterfibre database, and a difference-in-differences methodology, this study aims to assess the impact of the arrival of broadband internet on preventive health behaviors in Senegal. Broadband access is found to be positively associated with the use of bed-net, mixed results are found regarding the use of antenatal care and child immunization. If the positive impacts of internet access are confirmed, the expansion of broadband internet could be important to improve health.

JEL: I12, I15, L86, O33
Keywords: preventive healthcare, broadband internet, Senegal, difference-in-differences

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Preventive healthcare is of the utmost importance for developing countries. Since the Alma-Ata Declaration in 1978, primary health care,[1] in which preventive healthcare plays an important role, has been considered a necessary step towards achieving universal health coverage (UHC) and the Sustainable Development Goals (SDGs). Nonetheless, households in Low and Middle-Income Countries (LMICs) invest little in preventive care but rather face high levels of curative health expenditures (Dupas, 2011a). This low level of investment is even more problematic for LMICs given the multiple health challenges they face. Indeed, disease burden affects people at a younger age than in developed countries and the main channels of morbidity and mortality are infectious and parasitic diseases. The great majority of diseases encountered in those countries (e.g. malaria, respiratory infections, diarrhea, AIDS) can be prevented or treated, highlighting the crucial role of primary and preventive care. In sub-Saharan Africa, communicable, maternal, neonatal, and nutritional diseases accounted for two third of mortality in 2010, according to the Institute for Health Metrics and Evaluation (IHME).

Low-level of investments in preventive healthcare is sometimes linked to individuals' present bias (Kremer & Glennerster, 2011). In the absence of budget constraints, under-optimal adoption of high-return health products or behaviors can also be explained by a lack of information on the health costs or benefits of different products or behaviors (Dupas & Miguel, 2017). Literature available on developing countries has shown that providing health information can have an important impact on health behaviors such as a change in sexual behaviors in response to information on the risk of contracting HIV (Dupas, 2011b) or improvements in good hygiene practices after promotion campaigns for hand-washing to reduce diarrhea (Cairncross *et al*., 2005; Luby *et al*., 2004). Another example is the change in household behaviors toward water storage to limit dengue contamination after repeated exposure to information in Peru (Dammert *et al*., 2014). However, the impact of information provision on health behaviors is not always so clear. Indeed, other studies have found little effect of information on health behaviors. For example, Meredith *et al*. (2013) found that health information did not impact healthcare demand for preventive healthcare products (rubber shoes for children as prevention against hookworm infection in Kenya, hand soap as prevention against diarrhea or multivitamin supplements as prevention against nutritional deficiencies in Guatemala, Uganda, and India). These results are consistent with the study of Iajya *et al*. (2013) highlighting that blood donations were not impacted by information on their importance in Argentina.

Internet is an established effective way of data and knowledge transmission that can provide health information as well as constitute a new mode of connection to the healthcare environment (Lewis & Behana, 2001). Information and communication technologies can help improve access for geographically isolated communities, provide support for healthcare workers, or even inform the population regarding outbreaks of diseases (Majeed & Khan, 2019). In America, Rains (2008) highlighted that broadband users were more likely than those with dial-up access[2] to internet to perform health-related communication and information-seeking behaviors online. As submarine cables giving access to broadband connectivity are fairly recent in sub-Saharan Africa, very few studies regarding the impact of high-speed internet on health outcomes have been conducted in this region. Most of the available studies on LMICs focus on cell phone access only and do not address the specific effect of broadband internet, such as Gonzalez & Maffioli (2020) who studied the impact of mobile phone access on the spread of Ebola during the 2014 epidemic in Liberia. Their results pointed to a reduction in the likelihood of Ebola cases in villages with access to mobile phone coverage.

Outside of the health area, the literature on the various impacts of high-speed internet in LMICs is growing. Bahia *et al*., (2020) found that mobile broadband internet boosted household consumption and contributed to a reduction in moderate and extreme poverty in Nigeria. In Senegal, a World Bank report on the impact of digital technologies on household welfare (Rodriguez-Castelan *et al*., 2021) confirmed this result. Hjort & Poulsen (2019) also found that broadband internet enabled more rapid job creation and economic activity in 12 sub-Saharan countries. Farrell (2012) and Campante *et al*. (2018) investigated the relationship between internet and political participation finding a negative impact on election turnout.

Within the health domain, studies on the effect of internet connectivity on health mainly focused

1. Primary care corresponds to first-line or local healthcare. It differs from specialized (secondary) or hyperspecialized (tertiary) care.

2. Dial-up internet users must establish a connection each time they desire to use the Internet and are subject to substantially longer wait-time for Web pages to properly load and files to be transmitted than broadband users.

on developed countries. Amaral-Garcia *et al*. (2020) studied the effect of internet diffusion on childbirth procedures in England. Evidence of the growing importance of the internet as a source of health-related information was provided by the authors and reflected by the C-section 'gap' between high-income and low-income mothers that closed after the diffusion of broadband internet. Studies also investigated how 5G internet could improve medical practices with the help of virtual reality of artificial intelligence (Latif *et al*., 2017; Dananjayan & Raj, 2021). However, as for the relationship between information and health behaviors, a positive relationship between internet use and health outcome is not systematic. Indeed, in a survey of the literature investigating internet use and well-being mixed results were found (Castellacci & Tveito, 2018). These discrepancies might be explained by the health indicators used and specific behaviors associated with them, but also due to differences in individuals' use of internet. Nonetheless, most of those studies conducted in developed countries focused on concerns that are not the ones that matter to developing countries. Indeed, these studies did not focus on primary care, including preventive healthcare, which is of the utmost importance in LMICs. Moreover, the development of broadband internet and the utilization of the internet differ between developed and developing countries (improvement of internet speed was more gradual over time in developed countries), thus calling for specific analyses regarding the impact of broadband internet on health behaviors in LMICs.

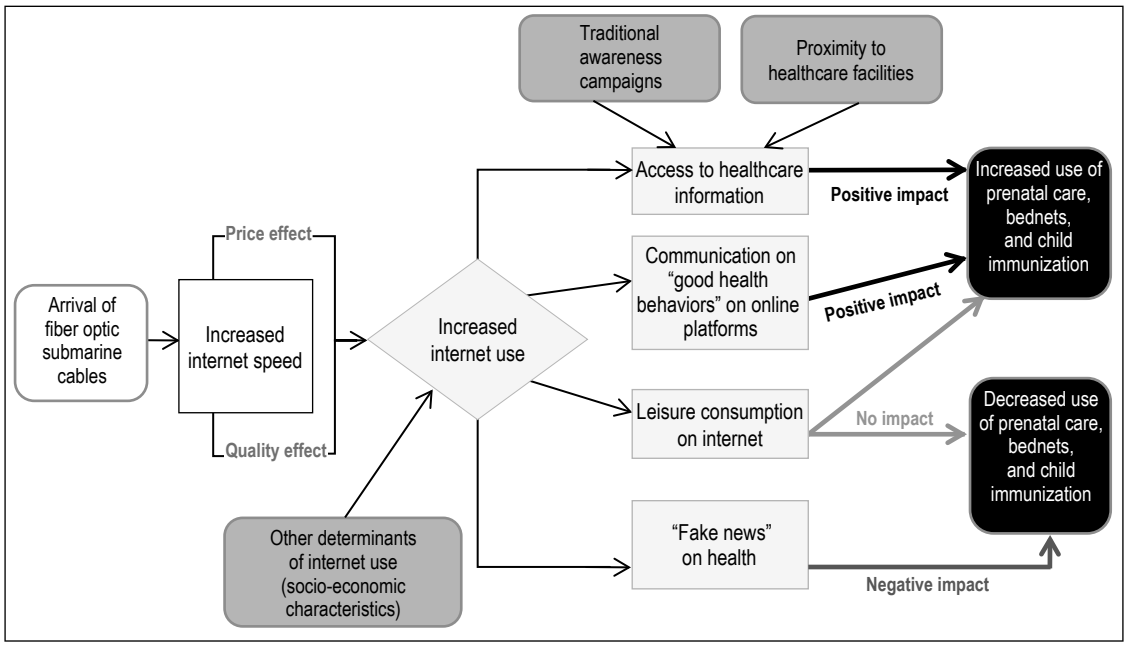
In LMICs, a notable exception in the lack of literature is a study by the World Bank assessing the effect of mobile phone access (2G, 3G, and 4G) on health outcomes in 25 African countries (Mensah *et al*., 2022). This study found that a 10% increase in mobile phone coverage was associated with a 0.45% reduction in infant mortality. We aim to extend the analysis offered in this paper by broadening the scope of health preventive behaviors studied. Moreover, the study of the World Bank included the effect of 2G coverage, which corresponds only to voice calls and text messaging, that largely drove the main results obtained, while we aim to study the impact of broadband internet which is supported by 3G and 4G coverage only. Finally, our study also differs from that of the World Bank by the econometric techniques used to identify the effect of broadband internet on preventive healthcare behaviors.

Other studies have recently emerged such as Byaro *et al*. (2023) who studied the impact of internet use on infant mortality, under-five mortality, and life expectancy in 48 sub-Saharan countries. They found that internet use has a positive effect on health outcomes. A recent Demographic and Health Surveys (DHS) analytical study investigated, at macro-level, the relationship between three types of access to or use of digital resources (ownership of a mobile phone, use of a mobile phone for financial transactions, and frequent use of the internet) and several health outcomes, namely correct knowledge of the fertility cycle, current use of modern contraception, use of a condom at last sexual intercourse, use of antenatal care, iron supplementation during pregnancy, medical treatment of child illness, and health-seeking for experience with physical or sexual violence (Edmeades *et al*., 2022). Their results suggested that the strength of the relationship between health and digital resources access varies depending on the health outcome examined and between men and women, even though digital resources access and use were generally associated with better health outcomes.

The objective of this study is to assess the impact of the arrival of broadband internet on preventive health behaviors in Senegal. Since access to the internet might allow individuals to gather information regarding good health practices, but also to benefit from information on the behaviors of others (*via* access to social networks for example), we formulate the hypothesis that the availability of broadband internet (both fixed and mobile) has positive effects on the use of preventive health care in connected areas, and more specifically on the use of antenatal care, bednet and child immunization.

Figure I summarizes the framework and hypotheses of the study. The arrival of fiber optic submarine cables increased internet speed (Akamai, 2012; Hjort & Poulsen, 2019). This increased speed of the internet led to an increase in internet utilization. Access to internet does not guarantee internet use as many socio-economic characteristics matter for internet adoption. However, it has been shown that the arrival of broadband internet led to an increase in internet use in SSA, thanks to both a price reduction and quality improvement effect (Cariolle, 2021; Hjort & Poulsen, 2019). This increase in internet use can have consequences on healthcare utilization and healthcare behaviors through many channels. In this study, the main channel we are interested in is access to information. Thanks to internet use, people can easily access

Figure I – **Diagram summarizing the study hypotheses and illustrating the potential transmission channels between the arrival of the submarine cables and preventive healthcare**



Note: This diagram summarizes the hypotheses used in the study. The black boxes represent the main variables analyzed, namely the arrival of fiber optic submarine cables and the preventive healthcare use. The other boxes represent the potential effects and mechanisms underlying the main link studied. To signify the hypothetical relationships between these variables, arrows connect each box, indicating the assumed direction of the link between two variables. A dark, grey and light grey arrow represents a positive, negative and null impact, respectively.

health information leading to a positive effect on preventive healthcare behaviors (Dupas, 2011b; Cairncross *et al*., 2005). Another channel through which the adoption of preventive healthcare behaviors can increase with internet use is the communication on "good health behaviors" on online platforms such as social media (Willis, 2016). In addition, increased internet use can translate into an increase in leisure consumption online (Bryce, 2001; Falck *et al*., 2014), without influencing healthcare behaviors. Some studies have shown that intensive internet use can lead to depression, anxiety, and poor sleep quality, but most of the studies on the subject focus on teenagers in developed countries (Morrison & Gore, 2010; Weinstein & Lejoyeux, 2010). Additionally, the increased use of internet can also lead to an increased exposition to fake news (Del Vicario *et al*., 2016), which in turn can modify healthcare behaviors and reduce some preventive healthcare use such as vaccinations (Wilson & Wiysonge, 2020). Internet use can also affect other aspects of health not studied here, for example, the use of social networks allows communication with distant relatives and friends which can lead to a positive effect on mental health, or internet use can increase healthy behaviors such as engaging in physical activity (Li *et al.*, 2020). Nevertheless, as those pathways are out of the scope of our study, they do not appear in Figure I. It is also important to keep in mind that access to healthcare information does not occur exclusively thanks to the internet, but that traditional awareness campaigns or proximity to healthcare facilities are also important transmission vectors of health-related information. Indeed, the transmission of preventive health information can occur thanks to community health workers or peers. In addition, the channels presented in Figure I might not be effective right after individuals gain access to internet, as a "learning phase" might be necessary to identify appropriate health information online.

Access to information (thanks to internet or via other means) does not solve all the issues of healthcare access and healthcare utilization. Indeed, for healthcare services to be used, they must be accessible both economically and geographically. The Senegalese health system is organized following the standard 3-level pyramid. Achievement of universal health coverage is one strategic priority for the country, however, improvements on the subject are still needed despite progress over the last decades. Communicable, maternal, neonatal, and nutritional diseases were responsible for 87% of deaths in under-5 children in 2010, according to the IHME. Insurance coverage was quite low (Daff *et al*., 2020) but healthcare services, especially for women and children such as vaccination included in the WHO

Extended Program on Immunization (EPI), were provided free of charge. The ESPCC/SPA survey of 2014 in Senegal showed that 91% and 84% of health structures offered prenatal healthcare services and children immunization respectively (ANSD & ICF International, 2015). Regarding the availability of bednet, nearly 80% of surveyed households possessed a bednet over the period studied, yet their actual utilization lagged significantly behind ownership rates. Indeed, several national and regional campaigns were conducted in the country over the years to distribute bednets free of charge. Thus, the main concerns seemed to be the actual utilization of bednet rather than having access to it, even though, for the poorest households, financial barriers to accessing bednets could still be a reality.

The paper is organized as follows. Section 1 provides information on internet infrastructure in Senegal, the data and methodology used. Section 2 presents the results which are further discussed in section 3.

1. Material and Methods

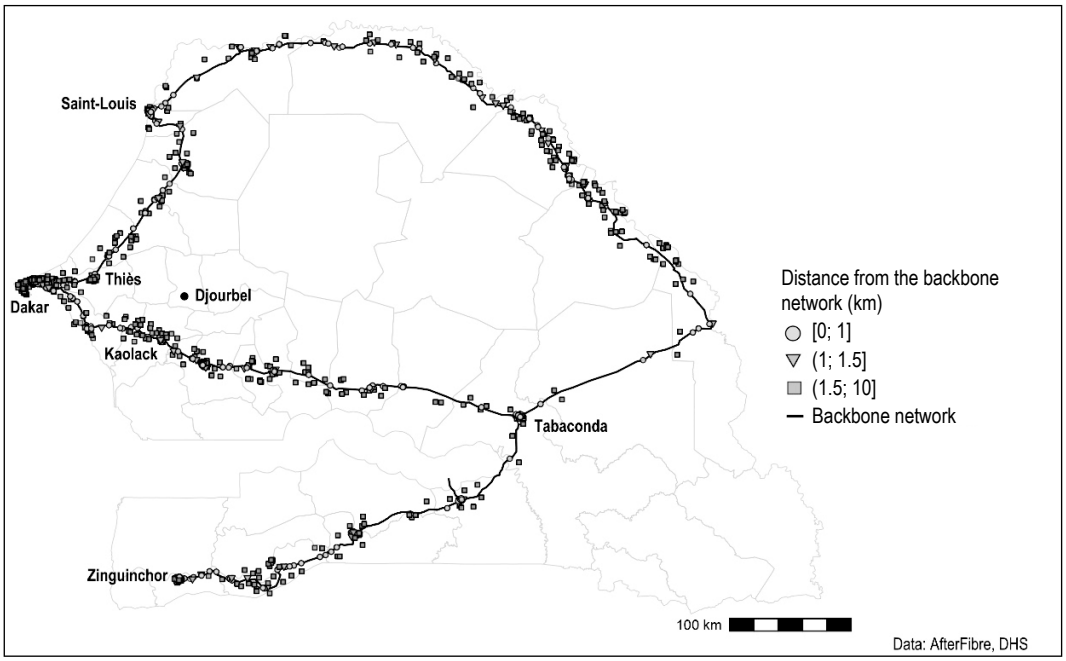
1.1. Background on Internet Infrastructure

In sub-Saharan Africa, most of the internet traffic (fixed and mobile) goes through backbone networks. The backbone network, also called the core network, is partly the legacy of the fixed telephone network and of the first mobile telephone antennas and provides low internet connectivity. As shown in Figure II, in Senegal, the backbone network (represented by the black line) mostly follows the borders of the country, both in rural and urban areas, leaving the central and south-eastern parts of the country uncovered. Each observation in our database is associated with GPS coordinates represented by dots (the shape depending on the distance to the network), allowing to see differences in the density of the population. Fiber-optic submarine cables can carry a huge amount of data from one remote location to another (e.g. from Europe to Southern Africa). The arrival of optic-fiber submarine cables in 2010 brought international broadband connectivity in Senegal which highly increased the availability of high-speed internet in areas near the already existing backbone networks.

It is globally recognized that you need to be no more than 1,000 m to 1,500 m from the backbone to benefit from broadband. Indeed, the quality of bandwidth, and thus access to the internet, decreases very quickly as the distance to the main network increases in the absence secondary network or antenna as it is the case in Senegal.[3]

3. For fixed network (copper network) the attenuation decreases very quickly 1.5 km after the splitter, depending on the technology (ADSL, VDSL, ADSL2...). For mobile network (cell phone antennas), the signal quality decreases rapidly after 1 km distance.

Figure II – **Backbone network in Senegal**



Note: This map provides a comprehensive overview of Senegal, displaying geolocated observations (the dots) from the DHS databases. The black lines represent the projection of pre-existing backbone cables, which were in place prior to the introduction of submarine cables. The shape of the dots on the map indicates the distance of each observation from the backbone infrastructure.

As our study focuses on internet access rather than internet use, it is crucial to establish a relationship between the two. This has been done by Hjort & Poulsen (2019) who highlighted a clear link between submarine cable arrival and internet speed and use in SSA. Indeed, based on the Akamai's data,[4] they found that cable arrival increased measured speed by around 35 to 38% in connected locations compared to unconnected locations (these coefficients being likely underestimated). Regarding internet use, and based on data provided by the Afrobarometer, the authors found that daily and weekly internet use among connected individuals increased by 12 and 14% respectively after the arrival of submarine cables arrival compared to unconnected individuals.

1.2. Data

Data on health behaviors were extracted from the Demographic and Health Surveys datasets which are nationally representative population-based surveys with large sample sizes (see Box). Our database included Standard DHS from the years 1997, and 2005 as well as Continuous DHS from 2012, 2014, and 2016 with geolocation of participating households for all surveys. In addition to the DHS datasets, the Malaria Indicators Survey (MIS) of 2008 was included in our database for regressions regarding the use of bednet.

We considered three preventive health indicators: use of antenatal care, use of bednet for children, and child immunization.

Use of antenatal care was measured as a dummy variable equal to 1 if the mother had at least 4 antenatal care visits during her last pregnancy. The threshold of 4 visits was used as the World Health Organization (WHO) considered a minimum of 4 visits to have complete antenatal care before 2016 – since then this number has been increased to 8 visits. Indeed, in 2002 the WHO recommended a focused or goal-orientated approach to antenatal care (ANC) to improve the quality of care and increase ANC coverage, particularly in LMICs. The focused ANC (FANC) model, also known as the basic ANC model, includes four ANC visits occurring between 8 and 12 weeks of gestation, between 24 and 26 weeks, at 32 weeks, and between 36 and 38 weeks.

Use of bednet was measured as a dummy variable equal to 1 if the child (under the age of 5) or some or all children under the age of 5 in the household slept under a bed net the previous night.

Child immunization was measured as a dummy variable equal to 1 if children from 1 to 5 years old received all vaccination from the Extended Program on Immunization. This EPI includes 4 vaccines: BCG vaccine, DPT/pentavalent vaccine, OPV vaccine, and measles vaccine, and should be completed by the time the children are

4. Akamai Technologies, Inc. is a content delivery network which owns servers around the world. Akamai's data provides average internet speeds recorded for different users (residential, educational, government and business) in a given area for each quarter, excluding mobile network connections.

Box – **Insights on DHS Datasets**

The Demographic and Health Surveys (DHS) program is responsible for collecting nationally representative data on health and population in developing countries (over 90 countries since 1984). The project is funded by the United States Agency for International Development (USAID) with contributions from other donors such as UNICEF, UNFPA, WHO, and UNAIDS. Several data collections are available among which we can find:

The Demographic and Health Surveys (DHS). Those surveys are nationally-representative household surveys that provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition. The samples are stratified, weighted, and representative at national, regional, and residence levels (urban-rural). We used women's questionnaire targeting women age 15-49. We used Standard DHS for the years 1997 as well as 2005 and Continuous DHS for the years 2012, 2014 and 2016. Standard DHS surveys are typically conducted every few years, with a gap of several years between each survey round whereas continuous DHS surveys are conducted continuously throughout the year, enabling more frequent data collection. Croft *et al.* (2018) provide more details about DHS surveys.

The Malaria Indicators Surveys (MIS) are surveys nationally representative focusing on malaria. The methodology is similar to standard or continuous DHS. We also used the women's questionnaire. More details about MIS 2008 can be found in Ndiaye & Ayad (2009).

The Service Provision Assessment (SPA) Surveys are surveys of a national sample of formal health facilities. We used SPA Senegal 2012, the sample of surveyed facilities includes 35 hospitals, 64 health centers, 265 health posts, and 74 health huts. More details can be found in the final reports (ANSD & ICF International, 2012).
All of those databases are available upon request on https://dhsprogram.com/, journal articles based on those databases are also available on the website.

9 months old. The BCG vaccine (named after its inventors A. Calmette and C. Guérin) targets tuberculosis and is injected at birth. The DPT vaccine targets diphtheria, pertussis, and tetanus. After 2005, the DPT vaccine has been replaced by the pentavalent vaccine which additionally targets hepatitis B and Haemophilus influenzae type b (Hib) disease. Both vaccines are injected at 6, 10, and 14 weeks. The OPV vaccine targets polio and is also injected at 6, 10, and 14 weeks. The measles vaccine is injected at 9 months. For vaccination requiring three doses, we considered receiving the third dose of vaccine as full vaccination.

These outcomes were chosen according to the availability of data and to account for the main health issues in Senegal. Indeed, maternal care, malaria prevention, and child immunization are well-known preventive healthcare behaviors and are of paramount importance within the Senegalese epidemiological context. In 2010, neonatal disorders, diarrheal diseases, lower respiratory infection, and malaria were indeed the four main causes of death for under-5 children according to the IHME. For this specific year, maternal disorder alone caused 1,705 deaths, while tuberculosis caused 3,700 deaths. Malaria and measles were responsible for 14.5% and 3.8% of under-5 deaths respectively.

Control variables corresponded to socio-economic and demographic variables and included localization of residence (urban or rural), wealth index factor (a composite measure of a household's cumulative living standard), mother's age, highest educational level (no education, primary, secondary, or higher), marital status (married or living together vs single, divorced or widowed), employment status (working or unemployed) and children birth order.[5] These variables were collected from the DHS datasets and MIS datasets. Children's birth order was preferred over the total number of children to account for shifts in parental knowledge and behaviors as they gain more experience with children. DHS datasets include a wealth income indicator (Rutstein & Johnson, 2004) instead of household income which is extremely difficult to measure accurately. DHS surveys collect a number of variables, usually for purposes other than ascertaining economic status which are thought to be correlated with a household's economic status. Almost all household assets and utility services available, such as type of flooring, water supply, type of vehicle, ownership of agricultural land, etc., are included in the construction of the wealth index factor. In addition, an indicator of healthcare centers' density at the regional level was included. This measure was constant throughout the whole study period and was obtained from the Service Provision Assessments (SPA) dataset of 2012. This database contains a representative sample of health facilities (health huts, health centers, hospitals, and health posts) in Senegal, and their GPS coordinates. To construct an indicator of health facility density, we aggregated the number of health facilities per region and divided the resulting value by the surface area in each region. However, only fixed health facilities were included in the indicator; itinerant healthcare services were not included, which may lead to an under-representation of healthcare services in rural areas.

Depending on outcome variables, the availability of data was different. Thus, for each outcome, different datasets were used. Table 1 displays which waves of DHS or MIS were used depending on the outcome considered. More recent surveys were also available but we choose not to include them due to the recent development of new internet infrastructures in Senegal which increases the risk of individuals considered as controls being in reality treated (i.e. having access to the internet).

Access to broadband internet (our treatment variable) was measured by the distance from the backbone network, only backbone cables that have been installed prior to the arrival of broadband were considered. Data on the localization of the backbone network and on the date of the cables' installation was obtained thanks to the Afterfibre database (www.afterfibre.nsrc.org). The date of arrival of the submarine cable, and thus connection, was obtained from www.infrapedia.com.

It is important to note that GPS localization in DHS is not exact. Indeed, to protect the confidentiality of respondents the geo-located data are displaced up to 2 km in urban areas and up to 5 km in rural areas (and even can go up to 10 km for one observation out of 100). The displacement is a random direction/random distance process and the new location is checked to make sure it falls within the designated administrative boundaries, i.e. within the same district in Senegal. Several analyses have been made on the impact of displacement. For example, for the 2010 wave in Senegal (not used in this study as it was the year of optic-fiber cable arrival) the average displacement was 0.92 km in urban

5. Except in regressions including MIS 2008 database in which employment and marital status of the mother were not available.

Table 1 – **DHS wave used by outcome**

	Before optic-fiber cable arrival			After optic-fiber cable arrival		
	DHS 1997	DHS 2005	MIS 2008	DHS 2012	DHS 2014	DHS 2016
Use of antenatal care	X	X			X	X
N	7,146	6,604			4,375	4,470
Use of bednet		X	X	X	X	
N		10,202	15,217	6,771	6,629	
Child immunization		X		X	X	
N		7,243		5,154	5,154	

Note: This table indicates the surveys used depending on the outcome considered (one line per outcome).
The number of observations (N) in each survey is also included.

areas and 2.36 km in rural areas (Burgert *et al*., 2013). Despite the inexact localization of our individuals, a household actually living within a 1-kilometer distance from the backbone network has a higher chance to be relocated in the 1-kilometer area around the network than a household located 1.5 kilometers away or more from the backbone network. Then, inexact localization in DHS data does not prevent the creation of the control and treatment groups but only implies interpreting our results as 'intention to treat' estimators.

