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FLASH – Flexible Approaches to Support Health through financing

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Abbreviations

Art.	Article
C/E	cost effectiveness (ratio)
cf.	confer (= compare)
CIFREL	Inter-University Research Centre on Local and Regional Finance
CM	Capacity Management
COM	(European) Commission document
CPMS	Clinical Patient Management System
DE	Germany
DRG	Diagnosis-related groups
ECDC	European Centre for Disease Prevention and Control
ECJ	European Court of Justice
EEA	European Economic Area
EFTA	European Free Trade Association
EHDS	European Health Data Space
EHIC	European Health Insurance Card
EHU	European Health Union
ERN	European Reference Networks
et al.	et alii (= and others)
etc.	et cetera (=and other things)
EU	European Union
FB	First Best
FLASH	Flexible Approaches to Support Health through financing
GA	Grant agreement
HADEA	European Health and Digital Executive Agency
HCPs	Healthcare Provider ERN members

HLY	healthy life years
HSC	Health Security Committee
i.e.	id est (= that is)
ibid.	ibidem (= in the same place)
IHR	International Health Regulations
IT	Information Technology
JARDIN	Joint Action on integration of ERNs into national healthcare systems
lit	litera (= letter)
LOS	length of stay
MS	Member State(s)
MSA	Member State of Affiliation
MST	Member State of Treatment
NCPs	National contact points (for cross-border healthcare)
OECD	Organisation for Economic Co-operation and Development
OJ	Official Journal (of the EU)
OR	Operational Research
p.	page
para.	Paragraph
PET	Positron Emission Tomographys
PHEIC	Public health emergencies of international concern
PMD	Directive 2011/24/EU on the application of patients' rights in cross-border healthcare (Link)
p.	page
pp.	pages
PPS	Prospective Payment Systems
S1	form for full healthcare under Articles 17 and 18 SSCR
S2	form for planned care under Article 20 SSCR

SCBHRR	Regulation (EU) 2022/2371 on serious cross-border threats to health (Link)
SSC-IR	Regulation (EC) No 987/2009 laying down the procedure for implementing the SSCR (Link)
SSCR	Regulation (EC) No 883/2004 on the coordination of social security systems (Link)
SWD	Staff Working Document
TFEU	Treaty on the Functioning of the European
UK	United Kingdom
WP	Work package

Glossary of terms

Please note, the following terms are partially based on the official definitions as provided in the relevant EU legal documents, respectively partially on SWD(2022) 200 final 12.5.2022.

Border region patient mobility: patients moving between two neighbouring Member States (MS)[1], in order to seek or receive healthcare in close vicinity (not exactly defined) between the place of residence and the place of treatment.

Capacity Management (CM) decisions: the ability to find suitable levels of resources to meet demand.

Clinical Patient Management System (CPMS): a secure electronic information system (i.e. an IT tool provided by the Commission) established by EU law[2], "for the electronic exchange of personal data of patients between healthcare providers authorised to access CPMS" within the European Reference Networks (ERNs).

Cross-border healthcare: healthcare provided (or medicines prescribed) in a MS other than the Member State of affiliation (MSA, see below); applies to the 27 EU MS, as well as to the European Economic Area (EEA)/European Free Trade Association (EFTA) countries of Norway, Iceland and Liechtenstein, and in case of the SSCR (and the SSC-IR; see below) also to Switzerland and the United Kingdom (UK; under the Brexit rules).

Effectiveness: a treatment, a procedure, a payment system, which is able to reach the objective for which it has been devised.

[1] While border-region patient mobility could also take place between an EU MS and a third country, for this report we completely exclude this situation. On the countries covered, see also below at "cross-border healthcare".

[2] See Commission Implementing Decision (EU) 2019/1269 of 26 July 2019 amending Implementing Decision 2014/287/EU setting out criteria for establishing and evaluating European Reference Networks and their Members and for facilitating the exchange of information and expertise on establishing and evaluating such Networks, OJ 2019 L 200/35, inserting an Art. 16a to Decision 2014/287/EU (see note 126). This covers "diagnosis and treatment of patients with rare or low prevalence complex diseases or conditions across national borders and to facilitate scientific research of such diseases or conditions" (recital 7 Decision (EU) 2019/1269).

Efficiency: the ability of a treatment, procedure, or payment to reach a specific objective at the lowest possible cost.

Equalisation grant: A financial transfer from a higher to a lower government level, aimed at reducing disparities in fiscal capacity and expenditure needs. It is designed to help equalize the ability of different areas to provide public services, even if they have heterogeneous income sources.

Equity: the ability of a treatment, procedure, or payment system to redistribute benefit across patients' groups or at least to avoid that only some groups may benefit from its implementation. Also, one of the EU's health values.

EU patient mobility directive (PMD): Directive 2011/24/EU of the European Parliament and of the Council of 9 March 2011 on the application of patients' rights in cross-border healthcare.

EU social security coordination implementing regulation (SSC-IR): Regulation (EC) No 987/2009 of the European Parliament and of the Council of 16 September 2009 laying down the procedure for implementing Regulation (EC) No 883/2004 on the coordination of social security systems (see next entry).

EU social security coordination regulation (SSCR): Regulation (EC) No 883/2004 of the European Parliament and of the Council of 29 April 2004 on the coordination of social security systems.

European Health Insurance Card (EHIC): card issued by the competent institution (e.g. national health insurance), which enables patients to receive medically necessary, state-mandated healthcare during a temporary stay in another MS or EEA/EFTA country, Switzerland or the UK (under the Brexit rules); treatment is provided under the same conditions and at the same cost as the persons insured in the MST (see below).

European Reference Networks (ERN): "virtual networks involving healthcare providers across Europe"; they "aim to facilitate discussion on complex or rare diseases and conditions that require highly specialised treatment, and concentrated knowledge and resources"[3].

Excess capacity: In health care it refers to having available resources (like beds, providers, operating rooms, technology) that exceed the current demand. It may lead to inefficiencies and potential underutilization.

Flexibility: the quality of bending easily without breaking; the ability to be easily modified; the willingness to change or compromise (Stevenson, 2010, p. 669).

Full healthcare (according to the SSCR): for persons who reside in a MS other than the competent MSA (e.g. for posted workers, cross-border workers, pensioners) and asked for a certificate (portable document S1) that establishes a right to full healthcare coverage in the MS of residence (Article 17 SSCR) and also in the MSA (according to Article 18 SSCR).

Healthcare: means health services provided by health professionals to patients to assess maintain or restore their state of health, including the prescription, dispensation and provision of medicinal products and medical devices.

Member State of affiliation (MSA): Member State that is competent to grant to the insured person a prior authorisation under EU social security law (especially SSCR and SSC-IR) and to subsequently cover the costs.

