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Cost of non-Europe in health policy

STUDY

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Cost of non-Europe in health policy

The European Union stepped up its action in the area of health – a shared competence between the EU and its Member States – in response to the COVID-19 pandemic. Yet, the EU lacks a joint health policy that recognises health as a public good. This study investigates three areas where there is high added-value potential from a joint EU health policy: research and development; the availability of prescription medicines; and preventive healthcare. EU action in these areas could generate benefits for the economy (in particular the EU's health industries), society (through improved health and quality of life for patients and less absenteeism for employers) and fundamental rights (the right to timely access to healthcare). The EU could also help to reduce the carbon and environmental footprint of the healthcare sector. An EU health policy that speaks with one voice is especially advantageous in light of the ageing population, digitalisation and rapid technological change.

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Executive summary

Why this study?

The COVID-19 pandemic exposed significant weaknesses in the division of responsibility between the EU and the Member States to ensure their citizens' health. The European Parliament's Special Committee on the COVID-19 pandemic: lessons learned and recommendations for the future (COVI) identified measures to ensure better preparedness for future health emergencies.[1] Following recommendations from the Conference on the Future of Europe,[2] the **European Parliament called for a stronger EU role in public health and protection and improvement of human health**.[3]

What is the scope?

While significant progress is underway, **Europe lacks a vision of a joint health policy that recognises health as a public good** and that gives full consideration to the most appropriate level of governance to assume responsibility and ensure efficient coordination across different actors and geographic areas. A stronger EU role could offer value in delivering European public goods, especially when there are high economies of scale and/or geographic spillovers across Member States. **The study focuses on three areas where the cost of non-Europe is potentially high:**[4] (1) **Research and development** (R&D); (2) **Availability of prescription medicines**; and (3) **Delivery of preventive healthcare.**

The research draws on a range of publicly available data from Eurostat, research reports and industry organisations and an original quantitative analysis carried out by the Interuniversity Research Centre on Local and Regional Finance (CIFREL) based at the University Cattolica del Sacro Cuore in Milan, Italy (see Annex).

What are the key findings?

Health R&D in the EU is fragmented and uncoordinated, negatively impacting innovation, health industries, and the development of new medicines. **National pricing and reimbursement policies leads to high inequalities in access to medicines** across Member States, long waiting periods for patients and a higher morbidity and risk of death for those with an untreated disease. **Inefficient use of screening technologies** in the EU, such as magnetic resonance imaging (MRI) machines, computed tomography (CT) scanners and positron emission tomography (PET) scanners can contribute to low rates of screening for chronic diseases such as cancer. As Table 1 illustrates, EU action to address these challenges could generate **benefits for the economy** (in particular the EU's health industries), **society** (through improved health and quality of life for patients) and **fundamental rights** (the right to timely access to healthcare). The EU could also generate benefits for the **environment** by promoting the green transformation of the healthcare sector.

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1 Resolution of 12 July 2023 on the COVID-19 pandemic: lessons learned and recommendations for the future, European Parliament.

2 Report on the final outcome, Conference on the Future of Europe, May 2022. Relevant proposals are: Proposal 8 on 'reinforce the health system'; Proposal 9 on 'a broader understanding of health'; Proposal 10 on 'equal access to health for all'.

3 Resolution of 22 November 2023 on proposals of European Parliament for the amendment of the Treaties, European Parliament.

4 The costs due to the lack of new or additional action at the EU level. Stated differently, the cost of non-Europe can be understood as the added value of further EU action. Christof Cesnovar, Meenakshi Fernandes, Aleksandra Heflich et al., Mapping the cost of non-Europe report: Theoretical foundations and practical considerations, EPRS, European Parliament, October 2023.

Table 1 – Overview of challenges, the cost of non-Europe and avenues for EU action

Key challenges	Cost of non-Europe (the cost of the status quo)	Avenues for EU action
Insufficient (or insufficiently aligned with public health priorities) R&D	Uncompetitive health sector enough (e.g. low number of biotech initiatives). Low innovation and development of new medicines. Wasted public budget – potentially up to €254 million per year (equivalent to 20 % of the EU's research budget). Unmet health needs; patients with untreated diseases suffer low social inclusion. Low green transformation in the healthcare sector.	Establish a **European health infrastructure** that could: ➢ Build a portfolio of most-needed medicines; ➢ Oversee EU-run clinical trials through hospital networks; ➢ Carry out comparative medicine effectiveness trials; and ➢ Promote sustainable innovation (e.g. green patents) to reduce the carbon and environmental footprint of the healthcare sector. Provide **financial incentives for early-stage R&D** for small and medium-sized enterprises (SMEs) and biotech companies.
Significant inequalities in prescription medicine availability	New medicines are not available in all Member States. Longer waiting periods for patients. Higher morbidity and hospital admissions for patients with untreated conditions. Lower quality of life; threat to the right to live a life with dignity.	More **sharing of information and transparency between Member States** about public health needs, negotiations with pharmaceutical companies and the setting of reference prices. Promote a **common pharmaceutical culture** that fosters more standardised drug prescribing practices and labelling of prescription medicines.
Low and inefficient screening for chronic disease	Higher morbidity, hospital admissions and health care costs. Lower quality of life. Greater use of curative care, which has higher costs for the public budget and a larger environmental footprint. Higher rate of dependency and demand for care work.	EU-level screening recommendations and prevention programmes that take sex and gender into consideration, which could be supported by **European networks of excellence** to facilitate knowledge sharing between hospitals, healthcare services and research institutes, including the use of artificial intelligence to review scan results. Joint EU-level procurement of **medical equipment** (e.g. MRIs, PET scanners, CT scanners) and/or guidelines on placement, utilisation and replacement.

Source: EPRS.

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1. Introduction

1.1. Objective of the study

The Treaty of the Functioning of the European Union (TFEU) stipulates that **public health is a shared competence between the EU and its Member States** (Article 168 TFEU). Member States define and provide their national healthcare services, while the EU can complement national policies and promote coordination. The role of the EU in health policy is reflected in the work of specialised agencies such as the European Medicines Agency (EMA) and the European Centre for Disease Prevention and Control (ECDC). The European Pillar of Social Rights underlines that every citizen has 'the right to timely access to affordable, preventive and curative healthcare of good quality'.[5] All EU actors support this right, including the Council of the European Union.[6]

The COVID-19 pandemic **exposed significant weaknesses in the division of responsibility between the EU and the Member States to ensure their citizens' health.** The European Parliament's COVI special committee identified measures from the lessons learned from the pandemic to ensure better preparedness for future health emergencies.[7] The European Parliament called to amend the Treaties, following recommendations from the Conference on the Future of Europe,[8] to establish wider shared competences on public health matters and the protection and improvement of human health.[9]

Following calls for action from the European Parliament[10] and the European Council,[11] the **European Commission** decided to build a **European Health Union** in 2022.[12] This encompasses four areas of action: (1) crisis preparedness, (2) pharmaceutical strategy, (3) Europe's beating cancer plan, and (4) a comprehensive approach to mental health.

While significant progress is underway, **Europe lacks a vision of a joint health policy that recognises health as a public good** and that considers the most appropriate level of governance to take responsibility and ensure efficient coordination between different actors and geographic areas. Research suggests that existing EU action in the health sector offers added value.[13] Yet, there is room for a stronger EU role that could offer more value in delivering European public goods, especially when large economies of scale and/or geographic spillovers could be achieved across

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5 Communication on The European Pillar of Social Rights Action Plan - COM(2021) 102, European Commission, March 2021.

6 Council conclusions of 16 June 2021 on access to medicines and medical devices for a stronger and resilient EU.

7 Resolution of 12 July 2023 on the COVID-19 pandemic: lessons learned and recommendations for the future, European Parliament.

8 Report on the final outcome, Conference on the Future of Europe, May 2022. Relevant proposals are Proposal 8 on 'reinforce the health system'; Proposal 9 on 'a broader understanding of health'; Proposal 10 on 'equal access to health for all'.

9 Resolution of 22 November 2023 on proposals of European Parliament for the amendment of the Treaties, European Parliament.

10 Resolution of 10 July 2020 on the EU's public health strategy post COVID-19, European Parliament: point 17 calls for EU joint procurement.

11 Conclusions EUCO 22/20, European Council, December 2020.

12 European Health Union. Protecting our health together, European Commission website.

13 Niombo Lomba, The benefit of EU action in health policy: The record to date, European Added Value in Action, EPRS, European Parliament, March 2019.

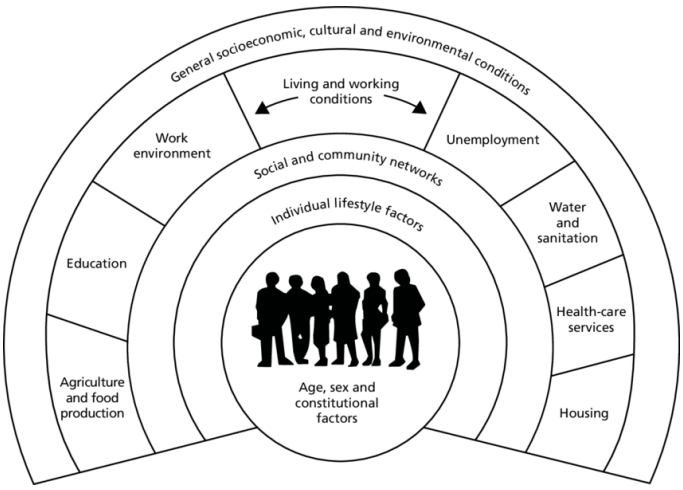
Member States.[14] The lack of sufficient EU action in such cases could be costly for citizens and society. **The additional costs resulting from the EU's current, limited role could be understood as the cost of non-Europe**.[15]

This study investigates the cost of non-Europe in health. It considers the economic, social and environmental dimensions of this cost as well as the relevance of fundamental rights. The findings can help to identify priorities for EU law-making on health issues for the 2024-2029 legislature.

1.2. Conceptual framework

The starting point for the study is the recognition of the multiple determinants of health and its close interlinkage with wellbeing. According to this framework (see Figure 1), an individual's health and wellbeing is determined by an interplay of multiple factors including education, housing conditions, transport and the environment.[16] **Healthcare services are one factor among many that determine health status.** Some research suggests that healthcare can contribute from 15 % to up to 43 % of overall health status.[17] Moreover, constitutional factors such as **gender, age and constitutional factors can play an important role**. The demand for care, including healthcare, is concentrated at the beginning and end of life. Providers of care, including healthcare, are predominantly women.[18]

Figure 1 – Main determinants of health



Source: G. Dahlgren and M. Whitehead, 2021.

Environmental determinants of health are especially relevant. According to medical journal *The Lancet*, climate change is 'the biggest global health threat of the 21st century'.[19] Climate change can have a direct, negative impact on health due to exposure to heat waves and floods, and also through the indirect impact of changing ecosystems.[20]

[14] Friedrich Heinemann et al., 'How Europe Can Deliver: Optimising the Division of Competences Among the EU and its Member States', Bertelsmann Stiftung, July 2017. Clemens Fuest and Jean Pisani-Ferry, 'A Primer on Developing European Public Goods', EconPol Policy Report, No 16, IFO Institute - Leibniz Institute for Economic Research at the University of Munich, November 2019.

[15] Christof Cesnovar, Meenakshi Fernandes, Aleksandra Heflich et al., Mapping the cost of non-Europe report: Theoretical foundations and practical considerations, EPRS, European Parliament, October 2023.

[16] Goran Dahlgren, and Margaret Whitehead, 'The Dahlgren-Whitehead model of health determinants: 30 years on and still chasing rainbows', *Public Health*, Volume 199, pp 20-24, 2021.

[17] Local Government Association, 'Report on Social determinants of health and the role of local government', 2020, pp. 6.

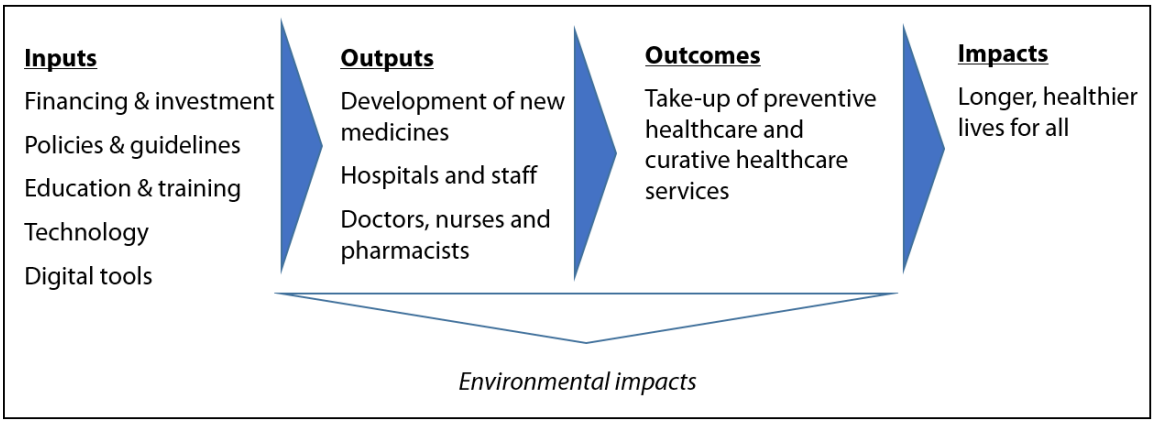
[18] European Institute for Gender Equality (EIGE), 'Report on Gender inequalities in care and consequences for the labour market', 2021.

[19] Reported in M. Romanello, C. Di Napoli, P. Drummond et al, '*The Lancet - Countdown on health and climate change report*' in 2022. The European Climate and Health Observatory collects climate-health related indicators relevant for Europe.

[20] European Academies - Science Advisory Council (EASAC), 'The imperative of climate action to protection human health in Europe', Summary of EASAC Policy Report No 38, 2019.

The desired healthcare sector role in contributing to health status can be defined in terms of an intervention logic (see Figure 2 and Table 2).

Figure 2 – Intervention logic of the health sector



Source: EPRS

Table 2 – Intervention logic

Level	Examples
Inputs	Financing and investment from public and private actors. The EU's multi-annual financial framework allocated €5.7 billion for health for 2021 to 2027.[1]
	Policies and guidelines are also needed to ensure healthcare practitioners are qualified, the availability and scope of health insurance, and secure handling of patient data. From artificial intelligence to robotics and personal health trackers, technology is transforming the healthcare sector.[2] Digital tools such as the European health data space could boost the exchange of information between patients and health care providers, as well as monitor treatment outcomes.[3]
Outputs	Research into and development of new medicines and treatments, as well as training and certification for the healthcare workforce.
Outcomes	Principle 16 of the European Pillar of Social Rights stipulates that every citizen has 'the right to timely access to affordable, preventive and curative healthcare of good quality'.[4] Such healthcare could also include mental health care.
Impacts	The primary desired impact of the healthcare sector is improved health and reduced inequalities. The public sector plays an important role in financing and regulation of healthcare to address market failures including asymmetry of information, non-alignment between profit motive and health needs, and the public good nature of health.[5]
	Environmental impacts should also be considered in the translation of inputs to impacts, given the healthcare sector's climate footprint and the growing body of research highlighting the health risks of climate change. An estimated 70 % of healthcare emissions stem from medical product and device supply chain (production, transport and disposal), such as pharmaceuticals and medical devices.[6]

Source: EPRS. [1] European Commission, Multiannual Financial Framework 2021-2027, 22 January 2021. [2] S. Yoon and A. Amadiegwu, Emerging tech, like AI, is poised to make healthcare more accurate, accessible and sustainable, World Economic Forum, June 2023. [3] C. Evroux, European health data space, EPRS, European Parliament, December 2023. [4] Communication on The European Pillar of Social Rights Action Plan - COM(2021) 102, European Commission, March 2021. [5] J. Watts and L. Segal L., Market failure, policy failure and other distortions in chronic disease markets, BMC Health Services Research, Vol. 9(102), 2009, pp. 1-6. [6] J. Karliner, S. Slotterback, R. Boyd, B. Ashby and K. Steele, Health care's climate footprint. How the health sector contributes to the global climate crisis and opportunities for action, Health Care Without Harm in collaboration with Arup, September 2019. Within the healthcare sector, the generation and distribution of electricity, gas and heat or cooling has the highest climate footprint (40 %) followed by healthcare facilities (13 %).

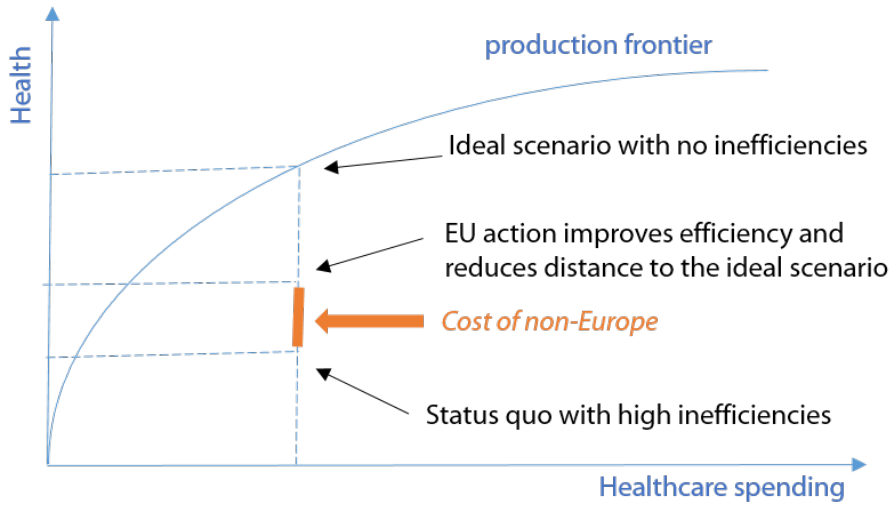
1.3. Analytic approach of the study

The study focuses on three elements where a stronger EU role has potential to generate substantial gains for society and that could be further explored for a joint EU health policy:

- Research and development;
- Prescription medicine availability; and
- Preventive healthcare delivery.

The study draws on an original data-driven analysis of the inefficiencies in the production of health in the EU (see Annex). Informed by the intervention logic in Figure 2 and using Member State-level data mainly available from Eurostat, the analysis estimates the level of inefficiency in the relationships between health expenditures (inputs), procurement of medical technologies (outputs), screening rates (outcomes) and healthy life years (impacts). **The study assumes that a stronger EU role could reduce the level of inefficiency and shift the production of health closer to the production frontier** (see Figure 3).

Figure 3 – Moving towards the production frontier: The cost of non-Europe



Source: EPRS

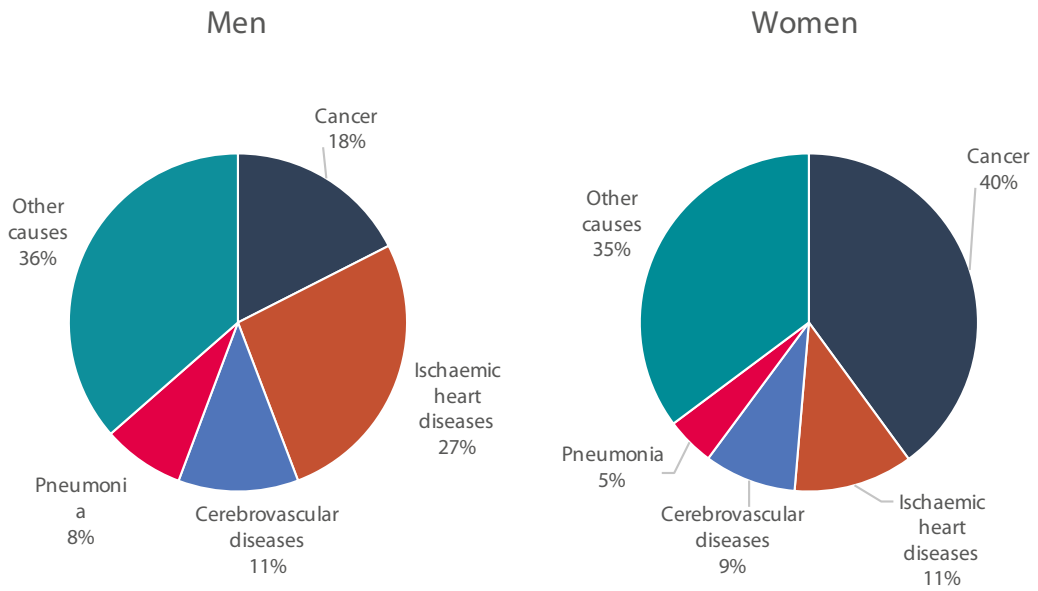
The study also considers the social and fundamental rights dimensions of the cost of non-Europe, most notably in terms of timely access to medicines and treatment. The environmental dimension is also explored, based on a literature review. With respect to the possible EU actions, the analysis gives due consideration to the existing EU and Member State competences in health policy, but also considers some flexibility in light of the European Parliament's call for an amendment to Article 168 TFEU.[21]

[21] Resolution of 22 November 2023 on proposals of European Parliament for the amendment of the Treaties, European Parliament.

2. A snapshot of health and healthcare in the EU

In 2021, the life expectancy of a person born in the EU was 80 years on average, which is among the highest in the world.[22] Women have a higher life expectancy than men, living from about 3 years longer in the Netherlands to almost 10 years in Latvia. The **COVID-19 pandemic reduced life expectancy in the EU by more than one year** –the largest decline in most EU countries since World War II.[23]

Figure 4 – Deaths in the EU-27 due to treatable conditions, by gender



Source: EPRS based on Eurostat data, 2019.

The COVID-19 pandemic exposed weaknesses in healthcare systems in the EU. For example, about 4 % of inhabitants aged 16 years and up had an unmet healthcare need because of the financial costs, distance or waiting time.[24] **About 1 in 5 deaths could have been avoided with better health care systems** (treatable mortality, 37 % of avoidable deaths in the EU), **or better public health interventions** (preventable mortality, 63 % of avoidable deaths).[25] Cancer, primarily of the breast and colorectal, can account for about 40 % of avoidable deaths caused by treatable conditions for women (Figure 4). Among men, ischaemic heart disease is the leading cause of death from a treatable condition that could have been avoided. The leading causes of death due to

22 Mortality and life expectancy statistics 2021 data, Eurostat website.

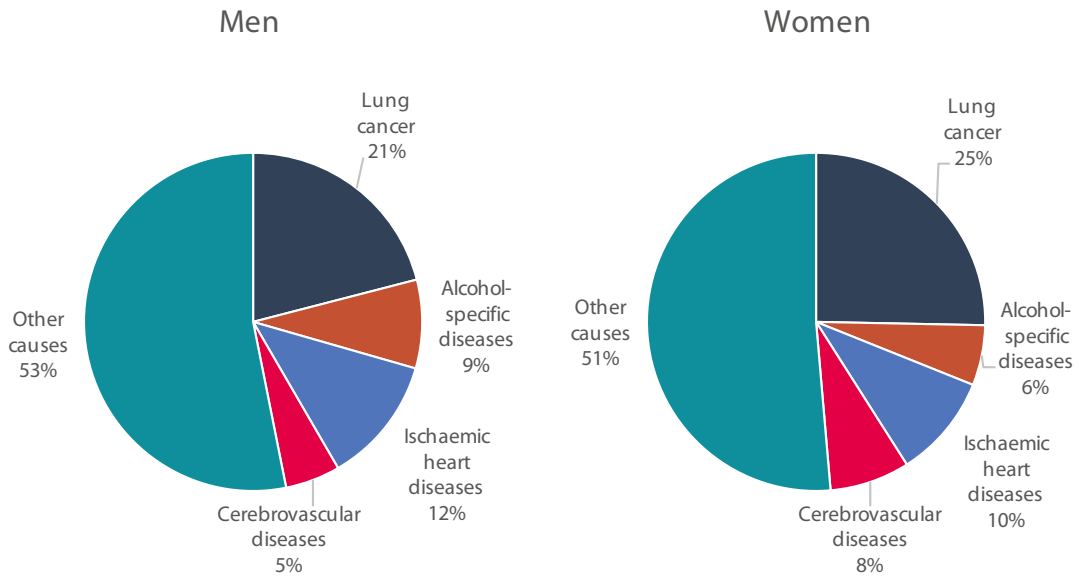
23 OECD, Health at a Glance 2023, 2023.

24 Unmet health care needs statistics 2022 data, Eurostat website.

25 Treatable and preventable mortality of residents by cause and sex, 2019 data, Eurostat website. According to data reported in Eurostat, a total of 1 015 251 deaths among people aged less than 75 years could have been avoided in 2019, equivalent to a rate of 243.16 deaths per 100 000 inhabitants. Of this figure, 643 862.5 was for preventable conditions and 371 388.5 for treatable conditions. The total number of deaths in the EU-27 in 2019 was 4 653 033 (Eurostat, variable name: demo_magec). Total population in 2019 was 446 559 279 (Eurostat, variable name: tps00001).

preventable conditions for both women and men is lung cancer (25 % and 21 % respectively) and ischaemic heart disease (10 % and 12 % respectively) (see Figure 5).

Figure 5 – Deaths in the EU-27 due to preventable conditions, by gender



Source: EPRS based on Eurostat data, 2019.

The ageing of the European population portends a higher burden of chronic diseases in the coming years.[26] According to projections, the incidence of new cancer diseases will increase by about 20 % by 2040 (2.74 million cases in 2022, 3.25 million in 2040), mainly because of a predicted increased share of the population aged over 56 years.[27] The prevalence of neurological and brain disorders such as dementia, Alzheimer's disease and Parkinson's disease are also projected to rise in the coming years. In addition to healthcare costs, such conditions require a significant level of care from family members or institutions (e.g. long-term care).

The number of healthy life years at birth (54 to 69 years) and healthcare spending (€817 to €6 402 per person per year) varies widely across the Member States (see Figure 6).[28] While the intervention logic of health (see Figure 2) would **suggest that more spending would lead to more healthy life years, this relationship is not evident in the cross-country comparison.** The lack of a clear relationship between these two variables raises questions about the efficiency of healthcare spending in the EU or in other words, the translation of healthcare spending into outputs and outcomes.

One of the possible factors contributing to cross-country differences in healthcare spending and healthy life years is the organisation of healthcare in Member States.[29] The **public sector plays a**

[26] OECD, Health at a Glance 2023, 2023.

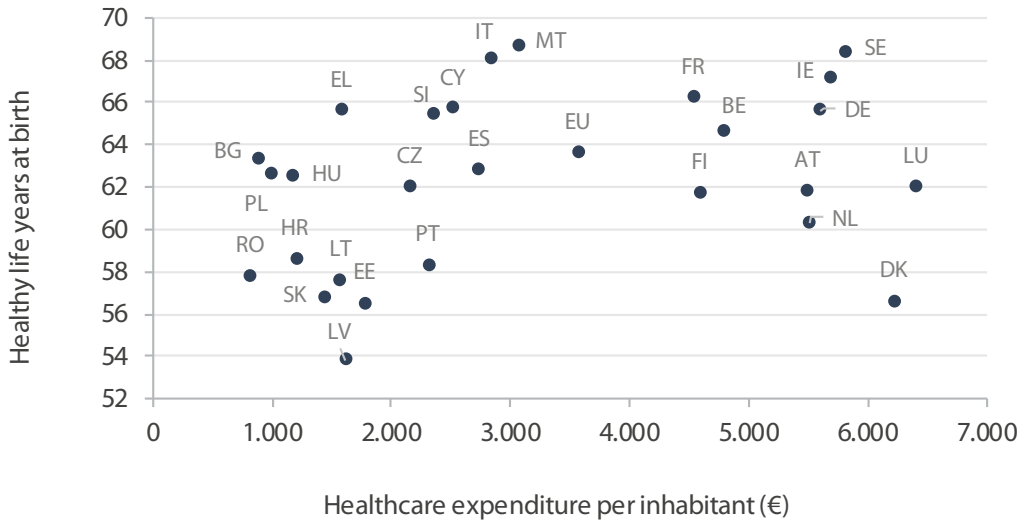
[27] European Cancer Information System (ECIS), European Commission website.

[28] Healthy life years by sex, 2021 data, Eurostat website. Eurostat, Health care expenditure by financing scheme, 2021 data, Eurostat website.

[29] As noted in Section 1.2, healthcare can contribute from 15 % up to 43 % of overall health status.

large role in many national healthcare systems – on average, the public sector contributes about 80 % to total expenditures, which increased from €3 116 to €3 562[30] (about 14 %) between 2019 and 2021 due to the COVID-19 pandemic. The private and non-profit sector also play an important role.[31] Figure 7 shows that the share of hospital beds that are managed by private hospitals in 20 Member States increased slightly (119 to 122 per 100 000 inhabitants), while the number of hospital beds in public hospitals declined (319 to 300 per 100 000 inhabitants) between 2013 and 2021 (see Figure 7).[32]

Figure 6 – Health care spending versus healthy life years in EU Member States



Source: EPRS elaboration based on Eurostat data, 2021.