To ensure the robustness of our analyses, we incorporated additional data sources. Population density information was obtained from the WorldPop hub (https://hub.worldpop.org), which provides highly precise spatial demographic data for countries worldwide. We utilized gridded population counts data with a resolution of 30 arc seconds, available since 2000.[6] This data source enabled us to assess population density at a fine-grained level. For information on the localization of healthcare centers, we referred to the dataset available at https://data.humdata.org/dataset/hotosm_sen_health_facilities. This dataset, derived from OpenStreetMap data, not only provides the location of healthcare facilities but also includes some of their characteristics. To enrich our analysis, we computed the distance between each cluster of surveyed individuals and the nearest healthcare facility. By incorporating these additional datasets, we aimed to capture the influence of healthcare accessibility on our research outcomes, thus enhancing the robustness of our findings. However, this database is not exhaustive and includes currently existing healthcare structures in 2023, while structures might have been created during or after the arrival of broadband internet.

1.3. Data Analysis

Two different empirical strategies, both based on the Difference-in-Differences (DiD) methodology, were used to estimate the impact of broadband internet on the three outcomes considered. DiD relies on several assumptions, the main one being the parallel trend assumption. Indeed, to ensure internal validity, DiD assumes that in the absence of treatment, the difference between the 'treatment' and 'control' groups would be constant over time. DiD also requires the intervention to be unrelated to the outcome at baseline, and the composition of the two groups to be stable over time, in the case of repeated cross-sectional design as it is the case here.

The first methodology follows the work of Hjort & Poulsen (2019), who assessed the impact of the arrival of high-speed internet on employment in Africa, and used a DiD methodology with fixed effects to estimate the causal impact of the arrival of broadband internet on preventive health behaviors in Senegal. Fixed effects based on localization (10 kms x 10 kms cell-level characteristics) were included in regression analysis along the aforementioned control variables. The databases used for this methodology were the ones presented in Table 1.

The model estimated with this first methodology is specified by equation (1):

$$Y_{ijt} = \alpha + \beta * SubCables_t * Connected_i + \delta_j * Connected_i + X_{it} + \gamma_t + \epsilon_{ijt} \quad (1)$$

where Y_{ijt} is one of the three health outcomes (use of antenatal care, use of bednet, child immunization) for individual i in cell j and at time t. $SubCables_t$ is a dummy variable indicating whether the submarine cable was available in the country at time t. $Connected_i$ corresponds to the treatment variable, based on the distance to the backbone cables. The coefficient on the interaction between the arrival of submarine cables and individuals' distance from the network

6. Open data available at this address: https://hub.worldpop.org/project/categories?id=3 – accessed June 2023.

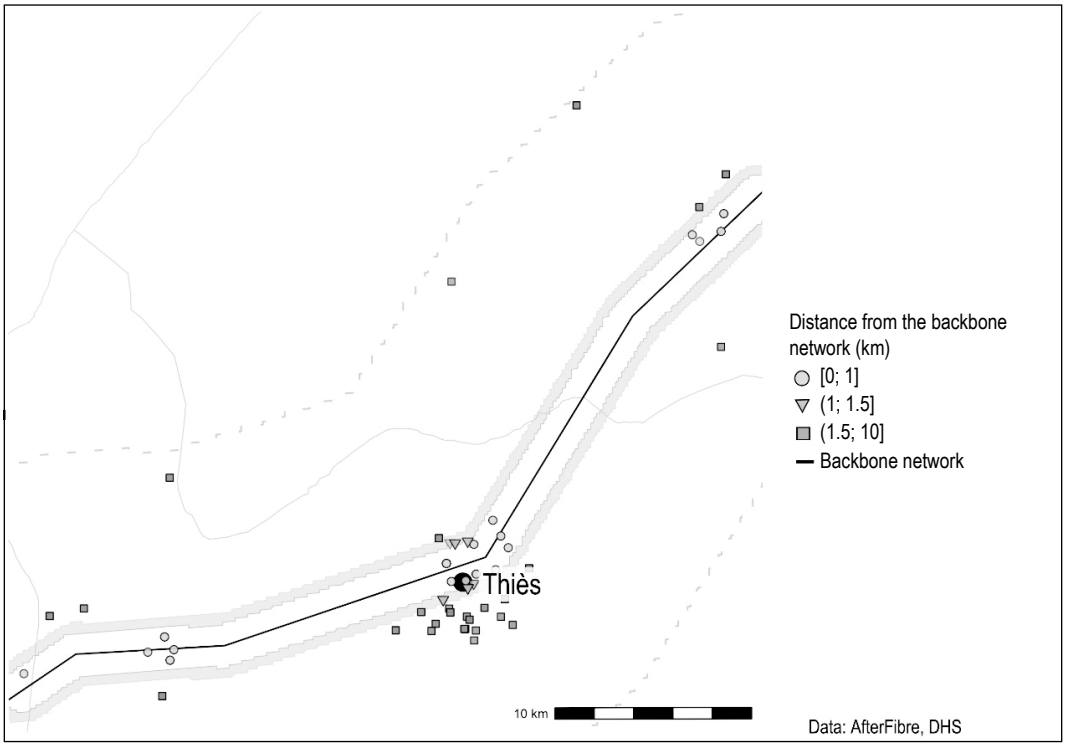
β is our coefficient of interest as it measures the impact of internet access on health behaviors. The δ_j coefficient (10 kms x 10 kms cell-level fixed effects) captures time-invariant differences in health outcomes between treatment and control groups. X_{it} is a vector of control variables for an individual i at time t and γ_t corresponds to time fixed effects.

Figure III provides a zoom of Figure II of the coast of Senegal around the city of Thiès to better illustrate individuals included in our analyses. People living between 0 and 1,000 m of the backbone network were considered connected, as illustrated by the dots, and thus constitute the treatment group, whereas people living between 1,500 m and 10 km were considered unconnected (squares) and constitute the control group. As a result, people living between 1,000 m and 1,500 m (triangles) from the backbone network were excluded. We also excluded individuals living further than 10 km as we considered those individuals to be too different from a socio-economic point of view from those living in connected areas, and we want to avoid including less comparable individuals. We chose this double cut-off of 1,000 m and 1,500 m given the fact that there is no clear consensus on the distance until which the quality of the bandwidth is acceptable. The most conservative definition for the treated group (1,000 m) and the least conservative definition for the control group (1,500 m), based on internet speed attenuation (cf. Section 1.1), was used to limit the risk of an individual being wrongly attributed to a group. This distinction between connected and unconnected areas slightly differed from the one used by Hjort & Poulsen (2019) who defined 500 m as the maximal distance acceptable. However, no clear justification for that very restrictive threshold was given in their paper.

As DHS surveys are not panel data but repeated cross-sectional surveys, the second methodology used in this study was DiD with coarsened exact matching. Exact matching provides perfect balance but produces few matches with continuous variables. Coarsened exact matching temporally coarsen continuous variables into strata to operate the matching.[7] The variables used for matching at baseline were the localization of residence, household wealth index factor, age, highest educational level, working and marital status of the mother, and child birth order. For categorical variables (localization of residence, highest educational level, working

7. *The* -cem- *Stata® command (Blackwell* et al.*, 2009) was used to perform this matching.*

Figure III – **Connected vs unconnected**



Note: This map zooms in on a specific area near Thiès, Senegal, representing the connectivity status of respondents based on their proximity to a central backbone (represented by a black line). Buffer zones, shown in grey on the map, represent people located between 1 and 1.5 km from the backbone network. They are excluded from the analysis. The shape of the dots indicates the distance from the backbone.

status, and marital status), exact matching was used while for continuous variables, bins were created. The age of the mother was divided into four strata, each covering 8 years (15-23; 24-32; 33-40; 41-49). The household wealth index factor was divided into five strata by quintile while child birth order was divided into 4 strata based on the distribution (1st kid; 2nd or 3rd; 4th or 5th; 6th or above). For the use of antenatal care, out of the 965 strata created, 532 were matched representing 11,847 observations out of 12,693 (93%). For the use of bednet out of the 364 strata created, 277 were matched representing 15,514 observations out of 15,750 (98%). Finally, for child vaccination, out of the 844 strata created, 469 were matched representing 8,897 observations out of 9,625 (92%). Once the weights were obtained from the matching, ordinary least squares regression was used.

In robustness analyses, urban and rural areas were analyzed separately. Then, the cut-offs for treated and controls were modified to limit the bias linked to the displacement of GPS localizations. In the second robustness analysis, we modified the control group to include people living between 3 km and 10 km from the backbone network in urban areas and people living between 6 km and 10 km from the backbone network in rural areas. In a third robustness analysis, the cut-off of 500 m used by Hjort & Poulsen (2019) for the treated group was considered. Finally, alternative coding of the health outcomes was used. Regarding antenatal care, different cut-offs were considered (8 visits as recommended since 2016 or 3 visits as recommended before 2002). Regarding the use of bednet, we considered a dummy variable equal to 1 only if all under-5 children slept under a bednet during the previous night and we restricted to household with bednets. Regarding vaccination, analyses were disaggregated by vaccines. In addition, robustness analysis performed heterogeneity analyses by wealth quintile and educational level. As the methodology with cells fixed effects relies on the hypothesis of no migration over time some robustness analyses with a measure of population density were performed. Lastly, since our proxy for healthcare offer (density of healthcare structures) extracted from the SPA database is not perfect, the main regressions were conducted with an alternative measure, the distance to the closest healthcare facility.

Geographical data were dealt with using R while regression analyses were run using Stata® version 17. With both methodologies, the same datasets were used.

2. Results

Table 2 displays the descriptive statistics before and after treatment. As the years considered varied from one outcome to another given data availability, the table is split into panel A for the use of antenatal care, panel B for the use of bednet, and panel C for child immunization. At baseline there was a higher utilization of antennal care from respondents living connected in areas, this difference was still significant after treatment following progress in both treatment and control groups. In detail, before treatment, only 29% of respondents were using antenatal care in the control group, whereas this percentage was up to 35% in the treated group. After treatment, the use of antenatal care was around 52% and 58% in the control and treatment groups, respectively. The use of bednet was significantly higher for the treated group both before (45% vs 41%) and after treatment (73% vs 57%). This difference between the two groups increased over time. Child immunization was equal to 59% at baseline for the two groups. After treatment, the mean vaccination score was 73% and 72% for unconnected and connected respondents, respectively. In all cases (panels A, B, and C) respondents living in connected areas were on average more urban, wealthier, and more educated than unconnected respondents, both before and after treatment.

In addition, the variable "density of healthcare structures", used as a proxy of the healthcare supply at the regional level in 2012, varied from 0.001 to 0.131 per km^2 with an average of 0.012. As part of the robustness analyses, the distance from the closest healthcare facility was used. The distance varied from 0.1 km to 45 km with an average of 6.4 km. We looked at the distance for connected and unconnected respondents separately. For connected respondents, the average distance was 4.8 km whereas for unconnected respondents the average distance was 7.1 km, this difference being significant ($t=22$, $p<0.01$).

Before conducting the regression analyses, the parallel trend assumption (i.e. the stability in the difference in the outcome variable between the 'treatment' and 'control' group over time in the absence of treatment) was checked as illustrated by Figure IV. For the use of antenatal care and bednet, the years displayed in Figure IV were the ones used for regression analyses. For child immunization, the 1992 wave (the most recent wave available before 2005) was added to the graphical representation but was not used in regression analysis as it was judged too old. Graphically, the parallel trend assumption seems

Table 2 – **Descriptive statistics**

Variables	Before [a]			After [b]		
	Treated (0-1 km)	Control (1.5-10 km)	Difference	Treated (0-1 km)	Control (1.5-10 km)	Difference
Panel A: Use of antenatal care						
Use of antenatal care	**0.35 (0.48)**	**0.30 (0.46)**	**0.05*** (0.01)**	**0.58 (0.49)**	**0.52 (0.50)**	**0.06*** (0.02)**
Controls						
Urban	0.65 (0.48)	0.45 (0.50)	0.20*** (0.01)	0.75 (0.43)	0.38 (0.48)	0.36*** (0.02)
Age	29.58 (7.35)	29.77 (7.20)	−0.18 (0.20)	30.05 (7.10)	29.83 (7.29)	0.26 (0.24)
Wealth index	0.33 (0.93)	0.21 (1.15)	0.12*** (0.03)	5.10 (8.49)	0.39 (10.17)	4.89*** (0.33)
Education level						
No education	0.61 (0.49)	0.69 (0.46)	−0.07*** (0.01)	0.49 (0.50)	0.64 (0.48)	−0.14*** (0.02)
Primary	0.29 (0.45)	0.21 (0.41)	0.08*** (0.01)	0.30 (0.46)	0.22 (0.42)	0.07*** (0.01)
Secondary or higher	0.10 (0.29)	0.10 (0.30)	0.00 (0.01)	0.20 (0.40)	0.13 (0.34)	0.07*** (0.01)
Married or living together	0.92 (0.27)	0.92 (0.27)	0.00 (0.01)	0.88 (0.33)	0.94 (0.24)	−0.06*** (0.01)
Currently working	0.48 (0.50)	0.48 (0.50)	0.00 (0.01)	0.43 (0.50)	0.41 (0.49)	0.02 (0.02)
Child birth order	3.93 (2.66)	4.05 (2.67)	−0.12* (0.07)	3.43 (2.27)	3.68 (2.40)	−0.21*** (0.08)
N	2,003	4,010		986	2,347	
Panel B: Use of bednet						
Use of bednet	**0.45 (0.50)**	**0.41 (0.49)**	**0.05*** (0.01)**	**0.73 (0.44)**	**0.57 (0.50)**	**0.17*** (0.01)**
Controls						
Urban	0.59 (0.49)	0.38 (0.49)	0.21*** (0.01)	0.76 (0.43)	0.39 (0.49)	0.36*** (0.01)
Age	28.85 (7.02)	29.27 (7.02)	−0.42*** (0.15)	29.79 (6.87)	29.67 (6.87)	0.12 (0.21)
Wealth index	1.88 (5.97)	0.70 (8.10)	1.19*** (0.16)	3.71 (8.68)	0.92 (9.78)	2.80*** (0.30)
Education level						
No education	0.62 (0.49)	0.71 (0.45)	−0.09*** (0.01)	0.51 (0.50)	0.65 (0.48)	−0.14*** (0.02)
Primary	0.28 (0.45)	0.22 (0.41)	0.06*** (0.01)	0.32 (0.47)	0.24 (0.43)	0.08*** (0.01)
Secondary or higher	0.09 (0.29)	0.07 (0.26)	0.02*** (0.01)	0.17 (0.37)	0.11 (0.31)	0.06*** (0.01)
Child birth order	3.51 (2.40)	3.75 (2.52)	−0.24*** (0.05)	3.43 (2.36)	3.53 (2.35)	−0.10 (0.07)
N	3,333	7,328		1,477	3,350	
Panel C: Child immunization						
Child immunization	**0.59 (0.49)**	**0.59 (0.49)**	**0.00 (0.02)**	**0.72 (0.45)**	**0.73 (0.44)**	**−0.01 (0.02)**
Controls						
Urban	0.67 (0.47)	0.43 (0.49)	0.25*** (0.02)	0.76 (0.43)	0.40 (0.49)	0.36*** (0.02)
Age	29.53 (6.90)	29.68 (6.84)	−0.16 (0.25)	30.35 (6.76)	30.11 (6.89)	0.24 (0.24)
Wealth index	0.33 (0.87)	0.05 (1.06)	0.28*** (0.04)	3.88 (8.70)	1.00 (9.73)	2.88*** (0.33)
Education level						
No education	0.60 (0.49)	0.72 (0.45)	−0.12*** (0.02)	0.52 (0.50)	0.66 (0.48)	−0.14*** (0.02)
Primary	0.30 (0.46)	0.21 (0.41)	0.09*** (0.02)	0.33 (0.47)	0.24 (0.43)	0.08*** (0.02)
Secondary or higher	0.10 (0.30)	0.07 (0.26)	0.03*** (0.01)	0.16 (0.37)	0.11 (0.30)	0.06*** (0.01)
Married or living together	0.95 (0.22)	0.94 (0.23)	0.01 (0.01)	0.88 (0.32)	0.94 (0.23)	−0.06*** (0.01)
Currently working	0.42 (0.49)	0.33 (0.47)	0.09*** (0.02)	0.51 (0.50)	0.42 (0.49)	0.09*** (0.02)
Child birth order	3.55 (2.42)	3.67 (2.52)	−0.12 (0.09)	3.46 (2.38)	3.50 (2.35)	−0.04 (0.08)
N	1,255	2,077		1,153	2,603	

[a] for Panel A: 1997 & 2005; for Panel B: 2005 & 2008; for Panel C: 2005.
[b] for Panel A: 2014 & 2016; for Panel B and C: 2012 & 2014.
Note: The first three columns "Before" refer to the period before arrival of broadband connection in Senegal while the last three columns "After" refer to the period of the arrival of broadband connection. The treatment group is composed of all individuals located between 0 and 1,000 meters from the closest backbone. The control group is made up of individual who are located between 1,500 meters and 10 kms from the blackbone. Means with standard errors in parentheses. ***p<0.01; **p<0.05; *p<0.1.

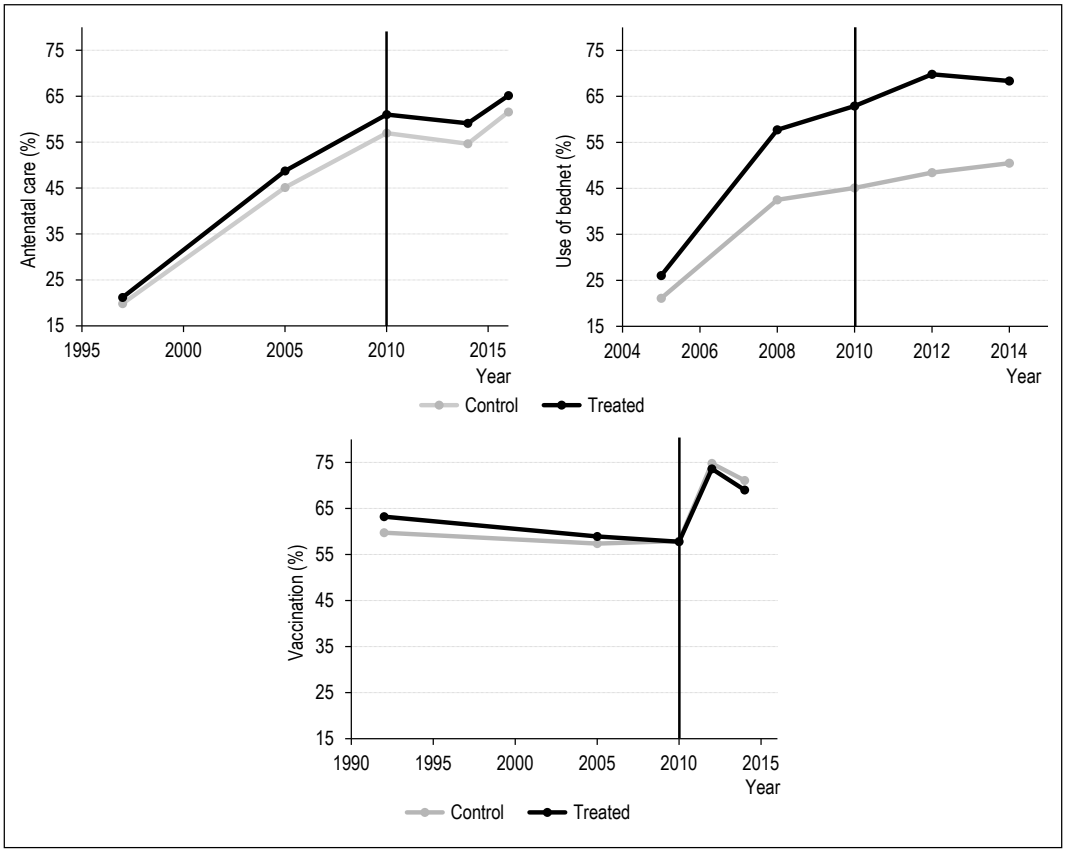
to hold for all three outcomes. Indeed, before the arrival of submarine optic-fiber cables in 2010, represented by the vertical line, outcome variables appeared to evolve in parallel. In addition, placebo tests with an earlier treatment date were performed for all the three outcomes. Placebo tests consist of running the regression with a fake treatment date prior to actual treatment, then necessitating at least two periods before treatment. No impact was found for our three outcomes confirming our visual impression that before actual treatment our two groups had similar evolution. Results of these tests are available in Appendix A1.

The results of the regression analyses are presented in Table 3. Mixed results were found regarding the utilization of antenatal care. While the first methodology using fixed effects highlighted a positive and significant association between broadband internet access and the use of antenatal care, the second methodology pointed to no impact. Regarding the utilization of bednet, our results pointed out a positive effect of the arrival of broadband internet with both methodologies. As could be expected from the descriptive statistics, broadband internet access did not seem to impact child immunization. Results of regression analyses including all control variables are available in Appendix A2. To ensure that the suppression of households between 1 km and 1.5 km from the backbone network does not create a selection bias, complementary analyses have been performed and results are available in Appendix A3.

Several robustness analyses were conducted to confirm the main findings. First, the main analysis was performed for urban and rural areas separately. Results are displayed in Table 4. Our main finding regarding the positive impact of internet access on the use of bednet was confirmed. Use of antenatal care also seemed to increase for connected respondents in urban areas, but not in rural areas. On the contrary, internet access was found to decrease child vaccination in rural areas.

Secondly, the cut-offs used to classify connected and unconnected respondents were modified as explained in the material and methods section. Results are displayed in Table 5. The positive association between internet access and the use of bednet was confirmed in the first two

Figure IV – **Parallel trend assumption**



Note: In this figure, each point represents the share of individual having used antenatal care, bednet, and child immunization for the specified group and for each available wave. The treatment group consists of individuals located within 1,000 meters of the nearest backbone. The control group consists of those located between 1,500 meters and 10 kms.

Table 3 – **Results of regressions analyses**

Outcome	Fixed effects	Matching	Impact of broadband
Use of antenatal care	0.057* (p=0.058)	−0.030 (p=0.240)	Positive / Not significant
N	9,346	8,703	
Use of bednet	0.143* (p=0.056)	0.078*** (p<0.001)	Positive
N	15,488	15,254	
Child immunization	−0.060 (p=0.460)	−0.007 (p=0.822)	Not significant
N	7,088	6,551	

Note: The "Fixed effects" column displays the reported estimates of the β coefficient on the $Subcables_i$*$Connected_i$ variable in model (1). Time fixed effects correspond to years, while Location fixed effects represent grid-cells of 0.1 x 0.1 decimal degrees, approximately equivalent to 10 kms x 10 kms. Individuals within a 1 km proximity to the backbone network are classified as connected, while those located between 1.5 km and 10 km from the backbone are considered controls. Robust standard errors are clustered at the level of Location fixed effects. The regressions include control variables such as urban or rural classification, age, wealth index, education level, marital status and employment status of the mother, and child birth order. The "Matching" column presents the estimation results of the Difference-in-Differences (DiD) analysis with coarsened exact matching, based on the localization of residence, household wealth index factor, age, highest educational level, working status and marital status of the mother, and child birth order variables. Each row reports the results for a distinct outcome variable. ***p<0.01; **p<0.05; *p<0.1.

specifications. A positive impact of internet access on antenatal care utilization was found when the distance to the backbone used to identify connected respondent is reduced, supporting the mixed results found in the main specification. However, given the displacement of the data and the lack of support for the 500 m limit from a technical point of view, results with this cut-off should be treated with caution. Lastly, child immunization did not seem to be impacted on average by internet access in robustness checks.

Alternative coding of the outcomes was also tested with Table 6 displaying the results. Once again, the main findings were confirmed. Mixed results were found regarding the use of antenatal care while a positive effect of broadband internet on bednet use was evidenced and no effect on child immunization was found.

In addition, as our outcomes, and especially child vaccination, could have been affected by disinformation spread on the internet some heterogeneity analyses were conducted. As income or education levels were found to be linked with the probability to holds such beliefs (Douglas *et al*., 2019), analyses based on the quintile of wealth and educational level were performed to identify a potential differentiated effect of internet access. Results are available in Appendix A4. The main findings were confirmed, no matter the level of wealth or education internet access did not impact children's vaccination except for those with a secondary or higher education level for which a positive impact was found. The use of bednet increased for respondents with lower levels of wealth (poorest, poorer, intermediate) or education (no education, primary) and the effect on the use of antenatal care remained uncertain.

Robustness analyses conducted with the variation of population density over time showed no major migration of individuals from unconnected areas to connected areas. More details are available in Appendix A5.

Table 4 – **Results of robustness analyses for urban and rural areas**

	Urban areas		Rural areas	
Outcome	Fixed effects	Matching	Fixed effects	Matching
Use of antenatal care	**0.087*** **	−0.016	0.062	−0.047
	(p=0.009)	(p=0.632)	(p=0.536)	(p=0.259)
N	4,769	4,506	4,577	4,197
Use of bednet	0.118	**0.095*** **	**0.279*** **	**0.057***
	(p=0.149)	(p<0.001)	(p<0.001)	(p=0.078)
N	7,200	7,130	8,288	8,124
Child immunization	−0.057	−0.001	**−0.338*** **	−0.018
	(p=0.574)	(p=0.973)	(p=0.001)	(p=0.686)
N	3,637	3,441	3,451	3,110

Note: The same models (Fixed effects and Matching) are estimated by subgroups of individuals (urban areas vs rural areas).
***p<0.01; **p<0.05; *p<0.1.

Table 5 – **Results of robustness analyses with different cut-offs for treated and control group**

	Control group >3 km (urban area) or >6 km (rural area) from backbone		Analysis of urban areas only and control group >3 km from backbone		Treatment group <=500 m and control group >500 m from backbone		Treatment group <=500 m and control group >3 km (urban area) or >6 km (rural area) from backbone	
Outcome	Fixed effects	Matching	Fixed effects	Matching	Fixed effects	Matching	Fixed effects	Matching
Use of antenatal care	0.073 (p=0.145)	−0.009 (p=0.789)	0.086 (p=0.150)	0.020 (p=0.645)	**0.091*** (p=0.002)	**0.049*** (p=0.094)	**0.112**** (p=0.040)	0.053 (p=0.163)
N	5,926	5,609	3,360	3,201	10,375	8,703	4,657	4,394
Use of bednet	**0.172**** (p=0.015)	**0.077***** (p=0.001)	**0.161**** (p=0.042)	**0.073**** (p=0.022)	0.068 (p=0.581)	0.016 (p=0.493)	0.141 (p=0.272)	0.023 (p=0.433)
N	9,464	9,343	4,936	4,790	17,491	14,905	7,205	6,979
Child immunization	−0.035 (p=0.712)	0.008 (p=0.844)	−0.050 (p=0.666)	−0.001 (p=0.978)	−0.069 (p=0.205)	−0.052 (p=0.118)	−0.008 (p=0.926)	−0.033 (p=0.444)
N	4,642	4,360	2,679	2,545	7,901	6,551	3,429	3,218

Note: The same models (Fixed effects and Matching) are estimated by varying the connection radius and the distances to determine the control group. ***p<0.01; **p<0.05; *p<0.1.