Member State of treatment (MST): Member State on whose territory healthcare is actually provided to the patient (in case of telemedicine, this is the Member State where the provider is established[4]); can also be Norway, Iceland or Liechtenstein, and in case of the EU social security law also Switzerland and the United Kingdom (under the Brexit rules).

Multi-level systems: an organisation (usually public), who's decision chain is set at a different level; the organisation may be more hierarchical (the higher level delegates the implementation

[3] Cf. https://ec.europa.eu/health/european-reference-networks/overview_en.

[4] See ECJ judgment of 11 September 2025, Case C-115/24, *Österreichische Zahnärztekammer*, ECLI:EU:C:2025:694.

of a specific decision to lower levels) or more decentralised (the higher-level delegates function to lower tiers and coordinate their actions).

Patient mobility: cross-border healthcare (provided or prescribed outside the MSA) where the patient actually moves (or is being moved) to the MST (or EEA/EFTA countries); hence, excluding situations where health professionals or only the service (e.g. telemedicine) are crossing the border.

Patient: human being seeking or receiving healthcare.

Planned healthcare (according to the PMD): healthcare provided or medicines prescribed in a country (including EEA/EFTA countries) other than the MSA based on the PMD, can require prior authorisation (according to Article 8 PMD).

Planned healthcare (according to the SSCR): situation of an insured person travelling to another MS (or EEA/EFTA country, Switzerland or the UK [under the Brexit rules]) with the purpose of receiving benefits in kind during the stay; necessity to seek prior authorisation from the competent institution (according to Article 20 SSCR; S2 form).

Prior authorisation: authorisation that patients need to receive from their competent institution (e.g. national health insurance institution) before seeking cross-border healthcare and often a precondition for subsequent reimbursement.

Resilience: "the ability to face economic, social and environmental shocks or persistent structural changes in a fair, sustainable and inclusive way"[5].

Unplanned – or necessary – health care: healthcare (including emergency care) received in an EU MS, an EEA/EFTA country, Switzerland or the UK (under the Brexit rules), which becomes 'necessary on medical grounds' during a 'temporary stay' (for work, study, or leisure) and without the initial intention of the patient to travel to receive treatment in this MST; based on EU social security law (Article 19 SSCR, SSC-IR; EHIC), or in a private clinic based on the PMD.

[5] Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility, OJ 2021 L 57/17, Art. 2 para. 5.

Executive summary

In 2023, the latest year for which **data** is available, over 20.0000 requests for cross-border treatment were received for 86.5 million EUR in reimbursements (EUROPEAN COMMISSION Directorate-General for Health and Food Safety, 2025).

Most of the **mobility** is **driven** by patients' aspiration to get better/closer/cheaper health care in a foreign country. Such mobility is highly regulated, it may create problems and **extra costs** in Member States (MS), since unless the numbers of patients that give up care in their MS to go abroad are known beforehand, it will replicate costs for health care (spare capacity in the origin country and extra cost to pay for mobility). This report moves from this fact to study under which conditions patients' mobility may be instead welfare improving.

We show that patients' mobility has little impact on reducing **quality gaps** and in some cases, it may also have non-desirable effects, as it may reduce quality in the region where it is already lower. Where some positive effects exist, they are often obtained in a context where such mobility is regulated. In this respect the present legislation and limits to patients' mobility make sense on economic grounds, especially when the latter is motivated by "quality" issues.

The report suggests possible areas, where instead patients' mobility (originating from MS rather than patients) may instead be beneficial. We argue that **capacity management** could be enhanced at EU level through patients' mobility. In this report we have identified at least two interesting areas, namely **supply**-driven **excess capacity**, i.e. when health care provision requires a fixed capacity that cannot be tailored to demand, and **demand**-driven capacity, which derives from unexpected peaks in the demand of some specific services. We propose prices schemes for **both** types of mobility, which could be adapted to different objectives (from fairness to solidarity) and discuss, whether and under which conditions this type of mobility is compatible with the present **EU legislation**. At present there does not seem to be a systematic use of such mobility and we propose a **more proactive** role of the EU by, for example, setting registry for such capacity in excess. While the present legislation on patients' mobility could accommodate for a systematic use of such instrument, the agreements across MS require the knowledge of where there are an excess capacity and an excess demand. The final area we have analysed, which could benefit from patients' mobility, is the enhancement of **research and treatments centres** for orphan diseases. In this case the EU is trying to pursue an interesting strategy that may allow to balance patients' aspirations to be treated as close to home as possible with the need of avoiding replications in sunk investments. We show that EU financed European Reference Networks (ERNs) combined with patients' mobility may provide an innovative way tackle this problem, provided their implementation is supported by a good **governance**.

1. Introduction

The European Union (EU) patient mobility directive (PMD), officially entitled Directive 2011/24/EU 'on the application of patients' rights in cross-border healthcare'[6], was enacted by EU institutions in order to take back control in a situation of growing patients' rights in cross-border healthcare. These rights have been shaped by individual patients with the help of the European Court of Justice (ECJ), by relying on EU law before national courts. The PMD codifies existing ECJ case-law, regulates patients flows across Europe and enhances these rights from a qualitative perspective.[7] The PMD tries to pursue the following general objectives:

1. Clarifying **patients' rights** when seeking healthcare abroad within a defined legal framework for cross-border healthcare in the EU.
2. Promoting **voluntary cooperation** between Member States (MS) in the field of healthcare (Chapter IV, Art. 10-15 PMD), specifically in border regions, recognition of prescriptions issued in other countries, and data collection on cross-border healthcare.
3. Creating European Reference Networks (**ERNs**) (Art. 12 PMD) on **rare** and low prevalence **diseases** (Art. 13 PMD) that are fully operational including their organisational structure, to scarry out their clinical, knowledge sharing, research, and other activities. They also aim at giving healthcare **providers** across the EU access to the best expertise and timely exchange of life-saving knowledge by combining skills of healthcare professionals involved and resources used. Therefore, in the end it also aims at ensuring that patients have better access to high quality healthcare services for rare or low prevalence complex disease.

In our **previous report** (Frischhut & Levaggi, 2023) we argued that one of the open issues for improving health care provisions across borders is the role of patient mobility. Patient mobility can take place in border regions or beyond. As border region mobility will be covered in **two other reports** within this Work Package (WP) 5, this report does not focus on border regions, which are only touched upon briefly and in another paper (Frischhut & Levaggi, 2024).

[6] Directive 2011/24/EU of the European Parliament and of the Council of 9 March 2011 on the application of patients' rights in cross-border healthcare, OJ 2011 L 88/45, as amended by OJ L, 2025/327 [see note 128]. (Directive 2011/24/EU of the European Parliament and of the Council of 9 March 2011 on the Application of Patients' Rights in Cross-Border Healthcare, 2011).