It is also relevant to consider the environmental dimension of the health care sector, as it contributed an estimated 4.7 % of the EU's carbon emissions in 2014.[33] This amount is equivalent to 64 coal-fired power plants in one year. About 70 % of carbon emissions in the health care sector are due to supply chains, which include the production, transport and disposal of healthcare goods and services. The EU was the healthcare sector's highest emitter (248 million metric tons of carbon dioxide equivalent (MtCO2e)) after China (342 MtCO2e) and the United States (546 MtCo2e) in 2014. The environmental impact of pharmaceutical products can significantly depend on their packaging, with blister packs showing a greater impact compared to bottles and sachets. Materials production is the primary contributor to these impacts and larger packaging implies greater transport use.[34]

30 Health care expenditure by financing scheme, Eurostat website.

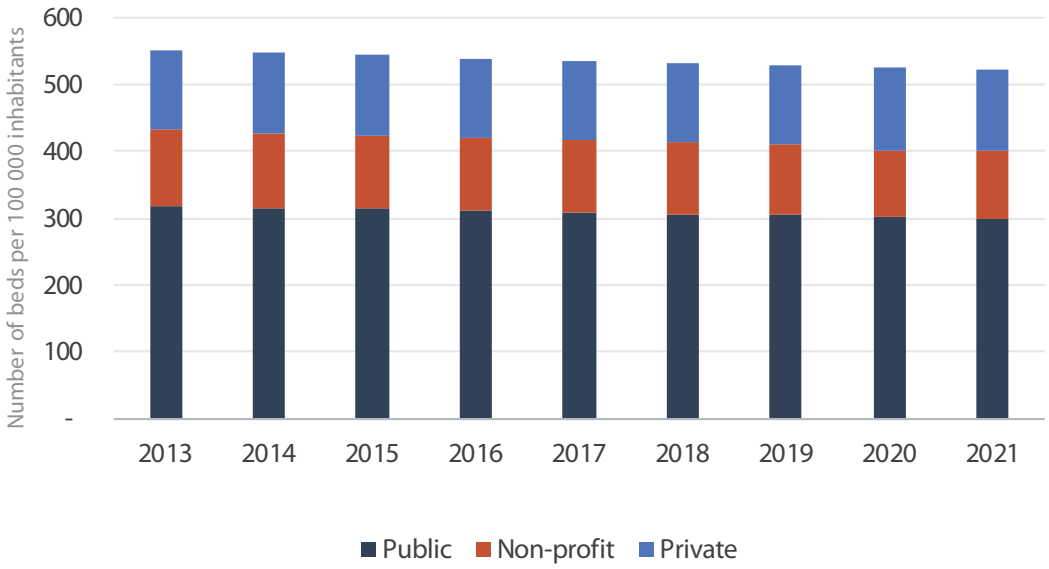
31 Rothgang H., Cacace M., Frisina L. and Schmid A., *The changing public-private mix in OECD health-care systems. In Welfare State Transformations: Comparative Perspectives*, Palgrave Macmillan UK, 2008, pp. 132-146.

32 Hospital beds by hospital ownership, 2013-2021 data, Eurostat website. Population data, Eurostat website.

33 Josh Karliner, Scott Slotterback, Richard Boyd, et al., 'Health care's climate footprint. How the health sector contributes to the global climate crisis and opportunities for action', Health Care Without Harm, in collaboration with Arup, September 2019.

34 Fabiana Bassani, Carla Rodrigues, Pedro Marques et al., Life cycle assessment of pharmaceutical packaging, *The International Journal of Life Cycle Assessment,* Vol 27, 2022, pp. 978–992.

Figure 7 – Composition of hospital beds by hospital ownership in 20 EU Member States, 2013-2021



Note: Population-weighted figures. Data missing or not complete for Finland, Ireland, Luxembourg, Poland, Slovakia, Sweden, Hungary.

Source: EPRS elaboration on Eurostat data, 2013-2021.

3. Potential #1: Research and development

Investment in research and development (R&D) in the health sector is critical to developing new and better medicines and treatments for health conditions. **Health R&D is important to healthcare sector competitiveness and its contribution to the EU's industrial policy.** Health expenditure represents about 11 % of the EU's GDP,[35] while the health and social care sector accounts for about 5.5 % of total employment in the EU.[36] The European Medicines Agency (EMA), plays an important role in evaluating the clinical efficacy and safety of new medicines for EU Member States.

One of the key outputs of health R&D is the development of new medicines, vaccines and laboratory diagnostics. An American association of pharmaceutical producers reports that it can take up to 10 to 15 years and cost up to US$ 2.6 billion to develop a new medicine.[37] A large share of these costs are those related to the failures along the way. Only about an estimated 14 % of medicines entering clinical trials receive market approval.[38] The development of artificial intelligence (AI) and its use in the health sector holds promise for reducing the number of failures, increasing the success of drug discovery and reducing its costs.[39] **Adoption of AI in healthcare in the EU is low.**[40]

A distinction can also be made between the development of 'first in class' medicines, which present the only available treatment for a health condition, and 'best in class' medicines, which offer greater therapeutic value than another medicines available for the same health condition. It can take significantly more time to develop a successful 'first in class' medicine than a successful 'best in class' medicine.[41] However, a 'best in class' medicine can be as commercially successful as developing a 'first in class' medicine.[42]

Since the early 1990s, **pharmaceutical R&D has shifted from Europe to the United States and other countries.** Over the last decade, the level of pharmaceutical R&D has grown markedly in Brazil, China and India.[43] Development and deployment of green technologies could help to reduce

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35 Healthcare expenditure statistics 2020 data, Eurostat website.

36 Sector employment by occupations 2021 data, CEDEFOP website.

37 2022 Profile Biopharmaceutical Research Industry, Pharmaceutical Research and Manufacturers of America (PhRMA), 2022.

38 OECD, Pharmaceutical Innovation and Access to Medicines, November 2018. See Table 2.1.

39 Karim Lekadir, Gianluca Quaglio, Anna Tselioudis Garmendia et al., Artificial intelligence in healthcare. Applications, risks, and ethical and societal impacts, external study prepared for the European Parliament's Science and Technology Options Assessment (STOA) Panel, June 2022. See sections 2.3 on AI in biomedical research; Wellcome Trust and Boston Consulting Group, Unlocking the potential of AI in Drug Discovery - Current status, barriers and future opportunities, June 2023. This study suggests that AI could generate savings of up to 50 % in the preclinical stage.

40 European Commission, Artificial Intelligence in Healthcare Report, November 2021.

41 This was the case for the mRNA vaccine that was used to fight COVID19. Elie Dolgin, The tangled history of mRNA vaccines, *Nature* website, 2021.

42 Ulrik Schulze and Michael Ringel, What matters most in commercial success: first-in-class or best-in-class?, *Nature Reviews Drug Discovery*, 12, 2013, pp. 419-420.

43 The Pharmaceutical Industry in Figures - Key data 2022, European Federation of Pharmaceutical Industries and Associations (EFPIA), 2022. The average market growth rate in Brazil, China and India was 11.7 %, 6.7 % and 11.8 % respectively in 2016-2021. The average growth rate was 5.8 % for five EU markets and 5.6 % for the US market over the same period.

the carbon footprint of healthcare supply chains. Health industries account for about 3 % of patent applications for green technologies in the EU.[44]

3.1. Key challenge: Health R&D investment is insufficient, or insufficiently aligned, with public health priorities

An estimated 13 % of EU private investment (€44 billion) in R&D is directed to health industries.[45] The EU's **collective public investment in health R&D reaches about €11 billion per year.** Yet, there is a high level of fragmentation and insufficient coordination.[46] Member State governments allocated about €9.7 billion to health R&D in 2022.[47] The EU itself invests approximately €1.18 billion in health R&D per year, through the Horizon programme.[48] These funds are principally directed towards frontier research and translation of research into innovation (see Table 3). The EU is planning to mobilise investment in strategic areas, including biotech, through the Strategic Technologies for Europe Platform (STEP).[49]

In contrast, **only about 15 % of private R&D is allocated to pre-clinical drug development.** Pharmaceutical companies have more incentive to license or acquire products that are in advanced stage clinical trials from biotech companies than to carry out their own basic research. Moreover, pharmaceutical companies have a limited incentive to invest in R&D in areas of high social need.[50] Only about a third of new drug approvals by the US Food and Drug Administration (FDA) and the EMA between 2007 and 2017 have high therapeutic value according to health technology assessments.[51] In addition to therapeutic value, there is also a need for health R&D investment to support the sector's environmental sustainability.

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44 N. Grassano, H. Hernandez Guevara, P. Fako, et al, The 2022 EU Industrial R&D Investment Scoreboard, European Commission Joint Research Centre, 2022. Green patents are more common in the automobile and transport sector (25 %) and information technology producers (30 %).

45 Ibid.

46 Karin Sipido, Fernando Antoñanzas, Julio Celis et al., 'Overcoming fragmentation of health research in Europe: lessons from COVID-19', *The Lancet*, Vol 395(10242), pp 1970-1971.

47 Government budget allocations for R&D (GBARD) by socioeconomic objectives, 2021 data. Eurostat website.

48 The total budget for the Horizon programme 2021-2027 is €8 246 million (including €1.35 billion from Next Generation EU funding); The EU Research & Innovation Programme 2021-27, European Commission website.

49 A provisional agreement was reached on 7 February 2024: the initiative was proposed by the European Commission as part of the package of proposals for the mid-term revision of the multiannual financial framework 2021-2027. Press release on Strategic Technologies for Europe Platform: provisional agreement to boost investments in critical technologies, Council of the EU, February 2024.

50 Ye Lim Jung, JeeNa Hwang and Hyoung Sun Yoo, 'Disease burden metrics and the innovations of leading pharmaceutical companies: a global and regional comparative study', *Globalization and Health*, Vol. 16(1), 2020, pp.1-11.

51 Thomas Hwang, Joseph Ross, Kerstin Vokinger and Aaron Kesselheim, 'Association between FDA and EMA expedited approval programs and therapeutic value of new medicines: retrospective cohort study', *British Medical Journal*, Vol. 371, 2020.

Table 3 – EU Horizon programme for basic, frontier research

Programme/initiative	Description	Financing
European Research Council[1]	Long-term funding for frontier research	€555 million for life sciences in 2022
Marie Skłodowska-Curie Actions[2]	Doctoral education and postdoctoral training	€429.4 million for doctoral networks in 2022
Innovative Health Initiative[3]	Supports public-private partnerships that include the pharmaceutical industry, diagnostics, imaging, digital health and medical devices.	€272.4 million in commitment appropriations in 2022
European Innovation Council (EIC)[4]	Support and scale-up breakthrough technologies and innovations. It includes the EIC Transition for transforming research results into innovation opportunities and the Accelerator for individual companies.	€416.7 million for health projects in 2022 An estimated 25 % of projects focused on health; €10 billion from 2021 to 2027.

Source: EPRS based on: [1] European Research Council Dashboard; [2] MSCA awards €429.4 million for doctoral programmes; [3] IHI Consolidated Annual Activity Report 2022; Evaluation study on the European Innovation Council (EIC) Pilot, European Commission, 2022; [4] Impact Report 2020 on Deep Tech Europe. European Innovation Council Pilot, European Commission, 2020.

The conduct of high-quality clinical trials is important in determining safety and efficacy. However, it carries high risks and costs,[52] including the crowding-out of drugs developed especially for diseases that affect a relatively small number of people (e.g. rare diseases). **About 44 % of private R&D is directed to clinical trials.**[53] During the COVID-19 pandemic, there was a notable lack of coordination to conduct clinical trials at sufficient scale to produce useful results.[54]

Table 4 presents a global perspective of R&D investment in the health sector. **While the overall level of health R&D in the EU is low compared with the United States, the public role in its financing is similar** (20 % versus 23 % respectively). In the United States, public funding is provided through federal organisations – most notably the National Institutes of Health. Private investment is primarily made by pharmaceutical companies, while venture capital plays an increasingly important role – especially so in the United States.[55] In 2016, an estimated US$ 13.8 billion in venture

[52] Hemme Hijma, Ahnjili Zhuparris, Ewoud-Jan van Hoogdalem and Adam Cohen, 'Disproportional inflation of clinical trial costs: why we should care, and what we should do about it', Comment in *Nature Reviews Drug Discovery*, January 2024.

[53] European Federation of Pharmaceutical Industries and Associations (EFPIA), The Pharmaceutical Industry in Figures - Key data 2022, 2022.

[54] Frank Vandenbroucke, 'The promise of a European Health Union, Journal of the European Observatory on Health Systems and Policies, Special Issue on the 2024 Belgian Presidency of the Council of the European Union', Vol 29(3), 2023, pp. 4-8.

[55] Waldemar Karpa and Antonio Grginović, 'Long-term perspective on venture capital investments in early stage life-science projects related to health care', Economic research-Ekonomska istraživanja, 33(1), 2020, pp.2526-2540.

capital was directed to the US life sciences sector compared with US$ 1.28 billion in Europe.[56] In the United States, big tech companies such as Google, Amazon and Microsoft are also investing in the development of AI applications in healthcare.[57] Foundations also provide an important source of financing in some countries, for example, the Wellcome Trust in the United Kingdom.[58]

The number of health industry firms whose parent company is located in the EU is much lower compared with firms whose parent company is in the US (69 versus 319 respectively). Health industry firms with a parent company in the EU are mainly large pharmaceutical companies. Biotech companies represent about two-thirds of all health industry firms in the US. In contrast, **EU biotech firms make up only about a third of the health industry.** China has more health industry firms than the EU. Europe also trails the United States in the development of new chemical and biological entities.

Table 4 – Health R&D in a global perspective

	EU	US	China	Japan
Public R&D investment[1] (2022)	€11 billion	€44 billion	Not available	€3 billion
Private R&D investment[2] (2022)	€44 billion	€137 billion	€16 billion	€16 billion
Total number of top R&D-intense health industry firms[2]	69	319	99	30
Pharmaceutical companies	32	61	67	23
Biotech companies	21	217	16	1
Other health firms (e.g. medical supplies, healthcare providers and services)	16	51	16	6
Number of new chemical and biological entities (2018-2022)[3]	74[4]	159	50	46

Source: EPRS:[1] Eurostat, GBARD by socioeconomic objectives (NABS 2007) data. For EU, the sum of Horizon programme (€1.18 billion) and government budget allocations for R&D (GBARD), by socioeconomic objectives (€10 billion); [2] The 2023 EU Industrial R&D Investment Scoreboard, European Commission 2023, Table 17. Data are based on a panel of the top 2 500 R&D investors worldwide and of the top 1 000 EU R&D investors; [3] The Pharmaceutical Industry in Figures - Key data 2023, European Federation of Pharmaceutical Industries and Associations (EFPIA), page 8, 2023; [4] This figure is for Europe and includes also non-EU countries such as the United Kingdom, Russia, Iceland, Norway and Turkey.

The distribution of health R&D investment across Member States may be inefficient, as research has uncovered for overall R&D investment in the EU. Using output indicators, including the production

[56] OECD, Entrepreneurship at a Glance 2017, 2017.

[57] European Commission, Artificial Intelligence in Healthcare Report, November 2021.

[58] The Wellcome Trust website notes that it disbursed about GBP1.5 billion for health-related research in 2021-2022 (accessed 13 February 2024).

of scientific documents, patent applications and high-tech export, research finds that there is some inefficiency in the use of public and private R&D investment. The finding implies that **there is potential room to increase R&D output in the EU by up to 25 % without changing R&D investment levels**.[59]

In industrial biotechnology, the EU has almost twice the share of publications, but only half of the number of patents compared with the United States.[60] In cancer research, nearly half of all international patent families (IPFs) from 2002 to 2021 originate from US companies, while Europe was in second place. Six of the top 10 applicants for patents were from Europe, while the other four were from the US. Universities, hospitals and public research organisations are increasingly applicants for cancer-related IPFs.[61]

3.2. European Parliament, European Commission and the Council positions

The **European Parliament has demanded more public R&D investment that serves public health objectives**.[62] It has also called for ambitious new EU financing for strategic R&D investments, including in biotech.[63] At the same time, it recognises the need for private R&D investment and public-private partnerships, including between research institutions and pharmaceutical companies. Parliament also demands increased EU funding for basic health research through the Horizon Europe programme.[64] To improve cooperation between Member States, Parliament considers that encouraging the mobility of researchers is essential, by offering fair working conditions and an attractive research environment.[65]

In April 2023, the **European Commission proposed a reform of the EU's pharmaceutical legislation**, which would introduce incentives to direct private R&D more towards addressing unmet medical needs and rare diseases. The proposed reform would also incentivise the development of new antimicrobials, promote responsible usage and apply stricter environmental controls – upstream measures to control EU pharmaceuticals authorisation.[66]

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59 Martina Halaskova, Beata Gavurova and Kristina Kocisova, 'Research and development efficiency in public and private sectors: An empirical analysis of EU countries by using DEA methodology', *Sustainability*, Vol. 12(17), 2020, pp. 7050. Data specifically for health R&D investment are not available.

60 Science, Research and Innovation performance (SRIP) of the EU Report, Chapter 2: Zoom Out, Zoom In – The Geography of R&I, European Commission, 2022. See Table 2.1-2.

61 European Patent Office, Study on Patents and innovation against cancer – Evidence from patent and company data, February 2024.

62 Resolution of 24 November 2021 on a pharmaceutical strategy for Europe, European Parliament.

63 Amendments adopted by the European Parliament on 17 October 2023 on the proposal for a regulation establishing the Strategic Technologies for Europe Platform (STEP).

64 European Parliament resolution of 18 October 2023 on the Council position on the draft general budget of the European Union for the financial year 2024 (11565/2023 – C9-0336/2023 – 2023/0264(BUD)). The 2024 EU budget includes an increase of €25 million for health research. S. Mazur, Adoption of the European Union's 2024 budget, EPRS, November 2023.

65 Council recommendation of 18 December 2023 on a European framework to attract and retain research, innovation and entrepreneurial talents in Europe.

66 Factsheet - Driving innovation for pharmaceutical industry, European Commission, 2023.

Parliament already highlighted e-health interoperability as a priority to support research, in its resolution on the implementation of the Cross-border Healthcare Directive[67] and the resolution on digital transformation of health in the single market.[68] In its resolution on eGovernment accelerating digital public services,[69] Parliament reiterated the potential of e-health to promote **cross-border research** and cross-border healthcare. According to Parliament's amendments,[70] a regulation on an **EU health data space,** proposed by the European Commission,[71] could contribute to boosting research, development of new medicines and other healthcare products, innovation and policy decisions.

3.3. Avenues for a stronger EU role in health R&D

The EU could pursue several ways to promote an ambitious EU health R&D strategy and its alignment to public health priorities. It could **establish a European health infrastructure,** with the core mission to support early-stage research and the development of medical therapies[72] that society needs most, and which the private sector is not already addressing.[73] This portfolio of therapies could include **a mix of 'first in class' and 'best in class' to maximise therapeutic value for society** while managing risk. As a third investment option, the infrastructure could also license promising compounds from other countries – the United States and Japan. The infrastructure could consider a long-term horizon and seek to boost synergies between public and private R&D investment.

The European health infrastructure could be organised in different ways. It could manage contractual arrangements with external researchers, support an in-house research staff or offer a combination of both. Ideas for the organisation's approach could be drawn from the European Molecular Biology Laboratory (EMBL), which operates across six sites and has its hub in Heidelberg, Germany[74] and the US National Institute of Health.[75]. **The proposed European health**

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67 Resolution of 12 February 2019 on the implementation of the Cross-Border Healthcare Directive, European Parliament.

68 Resolution of 18 December 2019 on enabling the digital transformation of health and care in the digital single market; empowering citizens and building a healthier society, European Parliament. More details in C. Evroux, European health data space, EPRS, European Parliament, December 2023.

69 Resolution of 18 April 2023 on eGovernment accelerating digital public services that support the functioning of the single market, European Parliament.

70 Proposal for a regulation on the European Health Data Space COM(2022) 197, European Commission, May 2022. Amendments of 13 December 2023 on European Health Data Space, European Parliament.

71 Proposal for a regulation on the European Health Data Space COM(2022) 197, European Commission, May 2022. Amendments of 13 December 2023 on European Health Data Space, European Parliament.

72 Medicines as we know them today may be very different in 10 to 20 years. Gene therapy and biologics are examples of what can be expected in the not so distant future. The infrastructure should take this into account and also include diagnostics and platform technologies within its scope, which have high potential therapeutic value.

73 The idea of an EU-level infrastructure was explored in Florio M., Pancotti C., and Prochazka, D., European pharmaceutical research and development: Could public infrastructure overcome market failures?, external study prepared for the European Parliament's Science and Technology Options Assessment (STOA) Panel, EPRS, December 2021. It is also referred to in this article: Cleemput I., de Noordhout C., Goettsch W., Identifying disease-specific patient and societal needs to foster needs-driven healthcare and innovation policies in the EU, *Journal of the European Observatory on Health Systems and Policies*, Vol. 29(3), 2023.

74 EMBL counts 22 EU Member States among its members - Austria, Belgium, Croatia, Czechia, Denmark, Finland, France, Estonia, Greece, Germany, Hungary, Ireland, Italy, Lithuania Luxembourg, Malta, the Netherlands, Poland, Portugal, Slovakia, Spain and Sweden.

75 Dr Emily Erbelding from the US National Institute of Health gave an overview at a STOA workshop on 28 September 2022 entitled: 'Creation of a public European medicines infrastructure: Purpose and feasibility'. She

infrastructure could promote a robust health innovation ecosystem in the EU that leverages the unitary patent.[76]

The EU could also offer added value by establishing EU-wide clinical trial networks for different types of disease (e.g. cancer, immunological diseases, diabetes). For example, the European health infrastructure could **oversee EU-run clinical trials through hospital networks**, following the example of the randomised evaluation of COVID-19 therapy (RECOVERY) trial, which identified the effectiveness of low-dose dexamethasone treatment against COVID-19.[77] Such a network could prove attractive to pharmaceutical companies by lowering the time and resources needed to set-up and run clinical trials. Clinical trials through an EU network could offer large sample sizes to investigate sex and race differences.[78] It could also carry out **comparative effectiveness trials on medicines already on the market** and assess the safety, therapeutic value and quality of life offered by different medicines for different population groups, as well as their environmental footprint.[79] Such trials could **leverage the EU health data space and AI potential,** while also ensuring protection of personal data, and could build on the Regulation for Health Technology Assessment.[80] It could be useful to also apply this approach for medicines that are being approved for supplemental indications, as their therapeutic value may be lower.[81] Based on these trials and assessments, the institution could issue recommendations on pricing to national authorities and indicate therapeutic value to potential prescribers of the products, including physicians and hospitals.

The resources for a new EU institution could come in part from **shifting R&D spending from the national to the EU level.** A shift of 10 % of national R&D budgets could generate €840 million for EU-level health R&D per year, which is more

Box 1 – Licenses and royalties to recoup the costs of public health R&D investment

The use of licenses and royalties could help to recoup the costs of public health R&D, while promoting the transfer of biomedical innovations to the private sector and ultimately to consumers.

As described in Danziger and Scott (2020), the NIH developed a technology (paclitaxel-eluting coronary stent), which was licensed to Angiotech Pharmaceuticals. The NIH negotiated royalties that corresponded to a share of sales each year until the patent expired. In total, the discounted value of the royalties exceeded the cost of the research project – the internal rate of return was greater than 7 %. In addition to the commercial benefits, the technology generated benefits for patients. In economic terms, royalties and licensing of technologies developed with public funds can support the distribution of the economic surplus to consumers.

Source: R. Danziger and J. Scott, Government royalties on sales of biomedical products developed with substantial public funding, *The Journal of Technology Transfer*, Vol. 46, 2020, pp.1321-1343.

reported that 85-90 % of the NIH budget is externalised while 10 to 15 % is spent within the institution's own laboratories.

76 Unitary Patent Overview, European Patent Office website, accessed 12 February 2024.

77 Martin Landray, Richard Haynes and Christina Reith, Accelerating clinical trials: time to turn words into action, *The Lancet*, 2023.

78 A broader vision for women's health, Editorial in *The Lancet*, Vol 402(10399), 2023, pp 34.

79 European Academies' Science Advisory Council and Federation of European Academies of Medicine (EASAC), Decarbonisation of the Health Sector: A Commentary by EASAC and FEAM, ', 2021.

80 Regulation (EU) 2021/2282 of 15 December 2021 on health technology assessment and amending Directive 2011/24/EU.

81 Kerstin Vokinger, Camille Glaus, Aaron Kesselheim et al., 'Therapeutic value of first versus supplemental indications of drugs in US and Europe (2011-20): retrospective cohort study', *British Medical Journal*, Vol. 382, 2023.

than double the budget of the EMBL.[82] The European health infrastructure could hold licenses for any therapies it develops and receive royalties from the commercialisation of the research it funds (see Box 1).

The EU could **offer seed money to attract biotech companies** to take on risky projects with potential to offer significant benefits for society in terms of health and environmental protection. Such funding could also promote the development and use of AI in drug development.[83] The European Investment Bank signed an agreement with the European Commission in July 2023 to set up Health Emergency Preparedness and Response (HERA) Invest, a €100 million guarantee to finance advanced research and development of medical countermeasures addressing health threats, which would be oriented towards SMEs.[84] Financing early-stage research on a larger scale and directing it towards biotech to develop new medicines or diagnostics through small business grant funding opportunities,, as is the case in the US, could offer added value.[85]

The EU can also help **catalyse investment to promote health sector energy transformation**. For example, the European health infrastructure could promote green patents depending on the scope of its mission, and contribute to reducing the health sector carbon footprint. Public R&D investment could support the development of biodegradable materials for stents and adhesives for wounds, to reduce waste and contamination.[86]

3.4. Cost of non-Europe in health R&D

Table 1 summarises the cost of non-Europe with respect to health R&D. Most notable is the cost in terms of **lost innovation and reduced development of medical interventions with high therapeutic value**. The costs of clinical trials would remain high, crowding out biomedical innovation. The prices for new medicines with limited therapeutic value would also remain high.[87] The decline in the number of biotech companies and overall health R&D in Europe could be expected to continue contributing to an erosion of the EU's competitiveness and strategic autonomy.[88]

The low development of medicines with high therapeutic value and the limited knowledge on the comparative effectiveness of therapies in the EU implies that health needs in society are not met.

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82 EMBL's total budget in 2021 was €315 million, which 40 % was contributed by Member States and 21 % was external grant funding.

83 Alexander Schuhmacher, Alexander Gatto, Michael Kuss et al., Big Techs and startups in pharmaceutical R&D - A 2020 perspective on artificial intelligence, *Drug Discovery Today*, Vol. 26(10), 2021, pp. 2226-2231. The paper notes: 'Big Techs have long-lasting experience in the digital field and offer more general IT solutions to support pharmaceutical companies in cloud computing, health monitoring, diagnostics or clinical trial management, whereas startups can provide more specific AI services to address special issues in the drug-discovery space.'

84 Press release on European Health Union: HERA Invest offers €100 million for innovative solutions to health threats, European Investment Bank, July 2023.

85 The National Institutes of Health offers 'Small Business Innovative Research' and 'Small Business Technology Transfer' funding for early-stage research and development. These programmes represent about 3.2 % of the NIH budget, or about US$ 1.3 billion. For more information see Understanding SBIR and STTR, NIH Seed website.

86 The chemical industry is developing solutions for the degradation of waste plastic and chemicals: see Rebecca Buller, Sean Lutz, Romas Kazlauskas, et al., 'From nature to industry: Harnessing enzymes for biocatalysis', *Science*, Vol. 382(6673), 2023.

87 Miloš Miljković, Jordan Tuia, Timothée Olivier, et al., 'Cancer Drug Price and Novelty in Mechanism of Action', *Journal of the American Medical Association Network Open*, Vol. 6(12), 2023.

88 European Commission, Science, Research and Innovation performance (SRIP) of the EU Report, Chapter 2: Zoom Out, Zoom In – The Geography of R&I, 2022.

This can lower quality of life for patients and reduce their labour market engagement and social inclusion. **Development of high therapeutic value medicines can help ensure patients' fundamental right to timely access to healthcare while promoting positive economic and social impacts.** Box 2 presents examples of NIH-funded research that has led to break-through developments addressing health needs in society. Thanks in part to health R&D over recent decades, the life expectancy of people with cystic fibrosis has increased dramatically, allowing for some to participate in the labour market, which can promote social inclusion.[89] A shift towards a more environmentally sustainable health sector could encourage the green transformation while also reducing health risks due to environmental degradation and climate change.

The continued fragmentation of R&D spending in the EU also carries a cost in terms of **wasted public funds**. Assuming that the level of inefficiency reaches 20 % would translate to €847.7 million lost per year. Assuming a stronger EU role in health R&D could reduce inefficiencies by 30 %, which implies a saving of €254 million each year. This is equivalent to about 20 % of the EU's budget for health research.[90]

A rich literature exists on the benefits of public investment on economic growth. Less is known however about the impacts of specific categories of investment such as health R&D in the European context. One such analysis finds no significant multiplier effect for public investment in medical products, public health

Box 2 – Impact of United States National Institute of Health (NIH) funded research – selected examples

Brain and mental health

About 1 in 8 people who give birth experience postpartum depression (PPD). The rate increased seven-fold between 2000 and 2015. Thanks in part to decades of NIH research, the Food and Drug Agency (FDA) approved the first specific medications for postpartum depression (PPD) in 2019.

The NIH made significant contributions to the development of deep brain stimulation (DBS), a treatment that can offer patients relief from symptoms in Parkinson's disease and other brain disorders. By 2021, it is estimated that more than 200 000 DBS devices were implanted globally.