Table 6 – **Results of robustness analyses with different outcomes**

	Outcome	Fixed effects	Matching
Use of antenatal care	*At least 4 visits*	***0.057**** *(p=0.058)*	*−0.030 (p=0.240)*
	N	9,346	8,703
	At least 3 visits	−0.019 (p=0.680)	−0.017 (p=0.403)
	N	9,346	8,703
	At least 8 visits	0.010 (p=0.196)	**0.012**** (p=0.049)
	N	9,346	8,703
Use of bednet	*Some children*	***0.143**** *(p=0.056)*	***0.078***** *(p<0.001)*
	N	15,488	15,254
	All children	**0.121*** (p=0.062)	**0.071***** (p=0.001)
	N	15,488	14,905
	Some children with a restriction to households with bednet	**0.123*** (p=0.070)	**0.080***** (p<0.001)
	N	15,152	14,558
Child immunization	*Complete EPI*	*−0.060 (p=0.460)*	*−0.007 (p=0.822)*
	N	7,088	6,551
	BCG vaccination	−0.039 (p=0.214)	−0.014 (p=0.305)
	N	9,071	8,399
	DPT/Pentavalent vaccination	−0.030 (p=0.455)	−0.005 (p=0.812)
	N	9,052	8,381
	OPV vaccination	−0.017 (p=0.781)	0.005 (p=0.827)
	N	9,055	8,384
	Measles vaccination	0.003 (p=0.964)	0.007 (p=0.785)
	N	9,017	8,346

Note: The same models (Fixed effects and Matching) are estimated by changing the outcomes used. Original outcomes are in italics. ***p<0.01; **p<0.05; *p<0.1.

Lastly, as controlling for healthcare supply is important but our indicator of healthcare centers' density has some limits (available only at the regional level and constant throughout the period studied) supplementary analyses were conducted using the distance to the closest healthcare facility. However, this alternative measure also bears some limits as we do not have information on the date of creation of the healthcare facilities, thus this variable is constant throughout

the period studied. Using this alternative variable, our results still hold and no difference is observed as shown in Appendix A6.

3. Discussion

According to our initial hypothesis, the arrival of broadband internet, and thus of increased information flows, combined with exposure to a larger variety of information sources was expected to increase knowledge in the healthcare domain translating into higher preventive healthcare demand. However, we found mixed results regarding the impact of broadband internet on various preventive health behaviors. Confirming our initial hypothesis, access to the internet was associated with an increase of bednet utilization for under 5 children. Heterogeneity analyses highlighted this positive impact for respondents with lower levels of wealth or education. Results regarding the impact of internet access on the utilization of antenatal care remained unclear, since there seemed to be a positive impact in some of our specifications, especially in urban areas, but not in others. Finally, no significant result was found in regression analyses regarding child vaccination, meaning that internet access did not seem to influence child immunization.

The positive association between internet access and some preventive health indicators (use of bednet in particular) is a positive finding for public authorities. Indeed, once broadband internet access is established, communication campaigns, which are among the most cost-effective interventions in the health domain, can easily be set up. As a result, the health of the population could be improved at low costs. Such campaigns have proven to be effective (Wakefield *et al*., 2010). Still, an important challenge remains for public authorities in order to make sure that information of quality is easily accessible on official websites and in all the languages needed.

The mixed or non-significant results for some of the outcomes studied (use of antenatal care and child immunization) seem in line with recent literature on the subject (Edmeades *et al*., 2022). It could be explained by the fact that people may use the internet rather for entertainment purposes than for informative purposes (Falck *et al*., 2014). Indeed, online care-seeking behaviors might be uncommon at first and public authorities may need to launch official platforms and online health promotion campaigns to provide trusted health information and build e-health literacy capacity among the population. Moreover, as evidenced by the literature presented in the introduction section, information provision can have a heterogeneous effect on different types of behaviors. Thus, it is also possible that access to broadband does not impact all preventive health behaviors, and therefore more research is needed to understand why internet access has a heterogeneous impact on various health behaviors. One explanation could be linked to the results of Jalan & Somanathan (2008) who found that giving specific information on contamination of water sources (i.e. telling each household the actual level of fecal contamination) led to deeper changes in healthcare behaviors (i.e. purifying their water) compared to the households that were only informed about the general importance of treating water. Our mixed results might then be explained by the lack of specific and targeted information online. In addition, it is also possible that the length of exposure to information matters regarding its effect on healthcare behaviors. Indeed, in the studies of Cairncross *et al*. (2005) and Luby *et al*. (2004) educational interventions were conducted over months and a positive effect was found whereas in the studies reviewed by Meredith *et al*. (2013) one-time-only visit did not have any effect. Although in our case the potential length of exposition to information is important, but we do not know how frequently respondents looked for information and a one-time visit to a webpage might not be enough to modify behaviors.

It is also important to keep in mind that access to internet can also increase exposition to health misinformation. As the recent COVID-19 pandemic has illustrated, such misinformation can have dramatic consequences on health behaviors (Baranes *et al*., 2022). In our case, the use of antenatal care and bednet are less likely to be sensitive to disinformation while vaccination is very often affected by fake news that fuel vaccine hesitancy which remains an important issue in Africa (Cooper *et al*., 2018). This could explain the negative association found between internet access and child immunization in rural areas, combined with difficulties in healthcare access. Indeed, if someone fears vaccination, they will make less effort to go to healthcare centers. However, the heterogeneity analyses conducted highlighted no clear differentiated effect for the poorest or less educated respondents, which are more susceptible to adhere to by conspiracy beliefs (Douglas *et al*., 2019), pointing to the relatively low influence of such phenomenon in our study. More globally, the quality of the information found on the internet is a real concern. Eysenbach *et al*. (2002) conducted a systematic review of studies

assessing the quality of health information online and found that 70% of included studies concluded that quality is an issue. More recently, while analyzing prostate cancer information online, Moolla *et al*. (2020) highlighted that the majority of websites are unreliable as a source of information by themselves for patients. Even though those studies looked at information available online worldwide, and mostly consulted by people leaving in developed countries, there is no reason to think that the quality of information online is not a matter in SSA also.

Some limitations of this study can be underlined. First, we only measured internet access and not internet use. As some households located in the treatment area are not internet users for financial or other reasons, our analysis tends to underestimate the effect of information provided through internet on health behaviors. However, even if we could not measure actual internet use, according to the International Telecommunication Union, the percentage of individuals using internet was more than multiplied by 3 between 2009 and 2016 (from 7.5% to 25.6%) in Senegal.[8] Second, while our outcome variables were more likely to be influenced by mothers, we did not know among households with internet connection which members can decide to buy internet access or use it. Third, we do not have information on possible obstacles to healthcare centers' access, thus mothers might have been informed about the four antenatal care visits recommended thanks to internet but not able to consult. This could explain why we found a positive effect of internet access in urban areas but not in rural areas where geographical constraints to access are higher. Additionally, traditional awareness campaigns were likely conducted during the period studied, potentially trageting areas not broadband connected in the first instance, allowing respondents from unconnected areas to have access to information they would not have had otherwise, leading to an underestimation of the effect of internet access on health behaviors. Broadband internet access could also possibly affect the healthcare supply and introduce some bias in our results. Indeed, doctors and other skilled medical staff might also benefit from easier access to information to improve their medical practice. However, as our outcome variables fall under primary care and only require basic medical knowledge, it is unlikely that such issues affected our results. Indeed, medical workers should already know the importance of antenatal consultations, child vaccination, and bednet utilization without broadband internet. Moreover, vaccination or prenatal monitoring require in person-consultation and cannot be done via tele-consultation since physical acts are needed. However, broadband internet access can influence the management of vaccine stocks and allow easier access to bednet purchase. Moreover, as mentioned in the data section, GPS localization is not exact in DHS data. As a result, some individuals might have been wrongly assigned to treatment and control groups, especially in rural areas where displacements for anonymity reasons can be made further away. However, to tackle this issue, we conducted different robustness analyses using different backbone distance cut-offs for treatment and control groups and a sub-analysis on urban areas only. All these robustness analyses confirmed the results of the main analysis then pointing to no or a low bias introduced by this issue. At last, we did not consider the migration of individuals over time, as DHS data does not allow it. This could be a problem with the first methodology if some respondents, with specific characteristics, decided to move from unconnected to connected areas because of internet access. However, our robustness analyses using change in population density seem to rule out a major impact of this issue. Moreover, the matching performed in the second methodology allowed us to make sure that differences in observable characteristics among respondents remained constant, then limiting this issue. Lastly, as there may be an omitted variable, the causal impact of our results must be used with caution while discussing the results.

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In the future, investigations on other sub-Saharan countries could be conducted to confirm our results and to test whether geographical disparities exist. Indeed, the timing of connection to sub-marine cables differed from one country to another in sub-Saharan Africa. The first African submarine internet cables arrived in 2009 and covered the east coast of Africa, while the western part of Africa was connected in 2010-2011 and the southeast part of Africa in 2012. These differences in the timing of optic-fiber submarine cables connection between African countries could be exploited to produce more robust results and to assess whether internet access had a differentiated effect on health behaviors depending on countries. The

8. https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx – accessed June 2023.

first studies on the topic seem to point out that relationship between digital resources use and health outcomes are linked to the country's context (Edmeades, 2022), reinforcing the need for further studies to better understand those mechanisms.

If the positive impact of internet access on some health outcomes, such as bednet use, are further confirmed, expansion of broadband internet could have important positive spillover effects to improve health through increased access to information. Prevention and promotion health campaigns would have to integer online campaigns as complementary to in-person actions to improve their efficacy and efficiency. On the other hand, equal access to the internet across a territory, especially between rural and urban areas, would be extremely important not to exacerbate already existing geographical health inequalities. □

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APPENDIX A1

RESULTS OF PLACEBO TESTS

Table A1 – **Results of placebo tests with the first methodology**

	Use of antenatal care	Use of bednet	Child immunization
Treatment	0.027 (p=0.46)	0.127 (p=0.11)	−0.032 (p=0.84)
Urban	0.044 (p=0.32)	−0.103* (p=0.05)	0.185** (p=0.02)
Age	0.004*** (p=0.01)	0.003** (p=0.03)	0.006*** (p=0.00)
Wealth index	0.077*** (p=0.00)	−0.001 (p=0.913)	
Education level	0.019* (p=0.07)	0.007 (p=0.64)	0.105*** (p=0.00)
Married or living together	−0.079*** (p=0.00)		−0.079** (p=0.04)
Currently working	−0.030* (p=0.06)		−0.021 (p=0.18)
Kid birth order	−0.023*** (p=0.00)	−0.008** (p=0.04)	−0.021*** (p=0.00)
Density of healthcare center			−1.070*** (p=0.00)
Constant	0.164* (p=0.05)	0.322*** (p=0.00)	0.539*** (p=0.00)
2005	0.267*** (p=0.00)		−0.057 (p=0.70)
2008		0.206*** (p=0.00)	
N	9,346	10,661	4,770

***p<0.01; **p<0.05; *p<0.1.

Placebo tests with an earlier treatment date were performed for all three outcomes with the first methodology. Placebo tests consist of running the regression with a fake treatment date prior to actual treatment (between 1997 and 2005 for antenatal care, between 2005 and 2008 for use of bednet, and between 1992 and 2005 for child immunization). The wave 1992 DHS wave for Senegal was added in order to perform the placebo test for child immunization as at least two periods before treatment are needed. No impact was found for our three outcomes confirming (first line), confirming that before actual treatment our two groups had similar evolutions).

APPENDIX A2

FULL RESULTS OR REGRESSIONS ANALYSES

Table A2-1 – **Full results of regressions analyses with the first methodology**

	Use of antenatal care	Use of bednet	Child immunization
Treatment	0.058* (p=0.06)	0.143* (p=0.06)	−0.060 (p=0.46)
Urban	0.022 (p=0.59)	−0.116* (p=0.07)	0.069 (p=0.16)
Age	0.006*** (p=0.00)	0.003** (p=0.02)	0.006*** (p=0.00)
Wealth index	0.012*** (p=0.00)	−0.002 (p=0.21)	0.001 (p=0.82)
Education level	0.043*** (p=0.00)	0.024 (p=0.11)	0.059*** (p=0.00)
Married or living together	−0.089*** (p=0.00)		−0.115** (p=0.02)
Currently working	−0.023 (p=0.14)		−0.010 (p=0.59)
Child birth order	−0.029*** (p=0.00)	−0.007** (p=0.01)	−0.022*** (p=0.00)
Density of healthcare center	−1.718*** (p=0.00)	−22.667** (p=0.03)	−65.248*** (p=0.00)
2005	0.273*** (p=0.00)		
2008		0.267*** (p=0.00)	
2012		0.265*** (p=0.00)	0.136** (p=0.04)
2014	0.210*** (p=0.00)	0.323*** (p=0.00)	0.086* (p=0.06)
2016	0.313*** (p=0.00)		
Constant	0.287*** (p=0.00)	1.589*** (p=0.01)	4.110*** (p=0.00)
N	9,346	15,488	7,088

***p<0.01; **p<0.05; *p<0.1.

Table A2-2 – **Full results of regressions analyses with the second methodology**

	Use of antenatal care	Use of bednet	Child immunization
Treatment	−0.030 (p=0.240)	0.078*** (p=0.000)	−0.007 (p=0.822)
Connected	0.035** (p=0.017)	−0.044*** (p=0.000)	−0.013 (p=0.582)
Submarine	0.176*** (p=0.000)	0.181*** (p=0.000)	0.125*** (p=0.000)
Urban	−0.042*** (p=0.003)	−0.023** (p=0.035)	0.044*** (p=0.009)
Age	0.008*** (p=0.000)	0.001 (p=0.382)	0.008*** (p=0.000)
Wealth index	0.011*** (p=0.000)	0.002*** (p=0.009)	0.001 (p=0.581)
Education level	0.053*** (p=0.000)	0.019*** (p=0.009)	0.084*** (p=0.000)
Married or living together	−0.136*** (p=0.000)		−0.109*** (p=0.003)
Currently working	−0.042*** (p=0.001)		−0.014 (p=0.350)
Child birth order	−0.031*** (p=0.000)	−0.000 (p=0.982)	−0.022*** (p=0.000)
Density of healthcare center	−0.144 (p=0.296)	−2.586*** (p=0.000)	−0.557*** (p=0.003)
Constant	0.406*** (p=0.000)	0.517*** (p=0.000)	0.485*** (p=0.000)
N	8,703	15,254	6,551

***p<0.01; **p<0.05; *p<0.1.

APPENDIX A3

RESULTS OF COMPLEMENTARY ANALYSES ON POTENTIAL SELECTION BIAS

Table A3 – **Results of complementary analyses on potential selection bias**

	Treated group <1.2 km & Control group >1.4 km from backbone		Treated group <1.25 km & Control group >1.25 km from backbone	
Outcome	Fixed effects	Matching	Fixed effects	Matching
Use of antenatal care	0.008	−0.035	0.004	−0.033
	(p=0.855)	(p=0.158)	(p=0.933)	(p=0.167)
N	9,901	9,346	10,375	9,816
Use of bednet	**0.127***	**0.082*****	**0.131****	**0.094*****
	(p=0.074)	(p=0.001)	(p=0.050)	(p=0.001)
N	16,700	16,475	17,491	17,266
Child immunization	−0.043	−0.018	−0.048	−0.035
	(p=0.518)	(p=0.513)	(p=0.445)	(p=0.188)
N	7,584	7,062	7,901	7,384

***p<0.01; **p<0.05; *p<0.1.

APPENDIX A4

RESULTS OF HETEROGENEITY ANALYSES

Table A4-1 – **Heterogeneity analyses on wealth quintile**

	Poorest		Poorer		Intermediate		Richer		Richest	
Outcome	Fixed effects	Matching	Fixed effects	Matching	Fixed effects	Matching	Fixe deffects	Matching	Fixed effects	Matching
Use of ante-natal care	**−0.452****	**−0.181****	0.066	−0.047	−0.002	−0.049	**0.154*****	0.074	0.056	−0.068
	(p=0.001)	(p=0.014)	(p=0.585)	(p=0.495)	(p=0.981)	(p=0.309)	(p<0.001)	(p=0.141)	(p=0.208)	(p=0.232)
N	1,661	1,473	1,819	1,696	2,214	2,112	2,025	1,901	1,627	1,532
Use of bednet	**0.449***	0.055	**0.205***	**0.164*****	0.116	**0.087***	0.099	−0.001	0.132	0.071
	(p=0.052)	(p=0.391)	(p=0.076)	(p=0.001)	(p=0.259)	(p=0.014)	(0.340)	(p=0.986)	(p=0.225)	(p=0.130)
N	2,826	2,697	3,595	3,465	3,819	3,715	3,015	2,910	2,233	2,118
Child immunization	0.268	0.092	−0.039	−0.122	−0.037	0.018	−0.261	−0.006	0.014	0.021
	(p=0.625)	(p=0.388)	(p=0.734)	(p=0.113)	(p=0.685)	(p=0.730)	(p=0.122)	(p=0.915)	(p=0.933)	(p=0.735)
N	1,110	966	1,434	1,636	1,904	1,798	1,483	1,397	1,157	1,068

***p<0.01; **p<0.05; *p<0.1.

Table A4-2 – **Heterogeneity analyses on the educational level**

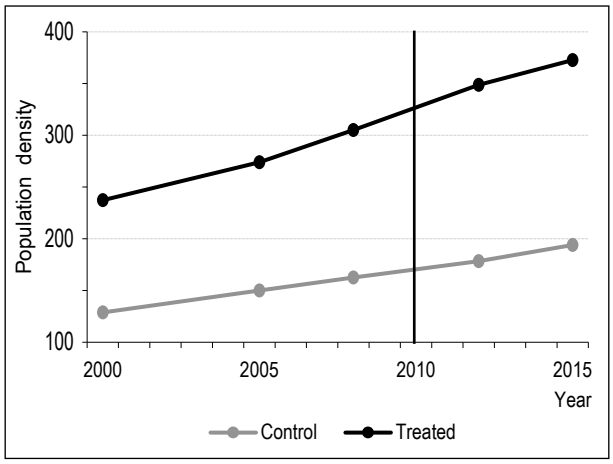
	No education		Primary		Secondary or higher	
Outcome	Fixed effects	Matching	Fixed effects	Matching	Fixed effects	Matching
Use of antenatal care	−0.038	−0.009	**0.171*****	−0.021	0.057	**−0.143****
	(p=0.532)	(p=0.792)	(p=0.001)	(p=0.666)	(p=0.485)	(p=0.035)
N	5,979	5,723	2,263	2,038	1,104	942
Use of bednet	0.122	**0.050***	**0.189****	**0.111*****	0.105	0.088
	(p=0.176)	(p=0.057)	(p=0.047)	(p=0.002)	(p=0.266)	(p=0.120)
N	10,210	10,063	3,836	3,584	1,442	1,258
Child immunization	−0.088	−0.011	−0.133	−0.027	−0.007	**0.129***
	(p=0.379)	(p=0.773)	(p=0.305)	(p=0.603)	(p=0.957)	(p=0.099)
N	4,539	4,324	1,827	1,626	722	601

***p<0.01; **p<0.05; *p<0.1.

APPENDIX A5

RESULTS OF ROBUSTNESS ANALYSES ON THE POPULATION DENSITY

Figure A5 – **Evolution of the density of population in Senegal between 2000 and 2015**



From additional data, we checked if the population density evolved due to internet access. Figure A5 shows that in both connected areas (treated group) and unconnected areas (control group), population density increased over the period. However, the increase in density is higher in connected areas than in unconnected are ($t=3.67$, $p<0.01$). Yet, those results are still reassuring, the growth rate of population density was already higher in connected areas before treatment. The arrival of broadband internet does not seem to have had a huge impact on migrations from unconnected to connected places.

APPENDIX A6

RESULTS OF ROBUSTNESS ANALYSES WITH ALTERNATIVE PROXIES OF HEALTHCARE SUPPLY

Table A6 – **Results of regressions analyses with distance to the closest healthcare facility instead of density of healthcare center**

Outcome	Fixed effects	Matching
Use of antenatal care	0.057* (p=0.064)	−0.029 (p=0.268)
N	9,346	8,703
Use of bednet	0.133* (p=0.070)	0.095*** (p<0.001)
N	15,488	15,254
Child immunization	−0.074 (p=0.356)	0.001 (p=0.998)
N	7,088	6,551

***p<0.01; **p<0.05; *p<0.1.

The Effect of Informal Care Provided by Children on Health in Nursing Homes

Quitterie Roquebert*

Abstract – This paper estimates the causal effect of informal care provided by children on health outcomes for nursing home residents. We exploit the cross-sectional French survey *CARE-Institutions* (2016) providing a representative sample of 2,382 residents aged 60 or more, with children. Adverse health outcomes are depression, sleep disorders, poor appetite, and feelings of weariness. To deal with the endogeneity of informal care, we exploit an instrumental variable strategy where informal care receipt is instrumented by the gender composition of siblings. Informal care is found to have overall little effect on these health outcomes, and this is stable across gender and education level. These results are contrasting with those observed at home and call for further researches on the specific determinants of health and well-being in nursing homes.

JEL: D10, I10, J14, I18
Keywords: aging, nursing homes, health, informal care

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Aging populations are associated with an increase of long-term care needs and costs. Informal care, defined as unpaid care provided by relatives, plays a major role in long-term care provision. While much attention has been paid to informal care provided to older persons living in the community, the literature on the role played by relatives in nursing homes is much more limited. However, evidence suggest that relatives are still providing concrete care for people living in nursing homes on top of providing emotional support (Keating *et al*., 2001; Gaugler, 2005; Jeanneau *et al*., 2022). This issue has been particularly raised by the COVID-19 pandemic: several studies have shown that lockdowns in nursing homes increased the loneliness of residents and diminished their well-being (Giebel *et al*., 2020; Roest *et al*., 2020; Verbeek *et al*., 2020; McArthur *et al*., 2021). Using the French survey CARE, Jeanneau *et al*. (2022) provide a detailed description of informal care in nursing homes. They show that three out of four nursing home residents receive informal care in France for the activities of daily living, with relatives being primarily involved in administrative tasks and activities related to mobility and the outside. Using the same data, Roquebert & Tenand (2023) show that the annual economic value of informal care provided in nursing homes represents an equivalent of 1.221 billion euros.

This paper estimates the causal effect of informal care provided by children on health for individuals living in nursing homes. While evidence exists for individuals living at home (Barnay & Juin, 2016), this question has not yet been directly explored in nursing homes. We explore the heterogeneity of the effect according to the gender of care recipient. Indeed, important differences are observed between men and women, both for informal care and health. Women are more likely to receive informal care than men, everything else being equal, in nursing homes (Jeanneau *et al*., 2022) and they are also more likely to declare a poor state of health (Read & Gorman, 2010; Read & Grundy, 2011). Gender differences are found in the factors influencing health, and in particular, those related to social support (Kendler *et al*., 2005; Pinquart & Sörensen, 2007; Fiori & Denckla, 2012; Santini *et al*., 2015). Considering this heterogeneity at home, Byrne *et al*. (2009) find that informal care provided to mothers is less effective in improving health than informal care provided to fathers, due to greater caregiving needs of mothers.

We exploit the cross-sectional French survey *CARE-Institutions* (2016) which provides a representative sample of 2,382 individuals aged 60 or more, with children and living in a nursing home. Health outcomes are the probability of declaring depression, sleep disorders, poor appetite and feelings of weariness. To deal with the endogeneity of informal care to health variables, we exploit an instrumental variable strategy, using the gender composition of the sibling (having at least one daughter).

This paper brings several contributions to the literature. First, it focuses on informal care in nursing homes, a scope that has been little considered up to now (Jeanneau *et al*., 2022), and it explores its causal impact on health. Second, it considers the heterogeneity of the effect according to gender, age and education level. Third, it shows that the usual instruments for informal care are weaker when focusing on the subsample of older men.

Results show that informal care has overall little effect on health outcomes, and this is stable across gender and education level. It is imprecisely suggested that it increases feelings of weariness for younger and single individuals. These results are contrasting with those observed at home and call for further researches on the specific determinants of health and well-being in nursing homes.

1. Literature Review

In the economic literature, formal and informal care are generally regarded as inputs in the health production function of an individual needing long-term care. Many papers have been interested in the theoretical formalization of the contribution of these inputs to the individual's health. Byrne *et al*. (2009) provide health-quality production functions in which health quality depends on the individual's characteristics and care provided by family members or by professional caregivers. The parameters associated to each type of care are allowed to depend on parent and child observed characteristics. Empirical evidence on the effect of informal care on health is more limited. Using US data, Byrne *et al*. (2009) find that formal and informal care slightly affect the individual's health quality. Focusing on French old individuals, Barnay & Juin (2016) show that informal care (instrumented by the proportion of daughters, having one child single, one child without children, one child living nearby) is likely to reduce the risk of depression. All these papers focus on informal care provided at home. One originality

of the present paper is to focus on informal care provided in nursing homes, where a considerable amount of formal care is provided. If the health production function is assumed to be similar for both people living at home and those living in nursing homes, we might expect that informal care could have an effect on individuals' health, even in the presence of quasi-constant formal care.

Recent evidence related to the COVID-19 crisis has shown that depriving individuals of their relatives' visits to nursing homes entails a deterioration of their well-being (Giebel *et al*., 2020; Roest *et al*., 2020; Verbeek *et al*., 2020) and health (McArthur *et al*., 2021). McArthur *et al*. (2021) evaluate the effect of some strategies (windows visits, use of technologies) used to prevent health disorders during the lockdowns and find that they are able to mitigate depression, delirium and behavioral problems. These papers are tied to the specific situation of the COVID-19 pandemic, however, where several mechanisms come into play (social isolation and limited interactions, as well as anxiety about the pandemic and increased workload of the staff). By contrast, the present paper highlights the effect of informal care on health outcomes in normal times.

2. Data

2.1. CARE Survey

We use the cross-sectional survey *Capacités, Aides et REssources des seniors* (CARE), which is a general population survey representative of French people aged 60 and older. Conducted by the statistical division of the Ministry of Health (DREES), it aims at documenting the living conditions of the individuals, their relationships with their relatives, and the limitations in the activities of daily living they face, as well as the human, technical and financial support they receive. The survey consists of two parts: *CARE-Ménages* (CARE-M) is devoted to individuals living in the community, while *CARE-Institutions* (CARE-I) surveys individuals living in nursing homes.