[7] From a quantitative perspective, recital 4 PMD emphasises that this directive and its implementation into national law "should not result in patients being encouraged to receive treatment outside their Member State of affiliation".

Patient mobility across countries may be a driver for **equity and efficiency** at European level in areas such as improving **quality**, in managing **excess capacity** and in the organisation and finance of **research centres** either for the development of state-of-the-art treatments or for treating patients affected by orphan diseases. In this report we study whether patient mobility may be used to achieve these goals and, if so, whether these instruments are compatible with the present EU legislation and ECJ case-law.

In this report we study patients' mobility for reaching **different objectives**. In a first part of the report (Chapter 2) we analyse whether a system of patient mobility can reduce the existing **quality** gap. In this first case mobility originates from patients choice. We will then move to examine the use of patients mobility in a different context where the decision originate from MS (i.e. the national government decides to treat patient abroad) in order to make a better use of hospital **excess capacity** (Chapter 3) across EU countries (i.e. Task 5.3 of the Grant Agreement). We then move to consider how patients' mobility may be used for **capacity management** mainly in three different instances:

- Facilities with fixed capacity that is set by technology, for example a Positron Emission Tomographys (PET) scan. In this situation, **capacity is fixed** also in the long run meaning that the technology itself has a fixed scale which can only be replicated (i.e. it can be doubled, triplicate and so on). Demand is known beforehand, is fixed, and cannot be adjusted with other technologies to capacity. In this context, we will explore whether patients' mobility, by pooling demand may allow to use improve capacity management.
- Treating patient requiring facilities with a fixed **capacity** that **can be adapted** to some extent before the capacity is set to demand, but in this case, demand is uncertain either because of some "normal variation" from one period to the next, or because of some unexpected event (such as a pandemic event).
- Finally, **research centres** and treatment facilities for rare/low prevalence diseases, where the fixed setup and treatment cost are rather high and patients are scattered across countries.

Each solution, in case it is welfare improving, will be analysed in the light of the current EU legislation to ensure its practical feasibility.

These rules of **EU law** can be found in Art. 56 TFEU[8] (freedom of services, also including the receipt of health services), the EU Regulation on social security coordination (SSCR)[9] and the corresponding implementing regulation (SSC-IR)[10]. In a similar way as the already mentioned PMD, both social security regulations[11] also apply to the European Economic Area (EEA)[12].

Against this background of existing EU law on cross-border healthcare, the issues of quality of care, excess capacity, capacity management and finally reference networks, **this report** aims at answering the **following questions**, concerning quality, excess capacity (both supply and demand driven), and research centres, etc.:

Patient mobility may improve quality. From a theoretical point of view, the welfare effects of patients' mobility across regions are not clear (L. Levaggi & Levaggi, 2024b). (Brekke, Gravelle, et al., 2014) show that cross-border patient mobility may be beneficial for both patients from high and low skill regions as in the classical Heckscher–Ohlin model of international trade (Heckscher et al., 1991). Patients from high skill regions receive benefits from high skill hospitals, while patients in the low skill regions that value quality may receive their preferred level in the other region. However, patient mobility may have countervailing effects on welfare when regions with different levels of income compete (Brekke et al., 2016). In the long-run, voluntary mobility should disappear competition should provide a strong incentive to stimulate quality improvements in the less efficient jurisdictions (Brekke et al. (2012a).

In some countries, such as **Italy**, mobility seems to have created the opposite effect (Berta, Martini, and Albini 2018; Balia, Brau, and Moro 2020; Balia, Brau, and Marrocu 2017; Berta, Guerriero, and Levaggi 2021). The example of Italy is quite interesting because non-border

[8] Treaty on the Functioning of the European Union; Consolidated version: OJ 2016 C 202/47.
[9] Regulation (EC) No 883/2004 of the European Parliament and of the Council of 29 April 2004 on the coordination of social security systems, OJ 2004 L 166/1, as amended by OJ 2019 L 186/21.
[10] Regulation (EC) No 987/2009 of the European Parliament and of the Council of 16 September 2009 laying down the procedure for implementing Regulation (EC) No 883/2004 on the coordination of social security systems, OJ 2009 L 284/1, as amended by OJ 2021 C 170/4.
[11] While the PMD and the relevant case-law are linked to the freedom of services, these two regulations are connected to the free movement of workers.
[12] I.e., likewise, to the European Free Trade Area (EFTA) countries of Norway, Iceland and Liechtenstein, also referred to as EEA/EFTA. However, unlike the PMD, these two social security regulations also apply in relation to Switzerland. In the following, this report will not focus on the UK (see glossary).

mobility (i.e. mobility between regions that do not share a MS border) is from low income to high-income regions, something that may replicate the eastern/western flow in Europe. This mobility is still quite marginal at present and there should be a **debate** on its role at European level. Countries are reluctant to allow their patients to go abroad because of possible double costs: from one side they have to plan supply to allow everybody to be treated, but if some citizens decide to be treated abroad, there is going to be excess, unused capacity and extra costs due to the reimbursement for treatment abroad.[13] Even if the PMD states that the **cost** for the national health care system should not be higher than what paid to patients within the country,[14] the health care bill may increase.[15] Furthermore, some countries use **waiting lists** as instruments to reduce health care expenditure growth. In this case, mobility can be used to reduce waiting time[16], but it is going to increase health care costs. In this respect, Italy is a good example of a system that is producing more damages than benefits. (Berta et al., 2021) analyse incoming patients' flows for Lombardy and show that border mobility is often driven by waiting times: patients are usually younger and less severe than residents are, while for those coming from non-border regions hospitals ask for a higher reimbursement despite the same quality level and a Prospective Payment System (PPS). This implies that **resources flow** from poor to rich regions; **quality gaps** are deemed to increase and only patients that can move are allowed to get a better quality. In the light of this evidence, it may be important to carefully study, how mobility could be regulated and (co-)financed at EU level. At European level, something similar seems to happen for the mobility from eastern to western countries. (Stan et al., 2021) show that patients moving to other countries increase the equity gap across national individuals and they also find specific differences between native and migrants. Mobility increases the cost of health care hence increasing the quality gap. Again, at regional level (Amuedo-Dorantes et al., 2022) present the results of a policy implemented by regions in 2012, in order to reduce mobility. The reduction does not seem to have affected equity in health care provision, but the study does not include

[13] This is basically the reason, why the ECJ has accepted planning requirements in case of hospitals and also in case of cost-intensive infrastructures. See ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, paras. 76-82, and ECJ judgment of 5 October 2010, Case C-512/08, *Commission v France*, ECLI:EU:C:2010:579.(EU Court, 2001).

[14] Art. 7 para. 4 PMD.