Genetic disease

More than 30 years of NIH-supported research led to the 2020 FDA approval of selumetinib, the first effective treatment for children with neurofibromatosis type 1 (NF1) and associated tumours. In clinical trials, this treatment shrunk tumours in 70 % of trial participants.

In the 1980s, most people with cystic fibrosis (CF) died as teenagers. Thanks to NIH-funded research, including identification of the gene responsible for the disorder and subsequent development of therapies, people with CF are living into middle age and have a better quality of life.

Source: NIH website

[89] Veruscka Leso, Vincenzo Carnovale, Paola Iacotucci, et al., Employment status and work ability in adults with cystic fibrosis, *International Journal of Environmental Research and Public Health*, 18(22), 2021.

[90] As noted earlier in Section 3, the budget for health in the Horizon programme, the EU's main instrument to support research and innovation, is €1.37 billion per year.

services, outpatient services and R&D.[91] Some insights into the potential gains of a European health infrastructure can be gained from analyses of the impacts of the NIH in the United States. The NIH's website reports that the organisation, which has a US$ 45 billion budget, generates US$96.84 billion in economic activity.[92] Every US$100 million spent funding NIH-supported research generates 76 patents, creating US$598 million in additional R&D.[93] This evidence suggests that **public health R&D could have a multiplier effect catalysing private R&D and economic activity.**

[91] Donatella Saccone, Pompeo Della Posta, Enrico Marelli and Marcello Signorelli, 'Public investment multipliers by functions of government: An empirical analysis for European countries', *Structural Change and Economic Dynamics*, Vol. 60, 2022, pp. 531-545.

[92] United for Medical Research, Report on NIH's Role in Sustaining the U.S. Economy - 2023 Update, March 2023.

[93] Michael Kalutkiewicz, Richard Ehman, Report on Patents, Pasteur and productivity. A Model for Promoting Scientific and Economic Growth at the National Institutes of Health, *Manhattan Institute*, June 2017.

Table 5 – Cost of non-Europe in health R&D

	Cost of non-Europe in health R&D
Economic	Low level of innovation and uncompetitive health care industry (not enough biotech and patent generation). Erosion of EU competitiveness and strategic autonomy. Waste of public budget in Member States due to inefficiencies (estimated to reach at least €254 million per year, equivalent to 20 % of the EU research budget). Based on evidence from the United States, €1 invested in a European health infrastructure could generate up to €2.15 in economic activity alone. Waste of public budget to procure medicines of limited therapeutic value.
Social	Unmet health needs and poor quality of life for patients. Low social inclusion of patients with untreated diseases.
Fundamental rights	Threats to citizens' right to live a life in dignity (Article 1 CFR) and right to life (Article 2 CFR).
Environmental	Low health sector sustainability and limited contribution to the EU's green transformation.

Source: EPRS.

4. Potential #2: Prescription medicine and treatment availability

Average health spending in the EU was €3 269 per citizen in 2020.[94] About 14 % of this amount – an estimated €462 – was spent on prescription medicines.[95] **Prescription medicines are increasingly important for the management of chronic diseases including heart disease and cancer**, and can support patient and quality of life and productivity.[96] The use of prescription medicines may also reduce other healthcare costs such as hospital stays.[97]

A large share of the EU's population takes at least one prescription medicine. One out of five 15-24-year-olds uses a prescribed medicine. Over half of the population aged 55 years and older uses at least one prescribed medicine.[98] Women at all ages are more likely to use prescription medicines than men (52.3 % versus 43.2 % respectively).[99] The prices of prescription medicines are not well-known and vary across distribution channels and Member States. Such costs are largely borne by the public budget. Pharmaceutical companies claim that prices are set to recoup the costs

94 Healthcare expenditure per inhabitant, 2020 data. Eurostat website.

95 Health at a Glance: Europe 2022: State of Health in the EU Cycle, Pharmaceutical expenditure, OECD, 2022.

96 Elizabeth Unni, Medicine Use in Chronic Diseases, *Pharmacy*, Vol.11 (100), June 2023.

97 EFPIA, The Pharmaceutical Industry in Figures - Key data 2023, 2023.

98 Self-reported use of prescribed medicines by sex, age and educational attainment level, 2019 data. Eurostat website.

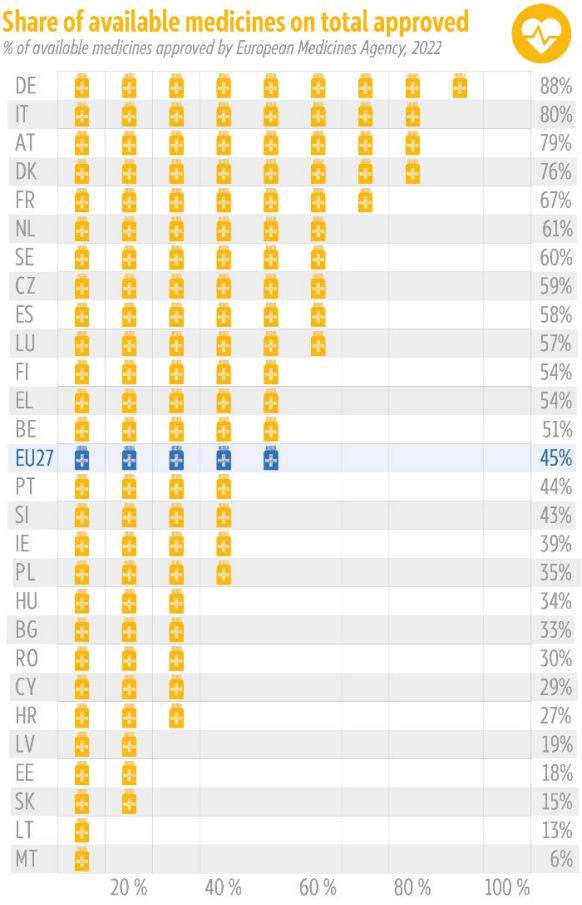
99 Ibid.

of R&D. However, some evidence finds that the price of anticancer drugs is not associated with their novelty.[100]

4.1. Key challenge: Missing EU single market for prescription medicines

The EMA evaluates applications for new medicines and recommends whether a new medicine should enter the market.[101] Based on the EMA evaluation, the European Commission can then issue EU-wide marketing authorisation for the medicine and the pharmaceutical company that holds the rights to the medicine can then consider where to launch the product and enter into negotiations with national competent authorities to set pricing and reimbursement conditions. Information from negotiations between pharmaceutical companies and national authorities is typically confidential and not shared between competent authorities. Moreover, **public authorities negotiate from a weak position of information asymmetry concerning the real therapeutic value of the medicine** for its population and must rely on the information available.

Figure 8 – High variation in availability of medicines in Member States



Source: EFPIA Patients WAIT Indicator Survey 2022.

The result is that new medicines are not launched in all Member States. Some countries with greater bargaining power are able to gain access to more medicines than others (see Figure 8). Moreover, **the time from central approval to availability in the country can vary almost 10-fold** – from 128 days in Germany to 918 days in Romania. The time to availability is longer for oncology drugs (526 days), and orphan drugs (625 days), compared to all products (517 days).[102]

[100] Miloš Miljković, Jordan Tuia, Timothée Olivier, et al., 'Cancer Drug Price and Novelty in Mechanism of Action', *Journal of the American Medical Association Network Open*, Vol. 6(12), 2023.

[101] The remit is the EEA, which includes the EU27 plus Iceland and Norway.

[102] IQVIA, The EFPIA Patients W.A.I.T. Indicator 2022 Survey, April 2023.

Data on the price of prescription medicines is limited and treated as confidential information by pharmaceutical companies. The Austrian Public Health Institute is gathering price data for medicines in 30 European countries.[103] While these data are self-reported and not complete, they offer useful insights. For example, the data show that medicine prices are lower in higher income countries (Austria, France, Germany, the Netherlands and Sweden) than lower-income countries (Greece, Hungary, Romania and Poland).[104] The authors report that higher-income countries represent a more attractive market as they are more willing and able to pay. Lower-income countries in contrast have more budget-constraints and have less bargaining power. Other research has found that central and eastern European countries are less likely to negotiate discounts.[105] Pharmaceutical manufacturers may be more willing to offer discounts for medicines when a generic product is available.[106]

Access to medicines is often governed through public procurement arrangements between a contracting authority and an economic operator chosen by the contracting authority. Approaches vary across Member States, ranging from a national centralised approach to a facility-based approach. Within Europe, **countries with more advanced public procurement approaches may have greater availability of medicines and at lower prices**.[107]

Citizens who live and work in different Member States face challenges in obtaining prescription medicines.[108] For example, as only a few Member States have implemented interoperable systems for e-prescriptions,[109] e-prescriptions might not be available in another Member State, or only paper prescriptions are acceptable. According to the overview provided by the European Commission,[110] e-prescriptions are not yet accessible in all Member States. Citizens of Spain, for example, can only fill e-prescriptions in pharmacies in Portugal, Croatia, Poland and Finland, while Croatian citizens can retrieve e-prescriptions in Finland, Estonia, Portugal and Spain, and Polish people in Croatia, Spain and Finland. While Directive 2012/52/EU[111] lays down minimum requirements for prescriptions (name of patient, identification of prescribing health professional or the prescribed product), an **EU-wide uniform prescription practice, form and format** does not currently exist. There are only guidelines that seek to promote that any prescription issued in one Member State contains the relevant information to obtain the medicine in another EU Member State.[112]

4.2. European Parliament and European Commission positions

The Charter of Fundamental Rights of the European Union stipulates citizens' fundamental right to access to medical treatment in Article 35, which can be understood to include prescription drugs.

103 Pharma Price Information (PPI), Pharmaceutical Pricing and Reimbursement information website.

104 Daniela Moye-Holz and Sabine Vogler, 'Comparison of Prices and Affordability of Cancer Medicines in 16 Countries in Europe and Latin America', *Applied Health Economics and Health Policy* Vol. 20, 2022, pp. 67–77.

105 Wim van Harten, Anke Wind, Paolo de Paoli, et al., 'Actual costs of cancer drugs in 15 European countries', *Lancet Oncology*, Vol. 17(1), January 2016, pp. 18–20.

106 OECD, Health at a Glance 2021: OECD Indicators, Generics and biosimilars, 2021.

107 European Commission, Study on Best Practices in the Public Procurement of Medicines - Final Report, September 2022.

108 Directive 2011/24/EU of 9 March 2011 on the application of patients' rights in cross-border healthcare.

109 Presenting a prescription in another EU country, European Commission website.

110 Electronic cross-border health services, European Commission website.

111 Directive 2012/52/EU of 20 December 2012 on measures to facilitate the recognition of medical prescriptions issued in another Member State.

112 Ibid.

Following the COVID-19 pandemic, the European Commission proposed a reform of the EU's basic pharmaceutical regulation that seeks to promote access to affordable medicines.[113] The proposed legislation would offer incentives for pharmaceutical companies to launch a new drug in all Member States.

The European Parliament has called for **universal, affordable, and timely access to preventive and curative medicines and the eradication of inequalities in access**.[114] Moreover, citizens' access to prescriptions, imagery and lab tests issued in different Member States and sharing aggregated health data for research purposes are underlined by Parliament in its amendments to the Commission's proposal on the European health data space.[115]

The European Parliament has also called on the European Commission to present **legislation on future joint European procurement,**[116] which could promote transparency and price agreements and reduce fragmentation in the availability of prescription medicines across Member States. This request was taken into account through the exclusivity clause of **Regulation (EU) 2022/2371**[117] on serious cross-border health threats, which entitles the Commission to carry out joint procurement in justified cases.

4.3. Avenues for a stronger EU role on prescription drugs

The spectrum of action that the EU could take to **promote one voice in negotiating prices of prescription medicines for a large market** (the EU), could build to some extent on the experience of procuring vaccines during the COVID-19 pandemic. One set of actions could stem from increased coordination in sharing information and transparency across Member States. The EU could establish **negotiation guidelines** on engaging with pharmaceutical manufacturers, and the **determination of reference** prices that reflect the therapeutic value of the product.[118] The EU could also facilitate transparency in pricing and reimbursement decisions across Member States, and the reporting of relevant information to a central portal such as that already available at the Austrian Public Health Institute.[119]

A second set of actions could step from stronger EU promotion of joint procurement of medicines. Guidelines specifying award criteria in the Public Procurement Directive could set out qualitative criteria for the most economically advantageous tender (MEAT), suggesting other criteria than the lowest price alone –[120] supply security for example.[121] The EU could support a **'common pharmaceutical culture'** in Europe that fosters accessibility to medicines through a standardisation

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113 Laurence Amand-Eeckhout, Revision of EU pharmaceutical legislation, EPRS, European Parliament, 2023.

114 Resolution of 21 November 2021 on a pharmaceutical strategy for Europe, European Parliament.

115 Amendments of 13 December 2023 on the proposal for a regulation on the European Health Data Space, European Parliament.

116 Resolution of 21 October 2021 on EU transparency in the development, purchase and distribution of COVID-19 vaccines, European Parliament.

117 Regulation (EU) 2022/2371 of 23 November 2022 on serious cross-border threats to health and repealing decision, accompanied by Communication on Building a European Health Union: Reinforcing the EU's resilience for cross-border health threats - COM(2020) 724, European Commission, November 2020.

118 A stronger EU role in clinical trials, as noted in Section 3.3, could also promote value-based pricing.

119 Austrian National Public Health Institute website (see Daten und Register).

120 Question for written answer E-005638/2020, Directive 2014/24/EU on public procurement and most economically advantageous tender (MEAT) criteria, European Parliament, October 2020.

121 Communication on addressing medicine shortages in the EU - COM(2023) 672, European Commission, October 2023.

of drug prescribing practices across EU countries,[122] to ensure patients with similar conditions receive similar treatments and enhancing patient safety.[123] The EU could establish a common approach to prescription labels that includes all relevant information classified in a common approach (for example, conditions following the International Classification of Diseases).[124]

4.4. Cost of non-Europe in prescription medicines

The **lack of one voice in negotiating prices of prescription drugs in the EU** (as discussed in Section 4.3) implies costs to society in terms of reduced access to medicines, higher prices, poorer health outcomes, greater demand for care, including long-term care, and greater risk of death. The quantitative analysis found that the availability rate of new medicines could be about 20 % higher on average in EU Member States if the current inefficiencies were eliminated. The potential to reduce the time to availability is even greater and translates to a reduction of about 350 days.[125] Greater information sharing and transparency could help to counter these inefficiencies in the availability of prescription medicines across Member States. **Moreover, one EU voice can boost their bargaining power relative to pharmaceutical companies.**

Long waiting periods are especially critical for diseases like cancer where a new medicine can have a significant impact on survival. Research presented in the Annex finds that pharmaceutical innovations can reduce cancer mortality by 9 % to 20 %. Without such critical medicines, hospital admissions and demand for care work could be higher, and patient morbidity increased. The quantitative analysis estimated that the availability of new oncology medicines may play a role in reducing the costs of premature mortality, reaching the equivalent of €4 to €8 billion a year.[126]

The fragmentation of the prescription medicine market also has costs for pharmaceutical manufacturers – the **lost revenue due to parallel trade** (i.e. purchasing a medicine available in another market). The estimated loss in Europe was €6 billion in 2020.[127]

The lack of transparency in setting medicine prices could raise the risk of corruption in public procurement contracts, as well as in the delivery of treatment to patients.[128] Addressing bribery in medical service delivery remains a persistent challenge, exacerbated by the prevalence of privileged access across all EU Member States.[129] About one in three Europeans report that they, or a family member, were asked by a public official in a school or hospital or a police officer to give a bribe during the previous 12 months.[130]

Action to boost the implementation of EU cross-border health care may help to ensure mobile EU citizens' health and wellbeing. A more standardised approach to prescription labelling could

[122] Resolution of 2 March 2017 on EU options for improving access to medicines, European Parliament.

[123] Digital medication in healthcare settings: an opportunity for the European Union, European Health Management Association (EHMA) website, November 2022.

[124] Afonso Cavaco, Miguel Mourato, Sofia Ferreira, Selen Yeğenoğlu, 'Assessing medical prescription forms as a communication tool in trans-European health care', *Journal of Research in Pharmacy Practice*, Vol. 7(1), 2018.

[125] Annex, Section 3.4. The average time to availability is 537 days.

[126] Annex, Section 3.4.

[127] EFPIA, The Pharmaceutical Industry in Figures - Key data 2022, 2022.

[128] European Commission, Study on corruption in the healthcare sector, October 2013.

[129] European Commission, Updated Study on Corruption in the Healthcare Sector - Final Report, September 2017.

[130] European Quality of Government Index, University of Gothenburg website; Nicholas Charron, Victor Lapuente, Monika Bauhr M et al., 'Change and Continuity in Quality of Government: Trends in subnational quality of government in EU member states', *Investigaciones Regionales-Journal of Regional Research*, Vol 53, 2022, pp. 5-23.

promote harmonisation and information sharing across Member States. Citizens could gain more awareness of their health condition and treatment through better access to electronic health data. Patterns of prescribing medicines could be more easily monitored and regulated to ensure more **harmonised healthcare treatment and reduced health inequalities across the EU**.

The **potential budgetary impact of joint procurement of prescription medicines is mixed,** although some evidence suggests that budgetary savings could be achieved. In Jordan, joint procurement on pharmaceuticals was estimated to achieve a budgetary saving of 2.4 %.[131] In New Zealand, a government agency carried out a negotiation for hospital pharmaceuticals on behalf of all public hospitals in the country. Research found this saved about 3.7 %. The introduction of volume-based procurement in China also led to decreases in drug prices for some medicines.[132] It would also be relevant to address other impacts, such as patient outcomes and availability of pharmaceuticals, as well as on pharmaceutical expenditure, although the data is limited.

EU action to boost access to prescription medicines could potentially impose a cost on the environment if other measures are not taken. This is because prescription medicine residue is a known contaminant in water. There could be greater benefit in upstream measures at the stage of pharmaceutical authorisations, rather than at the level of waste water treatment, where remediation costs can be high.[133] **Ongoing EU action to introduce such measures could thus complement measures promoting consolidation of the EU pharmaceutical market and limit negative environmental impacts.**

[131] Ibrahim Al-Abbadi, Abdelraouf Qawwas, Mahmoud Jaafreh et al., One-Year assessment of joint procurement of pharmaceuticals in the public health sector in Jordan, *Clinical Therapeutics*, Vol. 31(6), 2009, pp. 1335-44.

[132] Jing Yuan, Z Kevin Lu, Xiaomo Xiong and Bin Jiang, 'Lowering drug prices and enhancing pharmaceutical affordability: an analysis of the national volume-based procurement (NVBP) effect in China', *British Medical Journal Global Health*, Vol. 6(9), September 2021. See Figure 1 for results of the change in medicine prices, and impact on affordability by therapeutic class. See also: Lei Chen, Ying Yang, Mi Luo, et al., The Impacts of National Centralized Drug Procurement Policy on Drug Utilization and Drug Expenditures: The Case of Shenzhen, China, *International Journal of Environmental Research and Public Health*, Vol. 17(24), 2020.

[133] Thomas Zandstra, Cost of non-Europe report on water legislation, EPRS, May 2015.

Table 6 – Cost of non-Europe in the area of pharmaceutical availability

	Cost of non-Europe in the area of pharmaceutical availability
Economic	Approved medicines are not available in all Member States. Some Member States pay more for new medicines due to lower bargaining power. Prices of new medicines do not necessarily correspond with therapeutic value for patients.
Social	Long waiting times for new medicines. Higher morbidity and risk of death for patients in need of treatment. About 9 % to 20 % of all cancer deaths can be attributed to differential waiting periods for new oncological medicines across Member States. Lower social inclusion and productivity. People affected by cancer are less likely to be in the labour market, contributing to losses of €4 to €8 billion. Continued inequalities across and within Member States in access to medicines. Increased dependence and demand for care work.
Fundamental rights	Threats to the right to healthcare (Article 35 CFR) and the right to engage in work (Article 15 CFR).
Environmental	Remediation costs of wastewater to remove pharmaceutical residue.

Source: EPRS.

5. Potential #3: Delivery of preventive healthcare

5.1. Key challenge: Low and inefficient screening for chronic disease

About 2.9 % of the EU's average healthcare spending was directed to preventive healthcare in 2019, which increased to about 6.0 % in 2021 due to the COVID-19 pandemic.[134] **The level of spending on preventive healthcare is low compared with curative and rehabilitative care**, which accounted for more than half of average EU healthcare spending in 2019 and 2021.

Preventive healthcare, which includes vaccination and screening programmes, could support early detection, diagnosis and treatment of diseases and control their advance.[135] It also includes sexual and reproductive health services. As noted in Section 2, an estimated 15 % of deaths could be avoided with better public health intervention.[136]

[134] Health care expenditure by financing scheme, Eurostat website.

[135] Health First Europe, The compelling case for better screening and secondary prevention in Europe: lessons from five representative diseases, Insight report, 2021.

[136] According to Eurostat preventable and treatable mortality statistics, over three quarters of a million (762 800) deaths in the EU – equivalent to 180.0 deaths per 100 000 inhabitants – could have been prevented through better public health intervention. Checking Population change - Demographic balance and crude rates at national level (variable

Yet, **there are significant differences in the availability and quality of preventive healthcare services across the EU**.[137] There is also a gap between what is recommended and actual practice. These gaps were notable during the COVID-19 pandemic with regards to access to primary care doctors[138] and to sexual and reproductive health services including contraception and abortion.[139] For example, despite the common understanding of the need for more and better screening, Member States' programmes to fight cancer differ greatly, for example in the case of the human papillomavirus (HPV) vaccine and cervical cancer (see Box 3). The 2022 Council Recommendation sets concrete screening targets for a defined age group and frequency for only a few types of cancer, such as breast, cervical and colorectal cancer,[140] while no specific requirements are envisaged at EU level for lung, prostate and gastric cancer. Evidence suggests that the use of preventive healthcare decreased during the COVID-19 pandemic. According to the European Cancer Organisation, over one million cancer cases could have been undetected in 2020.[141]

With regards to preventive healthcare, it is useful to explore the number and use of screening machines: magnetic resonance imaging (MRI) machines, computed tomography (CT) scanners and positron emission tomography (PET) scanners.[142] Lung cancer, which is the most common preventable disease (see Figure 5), can be detected at an early stage with a CT scan. Other types of cancer and their evolution can be investigated with PET scans. Cerebrovascular diseases can be detected with MRIs.

At present, there are no guidelines or benchmarks regarding the optimum number of CT, PET or MRI units per population.[143] Too few units could limit the availability of scans, resulting in longer waiting times and greater pre-diagnosis disease progression. On the other hand, more units than necessary could be needlessly costly. Yet there is a **procurement of technologies for scanning disease, and their use, differ greatly across Member States** (see Figure 9). There is positive correlation between the level of technologies and the rate of screening, but also evidence of excess capacity in some Member States. It should be noted other factors could also influence the level of use – healthcare policies, demographics and disease profile, as well as the number of medical professionals, in particular healthcare technicians and radiologists. Attention should be paid to addressing the shortage in healthcare professionals, which can affect the rate of screening.[144]

The use of **new technologies, in particular artificial intelligence** could play a vital role in prevention and early detection of cancer. It is recognised that image diagnostic through AI technology could contribute to the early detection of diseases and increase the success of

name: demo_gind) data on Eurostat, the total number of deaths in 2020 was 5 184 078. This suggests that about 15 % of total deaths could have been prevented through better public health intervention.

137 European Commission, Inequalities in access to healthcare - a study of national policies, 2018.

138 Giuliano Russo, Julian Perelman, Tomas Zapata and Milena Šantrić-Milićević, 'The layered crisis of the primary care medical workforce in the European region: what evidence do we need to identify causes and solutions?' *Human Resources for Health*, Vol 21(55), 2023.

139 International Planned Parenthood Federation (IPPF) and European Parliamentary Forum for Sexual and Reproductive Rights (EPF), Sexual and Reproductive Health and Rights during the COVID-19 pandemic, April 2020.

140 Council Recommendation of 9 December 2022 on strengthening prevention through early detection: A new EU approach on cancer screening replacing Council recommendation 2003/878/EC.

141 Dire new Warning about Cancer in Europe, European Cancer Organisation website, October 2022.

142 These three indicators were selected because they were available from Eurostat.

143 OECD, Health at a Glance 2023: OECD indicators, 2023.

144 Matthias Wismar and Tom Goffin, 'Tackling the Health workforce crisis: Towards a European Health Workforce Strategy', *Journal of the European Observatory on Health Systems and Policies*, Vol. 29(3), 2023.

treatments and survival rate, for example for cardiovascular diseases or cancer, both the leading causes of mortality in the EU and both a financial burden on healthcare systems.[145] The use of AI in screening and early detection of disease in the EU is limited, due to insufficient data (big data);[146] as a consequence, **health professionals need to be trained** in the use of AI and digital literacy and the **infrastructure** in many EU countries needs to be upgraded. Furthermore, digital therapeutics[147] is fragmented in the EU; streamlining could contribute to reduce costs.

Box 3 – The example of the HPV vaccination and cervical cancer

The human papillomavirus (HPV) vaccination could prevent up to 90 % of cancers caused by HPV including cervical cancer. All EU countries have HPV vaccination in their national prevention programmes and many have moved from a girls-only to a gender-neutral strategy. Regular, comparable data on actual vaccination rates across Members States is not available. Nonetheless, the evidence suggests that there is significant variation.

Sweden is projected to eliminate cervical cancer by 2030 as a result of a high vaccination rate (above 90 % for girls, a bit lower for boys) and screening. In addition, Sweden offers self-sampling kits to all eligible women, a strategy that has proven both successful and cost-efficient. Eastern European countries, in contrast, have lower levels of vaccination, screening and higher number of cases of cervical cancer. For instance, Romania started a programme for HPV vaccination but discontinued the vaccination in the face of low acceptance. In Bulgaria, the vaccination rate in general is low, and extremely low against HPV. A study demonstrates that the number of deaths from cervical cancer in Bulgaria increased from 304 in 2018 to 364 in 2020 and estimates a loss of 5 092 years of working life and a €2 to €3 million annual loss in productivity (GDP) per employee. HPV vaccination rates are low in Germany and Austria compared to Sweden and Portugal.

In Czechia, only 2.6 % of women reported never had undergone a cervical test, compared to Romania where more than 47 % have not undergone examination.[1] Socio-economic inequalities exist in many countries, for example in Bulgaria, where women with lower income tend to have fewer tests (18 %), compared to high income earners. In Austria, a large proportion of women took a cervical test (78 % women, EU average 60 %).

Sources: Polona Maver and Mario Poljak, 'Primary HPV-based cervical cancer screening in Europe: implementation status, challenges and future plans', *Elsevier Clinical Microbiology and Infection*, Vol. 26(5), 2020, pp. 579-583; Marc Arbyn, Murat Gultekin, Philippe Morice, et al., 'Cervical cancer: The European response to the WHO call to eliminate cervical cancer as a public health problem', *International Journal of Cancer*, July 2020; Edoardo Colzani, Kari Johansen, Helen Johnson and Lucia Celentano, 'Human papillomavirus vaccination in the European Union/European Economic Area and globally: A moral dilemma', *Eurosurveillance*, 26(50), 2021.

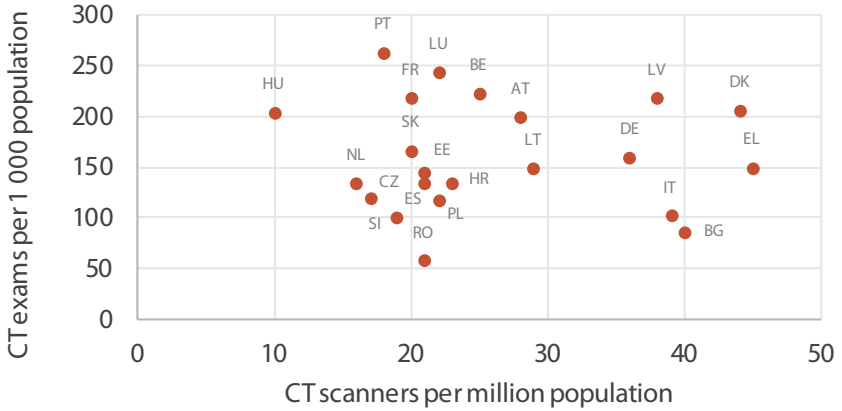
Note: The European Cancer Organisation's HPV Action Network has called for an HPV vaccine tracker to be hosted by the European Centre for Disease Prevention and Control (ECDC).

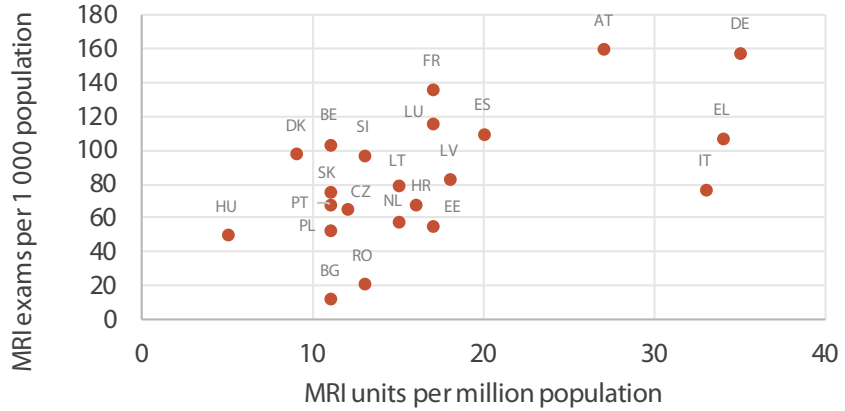
[145] European Health Management Association (EHMA), My City-Lab Talk Series – AI and cardiovascular diseases, Event summary of the EMHA Annual Congress, November 2022.