CARE-I was conducted between September and December 2016. 3,223 respondents from 616 long-term care units (non-medicalized and medicalized nursing homes, long-term care units of hospitals) participated in the survey, an average of 5 residents per unit. Due to the compulsory nature of the survey, the response rate was high (88% at the nursing home level and 86% at the respondent level). Survey weights are provided together with the data to correct for non-response. About 80 observations are dropped because of missing information on activity restrictions or children. Focusing on individuals with children (75% of the initial sample), our sample consists of 2,382 individuals.

2.2. Variables

We are interested in informal care received by residents. In the survey, residents declare if they receive some care from relatives; for each informal caregiver, they declare the type of care provided (concrete help for activities of daily living, either essential (ADL) or instrumental (IADL); moral support; financial support), and the frequency and the volume of care received. This paper focuses on informal care provided by one child (at least) for concrete help with the activities of daily living. Receiving care from someone other than a partner or a child is uncommon: about 5% of individuals having a partner or children declare receiving care from other family members, 2% from friends (Jeanneau *et al*., 2022).[1] Care for the activities of daily living is the most prevalent and is frequently associated with moral support, both at home and in nursing homes (Gramain *et al*., 2024; Jeanneau *et al*., 2022; Roquebert *et al*., 2018). It includes help for essential activities of daily living (ADL): grooming, dressing, using the toilet, transferring (from and to bed), and cutting and eating food (once it has been prepared). It also encompasses instrumental activities of daily living (IADL): grocery shopping, domestic chores, preparing meals, taking medication, moving around alone (in the area of one's room), using a phone, using transportation, leaving the nursing home, finding one's way and administrative tasks. In our sample, 75% of individuals receive informal care, corresponding to 63% of men and 78% of women (significant difference at the 1% level, Student test).

The outcome variables are health measures. In the survey, individuals are asked if during the last 12 months, they have had one of the diseases or health issues mentioned in a list, including depression.[2] They are additionally asked if in the last 12 months they have encountered one of the health issues mentioned in a list, including

1. For individuals without partner nor children, however, shares are higher: 28% of individuals receive care from another family member, 13% by somebody else.

2. The other diseases are heart diseases, hypertension, cerebrovascular accident, back pain, pressure sore, diabetes, Alzheimer's, Parkinson's, cancer.

sleep disorders, poor appetite and feelings of weariness.[3]

Overall, we consider four health dichotomous variables: the fact of having suffered from *(i)* depression, *(ii)* sleep disorders, *(iii)* poor appetite, or *(iv)* feelings of weariness. These variables reflect the way individuals are feeling themselves. They are symptoms of a deteriorated health, while not necessarily requiring a diagnosis from a doctor. They are also relatively comparable from one individual to the other, compared to more general subjective health measures (Roquebert *et al*., 2021). Indeed, general subjective health assessments are influenced by the reporting behavior of individuals, corresponding to the effect of non-health characteristics on the value of subjective health (age, gender, socio-economic variables, social norms, personality traits) (Layes *et al*., 2012). Using narrow (closed-formed) questions on specific aspects of health is a relevant way to overcome this limitation (Bound, 1991).

2.3. Descriptive Statistics

Figure I shows the means of the outcome variables in our sample for women and men. There are similar in both populations, except that women more frequently declare a poor appetite (29% *vs* 19% among men) and feelings of weariness (53% *vs* 47% among men). These differences are respectively significant at the 1% and 5% level (Student test).

Table 1 presents the socio-demographic characteristics and health characteristics of women (Column (1)), men (Column (2)) and for the full sample of persons living in a nursing home and having children (Column (3)). About 3/4 residents of nursing homes with children are women. Reflecting differences in life expectancy, women are older on average and they are more frequently widowed while men are on average more frequently married or single/divorced, with a lower number of children. Regarding activity restrictions, based on the epidemiological literature (Barberger-Gateau *et al*., 2000; Edjolo *et al*., 2016), we distinguish between individual with moderate activity restrictions (IADL only), high activity restrictions (ADL) and severe activity restrictions (ADL including those on minimum independence: going to the toilet, self-feeding, getting up and down). Women are more frequently facing severe activity restrictions, echoing the difference in the age distribution. Appendix 1 provides more detailed descriptive statistics on the health status of nursing home residents.

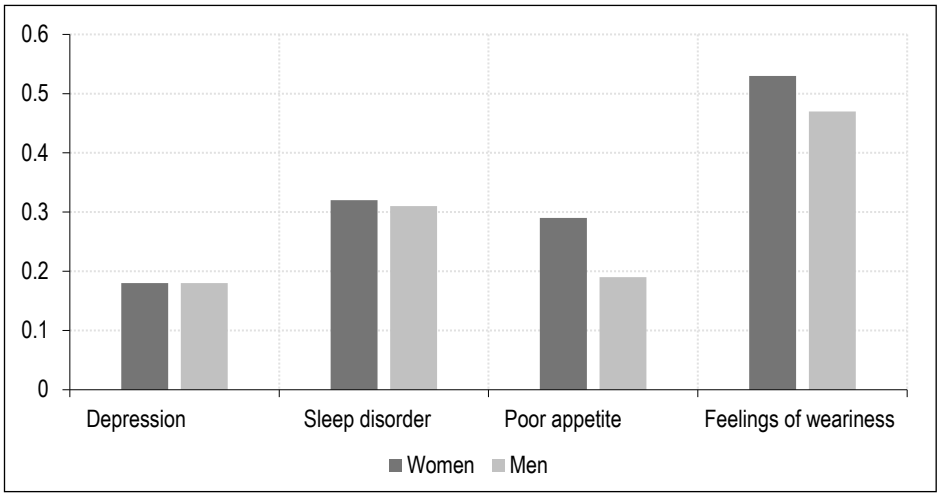
3. Empirical Specification

3.1. Instrumental Variable Strategy

To identify the effect on health of informal care provided by children, we need to deal with the endogeneity of informal care to health. Indeed, reverse causality – when the health status of the individual affects informal care provision – and omitted variable bias – when unobserved characteristics affect both health and informal care – are likely. Appendix 2 shows the results of the estimation with health outcomes directly regressed on informal care provision (naive OLS estimations). On the full sample, a significant positive correlation is found between informal

3. The other issues are: respiratory problems, cough, gastric issues, dizziness, paralysis

Figure I – **Relative frequency of health troubles**



Notes: Weighted frequencies.
Sample: 2,382 individuals living in a nursing home and having children.

Table 1 – **Descriptive statistics: socio-demographic characteristics and activity restrictions**

	Women (1)	Men (2)	Full sample (3)
Informal care from children	78.0	62.8	74.6
Woman	100.0	0.0	77.7
Age: 60-74	5.2	12.4	6.8
Age: 75-84	19.8	26.2	21.2
Age: 85-89	30.1	25.5	29.1
Age: 90-94	30.0	26.0	29.1
Age: ≥ 95	14.9	9.9	13.8
Married	9.4	35.8	15.3
Widow	81.5	46.3	73.7
Single or divorced	9.0	17.9	11.0
Children: 1	30.7	28.6	30.2
Children: 2	33.1	29.0	32.1
Children: 3 or more	36.2	42.4	37.6
Sister(s) or brother(s) alive	41.7	47.2	42.9
Income: < 10,0000 €	5.1	2.1	4.4
Income: 10,000 - 14,999 €	30.2	14.6	26.7
Income: 15,000 - 19,999 €	27.2	20.2	25.6
Income: 20,000 - 24,999 €	15.3	19.3	16.2
Income: ≥ 25,000 €	22.2	43.9	27.1
Diploma: none	26.5	19.5	24.9
Diploma: primary education	34.3	32.1	33.8
Diploma: secondary education	17.3	22.5	18.4
Diploma: higher education	2.9	8.8	4.2
Diploma: missing	19.1	17.1	18.6
Restrictions: IADL only	11.5	14.6	12.2
Restrictions: ADL, except those of minimum independence	41.0	41.1	40.9
Restrictions: ADL on minimum independence	46.1	40.9	44.9
Observations	1,858	524	2,382

Notes: Weighted statistics.
Reading: 78.0% of women living in a nursing home and having children receive informal care from one child at least.
Sample: 2,382 individuals living in a nursing home and having children.

care receipt and depression or feelings of weariness, which are mainly driven by the subsample of men. A significant and positive correlation is also observed between sleep disorder and informal care, mainly driven conversely by the subsample of women. Overall, a positive relationship is suggested between informal care and a deteriorated health status.

The literature analyzing informal care has often dealt with this endogeneity using instrumental variable (IV) strategies. An instrument provides an exogenous variation in the variable of interest (informal care): it has to be correlated with informal care (relevance condition) and it should be correlated to the outcome only through informal care, thus being orthogonal to the error term (exclusion restriction). When analyzing the effect of informal care on several outcomes (formal care, living arrangements or health of recipients), the literature has proposed various instruments for informal care provision. Several studies use the number of children and the gender composition of the family, such as the proportion of daughters, the fact of having at least one daughter, or having a daughter as eldest child (Lo Sasso & Johnson, 2002; Van Houtven & Norton, 2004; Charles & Sevak, 2005; Bonsang, 2009; Bergeot & Tenand, 2023). The rationale is that children, and especially daughters, are more likely to provide informal care. Another instrument relies on the geographical proximity of individuals to their children (Stern, 1995; Charles & Sevak, 2005; Bolin *et al*., 2008;

Hiedemann *et al*., 2017). Individuals living close to their parents are indeed more likely to provide informal care (Stern, 2023).

In this study, we do not consider the number of children as a valid instrument since it could directly affect the health outcomes of old parents (Kruk & Reinhold, 2014). The geographical proximity of children could also affect directly health, for instance if proximity is associated with a feeling of emotional security that affects health even if the child is not providing concrete help (van der Pers *et al*., 2015).

We use information on the sex of children as an instrument: the fact of receiving informal care for ADL/IADL is instrumented by the fact of having at least one daughter among children. To be valid, this instrumental variable has to be related to health only through the effect of informal care. Appendix 3 shows that *ceteris paribus*, daughters have a significant and higher probability to provide care than sons. Regarding the exclusion restriction, the sex composition of the sibling cannot be manipulated by parents since sex of children is random. It could nonetheless have a direct impact on health, for instance through the size of the sibling: the gender composition is correlated to the size of the sibling, which affects health outcomes of parents. Consequently, we control for the size of the sibling to have an effect of the instrument for a given number of children. Beyond this mechanism, there is no empirical evidence on a direct relationship between the gender composition of the siblings and the health outcomes of parents.

Compared to alternative instruments based on the gender composition of the siblings, having one daughter at least is statistically the strongest instrument on the full sample. Appendix 4 provides first stage and second stage results with alternative instruments based on the sex composition of the siblings (proportion of girls; eldest child is a daughter).

3.2. Econometric Specification

The instrumental variable estimator aims at identifying the causal impact of an endogenous explanatory variable. It is based on the following intuition: the effect of the endogenous regressor on the outcome breaks into two parts, one that might be correlated with the error term and one that is not. With the IV estimation, we isolate the part that is not correlated with the error term to estimate the effect of the endogenous regressor on the outcome. One can see Wooldridge (2009), for a general presentation of instrumental variables estimation. We estimate the model in two stages (two-stage least squares, or 2SLS). In the first stage, the probability of receiving informal care (IC_i, a dummy equal to 1 if the individual receives informal care) is regressed on the fact of having one daughter (D_i, a dummy equal to 1 if the individual has at least one daughter) and a set of covariates at the individual level (X_i) (1, linear probability model) and ϵ_i is an error term:

$$IC_i = \beta_1 D_i + X_i^{'} \beta_2 + \epsilon_i \quad (1)$$

In the second stage, the probability of declaring a health issue (H_{ik}) is estimated as a function of the predicted informal care receipt depending on the instrument and individual controls (Equation (2), linear probability model). We consider four health issues (H_{i1}: depression; H_{i2}: sleep disorders; H_{i3}: poor appetite; H_{i4}: weariness).

$$H_{ik} = \alpha_1 \widehat{IC_i} + X_i^{'} \alpha_2 + \varepsilon_i \quad (2)$$

With ε_i an error term.

In the first stage (Equation (1)), we assess the relevance of the instrument *(i)* looking at the magnitude and the significance of β_1; *(ii)* evaluating the F-stat corresponding to the test of the null hypothesis that the instrument is uncorrelated to the probability of receiving informal care ($H_0 : \beta_1 = 0$) (Staiger & Stock, 1997). Since we are estimating the model with clusters, we use the Kleibergen-Paap Wald F-test (Kleibergen & Paap, 2006). In the second stage (Equation (2)), we are not able to test the exclusion restriction using a Sargan test, which would require to have more instruments than endogenous variables (overidentification case).

We estimate this model for the full sample and for women and men separately. Regarding controls (X_i), we select variables that are the most exogenous to health and proceed in three steps: first, we estimate the model without any control; second, we control for sex, education level and number of children; third, we add to the previous controls the age category. To take into account potential correlation of disturbance terms, standard-errors are clustered at the nursing home level.

3.3. Relevance of the Instrument

Among individuals having children, 58% have at least one daughter and receive informal care from a child, while 9% have no daughter and do not receive informal care from children. Overall, for about 67% of the sample, we observe the expected relationship between informal care and the sex composition of the sibling. 16% have one daughter at least but do not receive informal

care, while 17% do not have a daughter but do receive informal care from a child at least.

Table 2 presents the first stage estimates of the simple IV model for the full sample and among subsamples of women and men. Models are successively estimated without any controls (Column (1)), controlling for gender, education level and number of children (Column (2)); adding age to the previous controls (Column (3)). It shows that having one daughter among children significantly increases the probability of receiving informal care, by about 10 percentage points in the full sample, with a similar magnitude for the subsamples of women and men. Whatever the controls included, the F-test is higher than 20 in the full sample and higher than 17 in the subsample of women. In the subsample of men, it decreases substantially, which might be explained by a lower number of observations in this subsample, and suggests that the instrument is weaker on the subsample of men. This is also the case when using alternative instruments (see Appendix 4, Table A4-1)

We have also tested if the instrument is correlated with the explanatory variables (see Appendix 4, Table A4-3). It shows that having one daughter at least is mainly correlated to the number of children but not to other explanatory variables. This is also the case for alternative instruments.

4. Results

4.1. Main Results

Table 3 presents the effect of informal care receipt from a child, instrumented by the fact of having one daughter at least, on the probability of declaring depression, sleep disorders, poor appetite and feelings of weariness, for the full sample (Panel A) and the subsamples of women (Panel B) and men (Panel C). For each outcome, we successively estimate the model without any controls (Columns (1), (4), (7), (10)); controlling for gender, education level and number of children (Columns (2), (5), (8), (11)); adding age to the previous controls (Columns (3), (6), (9), (12)). Reduced-form estimates (linear regressions of health outcomes on the instrument) are presented in Table 4, including all controls.

Informal care does not affect the probability to declare depression, sleep disorder or poor appetite in the full sample, nor in the subsamples of women and men. Regarding feelings of weariness, a positive but imprecisely estimated effect (significance at the 10% level) is found when there are no controls (Columns (10)) or

Table 2 – **First stage: correlation of having a daughter with informal care receipt**

	Receives informal care from one child at least		
	(1)	(2)	(3)
Panel A: Full sample			
At least one daughter	0.118***(0.022)	0.114***(0.022)	0.100***(0.022)
Observations	2,382	2,382	2,382
F-test (instrument)	29.634	25.906	20.947
Panel B: Women			
At least one daughter	0.119***(0.023)	0.111***(0.024)	0.101***(0.024)
Observations	1,858	1,858	1,858
F-test (instrument)	26.595	20.770	17.619
Panel B: Men			
At least one daughter	0.142***(0.051)	0.131**(0.053)	0.100** (0.051)
Observations	524	524	524
F-test (instrument)	7.725	6.021	3.912
Controls:			
Gender	No	Yes	Yes
Education	No	Yes	Yes
Number of children	No	Yes	Yes
Age	No	No	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL. Estimations of linear probability models. Kleibergen-Paap Wald rk F-test corresponding to the test of the null hypothesis that the instrument is uncorrelated to the probability of receiving informal care.
Sample: 2,382 individuals living in a nursing home and having children.

controls for gender, education and number of children (Column (11)). It seems to be mainly driven by the subsample of men. However, this effect vanishes when we control for age (Column (12)).

Looking at the effect of controls (see Table A5-1 in Appendix 5) we see that individuals older than 95 (both men and women) are less likely to declare depression, which might be related to a lack of diagnosis for these individuals. A lower education level affects the probability to declare adverse health events, but the sense of the correlation depends on the outcome (positive for poor appetite, negative for depression) and it is mainly driven by the subsample of women.

4.2. Extensions

To elaborate on the effect of informal care on health in nursing homes, we explore the potential heterogeneity of this effect, considering subsamples according to *(i)* age, *(ii)* education level (Table 5). For the younger individuals (aged 84 or less), we observe a positive effect of informal care on the probability to declare feelings of weariness. This effect is not observed for individuals aged 85 or more. It echoes the change in the significance level of the estimation when we add age as a control (Table 3). There is remarkably no heterogeneity of the informal care informal on subsamples depending on education level.

The definition of informal care includes administrative tasks. This item could be ambiguous since it might be provided remotely (paperwork for instance). We have thus estimated our model excluding administrative tasks from the definition of informal care. With this alternative definition, 57% of persons with children receive informal care from their children (compared to 75% with the previous definition). Despite this substantial change, results are stable and no effect of informal care is found on health outcomes (Table 6). Note that on the subsample of men, the instrument is particularly weaker.

The analysis shows that the instrument is particularly relevant for women: both men and women are more likely to declare receiving informal care when they have at least one daughter, but the instrument is weaker for men. This difference might be explained *(i)* by technical reasons (e.g. low number of observations for men) or *(ii)* by differences in the relationship between children's gender and informal care receipt. Given the difference in the life expectancy according to gender, older men are more likely than older women to receive care from a partner. We have

Table 3 – **Second stage: the effect of informal care receipt on health outcomes**

	Probability to have declared:											
	Depression			Sleep disorder			Poor appetite			Feelings of weariness		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Full sample												
Informal care receipt	−0.121 (0.156)	−0.133 (0.169)	−0.113 (0.191)	0.094 (0.182)	0.006 (0.202)	−0.007 (0.232)	0.140 (0.182)	0.237 (0.200)	0.217 (0.228)	0.392* (0.207)	0.416* (0.229)	0.410 (0.262)
Observations	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382
Panel B: Women												
Informal care receipt	−0.212 (0.181)	−0.197 (0.200)	−0.169 (0.218)	0.010 (0.198)	−0.110 (0.229)	−0.130 (0.255)	0.229 (0.207)	0.335 (0.240)	0.322 (0.264)	0.287 (0.228)	0.273 (0.255)	0.237 (0.278)
Observations	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858	1,858
Panel C: Men												
Informal care receipt	0.199 (0.284)	0.097 (0.319)	0.146 (0.411)	0.369 (0.358)	0.378 (0.413)	0.438 (0.552)	−0.075 (0.296)	−0.060 (0.336)	−0.174 (0.441)	0.743* (0.423)	0.848* (0.504)	1.059 (0.712)
Observations	524	524	524	524	524	524	524	524	524	524	524	524
Controls:												
Gender	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Education	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Nb. children	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Age	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL and is instrumented by the fact of having one daughter at east.
Sample: 2,382 individuals living in a nursing home and having children.

Table 4 – **Reduced-form estimations**

	Probability to have declared:			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)
Panel A: Full sample				
At least one daughter	−0.011 (0.019)	−0.001 (0.023)	0.022 (0.022)	0.041* (0.025)
Observations	2,382	2,382	2,382	2,382
Panel B: Women				
At least one daughter	−0.017 (0.022)	−0.013 (0.025)	0.033 (0.025)	0.024 (0.028)
Observations	1,858	1,858	1,858	1,858
Panel C: Men				
At least one daughter	0.015 (0.042)	0.044 (0.051)	−0.018 (0.044)	0.106** (0.054)
Observations	524	524	524	524
Controls:				
Gender	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level.
Sample: 2,382 individuals living in a nursing home and having children.

Table 5 – **The effect of informal care receipt on health outcomes, heterogeneity according to age and education level**

	Probability to have declared:			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)
Panel A: Age: 60-84				
Informal care receipt	−0.321 (0.331)	−0.075 (0.339)	0.485 (0.328)	0.992** (0.492)
Observations	671	671	671	671
F-test (instrument)	7.757	7.757	7.757	7.757
Panel B: Age ≥ 85				
Informal care receipt	0.005 (0.228)	0.057 (0.304)	0.035 (0.285)	0.057 (0.325)
Observations	1,711	1,711	1,711	1,711
F-test (instrument)	14.185	14.185	14.185	14.185
Panel C: Education: none or primary				
Informal care receipt	−0.239 (0.425)	0.264 (0.507)	0.908 (0.620)	0.058 (0.517)
Observations	1,406	1,406	1,406	1,406
F-test (instrument)	5.476	5.476	5.476	5.476
Panel D: Secondary or higher education				
Informal care receipt	−0.069 (0.235)	−0.322 (0.291)	−0.126 (0.249)	0.450 (0.334)
Observations	513	513	513	513
F-test (instrument)	14.430	14.430	14.430	14.430
Controls:				
Gender	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL and is instrumented by the fact of having one daughter at least. F-test (instrument) corresponding to the first-stage Kleibergen-Paap Wald rk F-test testing of the null hypothesis that the instrument is uncorrelated to the probability of receiving informal care.
Sample: 2,382 individuals living in a nursing home and having children.

Table 6 – **Effect of informal care receipt (excluding administrative tasks)**

	Probability to have declared:			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)
Panel A: Full sample				
Informal care receipt (excluding administrative tasks)	−0.116 (0.195)	−0.007 (0.236)	0.221 (0.233)	0.418 (0.266)
Observations	2,382	2,382	2,382	2,382
F-test (instrument)	16.637	16.637	16.637	16.637
Panel B: Women				
Informal care receipt (excluding administrative tasks)	−0.149 (0.194)	−0.115 (0.225)	0.285 (0.232)	0.210 (0.243)
Observations	1,858	1,858	1,858	1,858
F-test (instrument)	13.340	13.340	13.340	13.340
Panel C: Men				
Informal care receipt (excluding administrative tasks)	0.348 (1.025)	1.044 (1.693)	−0.415 (1.109)	2.523 (3.146)
Observations	524	524	524	524
F-test (instrument)	0.675	0.675	0.675	0.675
Controls:				
Gender	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL, excluding administrative tasks. It is instrumented by the fact of having one daughter at least.
F-test (instrument) corresponding to the first-stage Kleibergen-Paap Wald rk F-test testing of the null hypothesis that the instrument is uncorrelated to the probability of receiving informal care.
Sample: 2,382 individuals living in a nursing home and having children.

thus conducted estimations on the subsample of individuals who are single, divorced or widowed, thus excluding 35% of men and 10% of women (Appendix 6) Results are robust to this change, except that even when controlling for age, a positive effect of informal care on feelings of weariness is observed (significant at the 10% level).

5. Discussion

Results show that, in the population of nursing home residents, informal care provided by children little affects health outcomes, and this is true also when considering subsamples of persons of the same education level. In robustness checks, informal care is suggested to increase the probability to declare feelings of weariness for younger or single individuals. For these individuals, receiving informal care may have a signaling effect, increasing the feeling of vulnerability of individuals.

Additionally, there is little heterogeneity of the effect according to the gender of the care recipient. Men and women are however likely to have different behaviors when declaring health issues. The literature has observed that women are more likely to report a deteriorated health status than men. This result has been shown to come both from "true" health differences (differences in the prevalence of chronic deseases) (Case & Paxson, 2005) and from sex-related differences in health-reporting behavior. Indeed, for a given health status, some variables are found to influence self-reported health, in particular gender (Bago d'Uva *et al*., 2008; Caroli & Weber-Baghdiguian, 2016). Caroli and Weber-Baghdiguian (2016) show that reporting behavior depends on the social environment of individuals: women working with a majority of men tend to under-report health issues while the reverse is observed for men working with a majority of women. Transposing this idea to nursing homes, where a majority of women is found, we could expect that men over-report health issues. It could blur differences between gender.

Some limitations of this paper should be discussed. First, we are not able to disentangle the effect of the care provided in itself and the time spent with the parent or the moral support provided by children that might – or might not – be associated to care provision. When considering the effect of receiving moral support from children, instrumented by the fact of having a daughter, the results are very close to those we observe using informal care from children (results available upon request). Second, we miss some key information that would be useful to understand informal care in nursing homes, such as the seniority of nursing home entry, the history of informal care configurations or the intensity of informal care provision.

Finally, we are using cross-sectional data. While they offer us very rich information on care provided to the individuals in nursing homes and their families, longitudinal data would be useful to reinforce the causal aspect of the analysis.

Further investigation should explore the mechanisms through which informal care is related to health. Due to data limitations, the present analysis only considers the extensive margin of informal care (receiving informal care): future research could investigate the effect of informal care intensity on health outcomes for nursing home residents.

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This paper analyses the causal effect of informal care on health variables (depression, sleep disorders, poor appetite, feelings of weariness) for individuals living in nursing homes. We investigate the heterogeneity of the effect according to gender and according to age and education level. Informal care is found to have overall little effect on health outcomes, and this is stable across gender and education level. It is imprecisely suggested to increase feelings of weariness for younger and single individuals.

This study makes several contributions to the literature that has analyzed the effect of informal care for recipients. It explores the question of informal care in nursing homes, a scope that has been little considered up to now (Jeanneau *et al*., 2022) and it analyzes the impact of informal care, considering the heterogeneity of the effect according to gender, age and education level. From a methodological point of view, it shows that the usual instruments used in the literature for informal care are weaker when focusing on the subsample of men, at least for the population of nursing home residents.

These results on the causal effect of informal care on health are thus contrasting with those observed at home, where informal care decreases the risk of depression (Barnay & Juin, 2016). Moreover, the population dynamics of older individuals at home and in nursing home are expected to change in the coming years, with changes in the availability of informal caregivers and different populations in each setting (Carrère *et al*., 2023). These results, combined with the future sociodemographic changes, call for further researches on the specific determinants of health and well-being in nursing homes. □

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APPENDIX 1

DESCRIPTIVE STATISTICS ON HEALTH STATUS

Table A1-1 provides more details on the health status of nursing home residents, comparing men and women. Cognitive limitations refer to difficulties in sense of time, memory and concentration issues, taking risks for oneself and aggressiveness issues. Sensory limitations refer to eyesight and hearing issues. The share of individuals suffering from limitations (cognitive, sensory, mobility and dexterity, locomotion and balance) is at least 75% and generally about 90%. Rate are higher for women. Most differences are significantly different from zero at the 1% level, as evaluated by the Student test for continuous or dummy variables and the Chi-squared test for categorical variables. There is no significant difference at the conventional threshold for chronic diseases (p-value = 0.44) and subjective health (p-value = 0.67).