[15] While the PMD has a double cap of the level of reimbursement in the Member State of Affiliation (MSA) plus the actual cost, this can be different in case of the SSCR. See, for example, recently: Advocate General Spielman, Opinion of 17 May 2025, Case C-489/23, *Casa Județeană de Asigurări de Sănătate Mureș and Others*, ECLI:EU:C:2025:361, para. 84.

[16] On the requirements of EU law with regard to waiting lists, see, ECJ judgment of 16 May 2006, Case C-372/04, *Watts*, ECLI:EU:C:2006:325.(European Court of Justice, 2006).

long run effects. In this scenario, we propose to study (see below, **Chapter 2**) patient mobility to improve quality in two different cases:

A) Income differences are quite relevant so that a supra-national authority[17] may decide to use patients' mobility in combination with some form of equalisation grant.
B) The role of regulating patient mobility in asymmetric contexts, i.e. in a setting where the organisation of health care provision may be different across regions/countries.

Can we achieve a better (OECD, 2020; OECD/European Union, 2020) **and a more coordinated use of excess capacity** (see below, Chapter 3)? Capacity planning concerns the balancing of the demand for capacity with the available capacity of the production system. Within the healthcare setting, various studies report on the difficulties of providing healthcare services according to patient demand (Bos & De Fraja, 2002; Fagefors et al., 2020a; Fagefors & Lantz, 2021; Humphreys et al., 2022; Smith–Daniels et al., 1988). So, how can the balance between required and available capacity be achieved? How can we use our resources in accordance with what the patients need? In this report we are going to study whether patient mobility may be used in two different cases:

- Supply driven excess capacity
- Demand driven excess

What about supply driven excess capacity? In this instance the supply of a specific treatment is determined by the size of the equipment that is necessary to run a specific procedure. The equipment is costly[18] and it has fixed dimensions; in other words, it cannot be tailored to demand. This may be the case for some diagnostic equipment such as Positron Emission Tomography (PET) scans. In other cases, the fixed supply may derive from learning curves in the use of a specific equipment. Demand on the contrary may be predicted with high accuracy. The size of the equipment may mean that demand can be optimally satisfied by joining patients form different countries.

What about demand driven situations? In the past few decades, the number of hospital beds has been drastically reduced in most western countries in order to improve efficiency (*Health at a Glance 2023*, 2023; *Health at a Glance: Europe 2024*, 2024; OECD, 2018; OECD/European Union,

[17] See, below, Chapter 3.6.1.

[18] As mentioned above (supra, note 13), the ECJ has accepted planning requirements (i.e. prior authorisation) in case of patient mobility and cost-intensive infrastructure. See now also Art. 8 para. 2 lit a PMD.

2020). However, this reduction means that if demand increases for some fluctuations or some unexpected reasons, the health care system goes immediately under stress. Also, in this case the Covid-19 **pandemic** has shown effects of bed shortages across Europe: apart from a higher mortality rate, when bed occupancy increases above a specific threshold, it is necessary to lockdown the economy to stop the contagion growth. For these events and (more effectively) when the increase in the demand occurs in a subset of countries, planning bed excess capacity at EU level may be beneficial for all the countries. The number of unused bed decreases, while the availability in case of need may increase. For this type of patient mobility, a two-part payment system could be envisaged: the EU budget could pay the **fixed cost** for up to a specific number of beds in each country while the **running costs** (when the bed are actually used) would be settled through a country agreement based on a cross-national tariff. In this case, each country could decide whether to invest in extra capacity or pay for using excess beds. In the past, this system has been used by the United Kingdom (UK) to reduce their waiting lists for scheduled surgical interventions, mainly as a spot intervention (Andritsos & Tang, 2013). The use of the technology at **EU level** may allow sharing the costs and redressing the cost effective (C/E) ratio. Coordination[19] at this level could also mean that more rare diseases can be treated since some countries may specialise in some of them. Furthermore, countries with less technology/resources may benefit from their use, especially if the centres are **financed** at EU level and each country may send their patients to be treated free of charge or at marginal cost. In this respect, the PMD had foreseen some initiatives to improve treatment in this context.[20]

From a **legal perspective**, one way of achieving a more **solidarity**-based approach would be to revise the existing cross-border healthcare regime. Without going into details, redesigning the cross-border healthcare acquis more from a community-based, not only from an individual patient perspective would strengthen solidarity in this field. Apart from amendments to existing rules, most patients do not know about the difference between the SSCR and the PMD.[21] **Merging** the directive into the regulation would reduce complexity, allow for a general (solidarity-based)

[19] It is important to emphasise that social security systems are only coordinated (see also the title of the SSCR, i.e. Regulation on the coordination [!] of social security systems), but not harmonised (in other words, not aligned to each other); see recently, Advocate General Spielman, Opinion of 17 May 2025, Case C-489/23, *Casa Judeţeană de Asigurări de Sănătate Mureș and Others*, ECLI:EU:C:2025:361, para. 56.

[20] Especially Art. 12 (European reference networks) and Art. 13 (Rare diseases) PMD. See Chapter 4.

[21] In other words, the statement of recital 9 PMD; according to which "cross-border healthcare ensur[es] clarity for Union citizens about their rights and entitlements" could be further enhanced.

revision, and thereby might **reduce injustice** related to knowledge (epistemic injustice in a broad sense).[22]

What about research centres and orphan diseases? They require sunk investments in specific technologies. In this case, coordination at EU level would allow to treat more rare diseases (see below, **Chapter 4**). While at national level the development and the maintenance of an excellence centre to treat patients may not be cost effective (the sunk cost for the investment may be higher than the benefits), the use of the technology at EU level may allow to share the costs and redress the C/E ratio. Coordination at this level could also mean that more rare diseases can be treated since some countries may specialise in some of them. Furthermore, countries with less technology/resources may benefit from their use, especially if the centres are financed at EU level and each country may send their patients to be treated for free/at marginal cost. In this respect the PMD had foreseen some initiatives to improve treatment.[23]

For each of the different aspect in this report we will be using the **following method**: we will discuss the economic implications and whether mobility may be used to improve welfare. If the policy is viable, we will propose some solutions in terms of financial arrangements (prices and other source of finance) and the legal status quo respectively implications of our proposal.

2. Quality

2.1. EU legal framework (quality, values, etc.): Introduction[24]

According to the ECJ, in the field of healthcare Member States do enjoy some **discretion**, as the "health and life of humans rank foremost among the assets and interests protected by the Treaty and [therefore] it is for the Member States to determine the **level** of protection which they wish to afford to public health and the **way** in which that level is to be achieved"[25]. However, there is an important **limitation**, as the Member States have to take into account the **international 'state-of-the-art'**. In this context, the ECJ has referred to "what is considered normal according to the state of international medical science and medical standards generally accepted at

[22] On information, see, for example, Chapter 4.3.

[23] See note 20.

[24] The following is a short overview. For more details, see (Frischhut & Levaggi, 2023).