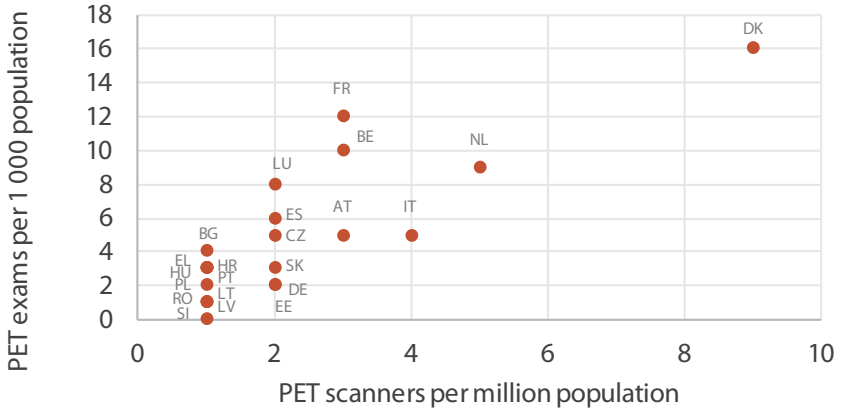
[146] Leveraging big data allows for image analysis based on early detection of cardiovascular diseases and making more precise predictions on providing individualised treatment.

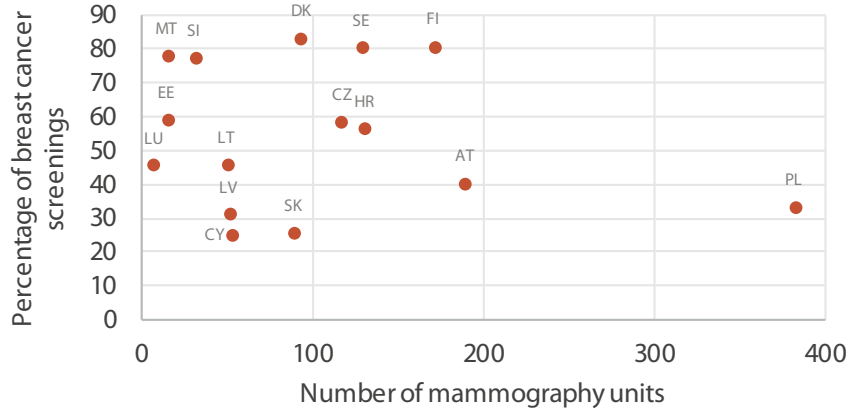
[147] Johannes Ahlqvist and Markus Kalliola, 'How can digital therapeutics help Europe?', Working Paper, Sitra (Finland's fund for the future), November 2021.

Figure 9 – Available units of devices for medical imaging v utilisation – 2021 or latest year available









Source: EPRS development of OECD Health Statistics 2023 and Eurostat data.

5.2. European Parliament, European Commission and Council positions

The Commission **Europe's beating cancer plan,**[148] one pillar of the European Health Union, contributes to prevention, early detection, diagnosis, treatment and quality of life to complement national action. The Knowledge Centre on Cancer at the Commission's Joint Research Centre[149] provides scientific evidence and improves collaboration in this field. The beating cancer plan has enhanced EU activities, such as EU cancer screening programmes, new EU screening guideline,[150] and an updated 2003 Council recommendation on screening and cancer screening campaign. The plan is reflected in EU programmes, such as Horizon Europe,[151] which support research and innovation. One of the five mission areas is devoted to research on cancer through support for EU-wide scientific coordination and collaboration. The EU4Health programme, established to reinforce EU crisis preparedness, contributes to long-term health challenges in general and health promotion and disease prevention in particular.[152] Cancer prevention is one of its key priorities, focusing on vaccine-preventable cancers. Routine vaccination against HPV should become the norm, covering 90 % of girls and a significant increase of vaccinated boys by 2030.

Parliament's resolution, based on the work of the **Special Committee on Beating Cancer (BECA),**[153] underlines the existing inequalities between Member States in access to cancer screening, resulting in discrimination among EU citizens, depending on the Member State in which they live, for instance for cervical cancer screening. Parliament calls for equal access to cancer care across borders and underlines the requirement for an EU approach to medicine shortages, aiming at ensuring a high quality of life for patients. The resolution[154] on the situation of sexual and reproductive health and rights (SRHR) in the EU highlights the lack of access to treatment in particular for cervical cancer, while prevention, such as vaccines for HPV,[155] could avoid cancer and the detection of reproductive cancers could save lives. In view of biological and genetic differences between men and women, Parliament advocates gender-based medicine and treatment.[156]

Council has confirmed prevention and treatment of non-communicable disease (such as cancer) has been confirmed is a priority.[157] Member States underpin the need to strengthen **cancer prevention** through early detection of cancer via the Council recommendation[158] on a new EU approach on cancer screening. They underline the need for accessible screening programmes for breast, cervical,

148 Communication on Europe's Beating Cancer Plan - COM(2021) 44, European Commission, February 2021.

149 Knowledge Centre on Cancer, European Commission website.

150 Cancer Screening, Diagnosis and Care - European guidelines on breast cancer screening and diagnosis, European Commission. Cancer screening in the European Union, Directorate-General for Research and Innovation, Group of Chief Scientific Advisors, European Commission, March 2022.

151 Horizon Europe, European Commission website.

152 Regulation (EU) 2021/522 of 24 March 2021 establishing a Programme for the Union's action in the field of health (EU4Health Programme) for the period 2021-2027, repealing Regulation (EU) N° 282/2014.

153 Resolution of 16 February 2022 on strengthening European in the fight against cancer - towards a comprehensive and coordinated strategy, European Parliament (recitals 86 and 87).

154 Resolution of 24 June 2021 on the situation of sexual and reproductive health and rights in the EU, in the frame of women's health, European Parliament.

155 Resolution of 16 February 2022 on strengthening Europe in the fight against cancer - towards a comprehensive and coordinated strategy, European Parliament.

156 Ibid.

157 Council conclusions of 20 December 2021 on strengthening the European Health Union.

158 Council Recommendation of 9 December 2022 on strengthening prevention through early detection: A new EU approach on cancer screening replacing Council recommendation 2003/878/EC.

colorectal, lung, prostate and gastric cancer and timely and complementary diagnostic procedures and treatment. The recommendation[159] only provides concrete targets for some types of cancer, for example for cervical cancer and HPV testing for women between the ages of 30 and 65 years at a minimum of every five years,[160] or a colonoscopy between 50 and 74 years to detect colorectal cancer.

According to the 2022 recommendation[161] on cancer screening, guidelines suggest mammography screening for women aged 50 to 69 years, with consideration for screening from the age of 45 years, potentially extending up to 74 years. Denmark, Finland, Malta, Slovenia and Sweden have the highest screening rates, while Cyprus, Bulgaria Hungary, Latvia and Slovakia have the lowest.[162] Furthermore, **breast cancer screening coverage** across the EU varies widely, ranging from 6 % to 90 % among the target population.[163]

In the context of **prostate cancer**, the 2022 recommendations advocate pilot programmes that follow a gradual approach to implementing organised screening initiatives. As an illustration, Czechia[164] is set to launch a screening programme for men aged 50-59 years in 2024. Several Member States, including the Netherlands, Portugal, Slovakia and Sweden, launched awareness campaigns in 2023.

5.3. Avenues for a stronger role for the EU on preventive healthcare

Common EU standards for health prevention do not yet exist, although secondary prevention[165] is crucial in early detection and impeding disease progression, ensuring quality outcomes for patients and minimising healthcare expenses. **Standardised practices, screening guidelines** and prevention programmes across the EU could establish a unified EU definition for essential preventive healthcare services. This could encompass common minimum standards, including screening intervals, age groups, and focus on diseases responsible for a significant proportion of preventable deaths, such as heart disease, diabetes and cancer.[166]

The development of non-invasive diagnostics and personalised vaccines can offer high therapeutic value and could be a higher EU R&D policy priority (see Section 3). Examples of such diagnostics that have already been developed include a stool test for colon cancer,[167] and a urine test for prostate

[159] Council Recommendation of 9 December 2022 on strengthening prevention through early detection: A new EU approach on cancer screening, replacing Council recommendation 2003/878/EC. Cancer screening in the European Union, Directorate-General for Research and Innovation, Group of Chief Scientific Advisors, European Commission, March 2022.

[160] Europe's Beating Cancer Plan. A new EU approach to cancer screening, European Commission, 2022.

[161] Council Recommendation of 9 December 2022 on strengthening prevention through early detection: A new EU approach on cancer screening replacing Council recommendation 2003/878/EC.

[162] Breast cancer screening rates across the EU, Eurostat website.

[163] Cancer screening in the European Union, Scientific Advise Mechanism of Group of Chief Scientific Advisors, *Scientific opinion*, N° 12, March 2022.

[164] Europa Uomo website.

[165] Insight Report: The compelling case for better screening and secondary prevention in Europe: Lessons from five representative diseases, Health First Europe, 2021.

[166] Prevention & Early diagnosis, Health First Europe website.

[167] Colorectal Cancer, Screening and testing, Digestive cancers Europe 2018-2023 website.

cancer.[168] A breath test, which is currently in development for lung cancer[169] has high potential therapeutic value considering the composition of deaths due to preventable conditions (see Figure 5). The **development of personalised vaccines** is also promising in view of reducing the risk of disease development.[170]

Additional measures could be implemented to ensure the effective use of **medical devices and machines.** EU-wide recommendations and guidelines for their placement and usage rates, along with joint procurement of essential medical imaging equipment such as MRIs, CTs and PET scanners, would not only facilitate universal and timely access but also enhance the accessibility of such medical devices, in particular in rural areas.

There is room more EU action related to improving efficiency, collaboration and knowledge sharing between hospitals, healthcare services and research institutes on issues such as exchanging experience on new drugs and treatment (protocols), which could be enhanced through **European networks of excellence** and supported by the digitalisation of the health sector and the proposed eHealth digital service infrastructure (eHDSI),[171] in particular regarding the cross-border exchange of health data.

The EU could enhance its impact by taking a more prominent role in the **integration of new technologies and AI into screening workflow and treatment.** This has been shown to alleviate the workload for radiologists, as demonstrated by a study conducted in a Swedish hospital.[172] The adoption of digital solutions has the potential to improve healthcare accessibility and contribute to early detection of cancer. While some studies suggest potential drawbacks such as over-diagnosis, over-treatment and increased costs,[173] it is equally probable[174] that AI can contribute to refining risk classification and detecting individuals at high risk of developing cancer. A coordinated effort to upgrade infrastructure across Member States at EU level could play a crucial role in mitigating costs. While the use of AI has positive effects for the healthcare sector, it is necessary to choose the AI programme carefully, to avoid discrimination and other negative effects. The EU could reflect upon establishing EU-wide auditing and inspection of AI systems to counteract these consequences.[175]

The use of AI in healthcare requires **training health professionals in digital literacy**. The EU could pursue several paths to enhance the free movement of healthcare workers by promoting EU-wide standards for vocational training,[176] job profiles and continued education in the health sector.

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168 Hojun Kim, Sungwook Park, In Gab Jeong, et al., 'Noninvasive precision screening of prostate cancer by urinary multimarker sensor and artificial intelligence analysis', *ACS Nano*, Vol. 15(3), 2021, pp. 4054-4065.

169 Miao Shi, Weiguo Han, Olivier Loudig, et al., 'Initial development and testing of an exhaled microRNA detection strategy for lung cancer case-control discrimination', *Scientific Reports*, Vol. 13, 2023.

170 Elie Dolgin, Personalized cancer vaccines pass first major clinical test, *Nature reviews - Drug Discovery* - News, 2023.

171 Electronic cross-border health services, European Commission website. Commission recommendation (EU) 2019/243 of 6 February 2019 on a European Electronic Health Record exchange format.

172 Karin Dembrower, Alessio Crippa, Eugenia Colón, et al., 'Artificial intelligence for breast cancer detection in screening mammography in Sweden', *The Lancet Digital Health*, Vol. 5(10), October 2023, pp. e703-e711.

173 Digital solutions for early breast cancer detection, *The Lancet Digital Health* - Editorial, Vol. 5(9), September 2023, pp e545.

174 Mikael Eriksson, Marta Román, Axel Gräwingholt et al., 'European validation of an image driven AI-based short-term risk model for individualized breast cancer screening - a nested case-control study,' *The Lancet Regional Health - Europe*, Vol. 37, February 2024.

175 Karim Lekadir, Gianluca Quaglio, Anna Tselioudis Garmendia et al., Artificial intelligence in healthcare. Applications, risks, and ethical and societal impacts, external study prepared for the European Parliament's Science and Technology Options Assessment (STOA) Panel, June 2022.'

176 Dimitra Panteli and Claudia Maier, 'Regulating the health workforce in Europe: implications of the COVID-19 pandemic', *Human Resources for Health*, Vol 19(80), 2021.

Establishing a joint framework could prevent skills and labour shortages in healthcare across Member States, leading to cost savings and improved automatic **recognition of professional qualifications**. Overall, investments in future skills should prioritise addressing the digital and green transformation within the health sector.[177]

Health literacy, defined as individuals' ability to comprehend and utilise health information regarding healthcare, disease prevention and health promotion in their daily lives, is an important component of preventive healthcare and could be part of health education curricula in schools.[178]

5.4. Cost of non-Europe in preventive healthcare

The cost of non-Europe with regards to preventive healthcare is reflected in the delayed diagnosis of chronic disease, higher morbidity and premature death. The quantitative analysis finds a positive correlation between procurement of screening technologies, the use of screening technologies and the mortality rate. The analysis takes into account to the extent possible that use of screening technologies depends on factors such as machine availability, patient accessibility, waiting times and resources allocation within the healthcare systems. The analysis suggests that a **more efficient distribution and use of screening technologies can save lives.** Moreover, the production function in most Member States displays increasing returns to scale, which means that the centralisation of procurement and screening activities can be more effective for the same level of financing. The analysis finds that the potential for efficiency improvement in the prevention function could be up to 88 %, when the outcome variable is the inverse ratio of the number of deaths due to infectious diseases. This inefficiency translates to about 74 000 deaths.[179]

Looking beyond budgetary waste, the inefficiencies across Member States in preventive healthcare can contribute to lower screening rates and worse health outcomes.[180] The quantitative analysis finds the potential in the EU to increase the screening rate for colorectal cancer by up to 9 percentage points and the screening rate for cervical cancer by up to 14 percentage points overall. The analysis also estimates the potential to increase the number of MRI examinations (with the existing number of machines) in the EU could be up to 2 900 per 100 000 inhabitants. Overall, these **inefficiencies in screening practices could account for up to an estimated 1.6 million deaths, of which about a quarter of a million are due to cancer** (see Table 7). The increased level of morbidity due to delayed preventive healthcare could also increase dependency and heighten the demand for care work, including long-term care.

[177] Health professionals: skill opportunities and challenges (2023 update), CEDEFOP website.

[178] David Ross, Mary Louisa Plummer, Paul Montgomery, et al., 'World Health Organization recommends comprehensive school health services and provides a menu of interventions', *Journal of Adolescent Health*, 69(2), 2021, pp.195-196.

[179] Annex, Section 2.5. The analysis finds an efficiency level of 12 % in preventive health spending in the EU.

[180] Annex, Section 4.

Table 7 – Cancer deaths in the EU that could have been averted through better preventive health practices

	Avoided deaths per million in 2019	Deaths per million inhabitants in 2019	Share of deaths that could have been avoided through more efficient preventive health practices
Breast cancer	69.92	183.4	38 %
Cervical cancer	24.71	27.1	91 %
Colon cancer	187.44	311.4	60 %
Prostate cancer	67.83	152.7	44 %
Lung cancer	238.22	509.1	47 %

Source: EPRS based on findings in Annex.

Lower use of curative care, which represented about 53 % of health care expenditure in the EU in 2020,[181] could contribute to a lower environmental footprint. Reducing the environmental impact of healthcare involves implementing measures in both the healthcare system itself and in addressing the factors that contribute to healthcare demand. This entails implementing strategies aimed at lowering the frequency and severity of illnesses, thereby reducing the quantity and intensity of medical care required, while also ensuring that the supply of healthcare services aligns with demand.[182] These figures do not reflect the potential for greater engagement in the labour market, and the lower dependence on family members and other care workers.

In total, **inefficient procurement and prevention across Member States could be responsible for about 2.1 million deaths in the EU**. Assuming a stronger EU role can reduce inefficiencies by 5 %, it could be possible to save 109 000 lives. Placing a value on life is controversial, but is increasingly done in the context of health and environmental evaluations to support risk assessments. The OECD uses values within a range of €1.8 million to €5.4 million per person.[183] ECHA uses a value of €3.5 million from 2012.[184] Assuming each life saved has a value of €1.8 million could lead to a lower bound estimate of €196 billion per year. Using a higher figure of €3.5 million per life saved could lead to an upper bound estimate of €381 billion per year. The monetisation is sensitive to the assumption of the estimated value of a statistical life.

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Table 8 – Cost of non-Europe in preventive healthcare

	Findings
Economic	Higher health care costs (due to more curative care and hospitalisation). More absenteeism and a less healthy society and workforce.
Social	Higher morbidity and risk of death. An estimated 109 000 lives are lost each year. Inequalities in screening and disease outcomes across Member States. High demand for care work. Higher risk for lower quality of life and fewer healthy life years.
Fundamental rights	Threat to the right to preventive care in the Pillar of Social Rights.
Environmental	Larger environmental footprint due to greater usage of curative care and hospitalisation.

Source: EPRS.

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Annex I

A quantitative analysis of inefficiencies in healthcare systems in the EU

Abstract. This research paper provides several benchmarking exercises based on the Data Envelopment Analysis (DEA) methodology to assess the actual performance of Member States along different dimensions of healthcare. Healthcare is analysed using a standard framework provided by the economic theory of production, according to which consumption of inputs (public spending) is needed to obtain outputs (healthcare services), which can affect citizens' health. Taking as given the current allocation of competences between the EU and Member States in the area of health, the analysis reveals significant inefficiencies. More EU action that could be achieved in part by attributing additional competences to the EU could help to reduce inefficiencies and shift the position of Member States closer to the 'efficient' production frontier.

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Executive summary

In Europe, healthcare systems are largely regulated at the national level. The EU plays a minor role, mostly focused on the determinants of individual health (like individual behaviours and the quality of the environment) rather than on the direct provision of services. In this paper, we provide several benchmarking exercises to assess the actual performance of EU Member States (MS) along different dimensions of the healthcare system. We then use these results to discuss a potential larger role of the EU in healthcare, with particular reference to Health Union Package launched in November 2020.

To perform our analysis, we exploit the framework provided by the microeconomic theory of production. In this framework, each MS is considered as a decision-making unit, taking decisions on inputs. Consumption of inputs is needed to obtain outputs, which can affect citizens' health, to be considered as the final outcome of the production process. Inputs can be defined in different ways, albeit it is customary to use mostly public spending when analyzing the performance of countries. Outputs might include discharges, vaccinations, availability of drugs or other healthcare services, while outcomes can be measured for example using life expectancy or mortality indicators. Each MS – through the choice of inputs and the regulation of the national healthcare system – influences the end result of the production process (output/outcome).

To benchmark the performance of different countries, we rely on Data Envelopment Analysis (DEA), a standard benchmarking tool based on linear programming techniques. Starting from the choice of inputs and outputs/outcomes, DEA allows us to estimate an 'efficient' production frontier and to estimate how far each MS is currently positioned with respect to this 'efficient' frontier. The performance of each country can then be assessed considering two different approaches: according to the so-called output oriented approach, we consider as given the amount of input and ask how outputs (outcomes) can be improved relative to the frontier; according to the input oriented approach, we consider a fixed amount of outputs (outcomes) and ask how inputs can be saved relative to the frontier. In both cases, throughout the paper we discuss how a larger role of the EU can help MS to get closer to the 'efficient' frontier. Hence, the '(in-)efficiency scores' characterizing each MS in each benchmarking exercise can be thought of as a 'cost of a non-Europe' option, which leaves the current allocation of competences between the EU and the MS unchanged.

While the microeconomic framework remain constant throughout the paper, the choice of specific inputs, outputs and outcomes needs to be adapted to the specific domain of the healthcare system under investigation. In the first part of the paper, we update and extend the analysis by Saulnier (2020), estimating the performance of the national healthcare systems as a whole, and then discussing more in details two specific sub-functions, procurement and preventive care. We focus on these two because their production is characterized by relevant economies of scale and potential spillovers across MS, that makes these two sub-functions important candidates for a larger EU role in their provision.

Our analysis documents the existence of large differences across MS in the organization of their public healthcare system and in the results they produce. Specifically, we define several different DEA models using total public spending as input and both the annual hospital discharges and the percentage of self-reported met needs as outputs, and healthy life years and life expectancy as outcomes. Considering these DEA exercises, we find average inefficiency (to be intended as potential output/outcome expansion) to range between 5% and 32% depending on the model specification. We also find that efficiency scores based on output and outcome models show a low degree of correlation, likely because of the role played by other variables on health outcomes, such as individual characteristics and behaviors. This intuition is confirmed by a second stage analysis where we regress the MS efficiency scores on a set of countries and individual characteristics.

The room for improvement is even larger when considering the two specific sub-functions. In the case of procurement, we consider public procurement spending as a percentage of the total public current health expenditure as the input, medical technology (like Computed Tomography or PET scanners and mammographs) as the output, and three key outcomes, healthy life years, the inverse ratio of overall deaths per 1,000 inhabitants, and the inverse ratio of cancer-related deaths per 1,000 inhabitants. In the case of preventive care, public preventive care spending out of total public current health expenditure is the input, the percentage of individuals aged over 65 who have received flu vaccinations is the output, while healthy life years and the inverse ratio of deaths attributed to infectious diseases per 1,000 inhabitants are the outcomes. According to our estimates, inefficiency is very high, ranging between 13% and 82%, depending on the model specification. This means that if we were able to eliminate entirely the inefficiency, bringing each national health care system to the frontier, we could for example reduce mortality by 1.8 million deaths per year (516,000 deaths in the context of cancer-related mortality and approximately 74,000 deaths for infectious diseases) (see Section 2).

As for the pharmaceutical strategy, we specify DEA models using either per capita healthcare expenditure within the pharmaceutical and other medical non-durable goods sectors or its share with respect to the total current health expenditure as inputs, and the availability of drugs in different countries and the time to availability as outcome variables. Our findings suggest that countries that perform better in the availability of drugs also perform better in terms of time. Inefficiency in availability is about 46-47%, while inefficiency in terms of time to availability is about 65-67%. In both cases, a second stage analysis reveals that larger countries perform better, suggesting the existence of important scale economies in pharmaceutical drugs procurement. If these inefficiencies were eliminated, this would translate into a potential 21% increase in the average availability rate across MS, and in a reduction in the average time to availability of about one year. These results extend also to more specific oncology medicines. Translating these inefficiency scores into measures mapping the reduction of premature mortality, we can infer that a larger efficiency in the availability of innovative pharmaceutical products could reduce the costs to society of premature cancer mortality by an estimated annual range spanning from €4 to €8 billion (see Section 3).

Finally, for the Europe's Beating Cancer Plan we specify several DEA models which consider expenditure on prevention per inhabitant as the input. Outputs include variables such as the self-reported percentage of women who have undergone a breast examination by X-ray or who have undergone a cervical smear test in the past year, the self-reported percentage of individuals who have undergone colorectal cancer screening in the past year, and the number of Magnetic Resonance Imaging (MRI) examinations relative to the population. Outcome variables include mortality indicators for five different types of malignant cancers (including breast, cervix uteri, colon, prostate, and lung cancers). We find large inefficiencies in the range of 29 % to 48 % for outputs and 37 % to 86 % for outcomes. Interestingly, we also find a negative correlation across these two groups of scores, suggesting that countries experiencing higher mortality rates also push more for screening programs. Eliminating inefficiencies in these cases would result in lower cancer-related deaths: the magnitude ranges from 24.71 per million inhabitants in the case of cervix-uteri cancer to 238.22 per million inhabitants in the case of lung cancer (see Section 4).

In the last part of the paper (Section 5), we explicitly discuss the strengths and weaknesses of the DEA approach, suggesting some limitations of the current analysis. We also summarize the main policy options available to the EU to help MS to get closer to the efficient frontier. Most of these actions would require improved transparency in the pharmaceutical markets in terms of, e.g., negotiation rules, contracts, prescribing, and screening practices.

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1. Introduction

According to Article 168 TFEU, EU competences in the area of health are very limited and mainly focused on the *determinants* of individual health (like individual behaviors and the quality of the environment) rather than to the *direct provision* of a full array of healthcare services. The organization of healthcare systems in charge of providing services to citizens is a clear competence of Member States. A corollary of this institutional arrangement is - to consider two important examples- that the procurement of important inputs in service provision (like pharmaceutical products or equipments) or the authorization of sites for the production of these inputs is also under the responsibility of the single Member State.

However, the COVID-19 pandemic has shown the limits of this arrangement, almost exclusively based on national policies, to face a global health threat, highlightening the role of supra-national entities, such as the EU. For instance, the crucial role played by the European Union in securing an ample vaccine supply for all Member States is unequivocally discernible. This stands in stark contrast to reliance solely on traditional market dynamics, which could disproportionately impact smaller and poorer EU member countries.

Defining and assigning additional scope for decision at the EU level in the area of health care is a request that also comes directly from European citizens. According to Eurobarometer surveys conducted after the pandemic, the majority of EU citizens supported the claim that the EU should establish a European strategy to face future global health crises and develop a common European health policy (Bordignon et al. 2023). Also the European Parliament calls for new actions in the area of health, pushing for centrally authorised medicines to be marketed in all Member States, and stressing the importance of new EU joint procurement mechanisms (European Commission 2022; Kohler et al. 2021; Vogler et al. 2021).

The EU has already moved forward with several initiatives after the pandemic. In particular, the *Health Union Package* was launched already in November 2020, including four key actions: (1) crisis preparedness, (2) pharmaceutical strategy; (3) Europe's Beating Cancer Plan; and (4) putting mental health on par with physical health. Following the Package, the European Health Emergency Preparedness and Response Authority (HERA) was created with the aim of providing better preparedness and response to serious cross-border health threats. In 2021, the Commission presented the Beating Cancer Plan, and subsequently, in 2023, proposed a new directive and a new regulation aimed at revising and replacing the current overarching pharmaceutical legislation.

The aim of this research is to deepen the knowledge on the cost of non-Europe in the area of health. Initially, we revisit and update the analysis conducted by Saulnier (2020), wherein the emphasis lay in quantifying the amount of resources that can be saved by assigning additional competences to the EU. In contrast, using the most recent Eurostat data, we propose a proper 'value added' analysis, aimed at estimating the gains achievable in terms of health outcomes when increasing the role of the EU. Furthermore, we also explore the cost of non-Europe relative to three key actions of the Health Union Package: (1) pharmaceutical strategy and (2) Europe's beating cancer plan.

The pharmaceutical strategy focuses on improving existing EU pharmaceutical legislation across multiple dimensions. This includes the establishment of a single-market for medicines, shortening the time to make new drugs available to patients, addressing shortages of medicines, and promoting innovation and competitiveness. To understand the cost of non-Europe in the case of pharmaceutical products, we run several benchmarking exercises exploiting available data on drugs availability across all Member States, also considering the time required to reach the market in each EU country. As in Saulnier (2020), these exercises are based on the assumption that through benchmarking, EU actions can help single Member States in improving their national performances.

Finally, the Europe's Beating Cancer Plan constitutes a political commitment to reduce cancer mortality in the EU by improving cancer prevention, with more and better screening practices. This implies, on the one hand, to work on individual behaviours (like drinking and smoking) and improving environmental standards, such as air quality. On the other hand, it also implies improving individual health literacy and guaranteeing an equal access to cancer diagnosis and treatment, including cancer medicines. As for the pharmaceutical strategy, we also run benchmarking analysis considering screening and availability of cancer medicines, stressing the link between the Beating Cancer Plan and the pharmaceutical strategy, two key areas of the EU Health Union Package, to define the cost of non-Europe in this area.

2. Measuring potential gains

2.1. Economic efficiency and the production frontier

The measurement of economic efficiency in the production of goods and services by private suppliers (mainly private firms) operating in private markets constitutes a central theme within the economic literature, with several empirical applications spanning many diverse markets and sectors. Building on this approach, in recent decades there has been a growing interest in evaluating the economic efficiency of public production units (such as public schools or hospitals) in the provision of public services, like education or healthcare services. A natural extension of this strand of research has been to evaluate the (overall) efficiency of governments in delivering goods and services to their citizens, as evidenced for instance by the World Economic Forum's report in 2019. In the case of governments, public spending can be considered the input to obtain services (outputs) or to evaluate outcomes (like citizens' health, education or satisfaction with these services).