Table A1-1 – **Detailed descriptive statistics on health characteristics**

	Women	Men	Full sample
	(1)	(2)	(3)
Restrictions: IADL only	11.45	14.64	12.16
Restrictions: ADL, except those of minimum independence	41.09	40.88	41.04
Restrictions: ADL on minimum independence	46.08	40.89	44.92
Alzheimer's disease	38.94	31.84	37.36
Limitations: cognitive	93.67	87.90	92.38
Limitations: sensory	75.91	74.65	75.63
Limitations: mobility, dexterity	96.36	93.01	95.61
Limitations: locomotion, balance	93.97	89.95	93.07
Incontinency	66.71	62.02	65.66
Self-reported chronic disease or health condition	67.21	70.01	67.84
Subjective health: bad or very bad	35.52	36.13	35.66
Subjective health: rather good	41.12	42.65	41.46
Subjective health: good or very good	22.47	20.66	22.07
Subjective health: missing	0.88	0.55	0.81
Underweight (BMI < 20)	16.11	8.73	14.46
Normal weight (20 ≤ BMI < 25)	30.50	33.19	31.10
Overweight or obese (BMI ≥ 25)	28.65	41.16	31.44
BMI missing	24.74	16.91	22.99
Has been hospitalized in the last 12 months	29.63	36.64	31.19
Proxy respondent	68.20	64.11	67.29
Observations	1,858	524	2,382

Notes: Weighted statistics. "BMI" stands for Body Mass Index.
Sample: 2,382 individuals living in a nursing home and having children.

APPENDIX 2

NAIVE ESTIMATIONS

Table A2-1 – **Naive estimations**

	Probability to have declared:			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)
Panel A: Full sample				
Informal care receipt	0.0335* (0.0195)	0.0405* (0.0230)	0.0239 (0.0218)	0.0628** (0.0256)
Observations	2,382	2,382	2,382	2,382
R^2	0.014	0.009	0.025	0.012
Panel B: Women				
Informal care receipt	0.0169 (0.0228)	0.0546** (0.0274)	0.0180 (0.0268)	0.0301 (0.0300)
Observations	1,858	1,858	1,858	1,858
R^2	0.014	0.010	0.019	0.009
Panel C: Men				
Informal care receipt	0.0743** (0.0366)	0.0002 (0.0434)	0.0370 (0.0373)	0.140*** (0.0462)
Observations	524	524	524	524
R^2	0.042	0.013	0.026	0.040
Controls:				
Gender	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL.
Sample: 2,382 individuals living in a nursing home and having children.

APPENDIX 3

DETERMINANTS OF CARE PROVISION

In this Appendix, we investigate at the child level the variables that correlate with the probability of care provision (Table A3-1), taking child, parent and nursing home characteristics into account. It shows that everything else being equal, daughters have a higher probability of being a caregiver. For both daughters and sons, the probability to be caregiver increases with the fact of being part of a couple that has children and decreases with job inactivity. When the size of the sibling group increases, the probability of being a caregiver decreases. This is also the case for daughters when the parent has a partner at home. Finally, care provision is affected by the health status of the parent, as measured by ADL restrictions, limitations and subjective health.

Table A3-1 – **Explaining children care provision**

	Probability of being declared as caregiver:		
	All	Daughters	Sons
Child characteristics			
Daughter	0.387*** (0.0364)		
Age 00-39	*Ref.*	*Ref.*	*Ref.*
Age 40-49	−0.109 (0.164)	−0.197 (0.228)	0.00272 (0.236)
Age 50-59	−0.164 (0.165)	−0.219 (0.230)	−0.0893 (0.230)
Age 60-69	−0.114 (0.172)	−0.222 (0.241)	−0.00280 (0.241)
Age 70-79	−0.0987 (0.188)	−0.159 (0.260)	−0.0256 (0.263)
Age 80-89	−0.563 (0.409)	0 (.)	0.287 (0.556)
Age missing	0.349* (0.182)	0.359 (0.257)	0.315 (0.253)
Single and no children	0.334*** (0.0999)	0.180 (0.144)	0.415*** (0.142)
Couple with child/children	0.323*** (0.0604)	0.315*** (0.0761)	0.310*** (0.101)
Couple without child/children	0.164 (0.105)	0.180 (0.153)	0.120 (0.150)
Single with children	*Ref.*	*Ref.*	*Ref.*
Family status missing	0.0434 (0.0992)	0.0828 (0.133)	−0.0316 (0.151)
Job status: inactive	−0.400*** (0.0964)	−0.377*** (0.113)	−0.519*** (0.200)
Job status: active	*Ref.*	*Ref.*	*Ref.*
Job status missing	−0.711*** (0.103)	−0.789*** (0.140)	−0.598*** (0.151)
Job status: retired	0.0105 (0.0675)	−0.0500 (0.0926)	0.0735 (0.0950)
Parent characteristics			
Woman	0.0376 (0.0560)	0.0550 (0.0748)	0.0152 (0.0740)
Number of children	−0.186*** (0.0226)	−0.172*** (0.0264)	−0.202*** (0.0243)
Age: 60-74	−0.310*** (0.112)	−0.380*** (0.140)	−0.248 (0.154)
Age: 75-84	*Ref.*	*Ref.*	*Ref.*
Age: 85-89	−0.00460 (0.0598)	0.0399 (0.0805)	−0.0378 (0.0817)
Age: 90-94	0.0904 (0.0742)	0.141 (0.0962)	0.0450 (0.0922)
Age ≥ 95	−0.0646 (0.0842)	−0.0569 (0.112)	−0.0533 (0.109)
Widow	0.246*** (0.0697)	0.0957 (0.0970)	0.399*** (0.0959)
Partner at home	−0.178* (0.108)	−0.331** (0.141)	−0.0295 (0.137)
No partner	*Ref.*	*Ref.*	*Ref.*
Partner in nursing home	−0.0414 (0.107)	−0.142 (0.148)	0.0859 (0.146)
Sister(s) or brother(s) alive	−0.0203 (0.0442)	0.0226 (0.0599)	−0.0625 (0.0587)
Income: < 10 0000	−0.200** (0.0987)	−0.321** (0.140)	−0.0912 (0.136)
Income: 10,000 - 14,999	−0.0793 (0.0529)	−0.0733 (0.0713)	−0.109 (0.0744)
Income: 15,000 - 19,999	*Ref.*	*Ref.*	*Ref*
Income: 20,000 - 24,999	−0.0156 (0.0622)	−0.0822 (0.0881)	0.0584 (0.0844)
Income: ≥ 25,000	0.0483 (0.0620)	0.0457 (0.0844)	0.0342 (0.0848)

➔

	Probability of being declared as caregiver:		
	All	Daughters	Sons
Diploma: none	−0.0456 (0.0574)	−0.0760 (0.0736)	−0.0335 (0.0746)
Diploma: primary education	*Ref.*	*Ref.*	*Ref.*
Diploma: secondary education	−0.194*** (0.0592)	−0.158** (0.0805)	−0.246*** (0.0842)
Diploma: higher education	−0.0837 (0.121)	−0.201 (0.155)	0.0374 (0.147)
Diploma: missing	−0.122** (0.0621)	−0.202** (0.0867)	−0.0416 (0.0865)
Restrictions: IADL only	*Ref.*	*Ref.*	*Ref.*
Restrictions: ADL, except those of minimum independence	0.277*** (0.0731)	0.343*** (0.0967)	0.238** (0.100)
Restrictions: ADL on minimum independence	0.217*** (0.0829)	0.252** (0.110)	0.206* (0.114)
Limitations: cognitive	0.171** (0.0816)	0.182 (0.114)	0.155 (0.110)
Limitations: sensory	−0.00828 (0.0599)	0.00267 (0.0758)	−0.00863 (0.0742)
Limitations: mobility, dexterity	0.322** (0.134)	0.304* (0.163)	0.338* (0.191)
Limitations: locomotion, balance	0.183* (0.0985)	0.174 (0.123)	0.187 (0.146)
Incontinency	−0.0299 (0.0490)	−0.0767 (0.0684)	0.0111 (0.0672)
Self-reported chronic disease or health condition	−0.0785 (0.0496)	−0.0879 (0.0662)	−0.0640 (0.0676)
Subjective health: bad or very bad	0.0136 (0.0461)	−0.0102 (0.0623)	0.0438 (0.0629)
Subjective health: average	*Ref.*	*Ref.*	*Ref.*
Subjective health: good or very good	−0.102* (0.0536)	−0.119 (0.0743)	−0.0786 (0.0748)
BMI: normal	*Ref.*	*Ref.*	*Ref.*
Underweight (BMI < 20)	0.0755 (0.0684)	0.0969 (0.0912)	0.0692 (0.0905)
Overweight or obese (BMI ≥ 25)	0.00433 (0.0556)	−0.0169 (0.0720)	0.0283 (0.0741)
BMI missing	0.0444 (0.0584)	−0.0204 (0.0775)	0.117 (0.0780)
Has been hospitalized in the last six months	0.0269 (0.0451)	0.0615 (0.0596)	−0.00220 (0.0608)
Tutelage	−0.382*** (0.121)	−0.394** (0.174)	−0.398** (0.174)
Proxy respondent	0.193*** (0.0513)	0.337*** (0.0681)	0.0411 (0.0699)
Nursing home characteristics			
For-profit	0.0402 (0.0559)	0.101 (0.0746)	−0.0246 (0.0825)
Public	0.0115 (0.0466)	−0.00969 (0.0638)	0.0372 (0.0626)
Not for-profit	*Ref.*	*Ref.*	*Ref.*
Constant	−0.687*** (0.244)	−0.214 (0.340)	−0.775** (0.333)
Observations	5,800	2,898	2,897

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the parent level. Estimation of Probit models.
Sample: 5,800 children of individuals living in a nursing home.

APPENDIX 4

DETAILS ON INSTRUMENTS

We have tested several instruments that are likely to correlate with informal care and are commonly used in the literature. Table A4-1 shows the first stage estimations, where the probability to receive informal care from a child is explained either by the proportion of daughters or by the fact that the eldest child is a daughter. These variables are indeed correlated with informal care receipt, but these instruments are weaker than the fact of having one daughter at least (lower F-test). Table A4-2 shows the second stage results of the estimations instrumenting informal care by each of the two instruments, controlling for sex, education level, number of children and age category. Results are consistent with our main estimations, using the fact of having one daughter as an instrument.

Table A4-1 – **First stage results with alternative instruments**

	Receives informal care from one child at least		
	All	Women	Men
Instrument: proportion of daughters			
Proportion of daughters	0.0892***(0.0235)	0.0819***(0.0255)	0.114** (0.0546)
Observations	2,382	1,858	524
F-test (instrument)	14.437	10.274	4.323
Instrument: eldest child is a daughter			
Elder child is a girl	0.0749***(0.0171)	0.0685***(0.0187)	0.0937**(0.0392)
Observations	2,382	1,858	524
F-test (instrument)	19.222	13.455	5.724
Controls:			
Gender	Yes	Yes	Yes
Education	Yes	Yes	Yes
Number of children	Yes	Yes	Yes
Age	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL. Estimations of linear probability models.
Sample: 2,382 individuals living in a nursing home and having children.

Table A4-2 – **Second stage results with alternative instruments**

	Probability to have declared:			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)
Instrument: proportion of daughters				
Panel A: Full sample				
Informal care receipt	0.103 (0.239)	0.261 (0.289)	0.362 (0.302)	0.643* (0.343)
Observations	2,382	2,382	2,382	2,382
Panel B: Women				
Informal care receipt	0.068 (0.303)	0.047 (0.344)	0.556 (0.401)	0.480 (0.403)
Observations	1,858	1,858	1,858	1,858
Panel C: Men				
Informal care receipt	0.216 (0.381)	0.837 (0.634)	−0.136 (0.435)	1.111 (0.695)
Observations	524	524	524	524
Instrument: eldest child is a daughter				
Panel A: Full sample				
Informal care receipt	0.273 (0.217)	0.131 (0.256)	0.015 (0.246)	0.335 (0.269)
Observations	2,382	2,382	2,382	2,382
Panel B: Women				
Informal care receipt	0.262 (0.281)	−0.040 (0.315)	0.062 (0.313)	0.114 (0.327)
Observations	1,858	1,858	1,858	1,858
Panel C: Men				
Informal care receipt	0.313 (0.355)	0.581 (0.508)	−0.110 (0.391)	0.877 (0.539)
Observations	524	524	524	524
Controls:				
Gender	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL. Estimations of linear probability models.
Sample: 2,382 individuals living in a nursing home and having children.

We additionally test if the instruments (having one daughter, eldest child is a daughter, proportion of girls) are correlated with the instrument (Table A4-3). Standard-errors are not clustered at the nursing home level since we are studying variables that are fixed before nursing home entry. The F-test corresponds to the F-statistic associated to the null hypothesis that all coefficients are jointly equal to zero. It shows that the null hypothesis can be rejected for the instrument "having one daughter at least", due to the high correlation of the instrument with the size of the sibling. For the other instruments, the null hypothesis cannot be rejected at conventional significance thresholds.

Table A4-3 – **Regression of instruments on controls**

	Having one daughter at least	Eldest child is a daughter	Proportion of daughters
	(1)	(2)	(3)
Woman	−0.022 (0.020)	−0.014 (0.024)	−0.027 (0.018)
Diploma: none	−0.029 (0.022)	−0.052** (0.026)	−0.027 (0.020)
Primary education	*Ref.*	*Ref.*	*Ref.*
Diploma: secondary education	−0.010 (0.024)	−0.034 (0.031)	−0.012 (0.023)
Diploma: higher education	−0.083* (0.046)	−0.121** (0.052)	−0.063 (0.040)
Diploma: missing	−0.050** (0.024)	−0.046 (0.029)	−0.039* (0.022)
Number of children	0.092*** (0.005)	−0.000 (0.007)	−0.007 (0.004)
Constant	0.556*** (0.026)	0.555*** (0.032)	0.563*** (0.024)
Observations	2,382	2,382	2,382
F-test	52.929	1.431	1.609

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses. Estimations of linear probability models.
The F-test corresponds to the F-statistic associated to the null hypothesis that all coefficients are jointly equal to zero.
Sample: 2,382 individuals living in a nursing home and having children.

APPENDIX 5

MAIN RESULTS WITH CONTROLS

Table A5-1 – **Second stage: effect of informal care receipt on health outcomes**

	Full sample				Women				Men			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness	Depression	Sleep disorder	Poor appetite	Feelings of weariness	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Informal care receipt	−0.113	−0.007	0.217	0.410	−0.169	−0.130	0.322	0.237	0.146	0.438	−0.174	1.059
	(0.191)	(0.232)	(0.228)	(0.262)	(0.218)	(0.255)	(0.264)	(0.278)	(0.411)	(0.552)	(0.441)	(0.712)
Woman	0.029	0.016	0.051	0.005	-	-	-	-	-	-	-	-
	(0.031)	(0.035)	(0.036)	(0.042)								
Diploma: none	−0.038*	0.033	0.057**	−0.004	−0.051**	0.032	0.066**	−0.022	0.008	0.030	0.018	0.045
	(0.021)	(0.027)	(0.024)	(0.028)	(0.024)	(0.031)	(0.028)	(0.030)	(0.044)	(0.064)	(0.049)	(0.081)
Diploma: primary educ.	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Diploma: secondary educ.	0.013	0.006	0.050*	0.047	−0.009	−0.009	0.047	0.006	0.045	−0.011	0.105*	0.091
	(0.028)	(0.030)	(0.028)	(0.032)	(0.036)	(0.040)	(0.037)	(0.041)	(0.056)	(0.068)	(0.057)	(0.095)
Diploma: higher educ.	−0.030	0.073	0.047	0.010	−0.042	0.080	−0.003	−0.008	0.035	0.110	0.067	0.127
	(0.044)	(0.053)	(0.045)	(0.054)	(0.050)	(0.068)	(0.055)	(0.065)	(0.086)	(0.115)	(0.089)	(0.142)
Diploma: missing	0.006	−0.066*	0.146***	0.034	−0.002	−0.071*	0.163***	0.012	0.035	−0.055	0.092	0.104
	(0.030)	(0.036)	(0.034)	(0.039)	(0.035)	(0.041)	(0.041)	(0.042)	(0.059)	(0.081)	(0.066)	(0.100)
Nb. children	0.002	0.008	−0.003	−0.001	−0.003	0.011	−0.005	0.002	0.014	−0.003	0.003	−0.012
	(0.006)	(0.008)	(0.007)	(0.008)	(0.007)	(0.009)	(0.009)	(0.009)	(0.013)	(0.016)	(0.012)	(0.020)
Age: 60-74	0.018	−0.007	−0.050	−0.028	0.030	0.017	−0.041	−0.153*	0.050	0.020	−0.135	0.297
	(0.056)	(0.068)	(0.062)	(0.077)	(0.065)	(0.075)	(0.068)	(0.080)	(0.123)	(0.161)	(0.127)	(0.203)
Age: 75-84	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*	*Ref.*
Age: 85-89	−0.022	0.026	−0.009	−0.000	−0.039	0.052	−0.011	−0.014	0.009	−0.098	0.043	−0.033
	(0.030)	(0.034)	(0.032)	(0.039)	(0.031)	(0.036)	(0.036)	(0.040)	(0.086)	(0.106)	(0.086)	(0.140)
Age: 90-94	−0.055	0.010	0.038	−0.041	−0.044	0.041	0.034	−0.042	−0.126	−0.126	0.084	−0.105
	(0.036)	(0.042)	(0.041)	(0.048)	(0.038)	(0.043)	(0.046)	(0.048)	(0.099)	(0.129)	(0.102)	(0.170)
Age ≥ 95	−0.080**	0.003	0.028	−0.032	−0.071*	0.024	0.013	−0.042	−0.172**	−0.089	0.135	−0.060
	(0.034)	(0.041)	(0.040)	(0.048)	(0.036)	(0.043)	(0.044)	(0.048)	(0.085)	(0.124)	(0.103)	(0.161)
Constant	0.286**	0.288**	0.012	0.216	0.378**	0.373**	−0.015	0.379*	0.080	0.106	0.224	−0.220
	(0.117)	(0.143)	(0.138)	(0.159)	(0.164)	(0.189)	(0.195)	(0.208)	(0.222)	(0.306)	(0.241)	(0.390)
Observations	2,382	2,382	2,382	2,382	1,858	1,858	1,858	1,858	524	524	524	524
F-test	20.947	20.947	20.947	20.947	17.619	17.619	17.619	17.619	3.912	3.912	3.912	3.912

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level.
Informal care is defined as concrete help for ADL/IADL and it is instrumented by the fact of having at least one daughter. Estimations of linear probability models. Kleibergen-Paap Wald rk F-test corresponding to the test of the null hypothesis that the instrument is uncorrelated to the probability of receiving informal care.
Sample: 2,382 individuals living in a nursing home and having children.

APPENDIX 6

EXCLUSION OF INDIVIDUALS WITH A PARTNER ALIVE

Table A6-1 – **Estimation on individuals without partner alive: informal care from a child**

	Probability to have declared:			
	Depression	Sleep disorder	Poor appetite	Feelings of weariness
	(1)	(2)	(3)	(4)
Panel A: Full sample				
Informal care receipt	0.031 (0.260)	0.313 (0.313)	0.339 (0.329)	0.717* (0.373)
Observations	2,017	2,017	2,017	2,017
F-test (instrument)	12.940	12.940	12.940	12.940
Panel B: Women				
Informal care receipt	−0.041 (0.309)	0.036 (0.348)	0.464 (0.400)	0.568 (0.415)
Observations	1,681	1,681	1,681	1,681
F-test (instrument)	10.146	10.146	10.146	10.146
Panel C: Men				
Informal care receipt	0.266 (0.453)	1.256 (0.909)	−0.082 (0.492)	1.270 (0.822)
Observations	336	336	336	336
F-test (instrument)	3.117	3.117	3.117	3.117
Controls:				
Gender	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes
Number of children	Yes	Yes	Yes	Yes
Age	Yes	Yes	Yes	Yes

Notes: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parentheses, clustered at the nursing home level. Informal care is defined as concrete help for ADL/IADL and it is instrumented by the fact of having at least one daughter.
F-test (instrument) is the Kleibergen-Paap Wald rk F-test testing of the null hypothesis that the instrument is uncorrelated to the probability of receiving informal care.
Sample: 2,017 individuals living in a nursing home, having children and having no partner alive.

Biosimilar Prescribing Incentives: Results of a French Pilot of Gainsharing Between Hospitals and the National Health Insurance

Vincent Attia*, Mathilde Gaini*, Edouard Maugendre* and Catherine Pollak*

Abstract – This article evaluates an incentive for hospital prescriptions of biosimilars delivered in retail pharmacies, whereby gains are shared between hospitals and the French NHI and incentives are directly redirected to prescribing units. Using SNDS data, we compare the pre- and post- biosimilar prescription rates of treated public hospitals with those observed at similar facilities. Between October 2018 and September 2021, the pilot led to an increase in biosimilar use for insulin glargine (+6.0 percentage points) and etanercept (+10.8 ppt). The pilot generated 0.5% cost savings for insulin glargine and 0.1% for etanercept. Cost savings for the French NHI are modest even though the incentive dramatically boosted biosimilar use. The fact that medication price changes outpaced the rate at which incentives are adjusted is the primary reason for this, in addition to deadweight loss effects.

JEL: I18, D04, D61
Keywords: pilot, pay-for-performance, biosimilars, hospital, difference-in-differences

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Medicinal products are one of the largest items in the French healthcare budget, with costs of medication dispensed by retail pharmacies totalling €31 billion in 2021, or 14% of all healthcare expenditure (Arnaud *et al.*, 2022). Public authorities have controlled the prices of reimbursable medicinal products and adjusted reimbursement rates in order to restrict the impact of this increasing burden of spending on social security accounts. These two regulation methods preceded a third, which was introduced in the late 1990s, through which the French state encouraged the use of generic medicinal products and attempted to change physician prescribing behaviours (Lancry, 2007). The rise of generics has curbed the increase in medicinal product spending, to some extent, and now the emergence of biosimilar medicines harbours similar potential for substantial costs savings. In the same way that generics are therapeutically equivalent to chemical brand-name medicines, biosimilars are equivalent to brand-name biologics (or reference biomedicines).[1] A policy to boost biosimilar use was therefore introduced in the mid-2010s in a context of soaring spending on biological drugs: these accounted for €4.4 billion and more than 20% market share of outpatient medicinal products in 2018 (Dahmouh, 2019). In conjunction with lapsing biologic patents, the emergence of biosimilars provides a more diverse supply network and opens up major saving potential for the *Assurance Maladie* (French National Health Insurance, NHI), which are necessary to pursue the funding of medicinal innovations (Box 1).

Prescribing behaviours in hospitals, including for medicinal products provided in retail pharmacies, greatly determines the expansion of biosimilars. It is in the hospitals' interests to negotiate optimal terms when purchasing medicinal products to be dispensed by their internal pharmacies and therefore minimise costs. However, there is no automatic incentive for hospitals to prescribe less expensive biosimilars for medications dispensed by retail pharmacies. Physicians choose not to prescribe biosimilars for many reasons, regardless of whether they work in hospitals or primary care facilities. They may be more accustomed to prescribing brand-name drugs that are more established and reputable, or they may expect their patients to be reluctant to switch treatments or receive biosimilars. Without any incentive being put in place, maintaining the status quo remains the simplest approach for physicians to adopt. However, prescriptions issued by hospital practitioners have a heavy influence on retail pharmacies, given that hospital prescriptions of medicinal products dispensed by these pharmacies (*Prescriptions Hospitalières de Médicaments Exécutées en Ville*, or PHMEV) account for nearly a third of the reimbursable outpatient medicinal product market. There are also a number of biologics for which hospital practitioners are exclusively authorised to commence treatment (Dahmouh, 2019). GPs also tend to prescribe whatever product has been selected by the prescribing hospital physician when they provide patient follow-up. If physicians are authorised to switch from one biologic to another from the same biologically equivalent group, primary care practitioners will generally continue the treatment initiated in the hospital. The impact of this behaviour is even greater for long-term treatments (Gallini *et al.*, 2013). It is also worth noting that, while pharmacists can substitute generic medicinal products, they are not allowed to substitute biological medicinal products in the general case.[2]

To encourage hospitals to prescribe biosimilars for outpatient use, an incentive scheme

1. A biological process is used to derive the active substance in biologics (animal-produced protein, complex formulation derived from a bacterium, etc.). This ultimately produces compounds of greater complexity than those found in non-biological medicinal products, which are generally the product of simple chemical synthesis. Examples of biologics include antibodies, hormones, growth promoters and many vaccines.

2. In 2022, following the recommendation issued by the ANSM (the French National Agency for the Safety of Medicines and Health Products), the French Social Security Financing Act introduced the first two groups of substitutable biosimilars: filgrastim and pegfilgrastim (ANSM, 2022 – Ministerial Decree of 12 April 2022, OJ of 14 April 2022).

Box 1 – **Price Cuts in Hospital and Retail Pharmacies Following the Introduction of Biosimilars**

When patents lapse for biologics and their therapeutically equivalent biosimilars are introduced onto the market, a series of price cuts for the reference medicinal product, other biomedicines with similar therapeutic indications, and any associated biosimilars is triggered by means of competition and regulatory measures. In France, the national price-setting authority marks down reference biomedicine prices and sets lower prices for their biosimilars in retail pharmacies. Hospitals and hospital procurement groups are encouraged to tap into the competitive environment to negotiate discounts from their suppliers. These negotiations also give the authority responsible for setting retail pharmacy prices an indication of the medicinal product reserve price for future price cuts, thereby minimising the risk of the product being withdrawn from the market (Robinson & Jarrion, 2021).

was introduced into French common law on January 1st, 2018, whereby prescribing hospitals receive 20% of the price difference between the reference drug and the biosimilar[3] for every biosimilar delivered in retail pharmacies from these hospital prescriptions. This article examines a pilot scheme that ran from October 2018 to September 2021, the purpose of which was to trial a higher financial incentive (30%) which would also be intended to be redirected directly to hospital's prescribing unit(s). The scheme focused on two formulations upon its launch in 2018 – insulin glargine, a slow-release long-acting insulin, and etanercept, which is primarily used to treat inflamed joints. Both formulations have been available as biosimilars since 2016.