[25] ECJ judgment of 19 May 2009, Case C-171/07, *Apothekerkammer des Saarlandes and Others*, ECLI:EU:C:2009:316, para. 19, emphases added.

international level"[26]. In addition, the ECJ has emphasized the need that treatment has to be "sufficiently tried and tested"[27] and that account must be taken of "existing scientific literature and studies, the authorised opinions of specialists [etc.]"[28].[29] In other words, the Court has emphasized requirement of **evidence-based** decisions.

Concerning quality of care in **cross-border healthcare**, the PMD does not provide a lot of substantive clarification. For reasons of lack of EU competence in this field, the PMD simply allocates the task for defining further details to one of the two MS involved in the process of the movement of a patient (i.e., from the MSA to the Member State of Treatment [MST]). According to Art. 4 para. 1 lit b PMD[30], it is the obligation of the **MST** to define "standards and guidelines on quality and safety laid down by the Member State of treatment"[31]. The obligation regarding the information to be provided by healthcare providers is addressed as follows. According to Art. 4 para. 2 lit b PMD, "healthcare providers provide relevant **information** to help individual patients to make an **informed choice**, including on treatment options, on the availability, **quality and safety** of the healthcare they provide in the Member State of treatment [...]"[32].

The PMD also foresees various fields of **cooperation** amongst MS, where one field includes "cooperation on standards and guidelines on quality and safety" (Art. 10 para. 1). Taking again into account the competence of MS for public health, most of these forms of cooperation are voluntary for MS. An important example of this cooperation between MS are **European reference networks** (ERN) between healthcare providers and centres of expertise in the MS,

[26] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 92, emphasis added. See also recital 22 PMD.
[27] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 94.
[28] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 98.
[29] It should be briefly mentioned, that this case-law of the ECJ (for the EU) has also been applied by the EFTA Court for the EFTA/EEA countries, that is to say, Norway, Iceland and Liechtenstein: See EFTA Court judgment of 19 December 2008, Joined Cases E-11/07 and E-1/08, *Rindal and Slinning*, [2008] EFTA Ct. Rep. 320; EFTA Court judgment of 5 December 2024, Case E-15/23, *K v Nasjonalt klageorgan for helsetjenesten (The National Office for Health Service Appeals)*, OJ C, C/2025/1926; EFTA Court judgment of 7 May 2025, Case E-9/23, *EFTA Surveillance Authority v The Kingdom of Norway*.
[30] This resonates what the ECJ had already decided earlier: ECJ judgment of 19 April 2007, Case C-444/05, *Stamatelaki*, ECLI:EU:C:2007:231, para. 37.
[31] Subject to the above-mentioned limitations of the international 'state-of-the-art'.
[32] Emphases added.

which shall be established "in particular in the area of rare diseases"[33]. In this context, the PMD addresses several objectives to be achieved by an ERN, where three of them explicitly refer to **quality**:[34]

- "to facilitate improvements in diagnosis and the delivery of **high-quality**, **accessible** and **cost-effective healthcare** for all patients with a medical condition requiring a particular concentration of expertise in medical domains where expertise is rare" (Art. 12 para. 2 lit c PMD);
- "to encourage the development of **quality and safety benchmarks** and to help develop and spread best practice within and outside the network" (Art. 12 para. 2 lit g PMD);
- "to help Member States with an insufficient number of patients with a particular medical condition or lacking technology or expertise to provide **highly specialised** services of **high quality**" (Art. 12 para. 2 lit h PMD).

Quality of care is also mentioned in EU **soft-law** (i.e. not legally binding), in the so-called 'Council Conclusions on Common **values and principles** in European Union Health Systems'.[35] This document issued by the Health Ministers at the time established the "overarching **values** of *universality, access to good quality care, equity, and solidarity*".[36] "Beneath these overarching values", there is also a set of **operating principles**, where quality of care is defined as follows: "All EU health systems strive to provide good quality care. This is achieved in particular through the obligation to continuous **training** of healthcare staff based on clearly defined **national standards** and ensuring that staff have access to advice about **best practice** in quality, stimulating **innovation** and spreading good practice, developing systems to ensure good clinical governance, and through **monitoring** quality in the health system. An important part of this agenda also relates to the principle of **safety**."[37]

[33] Art. 13 and recitals 54-55 PMD. N.B. A rare disease is one that "meet a prevalence threshold of not more than five affected persons per 10 000" (recital 55 PMD). On ERNs, see also Chapter 4.

[34] Emphases added.

[35] OJ 2006 C 146/1. This document is also referenced in the PMD (recital 22), as follows: "Systematic and continuous efforts should be made to ensure that quality and safety standards are improved in line with the Council Conclusions and taking into account advances in international medical science and generally recognised good medical practices as well as taking into account new health technologies".

[36] Ibid, no emphases added.

[37] Ibid, emphases added. Patient safety, which is closely linked to quality, has been defined as follows: "Patients can expect each EU health system to secure a systematic approach to ensuring patient

Besides quality, this document also addresses to other **health values** that are of relevance for our report, i.e. solidarity and equity. Concerning **solidarity**, which is also a general value of the EU (Art. 2 TEU[38]), the 2006 document emphasises that "solidarity is closely linked to the **financial** arrangement of our national health systems and the need to ensure **accessibility** to all"[39]. On equity, the 2006 document emphasis that "**equity** relates to **equal access** according to **need**, **regardless of** ethnicity, gender, age, social status or ability to pay".[40] The latter part can be translated as referring to the principle of non-discrimination, a general principle of EU law.

The **freedom of services**, also comprising patient mobility, forbids (direct and indirect) **discrimination** based on nationality.[41] From the various non-discrimination **EU directives**,[42] especially the Racial Equality Directive[43] and the Gender Equality Directive[44] play a role in the field of healthcare, as they cover the field of "access to goods and services"[45]. Although the wording slightly differs, both directives apply to "public and private sectors, including public bodies", amongst others in the field of healthcare.[46] Both directives cover direct and indirect

safety, including monitoring risk factors and adequate, training for health professionals, and protection against misleading advertising of health products and treatments"; ibid.

[38] Treaty on European Union; Consolidated version: OJ 2016 C 202/13.

[39] Ibid, emphases added.

[40] Ibid, emphases added.

[41] Both non-discrimination and equality are also listed in Art. 2 TEU on the EU's general values.

[42] See, for example, the overview in Commission, 'Staff Working Document accompanying the Proposal for a Council Directive on implementing the principle of equal treatment between persons irrespective of religion or belief, disability, age or sexual orientation. Summary of the Impact Assessment', SEC(2008) 2181 (Equality Staff Working Document), p. 3.

[43] Council Directive 2000/43/EC of 29 June 2000 implementing the principle of equal treatment between persons irrespective of racial or ethnic origin, OJ 2000 L180/22, as amended by OJ L, 2024/1499.