The standard microeconomic approach to measure economic efficiency is based on the definition of a fully efficient benchmark, the 'production frontier', that can be achieved using inputs (labor and capital) in the most efficient way given the available 'technology' transforming these inputs into outputs. In this framework, an obvious measure of (in)efficiency is the 'distance' between the combination of inputs and outputs that characterize a production unit and the combination of inputs and outputs of an analogous, fully efficient, production unit laying on the frontier. Benchmarking with the more efficient units then provides a measure of the inefficiency of the less perfoming ones. This method, while theoretically easy to understand, necessitates the empirical estimation of a production frontier based on the performance of the most efficient units within a given sample of production units (which can be everything depending on analysis at hand, from single firms to entire countries). Here, the '(in-)efficiency scores' characterizing each MS can be thought of as the costs of a non-Europe option, leaving the current allocation of competences between the Union and the member countries unchanged (the non-Europe option).

The 'production frontier' can be estimated through either parametric or non-parametric benchmarking techniques. The two most widely used in empirical applications are the Stochastic Frontier Analysis (SFA) and the Data Envelopment Analysis (DEA), respectively. When examining the efficiency of large productive units, such as entire nations, researchers commonly favor the utilization of the non-parametric approach using DEA.[1] The primary advantage of DEA lies in its relatively modest reliance on stringent assumptions concerning the production set, although it is important to note that results may exhibit sensitivity to variable selections and data errors (e.g., Kalirajan and Shand 1999). This approach was initially introduced by Farrell (1957) and further refined by Charnes, Cooper, and Rhodes (1978). The initial models were based on the assumption of constant returns to scale. Subsequently, Banker, Charnes, and Cooper (1984) extended the original model to variable returns to scale assumption, which provides insights into the specific nature of returns to scale characterizing the production function.

DEA entails the solution of a linear programming problem with the primary goal of determining the maximum achievable outputs or outcomes for a given set of inputs (referred to as the output-oriented approach) or establishing the minimum input requirements for each production unit to achieve efficiency along the frontier (referred to as the input-oriented approach) (e.g., Daraio and Simar 2007).

[1] The assessment of public spending efficiency in various sectors, including healthcare, through the use of DEA, has been a subject of interest for numerous researchers. Notable contributions in this area include Herrera and Pang (2005), Afonso and St. Aubyn (2005), Sutherland et al. (2007), St. Aubyn et al. (2009), Yauheniya and Müller (2016), and Gavurova et al. (2021).

DEA, the modelling strategy mostly adopted here, has strengths and weaknesses clearly identified in the literature (e.g., Kalirajan and Shand 1999). As for the strengths, a linear programming technique like the DEA does not impose any parametric restriction to the production set, only imposing minimal technical hypothesis required by the microeconomic theory of production. As for the limitations, it is important to recognize that DEA is subject to severe biases in the presence of outliers in the data, which can affect the estimate of the efficient frontier. Hence, the choice of variables to be considered as inputs, outputs and outcomes plays a key role in defining the final estimates of efficiency scores. In addition, differently from other econometric techniques (like the Stochastic Frontier Analysis), it is difficult to directly incorporate in a DEA model other variables which can affect outputs or outcomes. This is clearly an issue for what concerns outcomes like citizens' health, which are affected by more than the outputs provided by the healthcare systems. These variables include, for instance, individual behaviors, private healthcare spending, climate and environmental variables. To account for this issue, throughout the paper, we also provide a second stage analysis informing the readers of the role of these variables in influencing efficiency scores.

2.2. From an input to an output oriented approach

The 'production frontier' approach based on DEA can be exploited to provide a benchmarking analysis of how different EU countries perform with respect to a number of policies. The most simple exercise is to consider public spending as an input to obtain certain outputs, which in turn allow to obtain important outcomes for citizens. In the case of health policy, public spending allows to provide citizens with healthcare services (the outputs) to improve their general level of health (the outcome). According to the current allocation of competences between the EU and the MS (the *status quo*), different MS perform differently and are characterized by different levels of efficiency in transforming inputs into outputs/outcomes. The EU can support Member States (MS) to improve their performance toward best practices in several ways, including the sharing of information, better coordination among countries or with an even more direct role, by assigning larger competences to the EU. This would require 'more EU' with respect to the current allocation of competences.

The estimation of savings that can be achieved with more Europe requires an input-oriented approach. The 'waste rates', computed like in Saulnier et al. (2020), are obtained by estimating the amount of spending that can be saved for a *given* level of output. However, one can think of a different approach to quantify what might be called 'improvement rates' in terms of outputs/outcomes. In this case, that takes an output-oriented approach, more Europe would allow to obtain better output/outcomes for a *given* level of input. This approach measures (in)efficiency for each production unit (MS) by calculating the difference between the observed output (outcome) and the fully efficient output (outcome) represented in the production frontier starting from the *same level of input* (Daraio and Simar 2007).

The application of DEA offers a robust mechanism for appraising and contrasting the 'efficiency'/'effectiveness' of countries in their administration of public services. 'Efficiency' is connected to the relationship between inputs and outputs, whereas 'effectiveness' reflects the relationship between inputs and outcomes. According to the literature[2], a macro-analysis of healthcare systems can be based on the following assumptions concerning the production function of countries: a fully efficient country spends public monies (the input) to obtain the maximum achievable amount of hospitals or primary care services (the outputs) which in turn are useful to obtain the maximum achievable level of health for citizens (the outcome), given individual behaviors and all the other factors that can have an impact on health.

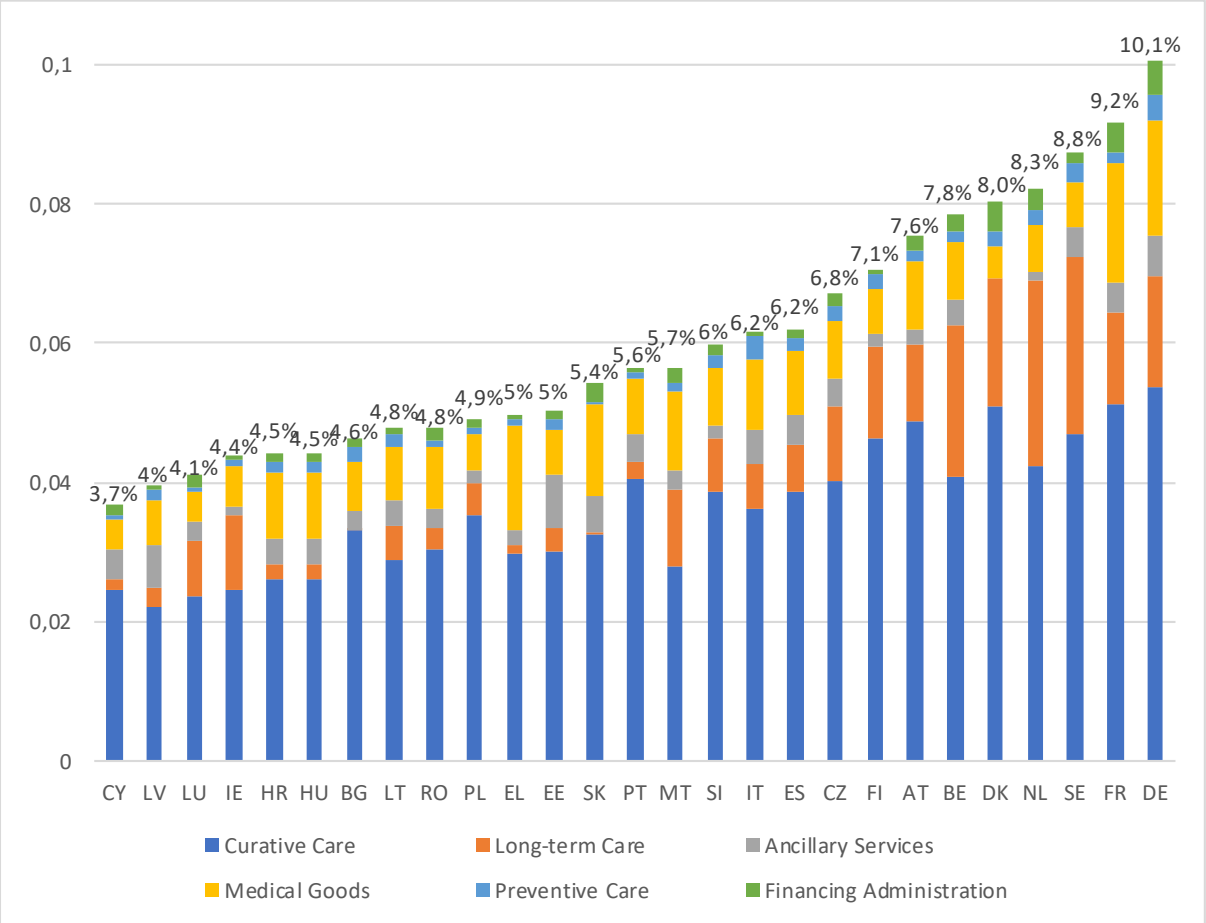
A crucial step of the analysis is the choice of input, output and outcome variables. Moreover, recognizing that efficiency scores derived through DEA models may be influenced by factors

[2] See, for instance, Greene (2004), Kumbhakar (2010), Piacenza and Turati (2014).

beyond those explicitly incorporated within the designated input, output, and outcome variables, we conduct second-stage regression analysis to explore the determinants of these efficiency scores.

In line with established practice within the literature employing DEA models to evaluate public sector efficiency, we choose to adopt public spending levels as our input variable.[3] Figures 2.1 and 2.2 provide data on public expenditures on healthcare in purchasing power standards (PPS) as a percentange of GDP: Figure 2.1 illustrates the composition and the level of spending in 2019 for each MS, while Figure 2.2 displays the trend in healthcare expenditure for various functions throughout the analyzed period from 2013 to 2019. We decided not to use data relative to the year 2020, although they are available, to avoid the disruptions caused by the COVID-19 pandemics.

Figure 2.1: Public Health spending (% GDP) by function, year 2019



Source: Eurostat

Figure 2.1 shows that different MS are characterized by different healthcare systems: Germany and France, display the highest spending (10% and 9% of GDP respectively). On the contrary, countries such as Cyprus and Ireland, spend less than half in terms of GDP for their healthcare systems. These differences in the level of spending persist even if we look at the composition of spending for most categories.

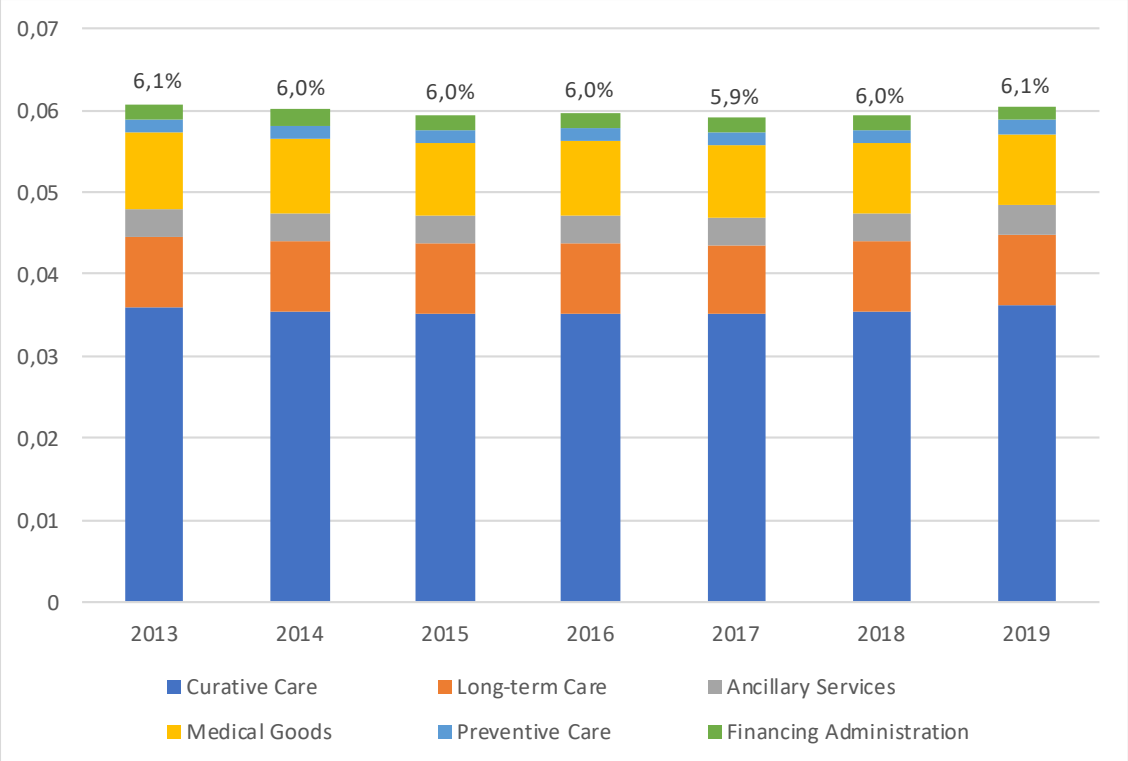
In relative terms, from Figure 2.2, it is clear that healthcare spending is largely dominated by *curative care* in all countries. However, we do observe, for instance, that countries like Belgium, Denmark, the

[3] See, for instance, Afonso, Schuknecht and Tanzi (2005), Herrera and Pang (2005), Afonso and St. Aubyn (2005), Sutherland et al. (2007), Afonso and Kasemi (2017).

Netherlands, and Sweden spend relatively more than other countries for *long-term care*, an item which is expected to raise in several countries due to population ageing.

Given the interest in understanding how the EU can improve health care provision, we focus here on *four* specific outputs (number of discharges, unmet needs, medical technologies, vaccinations) and *five* outcomes (healthy life years, life expectancy, overall mortality, mortality due to infectious diseases and cancer related mortality). Outputs include both the quality and the quantity of services offered by healthcare facilities, while outcomes reflect the overall health status of the population, which can clearly be influenced by many other factors (including health behaviors, education levels, the age distribution of the population, but also environmental factors like the concentration of pollutants in the area where citizens live). Some of the outputs and outcomes exhibit an inverse relationship between their values and performance. To address this issue, we transform variables in order to have higher values which are indicative of heightened performance.

Figure 2.2: Public Health spending (% GDP) by function, average values across MS from 2013 to 2019



Source: Eurostat

The measure of dispersion suggests the presence of significant variability among output variables. For instance, the number of hospital discharges varies substantially, ranging from approximately 97 (per 1,000 inhabitants) in the Netherlands to 301 in Bulgaria, highlighting again the considerable diversity in healthcare system organization across MS. One possible explanation for this diversity is that higher hospital discharges are associated to less available primary care services, which are now considered more appropriate for chronic patients (hence, better for their health). Notably, despite having the highest number of discharges, Bulgaria is associated with the lowest life expectancy (less than 75 years), 8 years less than that of Spain or Italy.

Similarly, when examining the percentage of individuals aged 65 years or above who are vaccinated, two MS, Estonia and Latvia, stand out with notably lower values compared to their counterparts. Furthermore, Latvia, in particular, ranks among the nations with the highest incidence of deaths

related to infectious diseases per 1,000 inhabitants. It is worth noting that this variable displays the most substantial coefficient of variation among outcomes, with the number of deaths varying from 0.05 in Finland and Poland to 0.33 in Greece.

Starting from these variables, we define two variant model configurations: one in which each intermediate output is expressed as a function of a single input, and a second one where each outcome is characterized as a function of a single input factor[4]:

Model for Outputs: $output = f(input)$ (2.1)

Model for Outcomes: $outcome = f(input)$ (2.2)

We employ DEA models specifically based on the Variable Returns to Scale (VRS) specification introduced by Banker, Charnes, and Cooper (1984). This VRS specification allows us to determine the type of returns to scale characterizing the production function for each MS. The models yield efficiency scores for each MS, ranging from 0 to 1, with a score of 1 indicating a fully efficient MS, that can then be taken as a benchmark. Efficiency scores are derived for each time period by MS. To enhance the robustness of our estimations, potential outliers that might have distort the results are systematically excluded.

2.3. Overall public healthcare spending: Data and model estimations

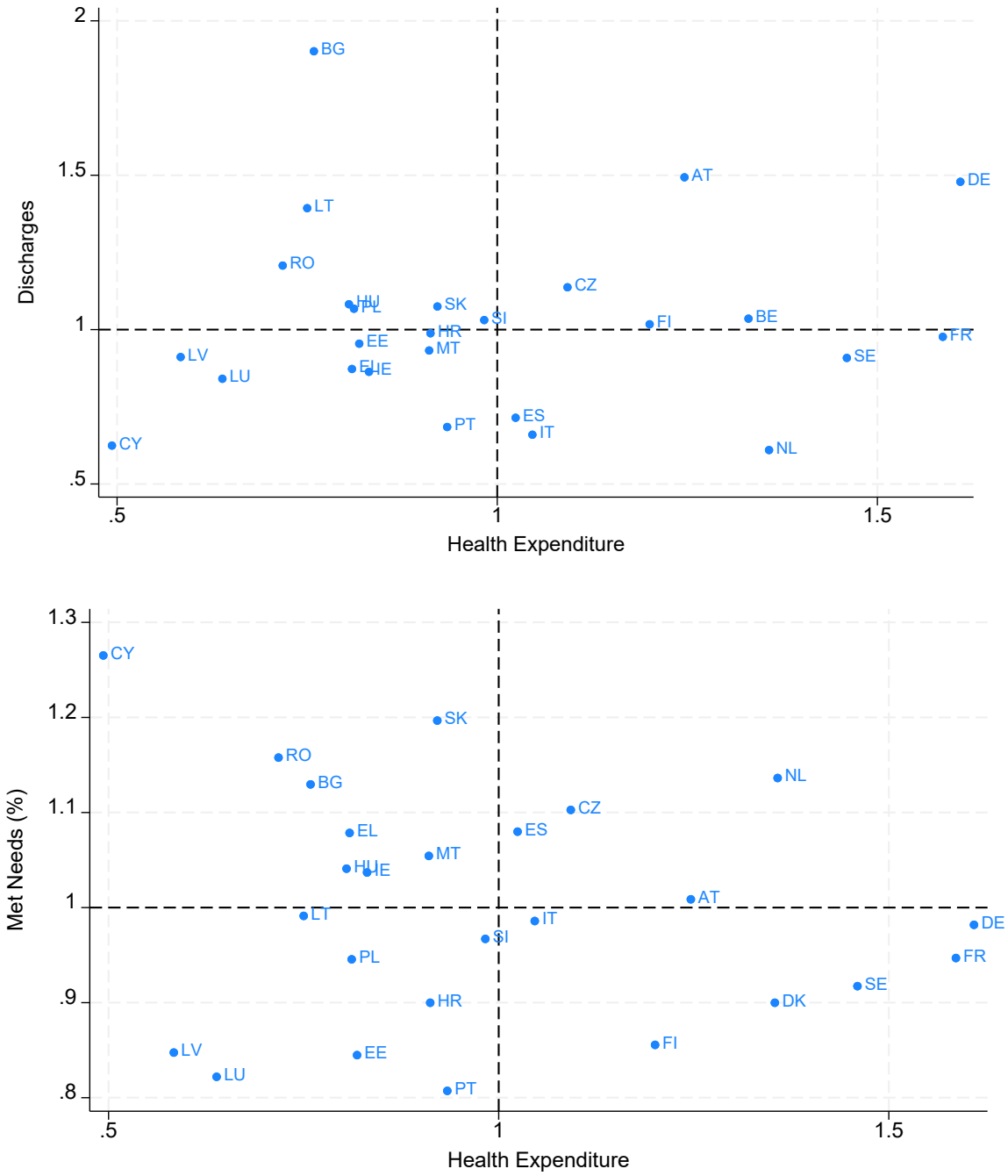
In the first step of our analysis, we employ the total public healthcare expenditure denominated in Purchasing Power Standards (PPS) and expressed as a percentage of Gross Domestic Product (GDP), as the input variable, herein referred to as 'pub. HE'. To estimate MS efficiency, we define four DEA models considering two different output and two different outcome variables:

- Output 1: Annual Hospital Discharges per 1,000 Inhabitants ('discharges');
- Output 2: The Percentage of Self-reported Met Needs for the year 2019 (computed from self-reported unmet needs and referred to as 'Met-Needs');
- Outcome 1: Healthy Life Years (abbreviated as 'HLY');
- Outcome 2: Life Expectancy (abbreviated as 'LE').

We investigate the relationship between input and output variables using two models: Model-Output 1 [*discharges=f(pub. HE)*], Model-Output 2 [*Met-needs=f(pub. HE)*]. Then, we explore the interplay between our input and outcome variables through two additional models: Model-Outcome 1 [*HLY=f(pub. HE)*], Model-Outcome 2 [*LE=f(pub. HE)*]. These models will provide a detailed evaluation of the efficiency levels of MS in utilizing healthcare resources to achieve desired healthcare outputs and outcomes.

[4] As DEA is a linear programming technique the function f(.) has to be intended as a linear combination of input and output/outcome describing the production set and the production frontier.

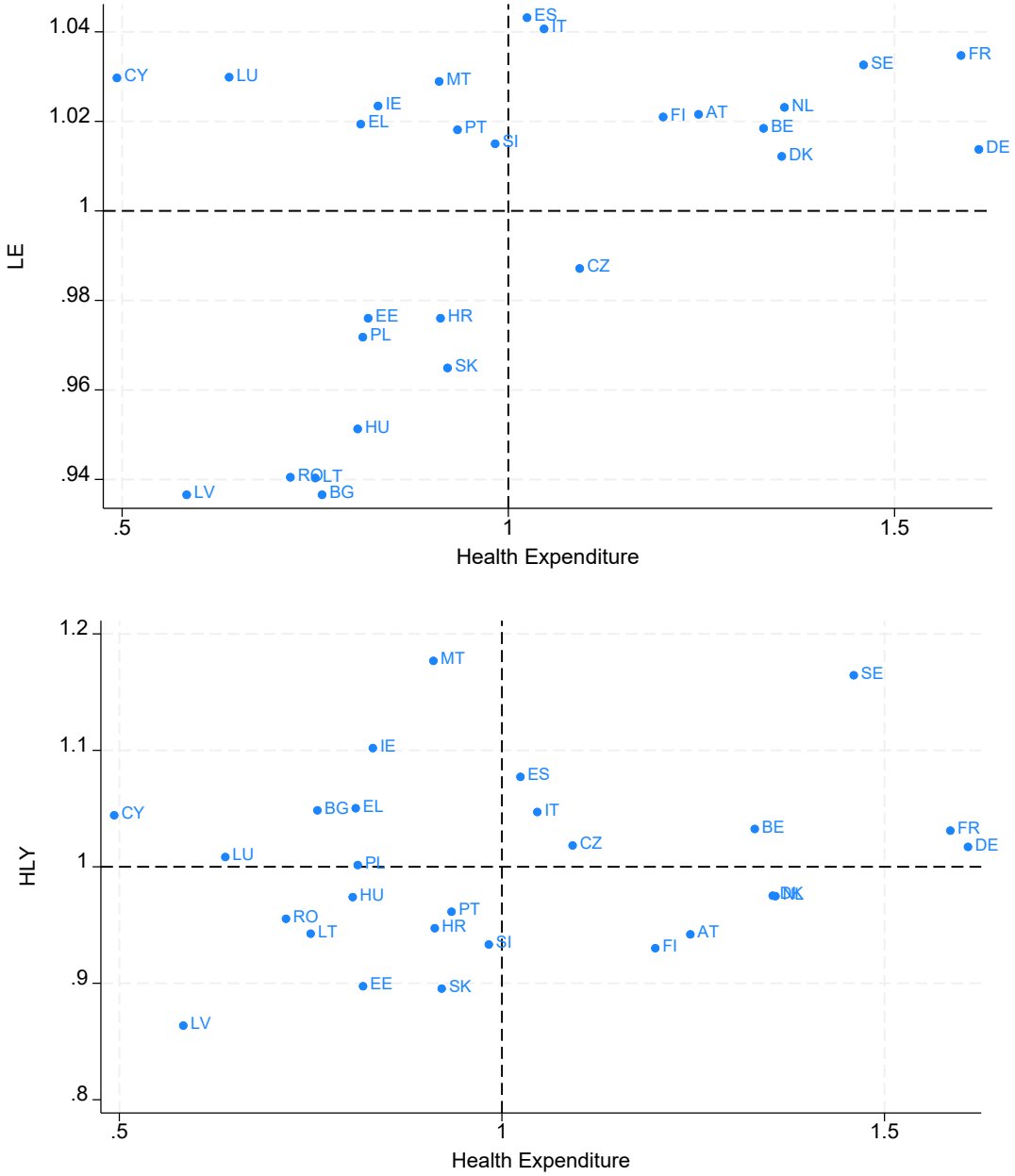
Figure 2.3: Outputs and public health spending



Variables are reported for each MS as the ratio between national and average EU level. The horizontal line 1 represents the average EU level of output indicator, while the vertical line 1 represents the average EU level of health expenditure. Source: Eurostat

Figures 2.3 and 2.4 provide a first visual insight into our data and help identifying graphically the production frontier. Scatter plots show input (public healthcare spending PPS as % GDP) against output and outcome variables measured as the average value over our predefined time period. These variables are determined as the ratio between the respective national level for each MS and the average levels within EU. Hence, countries represented in the upper right quadrant are those spending more and realizing a higher output/outcome level than the EU average. Correspondingly,

Figure 2.4: Outcomes and public health spending



Variables are reported for each MS as the ratio between national and average EU level. The horizontal line 1 represents the average EU level of output indicator, while the vertical line 1 represents the average EU level of health expenditure. Source: Eurostat.

those in the lower left quadrant are those spending less and realizing a lower output/outcome level than the EU average.

The general message conveyed by these charts is that MS are distributed across all the four quadrants. This dispersion implies that certain MS invest more than the average in spending while achieving output or outcome levels below the average, whereas others invest less than the average but attain output or outcome levels exceeding the average values. This distribution underlines the differences in healthcare system performance across different MS and, despite recognising the importance of other factors that might also influence outputs and outcomes besides resources, they likely indicate the presence of organizational 'inefficiencies'.

When examining Figure 2.3, it becomes also evident that there are outliers worth noting. In particular, within the first graph that considers the association between public health spending and the number of discharges, Bulgaria stands out due to a notably higher number of discharges compared to other MS. Similarly, in the second graph, Cyprus exhibits a considerably high percentage of met needs despite having the lowest level of public health spending among all MS. Given that results generated by Data Envelopment Analysis (DEA) are particularly susceptible to the selection of variables, we decided to exclude Bulgaria from Model-Output 1 and Cyprus from Model-Output 2, as a measure to mitigate the impact of these outliers on the robustness of our analyses.

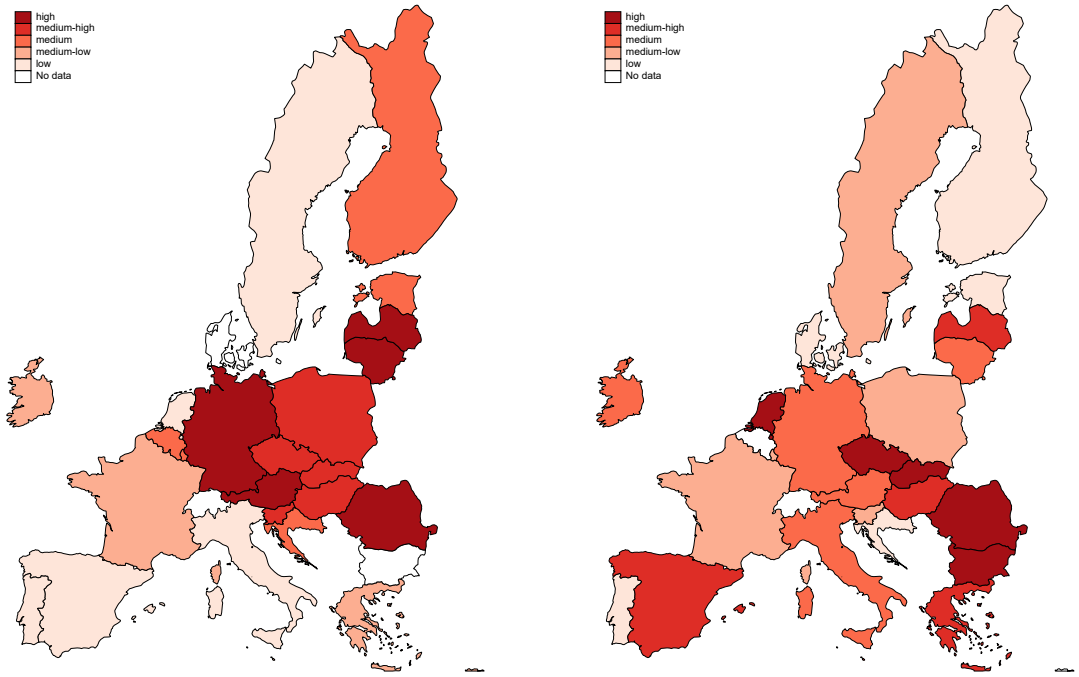
We estimate DEA scores separately for each year between 2013 and 2019, and then we calculate average efficiency scores for each MS across all years in the sample. Table 2.1 provides the average efficiency scores for each model for the EU-27. Figures 2.5 and 2.6 offer a visual representation of efficiency scores for each MS.