To measure the causal effect of the pilot on biosimilar use, we use exhaustive administrative data from SNDS (*Système National des Données de Santé*, French National Health Data System) and compare changes in biosimilar prescription rates among healthcare facilities in the pilot (treatment group) with similar facilities (control group), comparing the results obtained before and after the pilot (difference-in-differences model). Throughout the three-year pilot phase, we find that facilities receiving the incentive had a higher share of biosimilar prescriptions delivered in retail pharmacies for insulin glargine (+6.0 percentage points) and etanercept (+10.8 percentage points). These results are similar to the 9.7 percentage point increase estimated for etanercept following an evaluation of the first two years of the pilot using survey data (Tano *et al.*, 2023). We complement this study using exhaustive data to analyse the effect of the pilot on a second formulation, and we run the analysis over the entire three-year phase of the pilot. We also estimate the pilot's cost-effectiveness, considering all hospital prescription expenditure, including follow-up prescriptions by primary care physicians. All French NHI costs incurred as a result of the pilot (i.e. to cover incentives and the reimbursement of prescribed medicines) are compared with the costs that would have been incurred in the absence of a pilot, in order to assess the pilot's efficiency. We assume that the pilot does not affect effectiveness because biosimilars are therapeutically equivalent to their reference biomedicines. Our estimates indicate that the pilot would yield saving rates of 0.5% for insulin glargine and 0.1% for etanercept, modest savings for the French NHI. The pilot's design leads to reimbursement savings if there is a switch between biosimilars and reference biomedicines, such savings decreasing proportionally with the financial incentive rate, and to deadweight losses, which are a source of additional expenditure linked to incentives. The pilot's cost-effectiveness is dependent on the relative magnitude of these two counteracting effects. First, medication price changes outpace the rate at which incentives are adjusted. This can lead to higher financial incentives, reducing the profit that the French NHI gains from prescriptions of biosimilar medicines that are cheaper than reference biomedicines (substitution effects). Secondly, over the course of the pilot phase, biosimilars use for both formulations strongly increased, achieving a breakthrough comparable to previous biosimilars during their first few years on the market (Gouvernement, 2022). This led to more significant deadweight loss effects over time, since the higher incentive applies to all prescriptions, including those that would have been issued outside of a pilot.

This article contributes to the literature that examines pay-for-performance (P4P) arrangements for healthcare professionals. Since the 2000s, performance and quality-based payment programmes aiming to improve inpatient and outpatient care quality and effectiveness have been developed in several countries. Based on a summary of 14 programmes across 16 European countries and their evaluations, the OECD concluded that the programmes appear to have a moderate impact on process indicators (such as participation in programmes to help people stop smoking or manage diabetes). However, those evaluations do not reveal any progress in terms of health outcomes or healthcare security and the OECD found that their cost-effectiveness was inconclusive or even unfavourable (Eckhardt *et al.,* 2019).

In France, a target-based remuneration programme rolled out for primary care physicians[4] in 2012 features efficiency indicators in addition to quality indicators (Bras, 2020). The *Contrat d'Amélioration de la Qualité et de l'Efficience des Soins* (Contract for improved

3. The term "biosimilar" is used in this article for reasons of clarity despite the fact that the term is a misnomer since the pilot encourages prescriptions of cost-efficient biologics within comparable medicine *classes that do not necessarily correlate to the groups of* biosimilar *medicines as defined by the French Public Health Code (Decree of 31 March 2022 amending the Decree of 19 April 2021 on the pilot project to encourage hospital prescriptions of biologics dispensed by retail pharmacies – Légifrance, legifrance.gouv.fr).*

*4. The current programme is the ROSP (*Rémunération sur Objectifs de Santé Publique*, or Remuneration based on Public Health Objectives), which replaced the CAPI (*Contrat d'Amélioration des Performances Individuelles*, or Contract for Improving Individual Practices). In 2023, the ROSP is based on 29 indicators, 20 of which are quality scores (8 indicators for monitoring patients with chronic conditions, 12 indicators for prevention) and nine of which measure the efficiency of prescriptions.*

healthcare quality and efficiency, CAQES) is a P4P agreement for clinical facilities established in 2016 and which introduced an annual incentive when these meet fixed targets, including gainsharing agreements on healthcare savings. There are very few evaluations of these measures in France and the few existing studies focus on specific aspects of the programmes for primary care practitioners. No studies focus on the CAQES for clinical facilities. These studies have found no impact of these incentives on the quality of care or the uptake of preventive measures (Saint-Lary & Sicsic, 2015; Constantinou *et al.*, 2016; Sicsic & Franc, 2017). The only evaluation relating to prescription behaviour found that the incentives had a positive yet limited impact on benzodiazepine prescriptions (Michel-Lepage & Ventelou, 2016). Current quality and performance-based payment arrangements may hold a certain symbolic and educational value, yet their effectiveness remains somewhat inconsistent (Bras, 2020).

In France, the framework for structural innovation in healthcare ("Article 51" of the 2018 French Social Security Financing Act) allowed pilots to test funding methods that deviate from French common law. This framework creates the conditions to test the effectiveness of innovative financing solutions in a pilot and to perform evidence-based analyses prior to wider scaling. The pilot in which hospital are incentivised to prescribe biosimilars that are delivered in retail pharmacies was the first large-scale project of its kind to be carried out at the national level. Underpinned by a model of incentives that scale up based on the number of prescriptions issued, the pilot also focuses on hospital physicians, in that a percentage of the savings made in outpatient facilities as a result of the prescriptions issued by the physicians is filtered back to their hospital units directly. Another distinguishing feature of the pilot is that it is being trialled using a sample of facilities to establish a control group. This article expands on the existing literature by providing a quantitative evaluation of the impact of incentives on biosimilar prescriptions, measures the pilot's effect by using a counterfactual to compare pre- and post-pilot biosimilar prescribing patterns, and additionally includes an analysis of the pilot's cost-efficiency.

After setting out the pilot's principles and procedures in Section 1, we describe the empirical strategy followed to assess the pilot's effect and cost-efficiency for its first two formulations – insulin glargine and etanercept (Section 2) – and the data used (Section 3). We present the findings (Section 4) and conclude by discussing their limitations and implications.

1. Overview of the Pilot

Improved biosimilar uptake rates are one of the objectives of the 2018–2022 French national health strategy (*Stratégie nationale de santé*, SNS), which targeted a biosimilar uptake rate of 80% among prescriptions for biologics where a biosimilar is available, by 2022. A pilot was therefore launched in 2018 to encourage higher rates of biosimilar prescriptions for two formulations that are commercially available in pharmacies both within hospitals and in outpatient settings:

- insulin glargine: a slow-release long-acting insulin used to treat diabetes, which, despite being relatively affordable (average price of €45 (2018–2021) per standard box of the leading insulin glargine medication), is taken by many patients;
- etanercept: an anti-TNF immunosuppressive agent used to treat skin conditions such as psoriasis, or inflamed joints. A standard box of the leading etanercept medication costs €675 on average (2018–2021).

These two products are distinctive because they are prescribed in hospitals but mainly used on in outpatient settings and, having generated pre-tax sales revenue of €182 million (etanercept) and €145 million (insulin glargine) in the outpatient market in 2018, are the second and third most lucrative biologics among those with a commercially available biosimilar (Dahmouh, 2019).

When the pilot began in 2018, insulin glargine and etanercept biosimilars had respective penetration rates of 41% and 30% in the hospital market, and 13% and 14% in the outpatient market. The proportion of biosimilars among biologics for which a biosimilar is available increased from 16% to 32% in outpatient settings between 2018 and 2021 (Sécurité sociale, 2019; 2022). While hospitals receive incentives to switch to biosimilars to cut their medicine procurement costs, the limited penetration of biosimilars in the outpatient market may be explained by the relatively recent introduction of the incentives for primary care practitioners and hospitals to include biosimilars among prescriptions delivered in retail pharmacies.

Primary care practitioners in outpatient facilities are incentivised to prescribe biosimilars under the ROSP. The programme has a set target rate for biosimilar prescriptions. Insulin glargine was

the only formulation covered in 2017,[5] but others were included in 2022.

On January 1st, 2018, French common law introduced a financial incentive for healthcare institutions under the CAQES.[6] For eligible formulations, each clinical facility receives approximately 20% of the price difference[7] between the reference biomedicine and its biosimilar for each box prescribed by its physicians and delivered in retail pharmacies (PHMEV). However, this also applies to drugs prescribed by primary care practitioners providing patient care follow-up by continuing treatment with a biosimilar originally prescribed by a hospital physician. The hospital's legal entity is the final recipient of the incentive, which the *Agence Régionale de Santé* (Regional Health Agency, ARS) pays out on an annual basis.

A pilot initiated within the Healthcare Innovation Framework ("Article 51" of the 2018 French Social Security Financing Act[8]) aimed to trial a more extensive system of incentives for hospital units that rewards the latter for prescribing biosimilars that are delivered in retail pharmacies. There are two ways in which this initiative deviates from French common law. First, it duplicates the incentives provided for by the CAQES, albeit with a payment of approximately 30%[9] of the savings made by the French NHI as a result of a hospital's prescriptions, rather than the original 20%. Secondly, the terms of the pilot specify that any funds that a facility receives must directly accrue to its prescribing unit(s), in accordance with a framework defined by the facility (equipment, seminars or research, training, etc.), with the specific aim of promoting greater uptake of biosimilar medicines.[10] The pilot therefore provides a higher financial payout than the CAQES and also has an organisational aspect whereby the aim is to reward units for driving change. Application of the pilot is non-concomitant with application of the CAQES.

The principle behind this incentive-based pilot scheme was announced in early 2018, when the CAQES[11] was introduced, and the terms of the scheme were communicated in the decree concerning the pilot, issued on August 3rd, 2018.[12] The pilot start date was set for October 1st, 2018 for insulin glargine and etanercept, for an initial period of 3 years, for all selected clinical facilities.[13]

Following a call for submissions issued in the decree concerning the pilot, clinical facilities with an interest in applying and being selected were given a one-month deadline by which to submit their application files. Applications could be made for both target formulations, or just a single formulation. Evaluation of the files was delegated to the regional health agencies, which scored the files based on various criteria – the quality of biosimilar promotion measures already undertaken or planned for the future, the quality of the internal incentive-based scheme, and the target volume of biosimilar prescriptions, particularly for the target formulation. The French *Direction de la sécurité sociale* (Directorate of Social Security, DSS) and *Direction générale de l'offre de soins* (General Directorate of Healthcare Services) proceeded to select clinical facilities using the criteria and rankings of the regional health agencies as their primary source. However, consideration was also given to ensuring that hospitals were selected in such a way that a geographically consistent network covered mainland France.

The list of accepted facilities was notified in an order issued on October 2nd, 2018:[14] Of the 42 facilities that applied for insulin glargine, 23 were selected, and 40 of the 63 facilities that applied for etanercept were selected. Given that some hospitals were selected for both formulations, the pilot includes 45 different facilities in total (four facilities are geographical entities belonging to the AP-HP conglomerate of hospitals operating in Île-de-France). The selected facilities cover all 12 regions of mainland France. The whole pilot was extended in 2022.[15]

The pilot's stated aim was to increase by 15 percentage points the share of biosimilar prescriptions in treatment group facilities

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5. Initially 20% in 2017, the target biosimilar prescription rate was set at 40% of the total boxes prescribed in 2020. GPs that meet this 40% target gain 30 of the 940 points available under the ROSP, i.e. 3.2% of the total score. New entries have been added to the list of active substances qualifying for the programme since January 2022.

6. Decree of 19 March 2019 on the efficiency and relevance of hospital prescriptions of biosimilar medicines dispensed in retail pharmacies (https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000038268137).

7. Amounts are set by decree and vary according to the dosage on each box. The incentive rate may therefore vary over time to reflect any medicinal product price fluctuations.

8. Trials and innovation to improve care standards – French Ministry of Health and Prevention – https://sante.gouv.fr/systeme-de-sante/parcours-des-patients-et-des-usagers/article-51-lfss-2018-innovations-organisationnelles-pour-la-transformation-du/article-51

9. Under the pilot, amounts are also set by decree and vary according to the dosage on each box.

10. In reality, units primarily used the funds to purchase equipment, hire new staff, fund treatment programmes or improve financial standings.

11. Directive DSS/1C/DGOS/PF2/2018/42 of 19 February 2018. https://solidarites-sante.gouv.fr/fichiers/bo/2018/18-03/ste_20180003_0000_p000.pdf

12. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037316661

13. In early 2019, the pilot was expanded to include adalimumab, and this prompted a new selection phase in which 40 facilities were chosen from 78 applicants. (Decree of 12 February 2019 – https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000038129827).

14. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037477126

15. The Decree of 31 March 2022 extends the pilot project until September 2022. https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000045462658

compared to control group facilities. Biosimilars for insulin glargine and etanercept were widely available when the pilot launched and the biosimilar uptake rate for these two formulations increased sharply over the pilot phase, reflecting the trend observed for older biosimilars, which made a similar breakthrough during their first few years on the market (Gouvernement, 2022).

2. Empirical Strategy

2.1. Impact of the Pilot on Hospital Biosimilar Prescriptions

The empirical strategy initially aims to measure the pilot's effect on the rate of biosimilars. The rate of biosimilars among all PHMEV prescriptions issued by each hospital for a given formulation is the indicator of interest in order to capture the prescribing behaviours of hospital physicians, as it conveys the choice between the reference biomedicine and the biosimilar made by a hospital physician when writing a prescription. This rate, which is between 0 and 1, can be used to compare facilities, provides insight into the potential scope for improvement, and is independent of treatment durations and prescribed volumes.

It is possible to calculate this indicator over each period, provided that facilities prescribe a formulation on at least one occasion. As a result, we first verify that participation in the pilot has no bearing on the decision to prescribe the formulation. When modelling the probability that facilities record at least one prescription for the (reference biomedicine or biosimilar) formulation, the treatment effect is null for both insulin glargine and etanercept (model shown below in Table 1). We therefore subsequently focus exclusively on facilities that prescribe each of the formulations.

We use a difference-in-differences method to estimate the causal effect. The purpose is to use a time-series comparison of facilities in the treatment group and control group to estimate the pilot's effect. Selection of facilities in the treatment group is not random because they are all voluntary and have been selected after having submitted an application. In order to account for this as accurately as possible, we apply a doubly robust method to control for selection bias based on observed characteristics. This combines estimates for a propensity score and a conditional expectation (Sant'Anna & Zhao, 2020) (Box 2). However, selection bias cannot be completely eliminated and may also depend on unobserved characteristics of the facilities to some extent.

An advantage of this method is that it can be used to estimate a treatment effect for each month and consequently analyse the effect's dynamics as well as to estimate the mean effect over the entire treatment period. It makes it possible to ascertain whether the incentive appears to prompt temporary or sustained changes in prescribing patterns (over a 3-year period).

2.2. Efficiency Calculation Method

As biosimilars are therapeutically equivalent to their reference biomedicines, we assume that switching to a biosimilar from a reference biomedicine does not affect efficacy and that a cost analysis is sufficient to analyse efficiency.

The pilot is efficient if it generates positive net savings for the French NHI. French NHI expenditure incurred as a result of PHMEV for insulin glargine (or etanercept) issued by facilities in the pilot must therefore be subject to a comparison for pilot and non-pilot situations.

For both of these formulations, this expenditure consists of NHI reimbursements for medicines (reference biomedicines and biosimilars) and incentives to prescribe biosimilars. To quantify the differential for total pilot and non-pilot expenditure, it is compared with expenditure that would have arisen for treatment group facilities had there been no pilot.

A counterfactual value for the number of dispensed boxes of reference biomedicines and

Table 1 – **Effect of the treatment on the probability for facilities to record at least one prescription for the (reference biomedicine or biosimilar) formulation**

y	Insulin glargine			Etanercept		
	Effect	Standard error	p-value	Effect	Standard error	p-value
(ordo>0)	−0.01	0.06	0.99	−0.01	0.13	0.91

Notes: Linear regression estimate of the average effect of the pilot on the probability that the (reference biomedicine or biosimilar) formulation is prescribed on at least one occasion after its launch. This is calculated by comparing it with values for September 2018, the month immediately prior to the pilot's launch.
Sources and coverage: SNDS 2017–2021, SAE 2019 (facility categories); public facilities that include at least one hospital complex, long-term nursing home or healthcare cooperation association. PHMEV for insulin glargine and etanercept.

Box 2 – **The Econometric Model**

The econometric model uses the doubly robust method, which combines both an estimated propensity score and conditional expectation (Sant'Anna & Zhao, 2020).

First, it models the probability for facilities to be selected for the pilot using a logit model-derived propensity score (see Appendix A1). Non-treated clinical facilities are weighted in the calculation using this probability, with higher weightings being assigned to facilities with the highest selection propensity score. All non-selected clinical facilities are therefore included in the control group used for the estimate, albeit with a higher weighting if they are more likely to be selected[(a)]. The propensity score method is better suited than linear regression with the inclusion of covariates due to the high disparity between treated and non-treated facilities in terms of the variables observed, which increases the risk of omitted-variable bias[(b)].

Secondly, the conditional expectation of changes in the explained variable for the control group is estimated using an outcome regression. Calculating the "doubly robust" estimator then allows for the explained variable changes and propensity score to be modelled in order to obtain a more robust estimator than if the approaches were followed in isolation (Sant'Anna & Zhao, 2020)[(c)]. Estimates are made in R using the package (https://cran.r-project.org/web/packages/did/vignettes/did-basics.html) developed by Callaway and Sant'Anna (2021).

Strictly speaking, the average treatment effect on the treated $\boldsymbol{ATT}$ is estimated as follows:

$$\boldsymbol{ATT}(t) = \boldsymbol{E}\left[\left(\frac{\boldsymbol{G}}{\boldsymbol{E}[\boldsymbol{G}]} - \frac{\frac{p(X)C}{1-p(X)}}{\boldsymbol{E}\left[\frac{p(X)C}{1-p(X)}\right]}\right)\left(\boldsymbol{Y}_t - \boldsymbol{Y}_{T0-1} - \boldsymbol{E}\left[\boldsymbol{Y}_t - \boldsymbol{Y}_{T0-1} \mid \boldsymbol{X}, \boldsymbol{C}=1\right]\right)\right]$$

where $\boldsymbol{Y}_t$, the explained variable, is the rate of biosimilar prescriptions among prescriptions written by a facility in month $\boldsymbol{t}$, $\boldsymbol{G}$ is a dummy that indicates whether a facility is included in the treatment group, $\boldsymbol{C}$ is a dummy that indicates whether a facility is included in the control group, $\boldsymbol{T}0$ is the effective start date of the pilot, and $\boldsymbol{p}(\boldsymbol{X})$ is the propensity score, i.e. the estimated probability of selection in the pilot, which is calculated using covariates $\boldsymbol{X}$.

Thus, on average, the deviation $\boldsymbol{Y}_t - \boldsymbol{Y}_{T0-1}$ for a facility is compared to the average deviation for the control facilities $\boldsymbol{Y}_t - \boldsymbol{Y}_{T0-1}$ and conditionally to the covariates, by assigning either a constant weighting inverse to the probability of selection (i.e. $\boldsymbol{E}[\boldsymbol{G}]$) if the facility is a treatment group facility ($\boldsymbol{G}=1$) or the weighting $-\frac{\frac{p(X)}{1-p(X)}}{\boldsymbol{E}\left[\frac{p(X)C}{1-p(X)}\right]}$ if the facility is a control group facility ($\boldsymbol{C}=1$), with a higher weight being given to the facilities with the highest estimated probability of being selected on the basis of their observable characteristics.

If the covariates did not have an impact on the probability of selection in the pilot, in other words if the treatment and control group facilities had similar average characteristics, and if the common trend hypothesis between the groups was unconditional, in other words if the changes expected in the treatment group in the absence of treatment matched those of the entire control group, this would be simply expressed as the difference in changes in $\boldsymbol{Y}_t$ in the treatment group and the control group:

$$\boldsymbol{ATT}(t) = \boldsymbol{E}\left[\boldsymbol{Y}_t - \boldsymbol{Y}_{T0-1} \mid \boldsymbol{G}=1\right] - \boldsymbol{E}\left[\boldsymbol{Y}_t - \boldsymbol{Y}_{T0-1} \mid \boldsymbol{C}=1\right]$$

The average treatment effect on the treated $\boldsymbol{ATT}$ is estimated over the period from October 2017 (one year before the pilot began) to September 2021 (end of the three-year pilot phase). $\boldsymbol{T0}$ corresponds to the month of October 2018, which marks the beginning of the pilot. It is estimated separately for insulin glargine and etanercept.

The covariates $\boldsymbol{X}$ selected for sample rebalancing purposes measure the number of prescriptions, the size of the facility, the size of the prescribing unit (etanercept only), the mean proportion of prescriptions among deliveries of medication (a proxy for the validity period of a prescription and therefore patient follow-up intensity), and the proportion of first-time treatments among prescriptions (see the description of these variables in Section 3). Insofar as repeated cross-sectional data is used, the estimate for each month is based on the sample of facilities that issued at least one prescription for the formulation being studied. Facilities are clustered in the calculation of standard deviations so that intra-facility correlation is achieved without other covariates being correlated. Standard deviations are calculated by bootstrap (1,000 iterations).

(a) The study cannot be limited to applicant facilities that were not selected to form the control group, due to insufficient sample size (see Section 2). They are included in the control group because they share similar characteristics to the selected facilities. Their observable characteristics are similar to those of the treated facilities and their application was clearly motivated by an interest in actively boosting biosimilar prescriptions.

(b) When the standardised differences for the covariates are above 0.25, conventional difference-in-differences regression methods are considered to be highly sensitive to omitted variables (Imbens & Wooldridge, 2009). All the standardised differences exceed 0.6 here. Possible omitted variables could potentially characterise a clinical facilitie's medical team in terms of aspects such as qualifications, peer reviews, further training, inclusion in a network with a shared approach to biosimilars, prescriber age, etc.

(c) The OR (outcome regression) model requires efficient modelling of the conditional expectation of the changes in the explained control group variable, whereas the IPW (inverse probability weighting) model requires efficient modelling of the conditional probability of selection in the treatment group. The "doubly robust" model combines both methods by modelling explained variable changes as well as the propensity score. Results are accurate if at least one of these parameters is met and therefore the resulting estimator is more robust than if OR and IPW methods were used in isolation.

biosimilars is required to estimate the costs that would have been incurred had there been no pilot. To produce this, we econometrically estimate the effect of the pilot on the ratio of biosimilars to total boxes delivered, weighted[16] by dosage. Unlike the estimate in Section 2.1, this indicator refers to the number of boxes delivered as opposed to the number of prescriptions, in order to reflect the active substance volume and the prescribed treatment course duration. This estimate provides us with a counterfactual number of weighted boxes of reference biomedicines and biosimilars following PHMEV for each month and each facility (assuming that the number of dispensed weighted boxes of biologics is the same in pilot and non-pilot situations[17] and only the rate of biosimilars changes).

This then allows us to calculate pilot and non-pilot PHMEV-related spending. The incentives are calculated by multiplying the number of weighted boxes of biosimilars by the value of the incentive for a box with a weighting of 1. Reimbursements are calculated by multiplying the number of boxes by the price of boxes. A 100% French NHI reimbursement rate is assumed.[18] For the formulations in the pilot, the financial impact on households and supplementary health insurance is therefore assumed to be negligible.

However, the French NHI expenditure incurred as a result of PHMEV relates to all biologics delivered in retail pharmacies to patients who received a PHMEV, that is to say that biologics delivered following a subsequent prescription issued by a primary care physician are also included. This is because the incentives provided via the pilot scheme, just like those provided under the CAQES, apply to all medication delivered in retail pharmacies following an initial PHMEV. To shift from expenditure linked to boxes delivered following a PHMEV (reference biomedicines and biosimilars) to expenditure linked to all boxes delivered in retail pharmacies following a PHMEV or subsequent prescription issued by a primary care physician, in the counterfactual situation as well as in the pilot, we use two multiplicative coefficients (the total number of boxes delivered in retail pharmacies compared with the total number of boxes directly linked to a PHMEV, and the probability that the type of biologic prescribed in retail pharmacies is different from that prescribed as a PHMEV[19]) that are estimated on an annual basis using data from the pilot.

Annual expenditure is calculated by aggregating the expenditure for each month and facility, and total net savings are estimated by aggregating annual profits/losses over the entire period.

The pilot's design produces an effect which is caused by switching between biosimilars and reference biomedicines (a source of reimbursement savings) and a deadweight loss effect (a source of additional incentive-related spending). The pilot's efficiency is dependent on the relative magnitude of these two counteracting effects.

Net savings achieved via the pilot can more specifically be broken down as follows (see details of the calculation in Online Appendix S1 – link provided at the end of the article):

$$EXPENDITURE^{\text{Non-pilot}} - EXPENDITURE^{\text{Pilot}} = \underbrace{\Delta Price \times \left(1 - TI_{\text{Biosim}}^{\text{Pilot}}\right) \times \Delta Q_{\text{Biosim}}}_{\text{substitution effect}} - \underbrace{\Delta I \times Q_{\text{Biosim}}^{\text{Non-pilot}}}_{\text{deadweight loss effect}}$$

in which $\Delta Price$ is the difference between reference biomedecine and biosimilar, $TI_{\text{Biosim}}^{\text{Pilot}}$ is the pilot's incentive rate (defined as the ratio between the incentive paid out under the pilot and the price difference $\Delta Price$, i.e. $\frac{I_{\text{Biosim}}^{\text{Pilot}}}{\Delta Price}$), ΔQ_{Biosim} is the difference between the volumes of biosimilars delivered under the pilot and those delivered with no pilot, ΔI is the difference in incentives paid out for a box with a weighting of 1 under the pilot and those paid out with no pilot, and $Q_{\text{Biosim}}^{\text{Non-pilot}}$ is the counterfactual volume of biosimilars.

The substitution effect increases in line with the difference in price between reference biomedicines and biosimilars because when physicians prescribe biosimilars, the French NHI incurs lower costs due to the fact that they are more cost-effective than reference biomedicines if they both contain the same quantity of active substance. However, the gainsharing component minimises this positive effect on reimbursements since the price differential is partly redirected to the clinical facilities. The substitution effect therefore decreases when the incentive rate increases (assuming a fixed quantity of biosimilars).

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16. We apply a weighting that the Direction de la sécurité sociale *defined for each box of biological medicinal products in the decrees establishing the incentives under the CAQES and the pilot, which enables a shift from box counts to a total volume of active substance. Using etanercept as an example, 50 mg boxes of Enbrel brand (the reference biomedicine) will be assigned a weighting of 1, while 25 mg boxes of Enbrel brand will be assigned a weighting of 0.5.*

17. When the same econometric model described in Section 2 is applied to the total number of weighted boxes of biologics (reference biomedicines or biosimilars), the estimated effect is not significant at standard thresholds.

18. This is a reasonable hypothesis given that 90% of patients supplied with etanercept as well as insulin glargine in the first half of 2021 had a long-term medical condition for which their expenses were fully reimbursed.

19. Non-hospital physician prescriptions match the original prescriptions issued by hospital physicians in more than 97% of cases.