[44] Council Directive 2004/113/EC of 13 December 2004 implementing the principle of equal treatment between men and women in the access to and supply of goods and services, OJ 2004 L373/37, as amended by OJ L, 2024/1499.

[45] Equality Staff Working Document (n 42). Other fields covered comprise employment and vocational training, education, as well as social protection. These three fields will not be covered any further.

[46] Racial Equality Directive, Art. 3 para. 1 lit e ("social protection, including social security and healthcare") and Gender Equality Directive, Art. 3 para. 1 and recital 12 ("provision of healthcare services"). As a limitation, both directives refer to "limits of the powers conferred upon the Community [now: Union]", which requires an activity falling within the Social Security Coordination Regulation, the Patient Mobility Directive, or the freedom of services (Art. 56 TFEU).

discrimination[47] and allow for justifications.[48] Discrimination based on other grounds (i.e. religion or belief, disability, age, sexual orientation), covered by other EU directives,[49] is not covered in the field of healthcare, although the Commission had proposed another directive in 2008.[50] In February 2025 the Commission has announced to withdraw this 2008 proposal, because it "is blocked and further progress is unlikely".[51] Another EU directive covers non-discrimination based on sex/gender in the field of social security, which also covers sickness.[52] Hence, this is the non-discrimination framework that has to be respected in case of cross-border healthcare and which has also been addressed in the context of the health value of equity.

In conclusion, while quality of care is, basically, to be defined at national level, there are some implications of EU law in this context. In case of cross-border healthcare, this task falls to the MST, not the MSA.[53] EU law always refers to a high-quality treatment and the ECJ to the international "state-of-the-art", for example, in case one MS would argue that a certain treatment should be considered 'experimental', whereas another MS would see it as 'normal'. EU law forbids non-discrimination based on nationality (freedom to receive services), as well as based on race and sex/gender.

2.2. Economic perspective: Introduction

Health care systems rely on geographical boundaries that are necessary to secure financial stability and to ensure adequate planning[54] of health care infrastructure and capacity. This is true both at national level (where in several countries the organisation of health care has been devolved to lower government level) and at supra-national level, such as the EU. From an

[47] Racial Equality Directive, Art. 2; Gender Equality Directive, Art. 4 para. 1.
[48] Racial Equality Directive, Art. 4; Gender Equality Directive, Art. 4 para. 5.
[49] See Equality Staff Working Document (n 42), p. 3.
[50] Commission, Proposal for a Council Directive on implementing the principle of equal treatment between persons irrespective of religion or belief, disability, age or sexual orientation, COM(2008) 426 final 2 July 2008. According to Art. 3 lit a of this proposal, it would also have covered "Social protection, including social security and healthcare".
[51] Commission, Annexes 1-5 to the Commission work programme 2025. Moving forward together: A Bolder, Simpler, Faster Union', COM(2025) 45 final 11 February 2025 (2025 Work Programme), p. 25.
[52] Council Directive 79/7/EEC of 19 December 1978 on the progressive implementation of the principle of equal treatment for men and women in matters of social security, OJ 1979 L 6/24.
[53] The MSA can of course refuse prior authorisation (both in general, as well as in an individual situation) in case of quality and safety concerns.
[54] See note 13.

economic point of view health care may be considered a **merit good**, i.e. a private good that a country wants to be made accessible to a wider set of users than those that would be able to pay for its provision. **Solidarity**[55] plays a crucial role since one of the important features of this provision is to redistribute income from the rich to the poor. This implies that redistribution of income will be developed along two lines: a) at **patient** (individual) level through a system of (possibly) means tested prices that allow anybody to afford care; b) at **geographical**/regional level if income across regions is unevenly distributed. The ensuing income redistribution should reduce differences both across individuals and regions.

However, especially at regional level, quality may still be **different** because health care systems may have a different efficiency level. To this end providers competition both within and across regions may allow to reduce such differences. However, both the theoretical and empirical literature do not seem to agree on this conclusion. (Andritsos & Tang, 2014) show that cross-border patient mobility may improve welfare only if some conditions are met, but in general the welfare effects of patients' mobility across regions are not clear-cut (Guccio et al., 2024; L. Levaggi & Levaggi, 2014). In Brekke, Levaggi, et al. (2014) regions differ in quality efficiency and the authors show that cross-border patient mobility **may be beneficial** for both patients from high and low skill regions as in the classical Heckscher-Ohlin model of international trade, but this result is not so clear-cut when regions differ in income, especially if taxation is progressive (Brekke et al., 2016) and the level of vertical integration in health care provision may differ across regions (Aiura, 2019; Bisceglia et al., 2018, 2019). In the long-run, voluntary mobility should disappear; competition should provide a strong incentive to stimulate quality improvements in the less efficient jurisdictions, but this result is not so obvious. Bisceglia et al. (2020) and Brekke et al. (2012) show that **permanent differences** in quality **may persist**, even in the presence of a large degree of symmetry in parameters across regions. The findings of the theoretical literature are confirmed by the empirical evidence. Quality gaps appear to be related to the size of the income difference (Balia et al., 2018, 2020; Yuan et al., 2023) and patient mobility has produced a drain of resources from poor to rich regions.

As shown above, **income redistribution** is another key variable in this context. In order to reduce fiscal imbalances grants may be used, their form being quite heterogeneous as well as their effects on expenditure and local taxes (for a review see Lago et al., 2024). **Unconditional grants** (such as block grant or revenue-based equalisation grants) are said to be more effective to

[55] On solidarity, see in Chapter 2.1.

reduce fiscal imbalances since they leave the lower tiers a high degree of autonomy in their decision. However, they might be not so effective in targeting a specific sector. On the contrary, conditional grants (for example expenditure-based grants) should be more targeted and more effective.

A part of the research project has been devoted to study whether the goal of improving overall quality and decreasing the quality gap may be reached by **combining** patient mobility with **equalisation grant** while a second goal has been to study the effects of patient mobility on **quality** in a more general model than the one proposed by the literature so far. In what follows, we first present the general model that can be used to get both sets of results (Chapter 2.3) and we will then present the main results that can be derived in the two more specialized models separately (Chapter 2.4).

2.3. The general model

As in Bisceglia et al.(2018); Levaggi & Levaggi (2023, 2025b), we model a market for health care where patients are uniformly distributed on a circle of length equal to one; their size is also normalised to one. The **market** is split in **two** different **regions**, A and B. Patients located on the upper semicircle belong to region A, while the remaining consumers belong to region B. The market is served by **four** health care **providers** (hospitals), two in each region, which are uniformly distributed along the circle at locations $l_j,\ j = 1, \dots, 4$ with l_1, l_2 in region A and l_3, l_4 in region B (see Figure 1).