Table 2.1: Efficiency scores for the EU-27 (aggregate spending)

Output variables		Outcome variables	
Discharges	Met needs	Healthy life years	Life expectancy
0.68	0.84	0.85	0.95

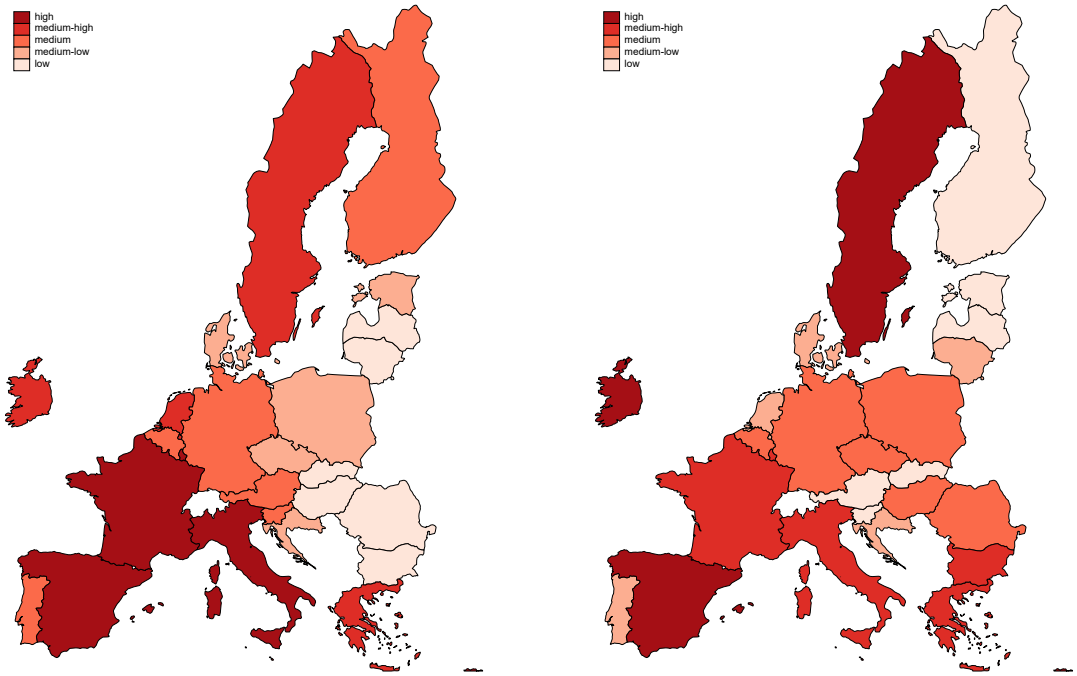
Source: Estimated by authors using 2019 data from Eurostat.

Figure 2.5: Efficiency estimations, Model-Output 1 (discharges) and 2 (Met-Needs)



Source: own estimates on Eurostat data.

Figure 2.6: Efficiency estimations, Model-Outcome 1 (HLY) and 2 (LE)



Source: own estimates on Eurostat data.

These findings show that the *efficiency* of healthcare systems exhibits significant variability, a phenomenon more pronounced than the disparities in their overall *effectiveness*. Once more, this initial finding provides compelling evidence that outputs (healthcare services) are only one of the factors influencing health outcomes. Thus, it becomes crucial to undertake a second-stage analysis in this context.

Notably, when considering discharges as output, efficiency scores are lower on average than when met-needs are employed as an alternative output measure (0.68 vs 0.84). This contrast implies that, on average, there is a potential for a 32% expansion in hospital discharges while maintaining the same level of expenditure, as opposed to a 16% expansion achievable when met-needs are considered as the primary output metric.

Moreover, higher average scores are observed for outcomes, although those obtained using Life Expectancy are higher than those obtained using Healthy Life Years as outcomes. In addition, the graphical representation of efficiency scores reveals that some healthcare systems that exhibit pronounced efficiency in terms of outcomes are relatively ineffective when it comes to outputs. Again, this observation aligns with expectations, as the effectiveness of healthcare services may depend on different factors, including the health behaviors within the population.

This interpretation is further reinforced by Table 2.2, which reports the correlation among country rankings resulting from the four DEA models under consideration. First, scores from the two output models are less correlated than scores from the two outcome models: efficiency rankings from considering discharges and met needs are less similar than rankings obtained from considering life expectancy and healthy life years (0.36 vs 0.70). Second, cross-correlations between output and outcome models never exceed 0.5: the highest correlation observed is between scores obtained from considering met needs as output and healthy life years as an outcome (0.32). As emphasized in the introduction, a simple explanation for these results is that outcomes are influenced by several factors extending beyond the realm of healthcare services, like individual behaviors. These additional factors may influence the positive impact that could otherwise result from the increased availability of services.

Table 2.2: Rank correlations between input-output and input-outcome models

		Input-output 1	Input-output 2	Input-outcome 1	Input-outcome 2
		Discharges	Met needs	Healthy life years	Life expectancy
Input-output 1	Discharges	1.0000			
Input-output 2	Met needs	0.3622	1.0000		
Input-outcome 1	Healthy life years	0.0679	0.3208	1.0000	
Input-outcome 2	Life expectancy	0.0249	0.0981	0.6984	1.0000

Source: Estimated by authors using 2019 data from Eurostat. The input measure is public healthcare spending.

This is the reason why we perform a second stage regression to study the determinants of yearly efficiency scores computed from the Input-Outcome Model 1 and 2. Given the bounded nature of our data, with a dependent variable that ranges from 0 to 1, we opt for a logit transformation within a linear regression framework to address issues related to heteroscedasticity. Specifically, starting from the efficiency scores , we consider the natural logarithm of $\frac{EFF}{1-EFF}$. The regression model is then specified as follows:

$$\ln \frac{EFF_{it}}{1-EFF_{it}} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 \sum MS_i + \alpha_3 \sum Y_t + e_{it} \qquad (2.3)$$

where '*i*' represents the MS, '*t*' denotes the respective year, '*MS*' incorporates fixed effects specific to individual MS, and '*Y*' accounts for the fixed effects associated with the year. Additionally, we have

integrated control variables *'X'*, encompassing metrics reflecting population health behavior, educational levels, age distribution, private healthcare investment, and GDP. Detailed information regarding these regressors, along with the outcomes of the regression analysis, can be found in Table 2.3.

Findings from the second-stage analysis reported in Table 2.3 reveal a clear pattern: the efficiency in delivering outcomes is negatively influenced by unhealthy behaviors among the population. In particular, when HLY serves as the outcome variable, there is a statistically significant reduction in efficiency scores associated with an increase in the percentage of individuals engaged in daily alcohol consumption, as well as an increase in the percentage of individuals classified as obese or pre-obese.

Furthermore, it is worth highlighting that an increased share of household out-of-pocket healthcare spending over total healthcare expenditure is positively associated with enhanced efficiency in achieving outcomes through public health expenditure.

Still, from this initial analysis it is evident that there exists substantial room for enhancing efficiency, particularly concerning the expansion of outputs while maintaining inputs at a constant level. Moreover, when we compare these findings with the efficiency scores derived from an input-oriented approach (as presented in Saulnier 2020, Chapter 4), it becomes apparent that the average efficiency level is lower when adopting an output-oriented perspective, as opposed to an input-oriented one. However, the correlation across scores obtained from input-oriented and output-oriented models is positive, though not particularly high. Considering together the average level of efficiency and the correlation across scores, we can conclude that the two analyses yield substantially coherent rankings but the room for improvement is larger in the case of the potential expansion of outputs than in the case of the potential reduction of budgetary wastes.

Could an enlarged EU role fully restore or at least improve efficiency in the delivery of better health outputs/outcomes? Providing an answer to this question at this very general level of analysis is difficult, albeit one should recognize that the current role of the EU in promoting healthier behaviour is important in influencing country performance. However, especially when considering Input-Output models, it is noteworthy that in the majority of MS, the production function exhibits 'increasing returns to scale.'[5] This suggests that operating on a larger scale (an option that would be allowed by the EU, especially for smaller countries) has the potential to enhance the efficiency in the provision of these services. This may be very important for some specific sub-function within the healthcare sector.

Table 2.3: Second stage regressions of models Input-Outcome 1 (Healthy life years) and Input-Outcome 2 (Life expectancy)

	Input-Outcome 1 (Healthy life years)	Input- Outcome 2 (Life expectancy)
Smoking	0.0211	-0.0658
	(0.112014)	(0.056544)
Daily alcohol intake	-0.9202***	0.1222
	(0.317161)	(0.219940)
Education	-0.4908*	-0.1330

[5] This result is consistent with findings in Saulnier (2020).

	Input-Outcome 1 (Healthy life years)	Input- Outcome 2 (Life expectancy)
	(0.273446)	(0.101492)
pop_y70	-3.7262	1.3240
	(9.809227)	(4.727923)
TOT_hous	3.9328*	2.5967**
	(2.206202)	(1.259616)
TOT_vol	7.7867*	1.1326
	(4.549156)	(3.208854)
Gdp	-1.7221	-0.1978
	(1.095936)	(0.432948)
Constant	52.3173*	12.3468
	(28.190399)	(10.479142)

Note: The regressions include MS and Year fixed effects.

2.4. The 'procurement' and the 'preventive care' functions

After assessing the efficiency of MS in delivering healthcare services taking a comprehensive view with the overall public spending, this section focuses on two specific functions: the 'procurement' of medical goods and 'preventive care.' The focus on these two functions is justified by the salience of economies of scale and spatial spillovers in these specific domains, which is well documented in the literature (see, also, Saulnier 2020). Consequently, the reallocation of competencies at the EU level in these domains could yield notable efficiency improvements.[6] Unsurprisingly, these functions are also closely related to the analysis of the subsequent sections, where we provide a more detailed examination of three of the four key actions characterizing the Health Union Package.

The procurement function represents a substantial portion of the total public healthcare expenditure, covering 15.3% of the overall healthcare budget from 2013 to 2019. Conversely, spending on preventive care is a minor spending category, accounting for just 2.6% of the total public healthcare expenditure.[7]

[6] The importance of scale economies in procurement is discussed, e.g., in Bandiera et al. (2019) and Baldi and Vannoni (2017). To gain an understanding of the role of spatial spillovers in the domain of preventive-care, see Fu et al. (2023).

[7] It comes as no surprise, then, that the percentage in 2020 (i.e following the advent of the COVID-19 pandemic) for preventive care experiences a notable increase, reaching a value above 3%.

We consider first the *procurement* function. In the analysis we employ public procurement spending as a percentage of the total public current health expenditure ('Proc HE %') as the sole input variable. For our output variables, we utilize the 'MT' variable, as defined in Table 2.1, representing medical technology per 100,000 inhabitants. Finally, as outcome variables, we have selected three key measures:

1. The Healthy Life Years ('*HLY*')
2. The inverse ratio of overall deaths per 1,000 inhabitants ('*1/OM*').
3. The inverse ratio of cancer-related deaths per 1,000 inhabitants ('*1/CM*').[8]

We define four DEA models: Procurement-Output 1 [*MT=f(Proc HE %)*], Procurement-Outcome 1 [*HLY=f(Proc HE %)*], Procurement-Outcome 2 [*1/OM=f(Proc HE %)*], Procurement-Outcome 3 [*1/CM=f(Proc HE %)*]. We run DEA models for each MS each year, that we average over the entire sample period. Table 2.4 provides the average EU-27 efficiency scores across the analyzed time period for each model. Additionally, Figure 2.7 offers a visual representation of these efficiency scores.

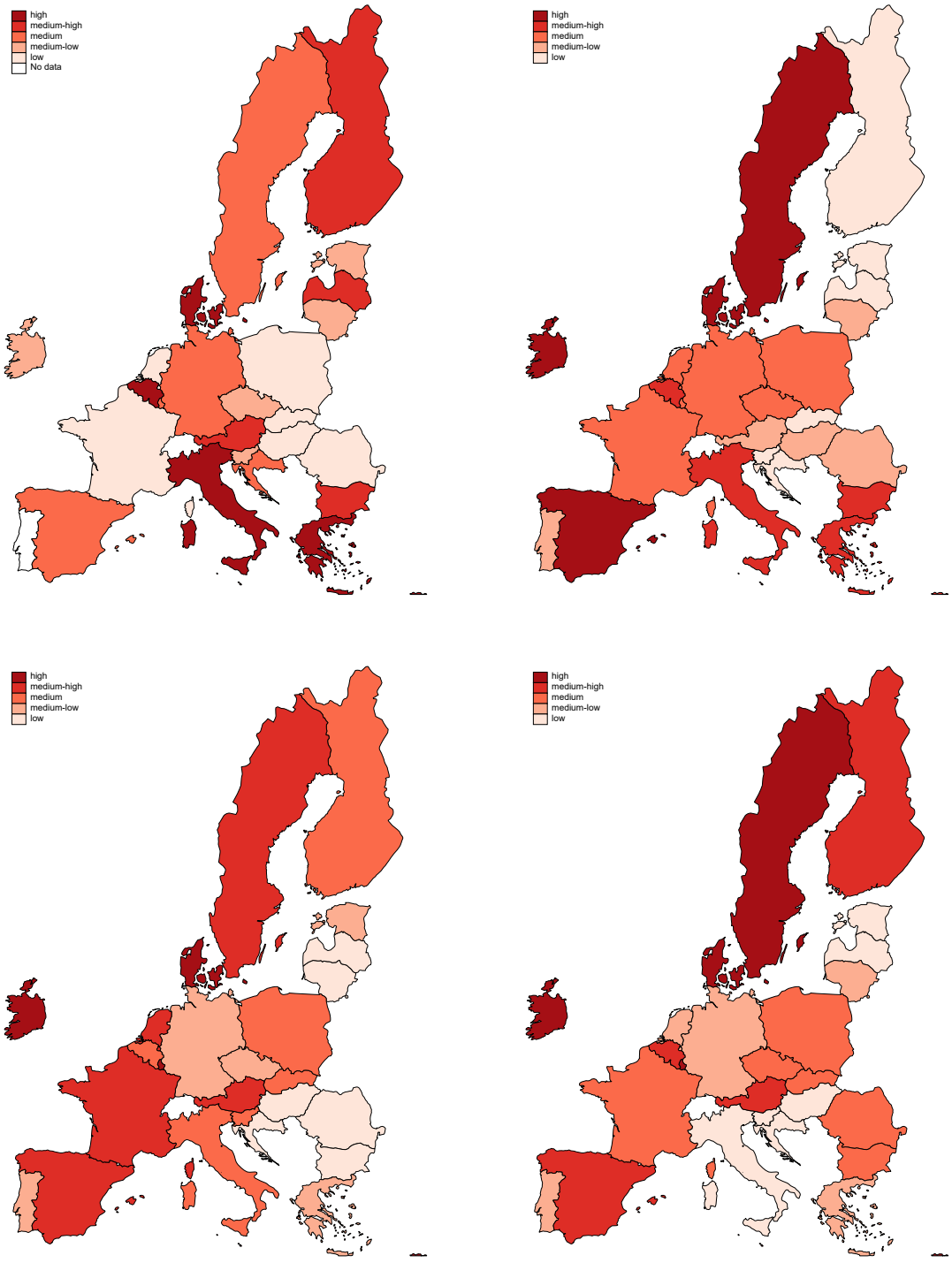
Table 2.4: Efficiency scores for the EU-27 (procurement spending)

Output variables	Outcome variables		
Medical technologies per 100 000 inhabitants	Healthy life years	Inverse ratio of overall deaths per 1 000 inhabitants	Inverse ratio of cancer-related deaths per 1 000 inhabitants
0.51	**0.85**	**0.63**	**0.59**

Source: Estimated by authors using 2019 data from Eurostat.

[8] Given that cancer-related deaths are a leading cause of mortality in the EU, it is reasonable to assume that a substantial proportion of pharmaceutical products are employed in the management of cancer-related diseases.

Figure 2.7: Efficiency estimations, Models Procurement-Output 1 (MT), Procurement-Outcome 1 (HLY), Procurement-Outcome 2 (1/OM) and Procurement-Outcome 3 (1/CM)



Source: own estimates on Eurostat data.

Table 2.4 and Figure 2.7 suggest several interesting observations. First and foremost, it becomes apparent that, in general, the efficiency levels of healthcare systems appears to be lower when the input variable is the share of public procurement in total public health expenditure rather than total public health expenditure.

Second, the coefficient of variation suggests that variability of scores is generally higher in the case of models referring to public procurement, as opposed to models employing total public health expenditure as an input.

Third, ranking correlation results presented in Table 2.5 reveal a positive correlation in rankings across models, suggesting that countries perfoming better in one model are those generally performing better in all the others. However, the size of this positive correlation varies considerably. It is worth noting that models Procurement-Outcome 2 and 3 exhibit a particularly high degree of correlation in terms of ranking, suggesting that cancer-related deaths have a significant influence on total mortality. Indeed, in 2020, cancer was the second leading cause of death in the EU, accounting for 23% of the total number of deaths (Eurostat, 2023).[9]

Table 2.5: Rank correlations between input-output and input-outcome models

		Procurement-output 1	Procurement -outcome 1	Procurement -outcome 2	Procurement -outcome 3
		Medical technologies per 100 000 inhabitants	Healthy life years	Inverse ratio of overall deaths per 1 000 inhabitants	Inverse ratio of cancer-related deaths per 1 000 inhabitants
Procurement-output 1	Medical technologies per 100 000 inhabitants	1.0000			
Procurement -outcome 1	Healthy life years	0.3622	1.0000		
Procurement -outcome 2	Inverse ratio of overall deaths per 1 000 inhabitants	0.0679	0.3208	1.0000	
Procurement -outcome 3	Inverse ratio of cancer-related deaths per 1 000 inhabitants	0.0249	0.0981	0.6984	1.0000

Source: Estimated by authors using 2019 data from Eurostat. The input measure is procurement spending.

The Procurement-Output model is helpful in evaluating how efficient the different MS are in the acquisition of medical equipment, encompassing devices such as Computed Tomography Scanners ('CT scanners'), Magnetic Resonance Imaging Units ('MRI'), Gamma cameras, PET scanners, and Mammographs, equipments which are used in the screening of several diseases, notably including cancer. One might wonder whether efficiency in procurement really translates into efficiency in the use of these equipments within hospital and medical centers to perform screening and examinations. To discuss this issue, we propose three distinct ad-hoc Procurement-Output models. In these models, the 'Proc HE %' variable will serve as our input, while the respective output variables are represented by the number of CT scanners, MRI and PET scanners per 100,000 inhabitants. After obtaining efficiency scores, we then analyze whether scores derived from the three models are

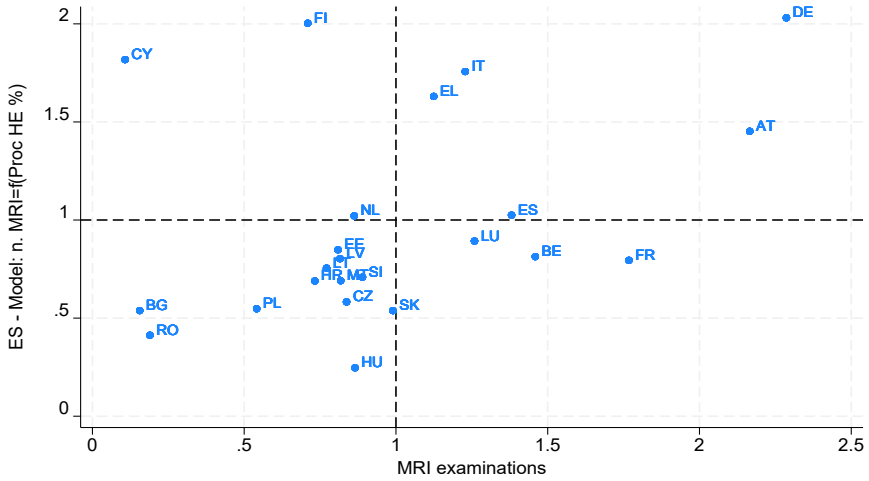
[9] When using HLY as the outcome variable, we might anticipate that efficiency scores are influenced by factors unrelated to healthcare provision. Nevertheless, when we conduct a second-stage regression using the same variables as in Equation 2.3, the results remain largely consistent and do not exhibit significant changes.

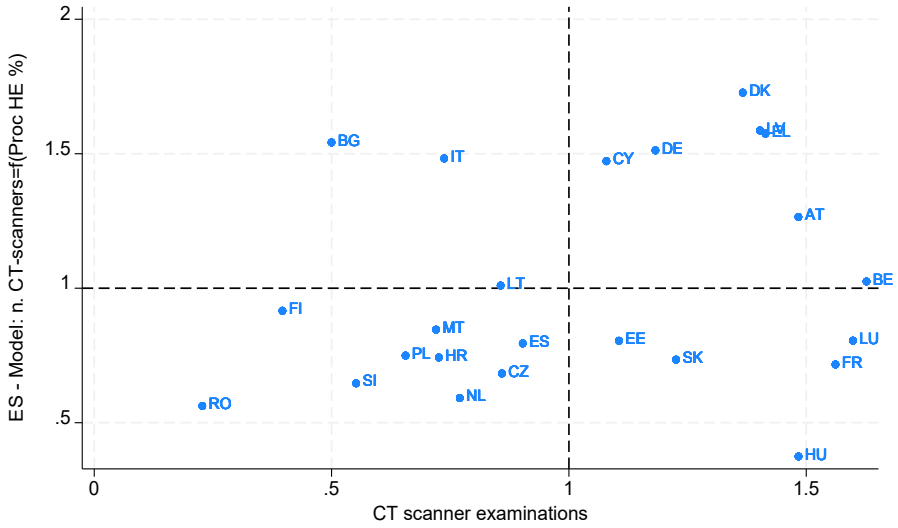
respectively correlated with the number of examinations by CT scanners, MRI, and PET Scanners per 100,000 inhabitants.[10]

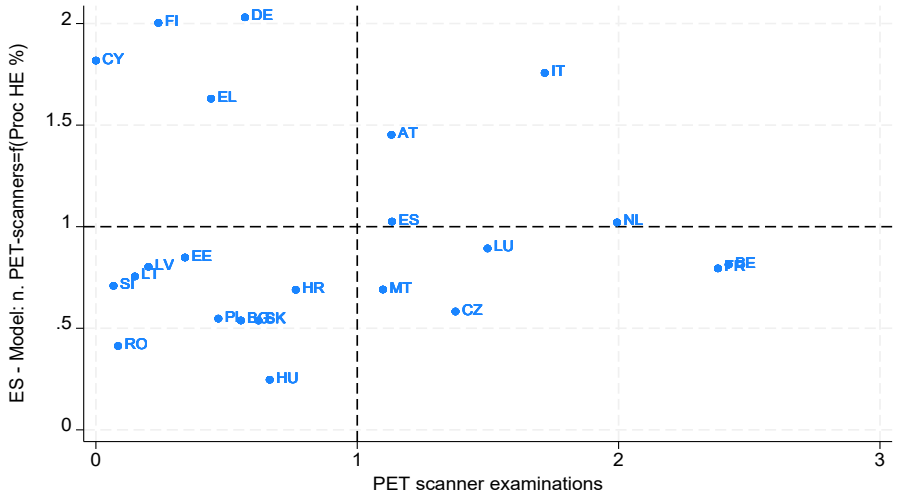
Figure 2.8 presents the average results over the years 2013-2019 in three different panels, one for each technology (CT scanner, MRI, and PET scanners), with all variables standardized by calculating the ratio between the corresponding national levels for each MS and the average levels within the EU. It is clear from the three panels in Figure 2.8 that efficiency scores are positively correlated with the number of imaging tests. However, there are notable exceptions to the trend. For instance, in the last figure, one can see that countries like France and Germany demonstrate notable efficiency in the acquisition of PET scanners, despite their relatively lower utilization rates for imaging studies when compared to the EU average. In other words, there is likely excess productive capacity in this sector in some EU countries that are very efficient in buying equipments but much less so in using these equipments.

[10] CT scans provide more detail than X-rays and are used to diagnose cancer, heart disease, trauma injuries, and musculoskeletal disorders. MRIs diagnose a range of conditions, such as torn ligaments and tumors, offering distinct information from CT scans. While MRIs are more time-consuming and expensive, they do not expose you to radiation. PET scans are employed for diagnosing cancer, heart disease, and certain brain disorders, emphasizing functional information and detecting abnormal cellular activity, in contrast to the structural focus of CT and MRI scans (Mallinckrodt Institute of Radiology website, February 2017).

Figure 2.8: Efficiency Scores and numbers of CT scanner, MRI and PET scanner examinations



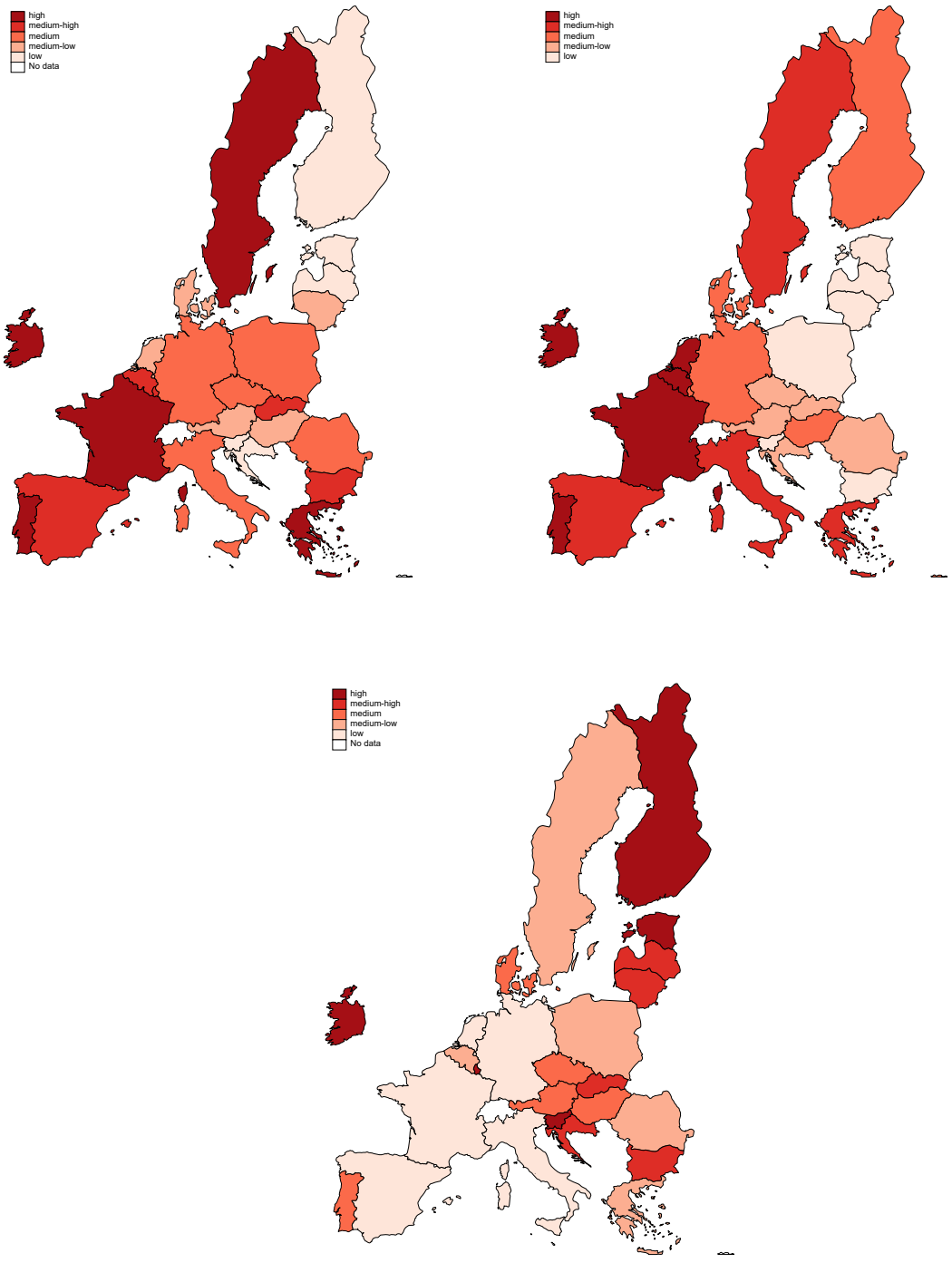




Variables are reported for each MS as the ratio between national and average EU level. The horizontal line 1 represents the average EU level of Efficiency Scores indicator, while the vertical line 1 represents the average EU level of medical technology. Source: Eurostat.

We now turn to the examination of the *prevention* function. In this context, we define DEA models utilizing the percentage of public preventive care spending out of total public current health expenditure ('Prev HE %') as the input variable. The main output variable is the percentage of individuals aged over 65 years who have received flu vaccinations ('% vacc.'); additionally, we employ two outcome variables: 'HLY' and the inverse ratio of deaths attributed to infectious diseases

Figure 2.9: Efficiency estimations, Models Prevention-Output 1 (% vacc.), Prevention-Outcome 1 (HLY), Prevention-Outcome 2 (1/IM) and Procurement-Outcome 3 (1/CM)



Source: own estimates on Eurostat data.

per 1,000 inhabitants ('1/IM').[11] These three DEA models can be written as follows: Prevention-Output 1 [*% vacc. = f(Prev HE %)*], Prevention-Outcome 1 [*HLY = f(Prev HE %)*], and Prevention-Outcome 2 [*1/IM = f(Prev HE %)*].