The pilot's higher incentive also creates a deadweight loss effect because it applies to all prescribed boxes, which, in turn, means that the French NHI redirects more incentive funds to treatment group facilities for boxes of biosimilars that would have been prescribed even in the absence of the pilot incentive (counterfactual). The higher the non-pilot biosimilar penetration rate and the greater the difference between the incentives under the pilot and under French common law, the more pronounced this deadweight loss effect.

The pilot's ability to deliver positive net savings and therefore its efficiency requires the deadweight loss effect associated with the pilot's higher incentive to be at least counterbalanced by the substitution effect caused by the increase in biosimilar prescriptions. The efficiency threshold value at which the pilot generates positive net savings for the French NHI can be calculated (see details of the calculation in Online Appendix S1):

$$EXPENDITURE^{\text{Non-pilot}} - EXPENDITURE^{\text{Pilot}} > 0$$
$$\Leftrightarrow \frac{\Delta Q_{\text{Biosim}}}{Q_{\text{Biosim}}^{\text{Non-pilot}}} > \frac{\Delta TI}{\left(1 - TI_{\text{Biosim}}^{\text{Pilot}}\right)}$$

where ΔTI is the difference between the pilot and non-pilot incentive rates.

The efficiency threshold increases in line with the pilot's incentive rate since this rate reduces the substitution effect. However, it also increases in line with the incentive rate differential on account of the deadweight loss effect.

Successive decrees set the amount of the incentive under the CAQES (French common law, no pilot) and the pilot at 20% and 30%, initially, of the price difference between standard boxes of the reference biomedicine and its biosimilar, i.e. boxes with a weighting of 1.

If $TI_{\text{Biosim}}^{\text{Non-pilot}} = 20\%$ and $TI_{\text{Biosim}}^{\text{Pilot}} = 30\%$, the efficiency threshold is about 0.14, which means that biosimilar volumes must increase by at least 14%[20] if the pilot is to yield positive net savings.

However, reference biomedicine and biosimilar prices may have varied over time while incentive unit amounts remained constant. This may have resulted in different incentive rates (see Section 3.2.3) and therefore different efficiency thresholds.

3. Data

3.1. Sources and Coverage

We use data from the French national health insurance reimbursement database (*Datamart de Consommation Inter-Regimes*, DCIR) of the SNDS, which comprehensively records services and items reimbursed by the French NHI. Every patient prescription delivered in a retail pharmacy includes the date on which the medication is delivered, the prescribing professional (clinical facility or primary care physician), the formulations and dosages (CIP code), and the number of boxes. Data concerning medication delivered in retail pharmacies is aggregated by formulation, prescribing facility and month of delivery. It should be noted that a pharmacy can repeatedly deliver medication under the same prescription if no further visit is required during the treatment period. Our analysis is limited to prescriptions (not deliveries), i.e. when a physician prescribes a first-time treatment or a different treatment, to calculate the monthly share of biosimilars among prescriptions issued by each facility, for each formulation[21] (explained variable).

We also use this data to construct multiple covariates. The patient population treated by a given facility is measured on the basis of the number of prescriptions it issues for each of the formulations. For each formulation, we also identify the proportion of first-time treatments among all of a given facility's prescriptions since initiating biosimilars as a first-line treatment is generally simpler than switching between reference biomedicines and biosimilars as a treatment. We use the historically extensive data up to 2012 to identify a first-time treatment, when the same patient receives a particular formulation for the first time (since 2012). Lastly, we include the percentage of deliveries for each prescription. A low percentage suggests that a facility is prescribing longer courses of medication between consultations. For these three covariates, we use the monthly average during the year preceding the pilot (October 2017 to September 2018) to account for seasonal patterns.

To characterise the facilities, we use the *Statistique Annuelle des Établissements de santé* dataset (Annual statistics of healthcare institutions,

20. This 14% increase applies to the total number of weighted boxes of biosimilars and cannot be compared with the estimated effect of the pilot on the percentage of biosimilars among all weighted boxes, which is given in percentage points.

21. Prescriptions are when a physician actively prescribes medication during a visit: the physician specifies the formulation, dosage and treatment course duration on the prescription. We only count prescriptions once, even if they have resulted in multiple instances of medication deliveries (for example, a single prescription for a 3-month course of treatment is recorded once, even if it has resulted in a pharmacy delivering medication for three consecutive courses of treatment each lasting one month). In practice, we use counts of medication being dispensed directly after a new prescription date in pharmacy reports to identify prescriptions in the data.

SAE 2019), in which each facility's size and legal category is provided. Facility sizes are measured on the basis of the number of beds available in medicine/surgery/obstetrics wards (and its square) and the FTE number of salaried physicians, with no distinction made for specialties (FTE and its square). The number of annual FTE dermatologists/venereologists/allergists and rheumatologists (and its square) provides the size of the units likely to prescribe etanercept. No equivalent indicator exists for insulin glargine because it is prescribed by physicians in many specialties.

Medicine prices and their changes over time are obtained from the monthly unit prices charged at retail pharmacies for each medicine (CIP), excluding sales tax, according to the data reported by the GERS (*Groupement pour l'Élaboration et la Réalisation de Statistiques* (Partnership to Collect and Prepare Statistics)). A 13% increase is applied to these prices (reflecting the estimated mean deviation between the pre-tax GERS prices and the prices inclusive of tax according to the *base publique du médicament* (public medicinal products database)) in order to derive the monthly prices, inclusive of tax, which correspond to the French NHI *base de remboursement*, or reimbursement rate. A price can be assigned to medicinal products under the pilot as their prescription data is known, whereas we are limited to the estimated weighted quantity of reference biomedicines and biosimilars for the counterfactual. For a specific facility, month and type of biomedicine (reference biomedicine or biosimilar), the average price of a box with a weighting of 1 is therefore used for boxes that have actually been prescribed (see Online Appendix S1). Lastly, to determine expenditure from PHMEV in retail pharmacies, the annual ratios of hospital/primary care prescriptions are calculated for the formulations.[22]

The analysis is carried out on prescriptions in clinical facilities using their legal entity as the unit. The legal identifier is the most reliable means of identifying a prescribing facility from the data, and it is this entity to which the incentive is redirected.[23] As individual physician identifier numbers are not always entered on hospital prescriptions, it is currently impossible to link prescriptions and prescribing physicians or units via the SNDS. The analysis therefore excludes facilities that have identifiers which are not recognised in the FINESS database – and that cannot therefore be matched with the *Statistique Annuelle des Établissements* (Annual statistics of healthcare facilities, SAE) dataset – as well as atypical facilities, and only includes facilities whose legal category includes at least one hospital complex, long-term nursing home or health cooperation association. We restrict the analysis to public sector hospitals because, in the private sector, it is not possible to comprehensively match physician prescriptions to the correct facility as physicians in for-profit facilities occasionally use their own prescribing books instead of the facility's books.

The analysis period used for the econometric estimate is from October 2017 to September 2021, that is to say the three years of the pilot plus the year preceding it. The statistics that describe prescription trends among the treatment and control groups are presented for the entire period during which biosimilars existed. The first biosimilars for insulin glargine and etanercept were marketed in January 2016 and October 2016, respectively.

3.2. Descriptive Statistics

3.2.1. Sample Description

The group of facilities selected for the pilot and used in the estimate (treatment group) consists of 18 or 19 hospitals for insulin glargine, depending on the month, and 36 hospitals for etanercept. Restricting the analysis to public hospitals effectively excludes four private hospitals selected for each of the formulations in the pilot.

The control group consists of approximately 530 facilities for insulin glargine and 270 for etanercept, taken from an initial sample of approximately 1,900 and 560 facilities that prescribe the formulations, respectively (Table 2). Less than 5% of facilities are excluded on account of their identifier being unknown (FINESS number not found in the database) or because of their legal category. The others are excluded on account of their private status. Although there are many excluded facilities, their prescription numbers are limited. Only 5% of prescriptions for the formulations studied were issued by private facilities.

The facilities selected in the pilot are predominantly large hospitals. They have for example more than a triple bed numbers in average

22. *The programs used by the* Direction de la sécurité sociale *(DSS) to calculate the amount of the incentives based on the SNDS are used to calculate this indicator.*

23. *Any legal entity that includes a cluster of geographical entities that may prescribe the formulations being studied is responsible for distributing the subsidies under the pilot or the CAQES among them. Four AP-HP geographical entities selected for the etanercept pilot are an exception to this, however. They are recorded here as separate entities (Pitié-Salpêtrière/Charles Foix, Cochin, Nord/Val-de-Seine and Mondor/Chenevier).*

Table 2 – **Facilities in the sample**

	Insulin glargine	Etanercept
Prescribing clinical facilities (initial sample):	1,924	561
Excluding:		
- Unknown identifier	27	10
- Atypical category	63	18
- Private sector (profit and non-profit)	1,288	227
Prescribing clinical facilities (final sample):	546	306
Including:		
- Accepted applicants (= treatment group)	**18***	**36**
- Non-pilot (= control group):	**528**	**270**
- Rejected applicants	10	12
- Applicants rejected but accepted for a different formulation	2	6
- Non-applicants	516	252

Notes: Prescribers are identified by the FINESS number of their facility's legal entity. The number of prescribers varies from month to month, as some facilities may not record any insulin glargine or etanercept prescriptions in a given month. These figures relate to facilities responsible for at least one dispensation of medication during September 2018. * 19 public facilities were selected, but only 18 recorded prescriptions in September 2018.
Sources: SNDS (prescribing facilities responsible for dispensing medication in September 2018), DSS (applications and rejections), SAE (facility categories).

than control group facilities. Their treated patient populations, which are measured using prescription numbers, are larger, irrespective of formulation (Table 3).

These observable characteristics can be linked to the ability of facilities to prescribe more biosimilars. We use the propensity score to make treatment and control group facility samples more comparable. This score enables to balance the treatment and control samples by assigning a higher weighting to those facilities that are closest to the treated facilities. This requires a common support assumption between both groups of facilities. Therefore, we ensure that there are sufficient control observations comparable to the treated facilities along the entire distribution of these characteristics (see Table S2-1, Online Appendix S2). We also make sure that the control sample features comparable characteristics to the treated sample once it has been weighted by the propensity score (see Table S2-2, Online Appendix S2).

3.2.2. Changes in Biosimilar Prescription Rate

The general trend observed for both formulations is an increase in prescriptions for biosimilars immediately after their introduction onto the market (Figures I and II). The very marginal upturn in 2018 coincides with the introduction of the CAQES on January 1st, 2018, for all facilities in France.

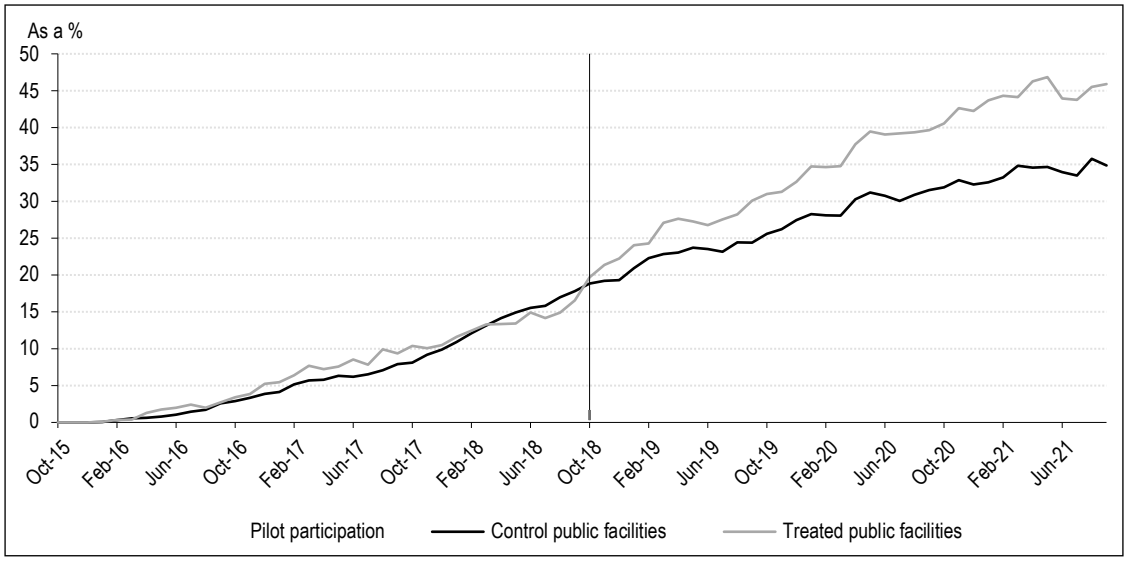
The patterns for insulin glargine prescriptions in treated facilities were similar to those in control facilities prior to October 2018 (Figure I). Over the three years of the pilot, biosimilar prescriptions among all prescriptions issued by treated hospitals increase by 7.0 percentage points, on average. Over the year preceding the pilot, the average biosimilar prescription rate for etanercept in treated facilities already exceeds the rate achieved by other facilities by 3.9 percentage points (Figure II). The mean difference is 9.7 percentage points over the three pilot years studied.

Table 3 – **Average characteristics of facilities in the sample**

	Insulin glargine		Etanercept	
	Treatment	Control	Treatment	Control
Number of prescriptions (monthly average)	169.7	39.7	44.6	6.6
% of first-time prescriptions	15.5	17.9	10.9	9.5
% of medication dispensed following a prescription	60.4	73.2	31.3	31.6
Unit size – salaried physicians	NC	NC	13.4	2.8
Facility size – salaried physicians	475.8	108.8	530.3	154.8
Facility size – beds	1,004.4	221.7	1,047.7	321.1

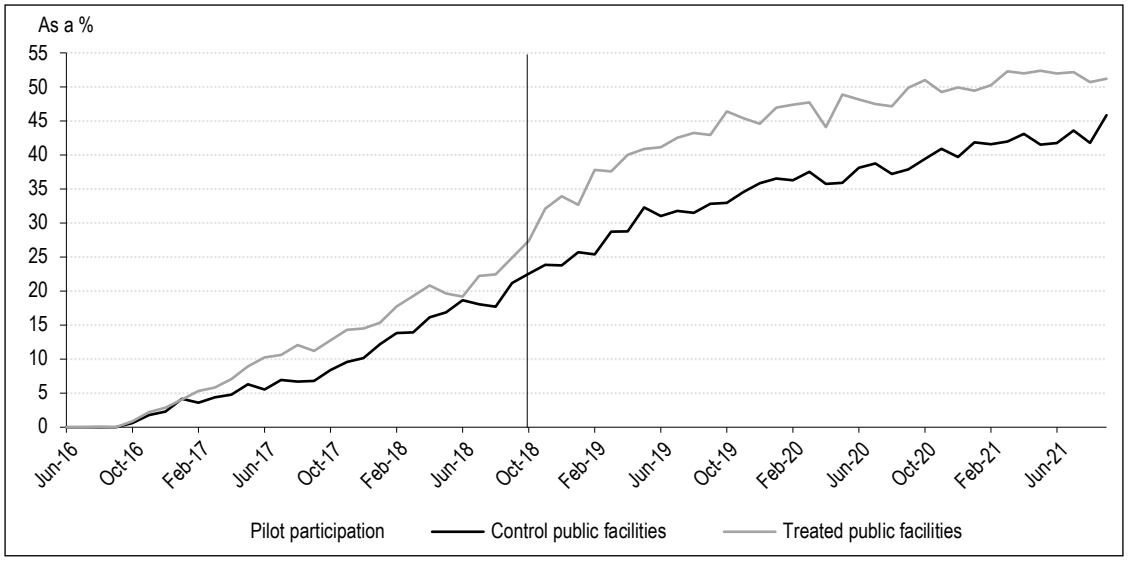
Notes: The size of the units is determined by the FTE of dermatologists, allergists, venereologists and rheumatologists. This is not calculated for insulin glargine.
Sources: SNDS (prescribing facilities responsible for dispensing medication in September 2018, indicators relating to dispensing of medication, repeat prescriptions and new first-time prescriptions), SAE 2019 (indicators relating to number of physician FTEs and beds in medicine, surgery and obstetrics wards).

Figure I – **Proportion of biosimilars among all insulin glargine prescriptions**



Reading note: The black (or grey) line shows the percentage of biosimilars among prescriptions issued in facilities excluded from (or included in) the pilot that resulted in medication being delivered in a retail pharmacy.
Sources and coverage: SNDS (2012–2021), DSS (applications), SAE 2019 (facility categories); public facilities that include at least one hospital complex, long-term nursing home or healthcare cooperation association and provide PHMEV for insulin glargine.

Figure II – **Proportion of biosimilars among all etanercept prescriptions**



Reading note: The black (or grey) line shows the percentage of biosimilars among prescriptions issued in facilities excluded from (or included in) the pilot that resulted in medication being delivered in a retail pharmacy.
Sources and coverage: SNDS (2012–2021), DSS (applications), SAE 2019 (facility categories); public facilities that include at least one hospital complex, long-term nursing home or healthcare cooperation association and provide PHMEV for etanercept.

The proportion of biosimilar prescriptions issued by treated facilities therefore increases sharply when the pilot begins, for both formulations. This suggests that the pilot has a positive effect.

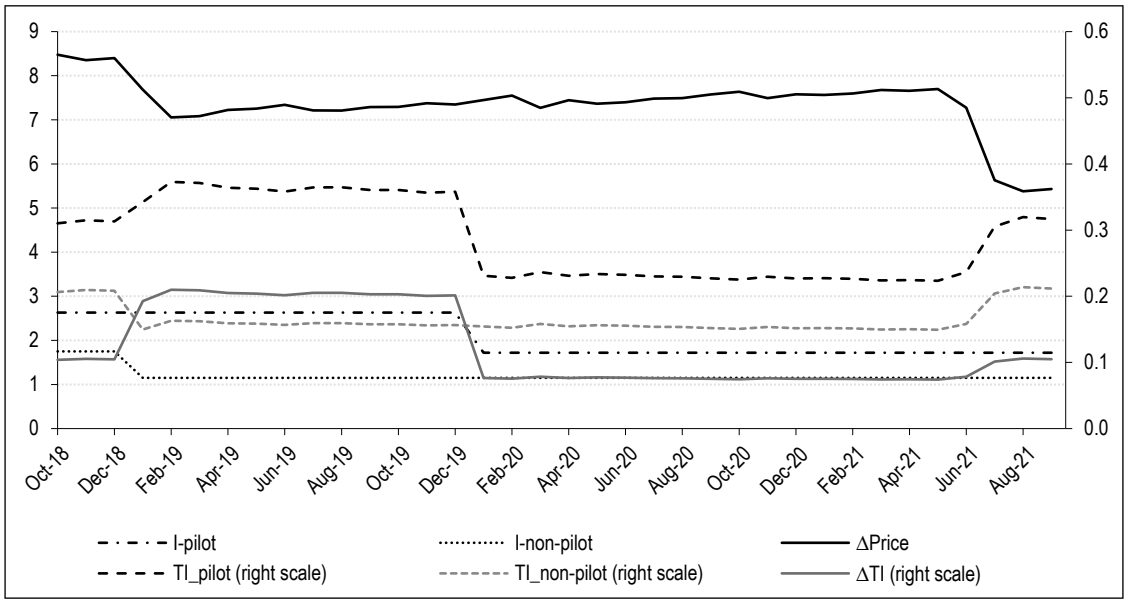
3.2.3. Changes in Incentives and Price Differences

At the start of the pilot, its incentives were set at 30% of the price difference between standard boxes of biosimilars and reference biomedicines with a weighting of 1. CAQES incentives were similarly set at 20% of the price differential. However, there is a fluctuating relationship between the incentives and the price differential as medicinal product prices change over time. As such, the amounts of the incentives were adjusted to reflect these price changes, albeit with a delay. CAQES incentive adjustments were more immediate than adjustments to incentives provided under the pilot (Figures III and IV).

These delays in adjusting incentives to reflect prices are not consistent between French

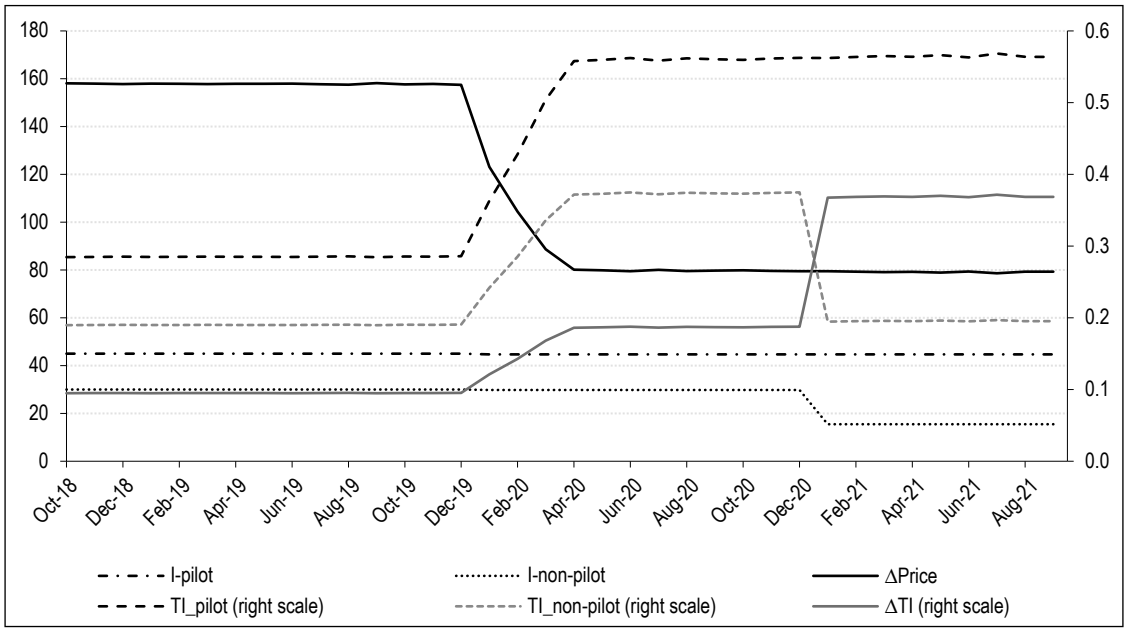
common law and the pilot and lead to variations in the incentive rates as well as the incentive rate differential between the pilot and common law over time. For insulin glargine, the pilot's incentive rate and the incentive rate differential increased in early 2019, following a reduction in the price differential, which was only passed on in the amount of the common law incentive.

Figure III – **Changes in financial incentives and difference between reference biomedicine and biosimilar prices for insulin glargine**



Reading note: In October 2018, the financial incentive for a standard box of insulin glargine is €1.75 under the CAQES (I_non-pilot), whereas it is €2.63 under the pilot (I_pilot). On the same date, the difference between the average prices (ΔPrice) of a box of reference biomedicine and a box of biosimilar (each with a weighting of 1) is €8.50. The CAQES incentive is equal to 0.21 of the difference between average prices (TI_non-pilot), i.e. 21% of the difference, and the pilot incentive is equal to 0.31 (TI_pilot), i.e. 31%. The difference in the pilot and non-pilot incentive rates is 0.1 (ΔTI).
Sources and coverage: Ministerial decrees relating to the CAQES and the pilot (incentives); GERS, French public medicinal products database and SNDS 2018–2021 (average box prices).

Figure IV – **Changes in financial incentives and difference between reference biomedicine and biosimilar prices for etanercept**



Reading note: In October 2018, the financial incentive for a standard box of etanercept is €30 under the CAQES (I_non-pilot), whereas it is €45 under the pilot (I_pilot). On this date, the difference between the average prices (ΔPrice) of a box of reference biomedicine and a box of biosimilar (each with a weighting of 1) is €158.10. The CAQES incentive is equal to 0.19 of the difference between average prices (TI_non-pilot), i.e. 19% of the dfference, and the pilot incentive is equal to 0.28 (TI_pilot), i.e. 28%. The difference in the pilot and non-pilot incentive rates is 0.09 (ΔTI).
Sources and coverage: Ministerial decrees relating to the CAQES and the pilot (incentives); GERS, French public medicinal products database and SNDS 2018–2021 (average box prices).

They then declined in early 2020 with the reduction in the pilot's incentive. Lastly, in mid-2021, a drop in the price differential led to an increase in the common law and pilot incentive rates and the incentive rate differential rose slightly. For etanercept, there was no quantitative adjustment of the incentives in early 2020 despite the sharp price differential drop that occurred, which led to an increase in the common law incentive rate, the pilot incentive rate, and also the incentive rate differential. In 2021, the common law incentive amount fell, further widening the difference in incentive amounts granted under the pilot and under common law.

4. Findings

4.1. Impact of the Pilot on Biosimilar Prescriptions

The primary factor associated with facilities' application and selection likelihood is their size and patient population size (see logit results in Table A1-1 in Appendix A1). Some variables have no significant effect on selection, such as the proportion of prescriptions among deliveries or the proportion of first-time treatments. The model still includes these variables given their differing distribution between the treatment and control groups and their tangible impact on the explained variable via the conditional expectation. Our reliance on a doubly robust estimator that combines two approaches to estimate the treatment effect means it makes sense for the estimate to include the covariates that allow changes in the explained variable (outcome regression) and conditional probability of inclusion in the treatment group (inverse probability weighting) to be modelled.

For comparable facilities, the estimated overall effect of the pilot between October 2018 and September 2021 for insulin glargine is a 6.0 percentage points increase in prescriptions filled by biosimilars (standard error of this mean effect over the 36 months of the pilot: 2.6). This is significant at the 5% threshold.[24] Although the estimated month-on-month effects of the pilot trend upwards over the study period (Figure V and see Table A1-2 in Appendix A1), these monthly estimates are less precise than a mean estimate that covers the entire pilot phase. Zero is included in the 95% confidence interval for each month. For example, the pilot's effect in June 2020 is estimated to be 10.6 percentage points, with a 95% confidence interval that ranges from −4.4 to 18.9.

For etanercept, the estimated overall effect of the pilot between October 2018 and September 2021 is 10.8 percentage points, which is statistically significant at a 7% threshold.[25] The standard error of this mean effect over the 36 months of the pilot (6.6) reveals widely varying results between clinical facilities.

Monthly effects vary between +3.3 and +17.4 percentage points for biosimilar prescriptions (Figure VI and see Table A1-2 in Appendix A1). However, the estimates for these effects are less precise. For example, the pilot's effect in June 2020 is estimated to be 17.4 percentage points, with a 95% confidence interval that ranges from −4.0 to 38.8.

4.2. Robustness Checks

4.2.1. Placebos

The model is estimated on the period preceding the pilot to confirm that it has not incorrectly inferred a causal effect of the pilot. Producing a zero effect thus enhances the degree of confidence that can be placed in the causal effect estimate, and more specifically in the rebalancing of non-treated facilities in the doubly robust method framework. For etanercept and insulin glargine, the effect of belonging to the treatment group is calculated for each month of the year that precedes the pilot (November 2017 to September 2018) as compared with October 2017 – the first month considered by the model.