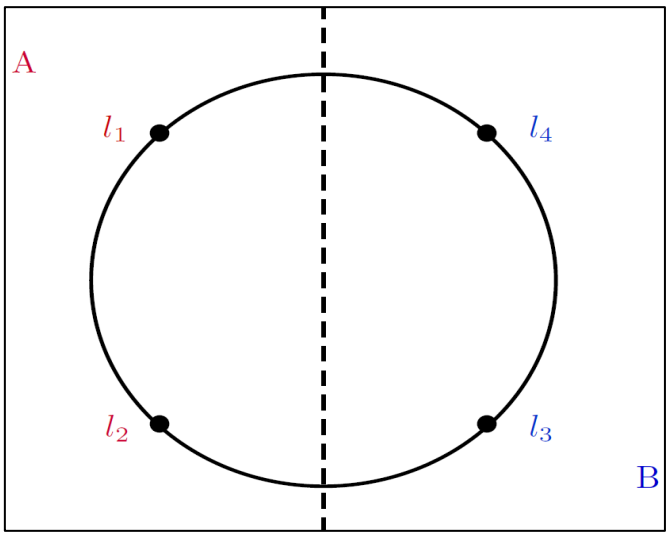

Figure:1: Spatial competition for hospital services

We assume that health care provision is **free** at the point of use and that the **net utility** of individuals located on the circle at x choosing hospital j located at l_j can be written as:

$$U_j(x) = v + \beta q_j - md(x, l_j),$$

where v is the intrinsic utility of hospital care, which is assumed to be sufficiently high to make any patient access the service from some provider (total cover), q_j is the **quality**[56] offered by provider j and the term $md(x, l_j)$ is a mismatch cost, linear in the distance $d(x, l_j)$ from x to l_j. The parameter $\beta > 0$ is the evaluation of quality and βq_j is the monetary equivalent gain derived from being treated at hospital j. The mismatch cost $md(x, l_j)$ may also comprise **search costs**, which are often quite important when patients choose to be treated outside their region of residence.

Users located at x choose between the two nearest providers j and k by comparing $U_j(x)$ and $U_k(x)$. The location x_{jk} of the indifferent patient satisfies the equation:

$$v + \beta q_j - md(x_{jk}, l_j) = v + \beta q_k - md(x_{jk}, l_k) = v + \beta q_k - m\left(\frac{1}{4} - d(x_{jk}, l_j)\right),$$

thus

$$d(x_{jk}, l_j) = \frac{1}{8} + \frac{\beta}{2m}(q_j - q_k).$$

As in Brekke et al. (2016; Brekke, Levaggi, et al. (2014), we assume that there are two types of patients: a fraction $1 - z$ that **always** seeks treatment from the **local** provider because of personal characteristics (e.g. age), while the **remaining** fraction is willing (if allowed) to **travel** to the neighbouring region if the quality gap is sufficiently high. If mobility between the two regions is allowed, each provider is faced with both "**internal**" (from the other hospital in the same region) and "**external**'" quality competition (from the hospital located in the other region). We denote by $D_{j,int}$ the ``internal'' demand of provider j and set $D_{j,ext}$ to be equal to the number of external patients treated by provider j, or to be zero in case no patient moves from the neighbouring region to provider j.

Health care is **financed** through general income taxation in both regions, which however differ for the structure of their internal market. Region A has chosen a **market oriented** organisational framework where the two hospitals are separate entities from the regulator/purchaser, while region B adopts a **vertically integrated** health care system, where the purchaser is also responsible for health care provision.

We assume that the cost of providing health care is **linear** in the number of treatments and **quadratic** in the offered quality. We allow costs to be region-dependent, so that the monetary cost of supplying D treatments of quality q in region i is given by:

[56] For a definition see paragraph 2.1

$$C_i(D,q) = c_i D + \frac{1}{2}\theta_i q^2, \quad i = A,B.$$

In **region A**, given a price p_A for treatments to resident patients and a price p for cross-border patients, quality q_j is set by the provider j by maximising the profit function:

$$\Pi_j = (p_A - c_A)D_{j,int} + (p - c_A)D_{j,ext} - \frac{1}{2}\theta_A q_j^2, \quad j = 1,2.$$

In **region B** the provision is vertically integrated and the quality q_B, equal for the two access points, is set by the regulator; the **social welfare** is:

$$W_B = r_B(1 - t_B) + U_T^B - \frac{w_B}{2}\left(D_{3,int} + D_{4,int}\right)^2$$

where r_B is the total income in region B, t_B the (proportional) tax rate, U_T^B the total utility derived from treatment by patients residing in region B and the last term takes into account the possible presence ($w_B \geq 0$) of an additional disutility in providing the service, e.g. due to the administrative effort. The **optimal quality** is set through the following maximisation problem:

$$max\ W_B \quad s.t. \begin{cases} q_B \geq 0 \\ t_B r_B = c_B\left(D_{3,int} + D_{4,int}\right) + \dfrac{\theta_B}{2}\left(D_{3,int}^2 + D_{4,int}^2\right) \\ \qquad +p(D_{1,ext} + D_{2,ext}) - G_B. \end{cases}$$

We assume that region A is **richer**, i.e. $r_A > r_B$ and has a **superior technology** for providing health care quality, i.e., $\theta_A < \theta_B$. In what follows, we will therefore refer to region A and region B as the **high-skill** and **low-skill regions**, respectively. An upper authority sets a policy to pursue **horizontal equity**, which implies that a given tax effort should be rewarded with the provision of a uniform amount of public services. This objective can be pursued using an **equalisation grant** G_i $i = A,B$, which allows to correct for disparities and imbalances in the geographical distribution of resources. In general terms, the social welfare function in region A is written as:

$$W_A = r_A(1 - t_A) + U_T^A + \Pi_1 + \Pi_2,$$

where r_A is income in region A, t_A the (proportional) tax rate, U_T^A is the total utility derived from treatment by patients residing in region A and the value of p_A is set by the regulator through the following welfare maximisation problem:

$$max\ W_A \quad s.t. \begin{cases} p_A \geq c_A \\ t_A r_A = p_A(D_{1,int} + D_{2,int}) + p(D_{3,ext}, D_{4,ext}) - G_A, \\ \Pi_j \geq 0, j = 1,2. \end{cases}$$

As for the equalisation grant, we will both analyse and compare the case where **no grant** is foreseen ($G_A = G_B = 0$) and the case where it is chosen as a **combination** of two kinds of grant:

- Expenditure based:

$$G_i^{EB} = \frac{t_A r_A + t_B r_B}{r_A + r_B}\left(\frac{r_A + r_B}{2} - r_i\right)$$

- Resource based:

$$G_i^{RB} = k\left(\frac{r_A + r_B}{2} - r_i\right)$$

where k is the tax rate at which the central authority decides to equalise resources; usually, this is correlated with a standard level of services. If the public authority pursues full equalisation, the level of k may be the one that would allow to obtain $t_A = t_B$ in First Best (FB). In both cases, the **grant** of one region **equals** the opposite of the other region's grant (i.e., $G_A = -G_B$). In order to consider both mechanisms in a unique framework, we set

$$G_i = \gamma G_i^{EB} + (1-\gamma) G_i^{RB}.$$

The **rationale** for using an expenditure-based grant is that the amount of the latter depends on expenditure. Since increasing quality may be costly, an expenditure-based grant may allow to reduce the burden the less region is facing to increase quality of provision. However, this grant may have two important **countervailing effects**: region A, the one that has to pay for the grant, may have an incentive to reduce quality so that also expenditure (hence the grant it has to pay) decreases; at the same time since region B is financed by the expenditure grant this region may try to incentivise patients mobility in order to reduce their effort. The model above has been used to answer some important policy questions and in what follows we present the main results of the two models that use this common framework.