Table 2.6 presents the average efficiency scores across the analyzed time period for each MS and for each of the aforementioned DEA models. Furthermore, Figure 2.9 provides visual representations of the efficiency scores.[12]

Table 2.6: Efficiency scores for the EU-27 (prevention spending)

Prevention-output 1	Prevention-outcome 1	Prevention-outcome 2
Percentage of 65+ people who have received vaccination	Healthy life years	Inverse ratio of deaths attributed to infectious diseases per 1 000 inhabitants
0.52	0.87	0.12

Source: Estimated by authors using 2019 data from Eurostat.

From Table 2.6, it becomes evident that, with the exception of the Prevention-Outcome 1 model, the levels of efficiency across MS are considerably lower than those derived from the previous analyses. This observation is further emphasised by the final graph in Figure 2.9, where it is apparent that, during the years 2013-2019, the majority of EU countries operated with significant inefficiency in responding to the threat of infectious diseases. This finding stems from the presence of few small countries performing relatively well in combating infectious diseases, taking spending constant, and most of the countries showing very low scores.

Furthermore, the figure also highlights the presence of heterogeneity across models with respect to country rankings, as shown by the correlation matrix presented in Table 2.7. Specifically, we observe that the Prevention-Outcome 2 model exhibits a negative correlation with the Prevention-Output 1 model and demonstrates almost no correlation with the Prevention-Outcome 1 model in terms of country rankings. Notably, the only two models displaying a positive and significant correlation are Prevention-Output 1 and Prevention-Outcome 1.[13] Country efficiency in flu vaccinations seems to be related to effectiveness in 'producing' healthy life years, likely because the elderly (ages 65 years and more) are more likely to seek preventive health services such as vaccinations. On the contrary, effectiveness in 'producing' a decrease in mortality related to infectious diseases is unrelated to both efficiency in flu vaccinations and effectiveness in delivering HLY, suggesting that combating infectious diseases (like AIDS/HIV, viral hepatitis and tuberculosis) possibly requires different processes from simple flu vaccinations.

[11] Eurostat classifies infectious diseases to include, among others, tuberculosis, viral hepatitis, sequelae of viral hepatitis, chronic viral hepatitis B and C, and human immunodeficiency virus (HIV) disease.

[12] Two countries, namely Cyprus and Luxembourg, exhibit notably lower levels of preventive care spending in comparison to the remaining MS. Since DEA is very sensitive to the presence of outliers, we decided to exclude these countries when conducting our benchmarking analysis.

[13] When using HLY as the outcome variable, we might anticipate that efficiency scores are influenced by factors unrelated to healthcare provision. Nevertheless, when we conduct a second-stage regression using the same variables as in Equation 2.3, the results remain largely consistent and do not exhibit significant changes.

Table 2.7: Rank correlations between input-output and input-outcome models

		Prevention-output 1	Prevention-outcome 1	Prevention-outcome 2
		Percentage of 65+ people who have received vaccination	Healthy life years	Inverse ratio of deaths attributed to infectious diseases per 1 000 inhabitants
Prevention-output 1	Percentage of 65+ people who have received vaccination	1.0000		
Prevention-outcome 1	Healthy life years	0.3676	1.0000	
Prevention-outcome 2	Inverse ratio of deaths attributed to infectious diseases per 1 000 inhabitants	-0.0949	0.0379	1.0000

Source: Estimated by authors using 2019 data from Eurostat. The input measure is preventive care spending.

2.5. Discussion of results and EU policy option

Our findings align with Saulnier (2020), suggesting that the primary sources of inefficiency within the healthcare sector are associated with the procurement and preventive care functions. Concerning the former, our analysis reveals a substantial potential for efficiency improvement, reaching up to 37% on average when utilizing the inverse ratio of overall mortality as the outcome variable, and up to 41% on average when focusing on cancer-related mortality. To put it differently, translating these numbers in outcomes, addressing the inefficiencies in the healthcare sector could potentially result in a reduction of approximately 1.8 million annual deaths when considering as outcome the total number of annual deaths, and a decrease of approximately 516,000 deaths specifically in the context of cancer-related mortality (see Table 2.8).

Table 2.8 displays the potential reduction in both overall and cancer-specific mortality rates, categorized by each MS, considering the annual averages for the period from 2013 to 2019. Examining Table 2.8, it becomes evident that certain MS exhibit a greater potential for efficiency enhancements. Notably, these MS tend to be smaller in size compared to their counterparts. It is important to acknowledge that a larger role for the EU in terms of procurement competences does not guarantee a complete restoration of efficiency. Nevertheless, the DEA models we have applied indicate that, in the majority of MS, their production functions display increasing returns to scale. Thus, simply optimizing the scale may enable the recovery of a substantial portion of the efficiency losses. To put it differently, the EU can help MS to move toward the efficient production frontier.

Table 2.8: Efficiency Improvement Potential – Procurement function (Total and Cancer Deaths)

Country	Total Deaths (in thousands)	Cancer Deaths (in thousands)	Efficiency Improvement Potential (Model Procurement-Outcome 2)	Efficiency Improvement Potential (Model Procurement-Outcome 3)	Potential Deaths Averted (in thousands)	Potential Cancer Deaths Averted (in thousands)
AT	81.09	20.53	0.36	0.40	28.98	8.12
BE	108.68	27.09	0.37	0.40	40.33	10.87
BG	107.37	17.78	0.60	0.42	63.95	7.49
CY	5.79	1.33	0.04	0.02	0.26	0.03
CZ	110.08	27.44	0.42	0.45	46.45	12.30
DE	914.34	227.40	0.46	0.49	425.64	110.84
DK	52.83	15.63	0.01	0.23	0.73	3.66
EE	15.43	3.79	0.48	0.50	7.45	1.92
EL	119.07	29.43	0.45	0.48	53.95	14.09
ES	411.67	107.83	0.32	0.38	131.18	41.17
FI	52.89	12.28	0.37	0.36	19.88	4.49
FR	589.68	161.41	0.32	0.41	189.98	66.68
HR	52.61	13.88	0.52	0.57	27.41	7.91
HU	129.20	32.74	0.54	0.57	69.74	18.58
IE	30.18	9.04	0.06	0.25	1.68	2.32
IT	625.13	169.73	0.42	0.49	261.67	83.24
LT	39.96	8.02	0.56	0.48	22.47	3.89
LU	3.96	1.08	0.12	0.24	0.50	0.26
LV	28.41	5.95	0.58	0.52	16.40	3.12
MT	3.52	0.94	0.22	0.31	0.79	0.29
NL	145.87	44.28	0.30	0.45	43.56	19.94
PL	395.49	98.35	0.42	0.45	167.25	44.39
PT	109.51	26.98	0.43	0.45	47.11	12.31
RO	255.56	50.48	0.53	0.44	136.49	22.44
SE	90.40	22.48	0.26	0.30	23.31	6.81
SI	19.61	6.19	0.37	0.53	7.25	3.30
SK	52.53	13.56	0.38	0.43	19.76	5.88
All countries	4,550.86 (SUM)	1,155.64 (SUM)	0.37 (MEAN)	0.41 (MEAN)	1,854.17 (SUM)	516.34 (SUM)

In the colums there are total annual deaths, annual cancer deaths, complement efficiency scores produces through Model Procurement-Outcome 2, complement efficiency scores produces through Model Procurement-Outcome 3, potential deaths averted obtained by multiplying the values in column 1 and column 3, the potential cancer deaths averted obtained by multiplying values in column 2 and column 4. Source: own estimates on Eurostat Data.

The analysis also underlines the correlation between improved procurement efficiency, expanded screening initiatives, and, consequently, a notable reduction in mortality rates.

With regards to the prevention function, the potential for efficiency improvement is even more substantial. For instance, when utilizing the inverse ratio of the number of deaths due to infectious diseases as an outcome variable, the efficiency level stands at 12% (see Table 2.6). This implies that

there is room for improvement of up to 88%, which could potentially result in a reduction of approximately 74,000 deaths.

Moreover, when examining the outputs, specifically focusing on the number of vaccinated individuals aged above 65 years, the potential for efficiency enhancement still remains considerable. In this case, there is room for improvement of up to 48%, which could translate into an increase of up to 11 percentage points in the vaccination rate among this part of the population.

Table 2.9 presents the mean annual values for each MS. A distinctive feature, in contrast to the procurement function, is the substantial potential for improvement observed across all MS when considering deaths due to infectious diseases. While the reallocation of competences at the EU level does not guarantee the complete restoration of efficiency, it is essential to recognize the relevance of spatial spillovers in the context of prevention (Fu et al., 2023). Consequently, the transfer of preventive-care competences to the EU to a larger scale may enable MS to recover a significant portion of their inefficiencies.

Table 2.9: Efficiency Improvement Potential – Prevention function (% vaccinated and Infectious Diseases Deaths)

Country	% Vaccinated (Aged 65+)	Infectious Diseases Deaths	Efficiency Improvement Potential (Model Prevention-Output 1)	Efficiency Improvement Potential (Model Prevention-Outcome 2)	% Vaccination Enhancement Potential	Deaths Averted (Infectious Diseases)
AT	19.30	855.62	0.71	0.94	13.76	802.62
BE	54.87	2,472.25	0.19	0.98	10.41	2,419.25
BG	2.95	576.12	0.96	0.91	2.83	523.12
CY	29.15	136.12	0.50	.	14.51	.
CZ	20.36	1,838.00	0.71	0.97	14.50	1,815.43
DE	39.79	17,930.62	0.45	1.00	17.03	17,877.62
DK	47.14	1,003.25	0.32	0.95	15.17	950.25
EE	5.27	134.12	0.93	0.60	4.54	81.12
EL	52.95	3,262.00	0.21	0.98	10.81	3,208.47
ES	55.86	6,646.50	0.21	0.99	11.83	6,593.50
FI	45.16	270.75	0.37	0.80	16.45	217.75
FR	50.71	11,308.88	0.20	0.99	10.01	11,248.90
HR	22.50	364.12	0.69	0.84	15.33	321.00
HU	26.84	803.12	0.61	0.93	16.41	750.12
IE	59.21	291.88	0.14	0.81	8.01	238.88
IT	52.27	13,730.00	0.28	1.00	14.36	13,677.00
LT	11.27	662.38	0.84	0.92	9.43	609.24
LU	39.63	74.38	0.40	0.24	15.65	21.05
LV	5.55	315.50	0.92	0.83	4.99	266.34
MT	53.38	33.38	0.22	.	11.77	.
NL	64.49	3,124.25	0.09	0.98	5.78	3,071.25
PL	10.05	1,972.50	0.85	0.97	8.56	1,833.43
PT	52.87	2,118.38	0.13	0.97	6.33	2,045.25
RO	12.03	3,063.00	0.82	0.98	9.53	3,008.48
SE	48.61	2,175.50	0.32	0.98	15.43	2,122.50

Country	% Vaccinated (Aged 65+)	Infectious Diseases Deaths	Efficiency Improvement Potential (Model Prevention-Output 1)	Efficiency Improvement Potential (Model Prevention-Outcome 2)	% Vaccination Enhancement Potential	Deaths Averted (Infectious Diseases)
SI	12.48	124.38	0.82	0.58	10.09	76.33
SK	13.40	520.75	0.71	0.82	9.60	430.85
All countries	35.05 (MEAN)	75,807.75 (SUM)	0.48 (MEAN)	0.88 (MEAN)	11.40 (MEAN)	74,209.75 (SUM)

In the colums there are % people vaccinated against influenza (aged 65+), annual infectious diseases deaths, complement efficiency scores produces through Model Prevention-Output 1, complement efficiency scores produces through Model Prevention-Outcome 2, % vaccination enhancement potential obtained by multiplying the values in column 1 and column 3, the potential infectious diseases deaths averted obtained by multiplying values in column 2 and column 4.
Source: own estimates on Eurostat Data.

3. Pharmaceutical strategy

The establishment of the European Medicines Agency (EMA) in 1995 is a landmark in the EU intervention in the European pharmaceutical market. Besides the additional tasks stemming from the recent pandemic experience, the agency is entrusted with the pivotal role of scientifically evaluating, overseeing and monitoring the safety of pharmaceuticals within the EEA (European Economic Area). Since its inception, a primary prerogative of the EMA has been the issuance of marketing authorization for specific categories of medicinal products. Upon obtaining authorization from the EMA, a product undergoes standardization across MS, and comprehensive product information is made available in all official EU languages (Kyle 2019).

However, the authorization process represents only the preliminary phase in ensuring a product's accessibility across all MS. The subsequent step involves negotiations regarding the pricing and reimbursement conditions for the product, a responsibility entrusted to individual national authorities in accordance with their respective competencies.

Despite the observed positive impact of the centralized authorization procedure in terms of an improved availability of medical products, certain MS continue to exhibit significantly lower levels of product availability in comparison to the total number of products authorized by the EMA (Kyle 2019; Zamora et al. 2019). This disparity is particularly pronounced in smaller and economically disadvantaged countries (European Commission 2022a).

Utilizing pharmaceutical availability data sourced from IQVIA (Newton et al. 2022), the objective of our analysis is to provide a benchmarking analysis of regulatory agencies within individual MS in ensuring the accessibility of pharmaceutical products for their respective citizens.

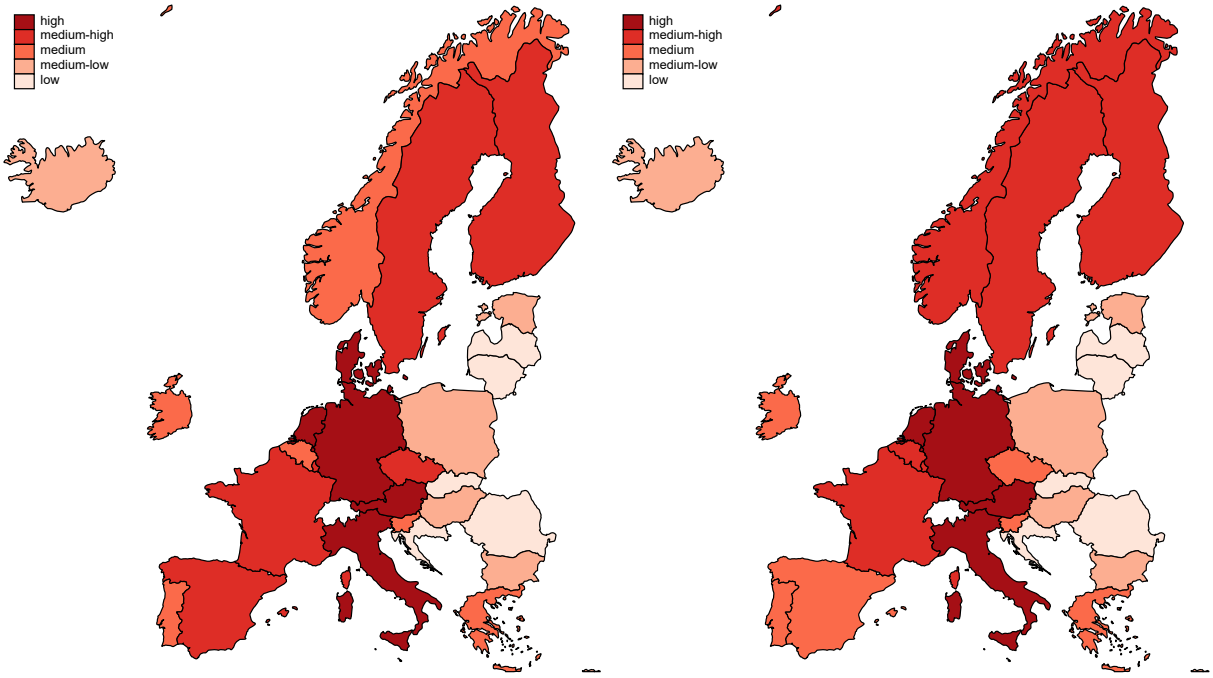
3.1. The benchmarking analysis with the availability rate

The selection of appropriate input and output variables is the first fundamental step when undertaking a DEA analysis. In this specific context, our chosen input variables from Eurostat encompass per capita healthcare expenditure within the pharmaceutical and other medical non-durable goods sectors ('*Ph. HE-PC*') and its share with respect to the total current health expenditure ('*Ph. HE %'*). We have utilized the rate (%) of availability of newly approved medicines in Europe spanning the years 2017 to 2020, sourced from Newton et al. (2022) ('*Avail. Rate*'), as our output variable. This variable is obtained from the WAIT (Waiting to Access Innovative Therapies) survey, jointly conducted by IQVIA and EFPIA (European Federation of Pharmaceutical Industries and Associations). It pertains to all innovative medicines authorized by the central regulatory agency.

We then define two distinct DEA models: the Availability Model 1, denoted as [*Avail. Rate = f(Ph. HE-PC)*], and the Availability Model 2, denoted as [*Avail. Rate = f(Ph. HE %)*]. The findings of these analyses

are summarized in the Figure 3.1. As in Saulnier et al. (2020), the basic idea is that EU interventions can enable MS to converge toward to the production frontier.[14]

Figure 3.1: Efficiency estimations, Availability Model 1 and 2



Source: own estimates on EFPIA, IQVIA and Eurostat data.

The overall level of efficiency within the EEA appears to be relatively low in both models. Additionally, considering Figure 4.1, it becomes evident that the two models yield congruent results, with less efficient countries mainly from Eastern Europe. These countries not only exhibit smaller populations but also rank among the less affluent European nations.

Nonetheless, for a more comprehensive exploration of the determinants influencing the efficiency scores generated by the two DEA models, we employ a second-stage regression analysis. Given the bounded nature of our data, which ranges from 0 to 1, as before, starting from the efficiency scores EFF, we consider the natural logarithm of $\frac{EFF}{1-EFF}$. The regression model is then specified as follows:

$$\ln \frac{EFF_{it}}{1-EFF_{it}} = \alpha_0 + \alpha_1\, pop_{it} + \alpha_2\, gdp\_pc_{it} + \alpha_3 \sum MS_i + \alpha_4 \sum Y_t + e_{it} \qquad (4.1)$$

In this model, '*i*' represents MS and '*t*' denotes the year; 'pop_{it}' is the natural logarithm of the population from Eurostat, 'gdp_pc_{it}' is GDP per capita from Eurostat, '*MS*' represents country fixed effects, '*Y*' represents year fixed effects. Estimates are reported in Table 3.1.

Both population and GDP per capita exhibit a positive coefficient, implying a positive correlation with efficiency levels. Interestingly, the effect of population shows a larger magnitude and it is statistically significant when using the efficiency scores derived from the 'Availability Model 2', where the input variable is the share of total health expenditure that is for pharmaceutical and other medical non-durable goods. Conversely, the coefficient of GDP per capita is larger in magnitude and

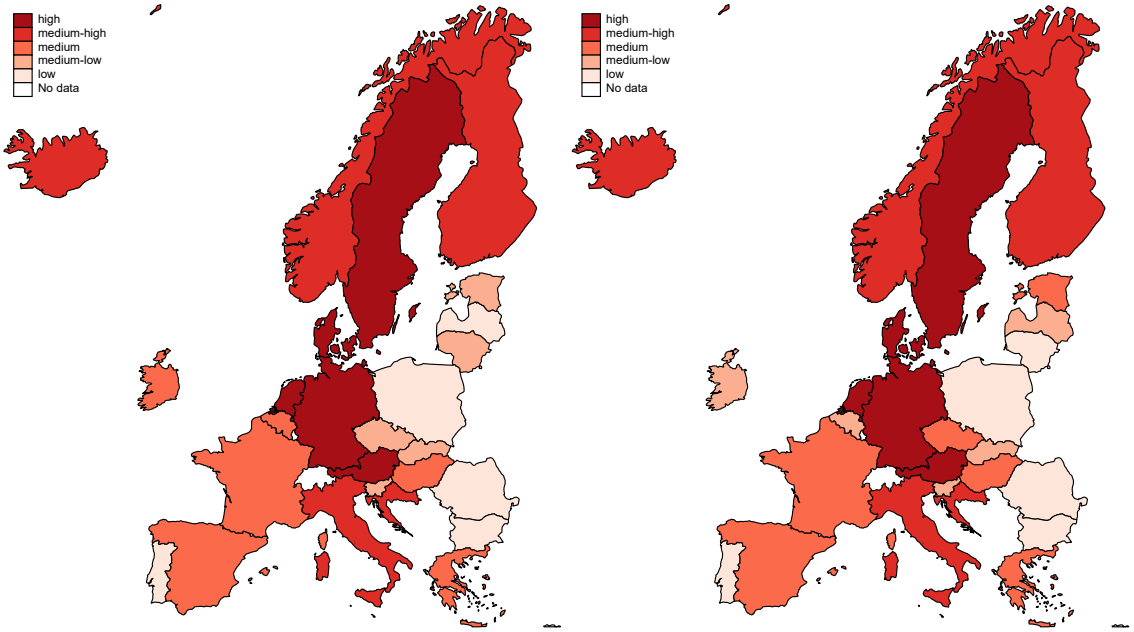
[14] Since EMA is responsible for all countries located in the EEA, in this analysis we consider all countries currently located in the EEA.

statistically significant when considering the per capita expenditure on healthcare for pharmaceutical and other medical non-durable goods as the input variable.

3.2. The benchmarking analysis with the time to availability

We further assess the efficiency of countries relative to pharmaceuticals by considering a temporal dimension of product availability, namely the time required to make drugs available (referred to as 'Time-to-Avail.'). This parameter measures the number of days between marketing authorization and the date on which pharmaceutical products become accessible to patients in each MS. The data utilized for this analysis are drawn from Newton et al. (2022) and pertain to the same medical products and the same time period (2017-2020) used in the calculation of the '*Avail. Rate*' variable. Employing the same set of input variables utilized previously (the per capita expenditure on pharmaceutical and other medical non-durable goods and its share with respect to the total current health expenditure), we estimate additional DEA models, specifically designated as follows: Time-Availability Model 1, denoted as [*1/Time-to-Avail. = f(Ph. HE-PC)*], and Time-Availability Model 2, denoted as [*1/Time-to-Avail. = f(Ph. HE %)*]. The findings of these analyses are summarized in the Figure 3.2.

Figure 3.2: Efficiency estimations, Time-Availability Model 1 and 2



Source: own estimates on EFPIA, IQVIA and Eurostat data.

Countries exhibit a noticeable disparity in efficiency, particularly in relation to the temporal interval between authorization and the subsequent availability of pharmaceutical products as opposed to the quantity of medical products made available within a three-year span. Nonetheless, upon conducting a comparative analysis of Figures 3.1 and 3.2, it is apparent that countries' rankings display a remarkable degree of consistency across different model specifications. This initial observation is confirmed by the correlation matrix detailing the interrelationships among countries' rankings

As before, we conduct a second-stage analysis, utilizing the same covariates outlined in Equation 4.1. Specifically, the regression model we specify is as follows:

$$\ln \frac{EFF_{it}}{1-EFF_{it}} = \alpha_0 + \alpha_1\, pop_{it} + \alpha_2\, gdp_{it} + \alpha_3 \sum MS_i + \alpha_4 \sum Y_t + e_{it} \qquad (4.2)$$

In this model, 'EFF_{it}' are the efficiency scores derived through Time-Availability Model 1 or 2, '*i*' represents MS and '*t*' denotes the year. The corresponding estimates are reported in Table 3.1.

Table 3.1: Second stage regressions of models Input-Outcome 1 (Healthy life years) and Input-Outcome 2 (Life expectancy)

VARIABLES	Avail. Model 1 (input: per capita prevention spending)	Avail. Model 2 (input: share of prevention spending over total healthcare spending)
Population	0.1301	0.7438***
	(0.254113)	(0.245848)
Gdp	0.1919*	0.0485
	(0.111449)	(0.069672)
Constant	-0.9752	-10.1028**
	(4.113207)	(4.144102)

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The results of the second stage analysis are reported in the table, where as dependent variable is used the efficiency scores computed through the DEA model (Availability-Model 1 in column 1 and Availability-Model 2 in column 2), while as explanatory variables there are: Population – ln of the population, gdp_pc – ln of the gdp per capita.

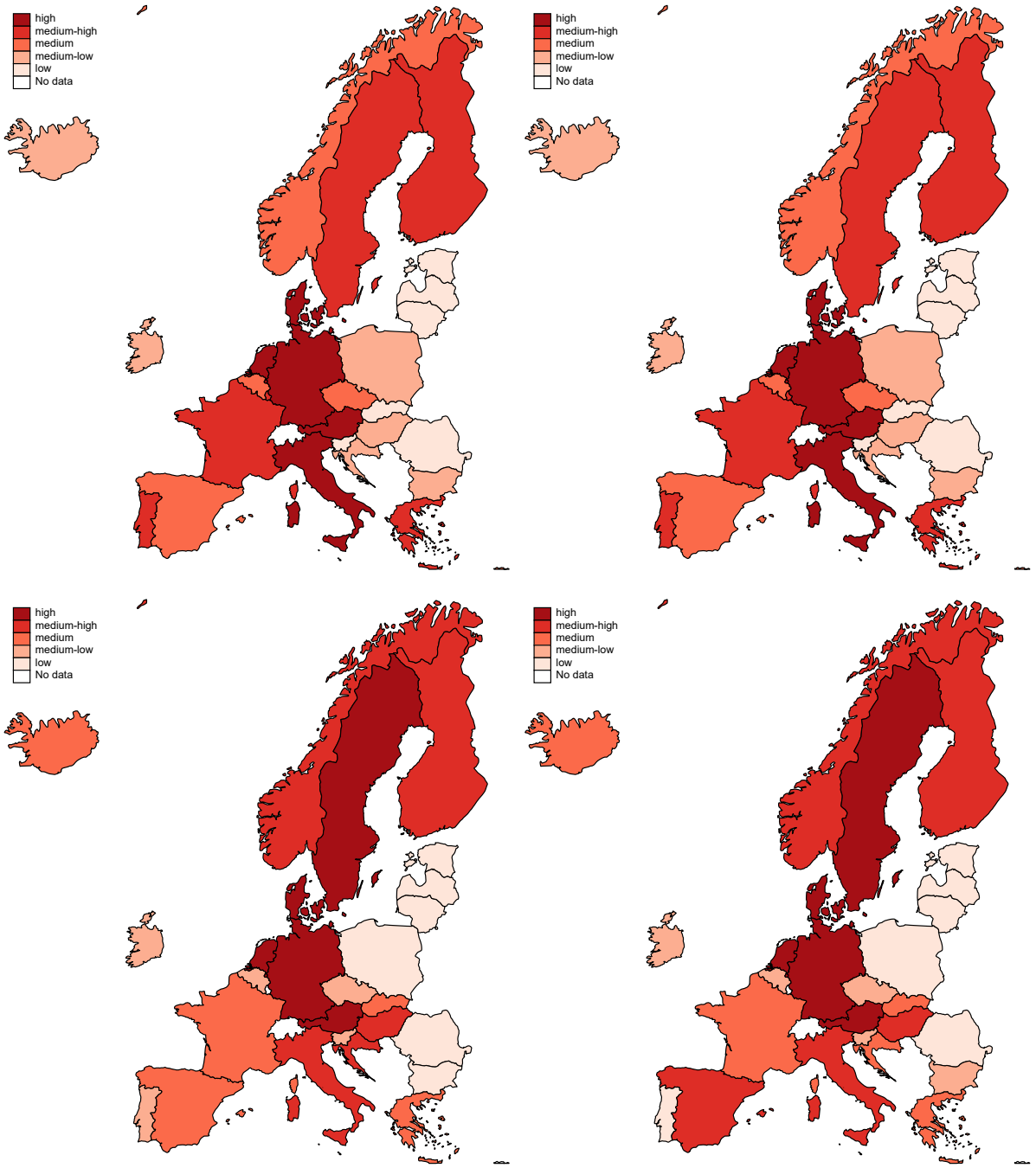
Source: own estimates on Eurostat, IQVIA, EFPIA data

The findings closely resemble those observed in the previous analysis. Specifically, when using the share of healthcare spending for pharmaceutical and other medical non-durable goods over the total current health expenditure as the input variable, the coefficient of population is positive and significant. This outcome implies that population size serves as a predictive factor, influencing the efficiency of MS in promptly providing pharmaceutical products to their populations. However, in this case, the coefficient of GDP per capita is consistently positive but lacks statistical significance. This consistent pattern suggests that larger countries maintain a comparative advantage over less populated ones in accelerating the availability of pharmaceuticals to the population.

3.3. Oncology medicines

Newton et al. (2022) also present data exclusively pertaining to oncology medicines. In this section, we then consider an additional benchmarking exercise to evaluate the efficiency of MS in delivering oncology medicines to their citizens. For this purpose we specify the following four DEA models that replicate the ones proposed in the previous section: Cancer-Avail. 1 [*Avail. Rate Cancer = f(Ph. HE-PC)*], Cancer-Avail. 2 [*Avail. Rate Cancer=f(Ph. HE %)*], Cancer Time-Avail. 1 [*1/Time-to-Avail. Cancer = f(Ph. HE-PC)*], Cancer Time-Avail. 2 [*1/Time-to-Avail. Cancer = f(Ph. HE %)*]. Results – which will be used also in the next section to discuss whether efficiency in delivering oncology medicine might have

Figure 3.3: Efficiency estimations, Cancer-Avail. 1, Cancer-Avail.2, Cancer Time-Avail. 1, Cancer Time-Avail. 2



Source: own estimates on EFPIA, IQVIA and Eurostat data.

an influence on the effectiveness of country-level initiatives aimed at combating cancer - are summarized in Figure 3.3 and Table 3.2.