The average estimated placebo effect is −0.1 percentage point for etanercept and 0.2 for insulin glargine. These values are close to zero and therefore not significant. These results can be considered with regard to the estimated causal effect of the pilot (see Figures V and VI): the estimated mean effect over the course of the pilot is 6.0 percentage points for insulin glargine and 10.8 percentage points for etanercept.

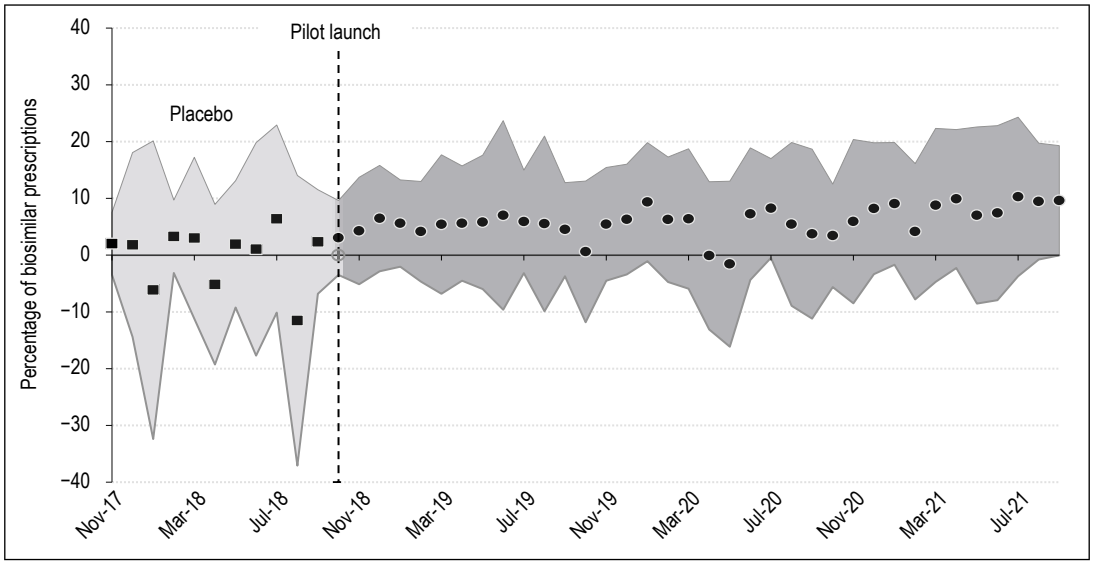
4.2.2. Private Sector

An alternative estimate is made by including private non-profit sector facilities. Since their physicians are typically salaried employees, the prescriptions they issue are generally registered with the facility.

167 private non-profit facilities are responsible for at least one delivery of insulin glargine in September 2018, four of which are treated facilities. The corresponding number of non-profit facilities for etanercept is 48, which includes three treated facilities.

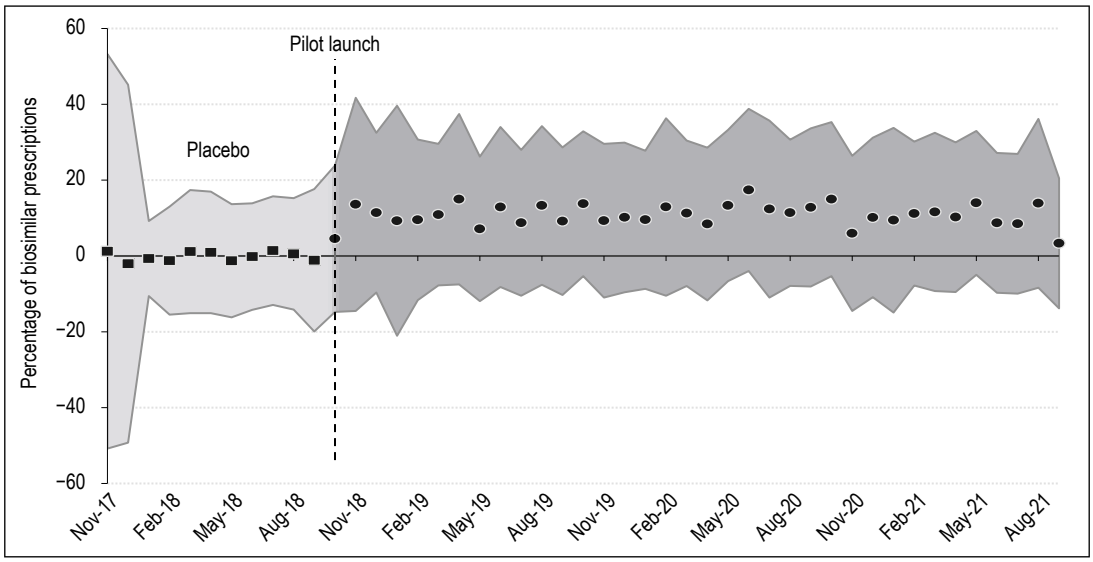
24. Significant at 5% for H0 = zero effect. The effect is significant at the 3% threshold where H0 = zero or negative effect.
25. Significant at 7% for H0 = zero effect. The effect is significant at the 4% threshold where H0 = zero or negative effect.

Figure V – **Insulin glargine – Estimated effect of the pilot on the proportion of prescriptions**



Notes: The dots starting from the vertical bar represent the estimate of the pilot's effect each month from its launch. This is calculated by comparing it with values for September 2018, the month immediately prior to the pilot's launch. The effect for the placebo is calculated for each month from November 2017 to September 2018 as compared with the month of October 2017. The greyed out areas represent the 95% confidence interval.
Sources and coverage: SNDS, SAE (facility categories); public facilities that include at least one hospital complex, long-term nursing home or healthcare cooperation association and provide PHMEV for insulin glargine.

Figure VI – **Etanercept – Estimated effect of the pilot on the proportion of prescriptions**



Notes: See Figure V.
Sources and coverage: SNDS, SAE (facility categories); public facilities that include at least one hospital complex, long-term nursing home or healthcare cooperation association and provide PHMEV for etanercept.

These facilities are generally smaller than those in the public sector and provide fewer first-time prescriptions. Among treated facilities, the highest increase in biosimilar uptake is observed in private non-profit facilities, for all formulations. Nevertheless, including private non-profit facilities in the econometric model leads to an estimate of +7.8 percentage points for biosimilar prescriptions attributable to the pilot for insulin glargine (significant at the 1% threshold), and +8.1 percentage points for etanercept (significant at the 10% threshold). These figures compare with +6.0 and +10.8 percentage points if only public facilities are included. Findings concerning the pilot's impact are therefore consistent with or without the inclusion of the private sector. The main reason for the lower impact for etanercept is a higher uptake rate of biosimilars among private non-profit control facilities.

4.3. Pilot Efficiency

Public treatment group facilities are used to calculate efficiency. The pilot's estimated effect on the total number of weighted boxes of biosimilars delivered following a PHMEV is slightly lower than the estimated impact on the proportion of biosimilar prescriptions alone (Tables 4 and 5). Aside from the scope selected (medication deliveries versus prescriptions), this difference can be explained by the fact that boxes are delivered following prescriptions that started before the pilot began in order to be consistent with the incentives that applied to all medication dispensed from October 2018 onwards. The model estimated to measure the effects on prescribing behaviour only applies to new prescriptions made from that date, however.

Table 4 – **Annual cost saving for insulin glargine**

Year	Insulin glargine						
	Effect of the pilot on the proportion of biosimilars among weighted boxes (ppt)	Estimated efficiency threshold	$\frac{\Delta Q\_biosim}{Q\_biosim^{non\text{-}pilot}}$	Cost saving (€)	Cost saving expressed as a share of non-pilot expenditure (%)	Estimated substitution effect (€)	Estimated deadweight loss effect (€)
2018 (1)	2.7	0.15	0.18	1,000	0.1	4,000	−3,000
2019	4.0	0.32	0.18	9,000	0.1	25,000	−45,000
2020	4.4	0.10	0.14	46,000	0.6	42,000	−30,000
2021 (2)	6.6	0.11	0.19	53,000	0.9	47,000	−27,000
All	4.7	0.17	0.17	109,000	0.5	117,000	−105,000

(1) from October 2018 to December 2018, (2) until September 2021.
Sources and coverage: Authors' calculations, details available in Online Appendix S1; public facilities included in the pilot.

Table 5 – **Annual cost saving for etanercept**

Year	Etanercept						
	Effect of the pilot on the proportion of biosimilars among weighted boxes (ppt)	Estimated efficiency threshold	$\frac{\Delta Q\_biosim}{Q\_biosim^{non\text{-}pilot}}$	Cost saving (€)	Cost saving expressed as a share of non-pilot expenditure (%)	Estimated substitution effect (€)	Estimated deadweight loss effect (€)
2018 (1)	4.2	0.13	0.18	23,000	0.2	82,000	−60,000
2019	11.2	0.13	0.37	623,000	1.2	954,000	−346,000
2020	11.6	0.35	0.30	21,000	0.0	383,000	−453,000
2021 (2)	9.8	0.85	0.23	−493,000	−1.4	200,000	−749,000
All	10.4	0.24	0.29	173,000	0.1	1,619,000	−1,608,000

(1) from October 2018 to December 2018, (2) until September 2021.
Sources and coverage: Authors' calculations, details available in Online Appendix S1; public facilities included in the pilot.

Over the course of the entire pilot, it is estimated that approximately 470,000 *weighted* boxes of insulin glargine and 230,000 *weighted* boxes of etanercept were delivered in retail pharmacies following a PHMEV issued in a treated public hospital, resulting in total spending of approximately €20 million (insulin glargine) and nearly €150 million (etanercept) (see Tables A2-1 and A2-2 in Appendix A2).[26] Over this period, the pilot is estimated to have generated total saving rates of 0.5% for insulin glargine and 0.1% for etanercept. These values are obtained by comparing values with the expected expenditure on biomedicines for public hospitals in the treatment group, had there been no pilot. Insulin glargine savings therefore exceed etanercept savings over the entire period, whereas the pilot's estimated effect on prescriptions is more pronounced for etanercept. However, this general finding masks contrasting annual effects for both formulations. Not only do these depend on the pilot's effect on prescriptions, they also depend on changes to biosimilar uptake rates in the counterfactual situation (with the overall proportion of biosimilars doubling for both formulations over the pilot) and to prices and incentives. To understand these effects more effectively, we provide the estimate of the substitution and deadweight loss effects for each year in addition to the net savings estimate.

For insulin glargine, the savings from the pilot represent an increasing proportion of non-pilot

26. Details of the calculations can be requested from the authors.

expenditure over time, rising to 0.9% in 2021. The deadweight loss effect peaks in 2019, when the difference between reference biomedicine and biosimilar prices narrows and the pilot incentive rate and differential between the pilot and French common law incentive rates increase (cf. Figure III). In 2020, the substitution effect increases due to a rise in the effect on prescriptions and a fall in the rate of incentives under the pilot. Deadweight loss effects also fall in 2020, coinciding with the fall in the differential between the pilot and French common law incentive rates.

The highest level of efficiency for etanercept is recorded in 2019, when the savings from the pilot reach 1.2% of non-pilot expenditure. The higher biosimilar uptake rate largely offsets the deadweight loss effect owing to the difference between biosimilar and reference biomedicine prices. This differential decreases in 2020 (cf. Figure IV), thereby increasing the pilot incentive rate and lowering the substitution effect. In 2021, there is additionally a steep rise in the deadweight loss effect, which follows from an increase in the incentive rate differential and leads to a negative estimated net saving.

* *
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In this article, we examine the effect of a financial and organisational biosimilar prescribing incentive on hospital prescriptions for drugs delivered in retail pharmacies by comparing changes in biosimilar prescriptions within facilities taking part in the pilot with the same changes observed in facilities that are not taking part in the pilot and which share comparable observed characteristics. The findings show that, for public facilities, the pilot led to an increase in the rate of biosimilar prescriptions, estimated at 6.0 percentage points for insulin glargine and 10.8 percentage points for etanercept, all other things being equal, on average over the three years of treatment. This effect may perform below initial expectations of the pilot (+15 percentage points), but it does testify to the interest of the tested incentive design. Despite the fact that the pilot's financial incentive, which is notionally set at 30% of the gains generated through biosimilar prescriptions, is only 10 percentage points greater than the financial incentive paid out under French common law, the pilot seems to have led to a more substantial and faster increase in biosimilar prescriptions issued by hospitals in the treatment group. Although the quantitative evaluation does not allow us to identify to which extent these effects are attributable to the financial incentive or the organisational incentive, these positive results suggest that the incentive being redirected to the prescribing units was certainly decisive in altering the prescribing behaviour of hospital physicians. The fact that the effect for insulin glargine is more muted than for etanercept could also be due to prescriptions of insulin glargine being more widespread across many specialties and units, whereas etanercept is prescribed in fewer specialties. This makes measures that target prescribing units more effective. By way of example, it is easier in practice to distribute gains to units for formulations prescribed in hospital units that can be easily identified upstream. This is because reporting data cannot always be used to identify individual prescribers within hospitals at present. Due to etanercept's much greater price differential, its financial incentive is also much higher than the incentive for insulin glargine.

The findings of this evaluation mirror predictions made in the field of behavioural economics, as aspects of this pilot emulate some of its principles. This literature has shown that financial incentives, of any size, are more effective at boosting motivation when they are clearly distinct from standard remuneration (Emanuel *et al.*, 2016). Another way to boost motivation is to set incremental targets that reflect the starting situation and which do not have thresholds that may be too easily attainable for some and seemingly unattainable for others. Conversely, guidance resource support has been minimal during the pilot's roll-out, even though results from randomised controlled trials, particularly those involving healthcare professionals, underscore how important it is to provide frequent feedback to those involved in the pilot to keep their engagement levels high (Fox *et al.*, 2020).

The results from the econometric model then allowed us to model expenditure that would have been incurred had there been no pilot as part of an efficiency analysis in which expenditure and savings resulting from the pilot are compared. Compared to spending on biomedicines by treated public hospitals in a non-pilot situation, the estimated total saving rates are 0.5% for insulin glargine and 0.1% for etanercept over the entire pilot period. The pilot's efficiency changes over time, depending on the difference between reference biomedicine and biosimilar prices, the pilot's incentive rate, the difference between pilot and common law incentive rates, and the use of biosimilars in the counterfactual trend. The distribution of biosimilars leads to price cuts,

as could a large-scale pilot. Although it is not possible to measure this positive potential effect of the pilot in this study, it should be considered in any wider roll-out of a similar programme. In any case, these findings underscore the value of fine-tuning incentives provided via gainsharing arrangements so that they align with medicinal product price variations as closely as possible. However, even if incentive changes had mirrored price trends more closely, the deadweight loss effect on biosimilars that would have been prescribed even if there had been no pilot would have limited savings under the pilot, given the underlying significant growth in biosimilars.

There are a number of limitations to this evaluation, which stem from the fact that the pilot's treated hospitals took part voluntarily. Treated facilities are typified by their motivation and large size, two characteristics that correlate with the facilities' prescribing behaviours. Despite the fact that the econometric estimate factors this in to the maximum extent possible by using observed characteristics to control for selection, the estimated effect nevertheless remains a local effect that cannot be extrapolated to estimate what impact this measure would have on all French facilities. Furthermore, a lack of comprehensive data relating to the for-profit sector means that the calculations made do not include prescriptions issued by private clinical facilities.

This evaluation also covers the entire period of the pilot as initially envisaged, namely three years, and its findings show that the effects of the pilot on biosimilar prescriptions have been, at the very least, consistently stable (etanercept) or even progressive (insulin glargine) over this period. These incentives based on shared savings therefore appear to be effective in the medium term, but it is too early to determine their longer term efficacy. The incentives could generate lasting effects once prescribing habits change, in which case it may be preferable to gradually scale back or phase out incentives or to incentivise different formulations instead in an attempt to avoid financing deadweight loss effects. On the other hand, scaling back incentives could lead to a slowdown and justify their continuation instead, albeit at the expense of considerable deadweight loss effects. The required duration for a measure of this type and the optimal level of incentives therefore remain unclear at present.

Lastly, this pilot ran during a period of biosimilar distribution buoyed by a greater level of awareness among hospital physicians and primary care practitioners. The effect of the incentives for prescribing biosimilars is likely to be determined by the margin for growth: biosimilar uptake rates in clinical facilities that did not take part in the pilot have continually risen in recent years due to other factors, such as the French common law incentive provided under the CAQES. It may therefore be the case that rolling out the measure more broadly will lead to less pronounced effects on prescriptions due to the greater uptake of biosimilars in general. □

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/8186110/ES542_Attia-et-al_OnlineAppendix.pdf

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APPENDIX A1

RESULTS OF THE ESTIMATES ON THE PILOT'S IMPACT ON BIOSIMILAR HOSPITAL PRESCRIPTIONS

The number of facilities in the sample varies each month because certain control group facilities may have no prescriptions in a particular month. Nearly 350 of the 530 insulin glargine-prescribing facilities have an insulin glargine prescription each month and are therefore routinely included in the sample. This is the case for just over 90 of the 270 etanercept-prescribing facilities in the control group. The stabilised panel is therefore much smaller than the non-stabilised sample used for the estimates. A logit model producing selection probabilities is run for each month of treatment, taking into account only facilities active in both the month examined and September 2018 (pre-treatment period). The logit results for the first month of the pilot (October 2018) are presented below.

Table A1-1 – **Results of the logit predicting the probability that a facility applied for inclusion in the pilot and was selected, for insulin glargine and etanercept, in October 2018**

	Insulin glargine		Etanercept	
	odds ratio	p-value	odds ratio	p-value
Constant	0.065	0.061.	0.020	0.003**
Average number of monthly prescriptions	0.999	0.715	1.074	0.001***
Proportion of prescriptions among monthly dispensations of medication	0.968	0.139	0.995	0.884
Proportion of new first-time prescriptions among monthly prescriptions	0.999	0.979	0.987	0.833
Number of beds	1.011	0.000***	1.000	0.942
square	1.000	0.047*	1.000	0.862
Number of salaried physicians	0.986	0.001***	0.995	0.283
square	1.000	0.057.	1.000	0.257
Number of dermatologists/venereologists/allergists and rheumatologists			1.672	0.000***
square			0.986	0.002**

Notes: Significance at the thresholds of 10% ".": 5% "*"; 1% "**"; 0.1% "***".
Reading note: The coefficients are odds ratios derived from a logistic regression, all other parameters being equal. Thus, for etanercept, an increase of 1 of the average number of prescriptions per month increases the probability of participating in the pilot rather than not participating of 7.4% (odds ratio of 1.074).
Sources and coverage: SNDS 2017–2018 (calculation of the monthly mean prescription numbers, the proportion of dispensations of medication following a prescription, and the proportion of new first-time prescriptions); DSS (list of treated facilities); SAE 2019 (bed and physician numbers); public facilities for which at least one prescription was recorded in September 2018 and in October 2018.

Table A1-2 – **Results of the estimate of the pilot's effect on the proportion of biosimilar prescriptions**

	Insulin glargine				Etanercept			
Month	ATT(g,t)	Standard error	Confidence interval at 95%		ATT(g,t)	Standard error	Confidence interval at 95%	
November 2017	2.0	2.0	−3.5	7.5	1.2	19.1	−50.8	53.3
December 2017	1.8	5.8	−14.4	18.1	−2.0	17.3	−49.2	45.1
January 2018	−6.1	9.3	−32.4	20.1	−0.7	3.6	−10.6	9.2
February 2018	3.3	2.3	−3.1	9.7	−1.2	5.2	−15.5	13.0
March 2018	3.0	5.1	−11.2	17.2	1.2	6.0	−15.1	17.4
April 2018	−5.2	5.0	−19.3	8.9	0.9	5.9	−15.1	17.0
May 2018	1.9	4.0	−9.2	13.1	−1.3	5.5	−16.2	13.7
June 2018	1.1	6.7	−17.7	19.8	−0.2	5.2	−14.2	13.9
July 2018	6.4	5.9	−10.1	22.9	1.4	5.3	−12.9	15.7
August 2018	−11.5	9.1	−37.1	14.0	0.6	5.4	−14.1	15.2
Sept. 2018	2.4	3.3	−6.8	11.5	−1.1	6.9	−19.9	17.6
October 2018	3.1	2.3	−3.5	9.6	4.6	7.1	−14.7	23.9
November 2018	4.3	3.3	−5.1	13.7	13.6	10.3	−14.5	41.7
December 2018	6.5	3.3	−2.8	15.8	11.4	7.7	−9.6	32.5
January 2019	5.6	2.7	−2.0	13.3	9.3	11.1	−21.1	39.6
February 2019	4.2	3.1	−4.7	13.0	9.5	7.8	−11.7	30.7
March 2019	5.4	4.3	−6.8	17.7	10.9	6.9	−7.8	29.6
April 2019	5.6	3.6	−4.5	15.7	15.0	8.2	−7.5	37.4
May 2019	5.8	4.2	−6.0	17.6	7.1	7.0	−11.9	26.2
June 2019	7.0	5.9	−9.6	23.7	12.9	7.7	−8.2	34.0
July 2019	5.9	3.2	−3.2	15.0	8.7	7.1	−10.5	28.0
August 2019	5.5	5.5	−9.9	21.0	13.3	7.7	−7.6	34.2
Sept. 2019	4.5	2.9	−3.7	12.8	9.2	7.1	−10.3	28.6
October 2019	0.6	4.4	−11.8	13.1	13.8	7.0	−5.3	32.9
November 2019	5.5	3.5	−4.5	15.4	9.3	7.4	−11.0	29.6
December 2019	6.3	3.4	−3.4	16.0	10.2	7.2	−9.6	29.9
January 2020	9.4	3.7	−1.1	19.8	9.6	6.7	−8.7	27.8
February 2020	6.3	3.9	−4.7	17.3	12.9	8.6	−10.5	36.3
March 2020	6.4	4.4	−5.9	18.7	11.3	7.0	−7.9	30.5
April 2020	−0.1	4.6	−13.1	12.9	8.4	7.4	−11.7	28.6
May 2020	−1.6	5.2	−16.1	13.0	13.3	7.3	−6.6	33.3
June 2020	7.3	4.1	−4.4	18.9	17.4	7.8	−4.0	38.8
July 2020	8.3	3.1	−0.5	17.0	12.4	8.6	−11.0	35.7
August 2020	5.4	5.1	−8.9	19.8	11.4	7.1	−7.9	30.7
Sept. 2020	3.7	5.3	−11.2	18.7	12.8	7.7	−8.0	33.6
October 2020	3.4	3.2	−5.6	12.5	15.0	7.5	−5.3	35.3
November 2020	5.9	5.1	−8.5	20.4	6.0	7.5	−14.5	26.4
December 2020	8.2	4.1	−3.4	19.8	10.2	7.7	−10.9	31.2
January 2021	9.1	3.8	−1.7	19.8	9.4	8.9	−14.9	33.8
February 2021	4.2	4.2	−7.8	16.1	11.2	7.0	−7.8	30.2
March 2021	8.8	4.8	−4.7	22.3	11.6	7.7	−9.3	32.5
April 2021	9.9	4.3	−2.3	22.1	10.2	7.2	−9.5	30.0
May 2021	7.0	5.5	−8.5	22.6	14.0	7.0	−5.0	33.0
June 2021	7.4	5.5	−7.9	22.8	8.7	6.8	−9.7	27.2
July 2021	10.3	5.0	−3.7	24.3	8.5	6.8	−9.9	26.9
August 2021	9.5	3.6	−0.8	19.7	13.9	8.2	−8.4	36.1
Sept. 2021	9.6	3.4	0.0	19.3	3.3	6.3	−13.8	20.5
Aggregate ATT	6.0	2.6	0.8	11.1	10.8	6.6	−2.2	23.9
Pre-treatment parallel trend test p-value:				0.88				1.00

Notes: The ATT provides an estimate of the pilot's effect each month from its launch. This is calculated by comparing it with values for September 2018, the month immediately prior to the pilot's launch. The effects for the period prior to the start of the pilot are calculated, for the placebo, between November 2017 and September 2018 in comparison with the month of October 2017. They are not taken into account in the calculation of the ATT.

Sources and coverage: SNDS 2017–2021, SAE 2019 (facility categories); public facilities that include at least one hospital complex, long-term nursing home or healthcare cooperation association and provide PHMEV for insulin glargine and etanercept.

APPENDIX A2

BREAKDOWN OF TOTAL PILOT AND NON-PILOT EXPENDITURE OVER THE ENTIRE PILOT PHASE

Table A2-1 – **Insulin glargine**

Insulin glargine		Non-pilot (counterfactual)	Pilot
Reference biomedicines	Number of weighted boxes	336,000	314,000
	Mean price of a box with a weighting of 1 (€)	45	
	Reimbursements (€)	15,089,000	14,000,000
Biosimilars	Number of weighted boxes	134,000	157,000
	Mean price of a box with a weighting of 1 (€)	38	
	Reimbursements (€)	5,074,000	5,904,000
Incentives (€)		156,000	306,000
Total expenditure (€)		20,319,000	20,209,000
Cost saving (€)		109,000	
Cost saving expressed as a share of non-pilot expenditure		0.5%	

Notes: Reimbursement amounts have been estimated on the assumption of a 100% rate of reimbursement by the French NHI.
Reading note: Between October 2018 and September 2021, a total of €14,000,000 is spent to cover reimbursements for reference insulin glargine biomedicines linked to PHMEVs issued by facilities in the pilot. This expenditure, under non-pilot conditions, is estimated to be €15,089,000 during the same period.
Sources and coverage: Authors' calculations; public facilities included in the pilot, October 2018 – September 2021.

Table A2-2 – **Etanercept**

Etanercept		Non-pilot (counterfactual)	Pilot
Reference biomedicines	Number of weighted boxes	149,000	125,000
	Mean price of a box with a weighting of 1 (€)	675	
	Reimbursements (€)	100,983,000	84,712,000
Biosimilars	Number of weighted boxes	83,000	107,000
	Mean price of a box with a weighting of 1 (€)	557	
	Reimbursements (€)	46,302,000	59,704,000
Incentives (€)		2,106,000	4,801,000
Total expenditure (€)		149,390,000	149,217,000
Cost saving (€)		173,000	
Cost saving expressed as a share of non-pilot expenditure		0.1%	

Notes: Reimbursement amounts have been estimated on the assumption of a 100% rate of reimbursement by the French NHI.
Reading note: Between October 2018 and September 2021, a total of €84,712,000 is spent to cover reimbursements for reference etanercept biomedicines linked to PHMEVs issued by facilities in the pilot. This expenditure under non-pilot conditions is estimated to be €100,983,000.
Sources and coverage: Authors' calculations; public facilities included in the pilot, October 2018 – September 2021.

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