Table 3.2: Efficiency scores for the EU-27 (availability of pharmaceuticals)

	Availability of new medicines		Time to availability of new medicines	
	Input: per capita preventive health spending	Input: share of prevention spending over total healthcare spending	Input: per capita preventive health spending	Input: share of prevention spending over total healthcare spending
All medicines	0.54	0.53	0.35	0.33
Oncology medicines	0.60	0.59	0.29	0.28

Source: Estimated by authors using data from Eurostat, IQVIA and EFPIA data

Table 3.2 shows that efficiency scores closely align with those obtained when considering the full set of pharmaceutical products. However, when the time to availability is employed as the output variable, the efficiency scores exhibit a further notable decrease. According to the standard interpretation adopted so far, country performance with regards to the time to availability of medicines can be improved by around 70% on average. This observation is particularly relevant since these medicines pertain to patients afflicted by cancer, for whom the timing of drug treatments assumes paramount importance, and any delay in availability can incur significant costs in terms of years of life lost.

Indeed, a cursory review of Table 3.3, which presents data on the availability rate and the time to availability for oncological products, reveals that, on average, patients are required to wait approximately 537 days—a temporal interval that holds considerable significance for individuals with oncological conditions.

Table 3.3: Average value by country of availability rate and time to availability, all pharmaceutical products and oncological products only

	All pharmaceutical products		Oncological products	
Country	Availability rate	Time to availability (days)	Availability rate	Time to availability (days)
AT	0.79	315	0.85	229
BE	0.54	534	0.66	598
BG	0.31	764	0.41	701
CY	0.28	1,436	0.56	
CZ	0.55	573	0.66	657
DE	0.92	133	1.00	100
DK	0.81	176	0.88	140
EE	0.26	599	0.22	960
EL	0.49	498	0.71	475
ES	0.53	517	0.61	469
FI	0.57	396	0.71	383
FR	0.66	497	0.80	490
HR	0.22	479	0.27	491
HU	0.41	480	0.49	405
IE	0.42	541	0.51	661
IS	0.27	464	0.32	572
IT	0.79	429	0.90	405

Country	All pharmaceutical products		Oncological products	
	Availability rate	Time to availability (days)	Availability rate	Time to availability (days)
LT	0.16	594	0.17	748
LU	0.66		0.80	
LV	0.17	627	0.15	927
MT	0.07		0.00	
NL	0.70	294	0.80	270
NO	0.52	414	0.61	473
PL	0.26	844	0.41	888
PT	0.51	676	0.71	753
RO	0.24	899	0.24	964
SE	0.62	261	0.80	318
SI	0.49	577	0.22	563
SK	0.22	564	0.22	488
All countries	**0.47**	**539**	**0.55**	**537**
Coefficient of variation	**0.47**	**0.47**	**0.47**	**0.44**

Source: EFPIA, IQVIA data.

In trying to quantify the impact of these delays in terms of a cost associated with premature mortality, we turn to the cost assessments of cancer derived from the research conducted by, e.g., Hofmarcher et al. (2018). Specifically, in their extensive analysis, the authors computed the economic consequences resulting from premature mortality for each EEA country. This metric is defined as the loss of future earnings attributed to individuals who pass away during their working years, individuals who would otherwise have remained productive members of the workforce until retirement age. Applying their estimated values to our selected group of countries, we can conclude that, in the year 2018, the productivity losses resulting from premature mortality amounted to approximately €41 billion. Furthermore, various cross-national analyses suggest that pharmaceutical innovations may have a positive impact on reducing cancer mortality rates, with estimates ranging from 9% to 20%.[15] Consequently, we can infer that the availability of innovative pharmaceutical products may play a role in mitigating the costs linked to premature mortality, with an estimated annual reduction spanning from €4 to €8 billion.

3.4. Discussion and EU policy options

Our benchmarking exercises show significant inefficiencies in the procurement of medical products. Specifically:

Availability Rate: Efficiency improvements of up to 46% are feasible, which could result in an increase of 21 percentage points in the availability rate.
Time to Availability: The potential for efficiency enhancement is even more substantial, reaching approximately 65%. This translates to a reduction of around 350 days in the time required for products to become available. Notably, the variation in time spans between authorization and availability among countries can be as high as tenfold.

When focusing specifically on oncological drugs:

[15] See Lichtenberg (2015, 2016, 2017, 2018) and MacEwan et al. (2020).

Efficiency in Availability: We estimate an improvement potential of up to 40%, equating to an increase of 22 percentage points in the availability of oncological drugs.
Efficiency in Time to Availability: Efficiency gains of approximately 70% are achievable, resulting in a reduction of around 375 days in the time it takes for these products to become available, considering the current average value of 536 days.

These findings highlight the substantial scope for enhancing efficiency within the procurement of medical products, particularly in the context of oncological drugs.

How can the EU strategically intervene in this domain, and what tools can be employed for such interventions? As previously mentioned, these inefficiencies are computed under the current allocation of competences between the EU and the MS. However, disparities in inefficiency levels among MS are salient, with our data indicating the stability and, in some cases, an expansion of these inefficiencies over time. Furthermore, Table 3.1 underscores that inefficiencies disproportionately impact smaller and economically disadvantaged countries in the EU.

4. The *Europe's Beating Cancer* plan

The Commission's Health Union Package includes the 'Europe's Beating Cancer Plan' as its third pillar. In this section, our primary aim is to assess the effectiveness of healthcare systems in addressing the cancer threat using DEA models.

Building upon the analysis conducted in Section 2, we identify relevant output and outcome variables. For what concerns the output variables, we select variables that pertain to the self-reported percentage of individuals who have undergone essential screenings for detecting the presence of cancer within the past year. Eurostat provides access to three specific variables:

- The self-reported percentage of women who have undergone a breast examination by X-ray in the past year ('*breast exam*');
- The self-reported percentage of women who have undergone a cervical smear test in the past year ('*cervical exam*');
- The self-reported percentage of individuals who have undergone colorectal cancer screening in the past year ('*colorectal exam*').

Additionally, we incorporate another output variable, which represents the number of Magnetic Resonance Imaging (MRI) examinations per one hundred thousand inhabitants (*'MRI exam'*). In chapter 2, we utilized this variable to explore the correlation between the efficiency of MS in the procurement of medical devices and their subsequent utilization. In the current chapter, our analysis shifts to a direct assessment of the efficiency of MS in delivering patient examinations through medical devices. Utilizing expenditure on prevention per inhabitant in Purchasing Power Standards (*'Prev HE'*) as an input, we construct four distinct DEA models, denominated as Cancer-Output 1 [*breast_exam=f(Prev HE)*], Cancer-Output 2 [*cervical_exam=f(Prev HE)*], Cancer-Output 3 [*colorectal_exam=f(Prev HE)*], and Cancer-Output 4 [*MRI_exam=f(Prev HE)*].

Although breast and cervix-uteri cancers generally exhibit higher screening rates compared to colorectal cancer, exceptions are noteworthy. For instance, in the Netherlands and Denmark, the self-reported percentage of individuals undergoing colorectal cancer screening in the last year exceeds that for cervix-uteri cancer. Conversely, in the Czech Republic, the self-reported percentage of individuals undergoing cervical smear tests in the last year significantly surpasses rates for other cancer screenings. Figure 4.1 visually represents the efficiency scores from the four DEA models, while Table 4.1 presents the overall EU-27 efficiency scores.

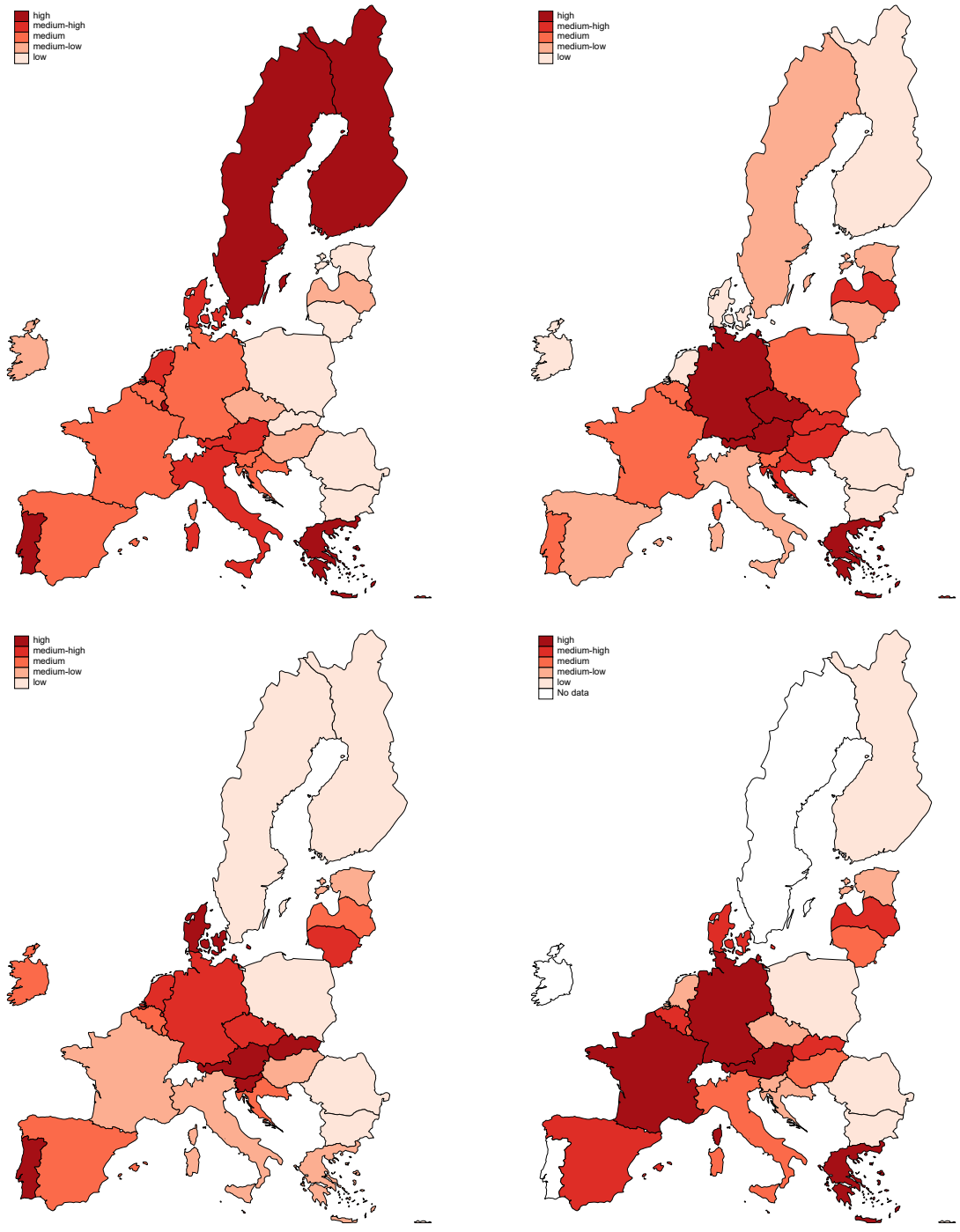
Table 4.1: Screening rate and efficiency scores for the EU-27 (screening exams)

	Breast exam (output 1)	Cervical exam (output 2)	Colorectal exam (output 3)	MRI exam per 100 000 inhabitants
Screening rate	34.70	34.97	18.60	6,095.21
Efficiency score	0.71	0.58	0.54	0.52

Source: Estimated by authors using 2019 data from Eurostat.

The efficiency scores, on average, tend to be relatively low, with scores slightly surpassing the 0.50 threshold. However, an exception is noted in the case of the first model, which specifically assesses the efficiency of breast screening (average efficiency score 0.71). Additionally, we notice that considerable heterogeneity exists, not only among countries but also across different models employed in the study.

Figure 4.1: Efficiency estimations, Cancer Output 1, Cancer Output 2, Cancer Output 3, Cancer Output 4.



Source: own estimates on Eurostat data.

Turning from efficiency to effectiveness, we identify five distinct outcome variables pertaining to the number of deaths caused by malignant neoplasms per one hundred thousand inhabitants. These variables correspond to the following specific types of cancers: 'breast', 'cervix uteri', 'colon, rectosigmoid junction, rectum, anus, and anal canal' (colon), 'prostate', and 'trachea, bronchus, and lung' (lung).

Using these outcome variables and the same input variable as before, that is, the expenditure on prevention per inhabitant in Purchasing Power Standards ('Prev HE'), we implement five DEA models denominated as: Cancer-Outcome 1 [*1/breast=f(Prev HE)*], Cancer-Outcome 2 [1/cervix uteri=f(Prev HE)], Cancer-Outcome 3 [1/colon=f(Prev HE)], Cancer-Outcome 4 [1/prostate=f(Prev HE)] and Cancer-Outcome 5 [1/lung=f(Prev HE)].

Figure 5.2 offers the graphical representation of efficiency scores by MS. The average EU-27 efficiency scores are presented in Table 4.2.

Table 4.2: Efficiency scores for the EU-27 (death from malignant neoplasm)

Breast cancer (outcome 1)	Cervical cancer (output 2)	Colon cancer (output 3)	Prostate cancer	Lung cancer
0.63	0.14	0.43	0.59	0.56

Source: Estimated by authors using 2019 data from Eurostat.

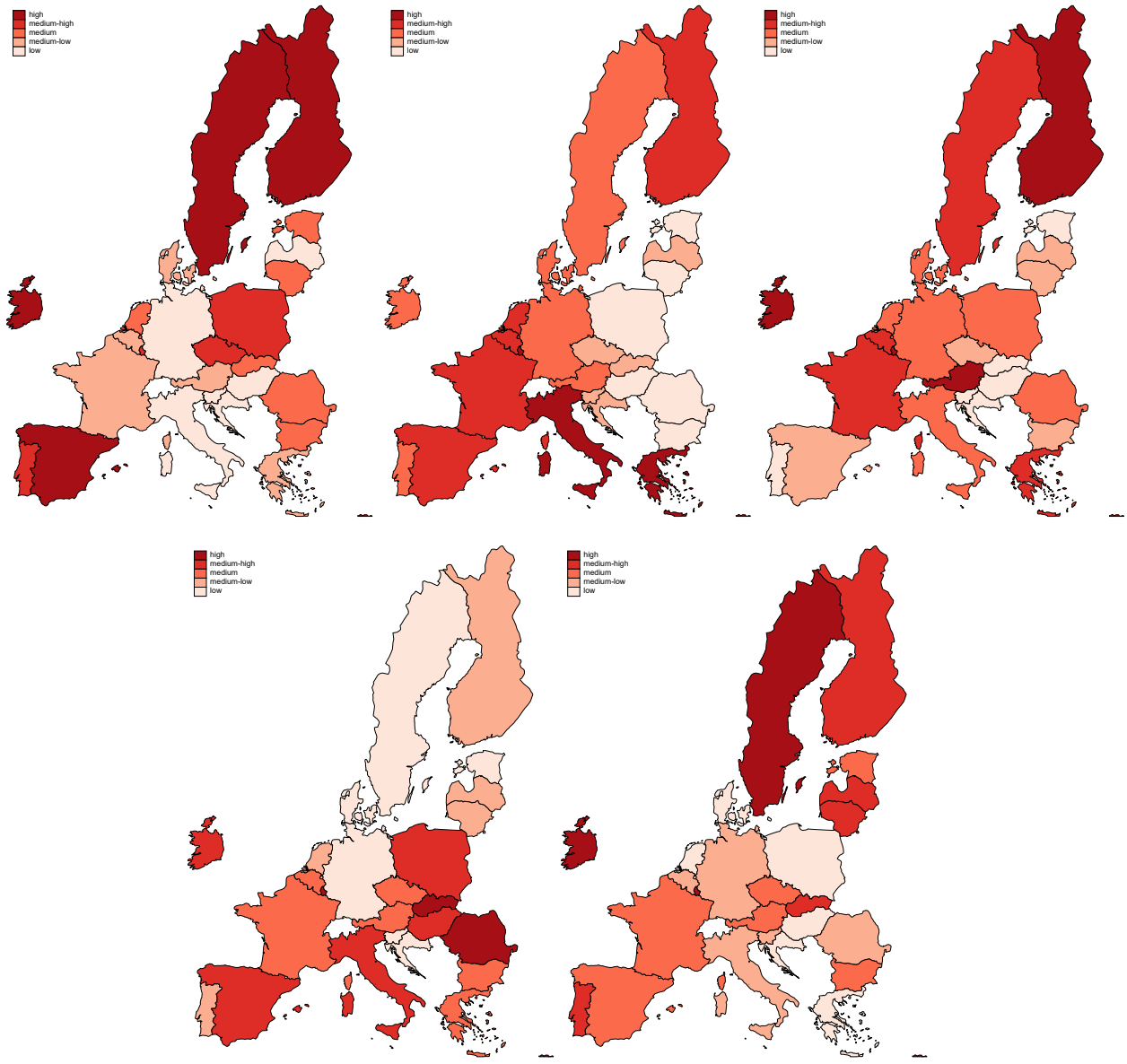
In terms of the average efficiency levels, we note that there are no substantial disparities between output and outcome models. However, when we turn our attention to the correlation matrix of rankings among MS across various models (Table 4.3) in the majority of cases output and outcome models exhibit a negative correlation. One possible explanation is that, taking spending for prevention constant, countries experiencing historically higher mortality rates for certain types of cancer are more aggressive in their screening programs.

Table 4.3: Rank correlations between input-output and input-outcome models

	C.Outp. 1	C.Outp. 2	C.Outp. 3	C.Outp. 4	C.Outc. 1	C.Outc. 2	C.Outc. 3	C.Outc. 4	C.Outc. 5
C.Output 1	1.0000								
C.Output 2	0.2411	1.0000							
C.Output 3	0.2272	0.1955	1.0000						
C.Output 4	0.0882	0.3627	0.3732	1.0000					
C.Outcome 1	0.1134	-0.1101	-0.2057	-0.3470	1.0000				
C.Outcome 2	0.6995	0.1346	0.0144	0.2721	0.2235	1.0000			
C.Outcome 3	0.3875	0.0797	-0.0904	0.1255	0.4195	0.6699	1.0000		
C.Outcome 4	-0.1885	0.2284	-0.2135	0.0133	0.3583	0.2434	0.3148	1.0000	
C.Outcome 5	0.1161	0.0434	0.0178	-0.1584	0.6636	0.2379	0.4328	0.2872	1.0000

Source: Estimated by authors using 2019 data from Eurostat. The input measure is preventive care spending.

Figure 4.2: Efficiency estimations, Cancer Outcome 1 (breast), Cancer Outcome 2 (cervix uteri), Cancer Outcome 3 (colon), Cancer Outcome 4 (prostate), Cancer Outcome 5 (lung)



Source: own estimates on Eurostat data.

Lastly, our objective is to examine the determinants of efficiency scores derived from the Input-Outcome models in a second-stage analysis. To this aim, we consider two variables: the first variable is the gender wage gap (*gwg*), which is obtained from OECD data and it is defined as the difference between median earnings of men and women relative to median earnings of men. Additionally, as a covariate, we incorporate the efficiency score derived from '*Cancer Availability 1*,' a model discussed in Section 3.[16] The aim is to investigate whether the efficiency of MS in providing

[16] If we use effieciency scores derived from other models such as 'Availability Model 2', 'Time-Availability Model 1', 'Time Availability Model 2', results do not qualitativerly change.

oncological products to their citizens has an impact on their efficiency in addressing the cancer threat. We specify the following model:

$$\ln \frac{EFF_{it}}{1-EFF_{it}} = \alpha_0 + \alpha_1\, EFF\_CA1_{it} + \alpha_2\, gwg_{it} + \alpha_3\, X_{it} + \alpha_5 \sum MS_i + \alpha_6 \sum Y_t + e_{it} \qquad (4.1)$$

In this model, '*i*' represents the MS, while '*t*' denotes the year. Our dependent variable is the logit transformation of the efficiency scores obtained from the five Input-Outcome models. The variable EFF_CA1_{it} is the natural logarithm of efficiency scores derived from 'Availability Model 1', whereas gwg_{it} represents the gender wage gap taken as a proxy of attitudes towards women experienced within each MS, which again can affect the different treatment and attention of cancers typically affecting only men or only women. Additionally, X_{it} encompasses supplementary covariates, including the (natural logarithm of the) population, the percentage of individuals in the population aged above 65 and the (natural logarithm of the) GDP. '*MS*' denotes the inclusion of country fixed effects, while '*Y*' accounts for year fixed effects.

Table 4.4 reports the results of our estimated regression analysis. The variable 'gwg,' representing the gender wage gap, consistently fails to achieve statistical significance. This observation suggests that different attitudes towards women do not affect the treatment and the attention devoted to cancer care, for types of cancers typically affecting only men or only women. [17] Conversely, the coefficient associated with the variable 'EFF_CA1' exhibits both positive and statistically significant results when considering efficiency scores derived from 'Cancer Outcome 1' and 'Cancer Outcome 3' models. These models specifically gauge the efficiency of MS in reducing the number of deaths caused by breast cancer and cancer affecting 'colon, rectosigmoid junction, rectum, anus, and anal canal,' respectively.

It is worth noting that the size of the population exerts a positive impact on efficiency scores with respect to certain types of cancer. Conversely, the effect of GDP demonstrates a negative and statistically significant relationship in two specifications, particularly when assessing the efficiency of MS in reducing mortality associated with 'cervix-uteri' and 'prostate' cancers. This finding suggests that, in the context of cancer diseases, there exists potential for efficiency improvement, even in MS with a higher level of well-being compared to their counterparts.

This observation is substantiated by the results presented in Table 5.5, where we quantify, for each type of cancer included in our analysis, the potential reduction in cancer-related deaths per million inhabitants achievable if efficiency was fully restored. These figures are calculated by multiplying the total cancer-related deaths per million inhabitants by the complementary efficiency scores provided in Table 4.2. Table 4.5 reveals that, for certain cancer types, such as 'colon' and 'lung' cancers, the potential reduction in mortality is quite substantial.

Table 4.4: Regression results of equation 4.1

VARIABLES	EFF (breast)	EFF (cervix uteri)	EFF (colon)	EFF (prostate)	EFF (lung)
aged65	-0.1017*	0.2685***	-0.0720***	0.0076	-0.0416
	(0.056086)	(0.068080)	(0.022884)	(0.054381)	(0.101015)
gwg	0.0188	0.0086	0.0042	0.0065	0.0195
	(0.016113)	(0.007536)	(0.003141)	(0.005046)	(0.022433)

[17] In the existing literature, there exists evidence of a gender bias, although it is primarily associated with the research phase rather than the screening and treatment stages (Beery and Zucker 2011).

VARIABLES	EFF (breast)	EFF (cervix uteri)	EFF (colon)	EFF (prostate)	EFF (lung)
EFF_m1o	9.0132**	5.5236	3.8310**	-1.5462	-3.4567
	(4.315644)	(5.110131)	(1.799718)	(2.722095)	(12.648145)
gdp	0.2997	-1.2618***	-0.1979	-0.8648**	0.7498
	(0.360690)	(0.455747)	(0.142140)	(0.384598)	(1.126169)
population	1.4056	5.1640***	1.4771***	3.7469***	5.1943
	(1.279894)	(1.318890)	(0.415475)	(0.989951)	(4.186699)
Constant	-23.1992	-72.7142***	-19.4244***	-49.0071***	-92.0523
	(21.152168)	(21.591013)	(7.185012)	(16.260608)	(82.038461)

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1. The results of the second stage analysis are reported in the table, where as dependent variable is used the efficiency scores computed through the DEA model (Cancer-Outcome 1 in column 1, Cancer-Outcome 2 in column 2, Cancer-Outcome 3 in column 3, Cancer-Outcome 4 in column 4, Cancer-Outcome 5 in column 5), while as explanatory variables there are: aged65 – % of the population aged 65+, gwg – gender wage gap, EFF_m1o – efficiency estimations of Availability Model 1, population – ln of the population, gdp – ln of the gdp . Source: own estimates on Eurostat and OECD data.

Table 4.5: Potential reduction in cancer-related deaths per million inhabitants achievable

Country	Potential Cancer Deaths Averted (breast)	Potential Cancer Deaths Averted (cervix-uteri)	Potential Cancer Deaths Averted (colon)	Potential Cancer Deaths Averted (prostate)	Potential Cancer Deaths Averted (lung)
AT	73.81	14.89	122.75	59.94	185.09
BE	85.00	12.20	124.60	53.68	279.22
BG	69.17	45.71	231.78	51.23	211.55
CY	22.08	8.69	21.88	16.65	24.74
CZ	45.08	28.62	212.49	51.73	236.76
DE	112.50	16.97	183.73	94.16	282.01
DK	80.27	14.76	194.81	134.17	368.95
EE	73.59	44.82	242.36	127.08	237.56
EL	85.59	10.24	129.97	63.12	385.41
ES	25.94	11.53	208.81	40.84	198.88
FI	44.50	7.84	110.62	82.12	140.24
FR	78.47	9.77	140.67	55.65	203.38
HR	112.07	26.19	381.99	100.28	420.58
HU	109.44	39.45	387.57	46.67	615.59
IE	41.04	16.34	90.89	36.01	127.43
IT	96.92	5.64	194.19	43.46	286.59
LT	71.58	62.85	196.73	95.68	173.32
LU	53.04	7.83	84.41	12.05	131.99
LV	102.17	56.67	212.40	104.55	177.31
MT	57.25	8.59	141.76	9.45	120.13
NL	72.38	10.45	173.83	81.66	343.15
PL	58.53	40.00	192.92	46.54	345.29
PT	57.29	18.02	247.65	88.08	130.06
RO	62.48	76.93	190.69	20.77	242.78
SE	30.96	12.74	155.49	156.34	100.37
SI	94.32	19.47	234.92	122.38	317.65
SK	73.92	37.05	251.09	36.54	140.25
All countries	69.92	24.71	187.44	67.83	238.22

In the colums there are the potential cancer deaths averted obtained by multiplying complement efficiency scores produced through Cancer Outcome models and annual cancer deaths per million inhabitants.
Source: own estimates on Eurostat Data.

Moreover, it is important to observe that the potential decrease in cancer-related mortality for certain cancer types remains notably substantial, even in MS characterized by a high level of well-being. For instance, Germany reports values that are among the highest for 'breast' cancer, Belgium displays significant values in the context of 'cervix-uteri and 'colon' cancers, while the Netherlands and Denmark demonstrate substantial values in the case of 'lung' cancer.

4.1. Discussion and EU policy options

Inefficiency in the provision of outputs, particularly screenings, is remarkably high, particularly for specific types of cancers. For instance, there exists potential for a 9-percentage-point increase in people participating in colorectal cancer screenings and approximately a 14% increase in participation to cervical cancer screenings.

Regarding the number of MRI examinations, the potential for efficiency enhancement is substantial, reaching 48%. This translates into an estimated increase of around 2,900 annual examinations per 100,000 inhabitants at the EU level. In terms of outcomes, inefficiency levels are considerable, particularly for certain cancer types such as Cervix Uteri, Colon, and Lung. The potential reduction in mortality, measured as the number of deaths per million inhabitants, is significant. For 'Breast' Cancers, it could decrease by approximately 70, for 'Cervix Uteri' around 25, for 'Colon' about 187, for 'Prostate' roughly 68, and for 'Lung' approximately 238. Notably, according to our findings these inefficiencies cannot be attributed to a different attention across genders. However, there is some evidence on the role played by the efficiency recorded by MS in the procurement of oncological medicines.

Should the allocation of competences between the EU and the MS remain the same, it is plausible that the level of efficiency will experience marginal changes in the short term. An examination of the historical variation in efficiency scores over time typically reveals a consistent constant trend, indicating that MS, in isolation, may not be effective in addressing the underlying causes of inefficiency.

Re-allocation of competences would allow the EU to take further actions, which should align with those delineated in Section 4. These include: the definition of transparent and standardized negotiation rules at the EU level when engaging with pharmaceutical companies; improved transparency in pricing and reimbursement decision-making processes at the national level; and the definition of a cohesive approach to drug prescribing practices across EU countries, which should also include common screening practices for different types of cancers.

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The European Union stepped up its action in the area of health – a shared competence between the EU and its Member States – in response to the COVID-19 pandemic. Yet, the EU lacks a joint health policy that recognises health as a public good. This study investigates three areas where there is high added-value potential from a joint EU health policy: research and development; the availability of prescription medicines; and preventive healthcare. EU action in these areas could generate benefits for the economy (in particular the EU's health industries), society (through improved health and quality of life for patients and less absenteeism for employers) and fundamental rights (the right to timely access to healthcare). The EU could also help to reduce the carbon and environmental footprint of the healthcare sector. An EU health policy that speaks with one voice is especially advantageous in light of the ageing population, digitalisation and rapid technological change.

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