2.3.1. Patient mobility may increase quality and if so, should it be free or regulated?

In Levaggi & Levaggi (2025b) we show that in some cases **regulated mobility** may be a better alternative to free patients' movement across borders in a setting where a lower[57] government level (national governments in our case) is responsible for health care. From the model presented above a **trade-off** may emerge between **equity** and **efficiency**. Patient mobility improves **welfare**, but this does not always mean that **quality** increases or that the quality gap shrinks and the effects are more important in a context where institutional settings and income are quite different across communities. On the other hand, when a **central planner** is responsible for decisions on quality, regulation of mobility is optimal for the maximisation of total welfare, with an even increased quality gap. If mobility is **free**, the **gap** may be enlarged or reduced, depending on the difference between overall costs and benefits. However, compared to decentralisation, the quality difference is usually higher. In this respect it may be possible to conclude that the choice of making MS responsible for healthcare organisation and quality setting may allow to get a more balanced quality level across regions. Furthermore, also the decision to limit patients' mobility seems to be warranted by the results of this model.

[57] I.e. below the EU level.

2.3.2. Does the form of the equalisation grant matter? If so, does it allow to increase quality and reduce the quality gap?

Let us now turn to study the effect of the grant by starting from examining the **determinants of quality**. Starting from a model where mobility is not allowed (see Annex 1), the **equilibrium** outcome depends on the differential in the **cost** to improve quality, on **mobility** propensity (z) and on the form of the **equalisation grant**, which is the main focus of our analysis. In what follows we will show the most interesting cases from a **policy point of view**.

In Levaggi & Levaggi, (2025a) we show that quality in region A is increasing in p (the price that region B pays for their resident patients treated in A and decreasing in the form of the equalisation grant, i.e. if the grant is served using an expenditure equalisation formula the quality in A is going to be lower other thing being equal. From a benchmark model where mobility is not allowed (see Annex 1), quality is increasing in p because an increase in the price paid for incoming patients will make hospitals in A increase quality, while it is decreasing in the form of the equalisation because an increase in the equalisation grant means that any extra expenditure is paid more by region A than B. For q_B the outcomes are less easy to analyse. An **increase** in the cross-border price has several **effects**: by increasing the quality in region A, more patients are willing to travel, B has to increase its quality to retain more patients. At the same time, the grant increases because of the extra expenditure and the incentive to retain patients decrease. For this reason, the effect is positive only under specific circumstances. In particular, it is possible to determine the following cases which are quite interesting from a policy point of view.

Efficiency (in terms of the non-monetary cost to organise care in their region, the parameter w) in delivering health care in region B determines the effects of the grant. If efficiency is sufficiently high, the region has an interest in increasing quality to make less patients move abroad; the cost is partially financed by region A through the grant. On the contrary if efficiency is too low, they decrease quality in order to reduce their effort; also, in this case part of the cost is paid by A through the grant. In Figure 2, we depict on the **horizontal** axis the ratio of grant that is served as an expenditure-based grant. For $\gamma = 0$ the grant is resource bases while for $\gamma = 1$ the grant is fully expenditure based. On the **vertical** axis we measure quality.

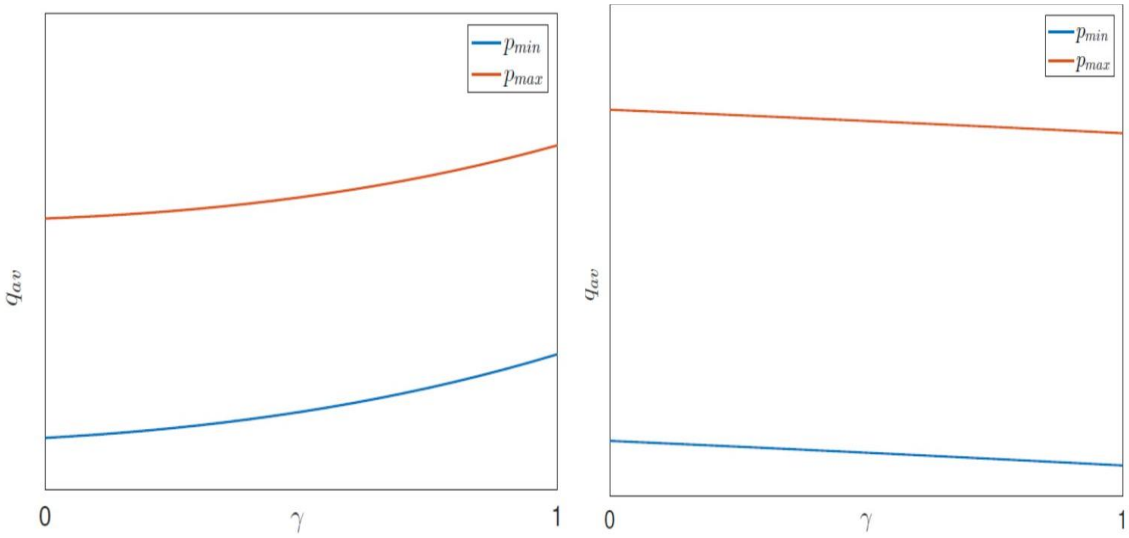

Figure 2: Quality in B when efficiency is high (left) and when efficiency is low (right)

If $w_B z > m$ (left panel), quality in A and B decreases, the quality gap may increase or decrease but certainly average quality decreases as shown in Figure 3. In this case using an expenditure-based grant is meaningless since it reduces average quality in both regions. Patients' **utility** decreases in both regions as well as welfare. Therefore, if the cost to treat patients in region B is sufficiently high, a switch from a resource-based grant to a more expenditure related one is not worth from a policy point of view. The net result is a quality and a welfare decrease.

In this case it may be worth for the upper level to think about reducing or not allowing patients mobility. When mobility is not allowed, the expenditure-based grant may improve quality at least in the less rich region.

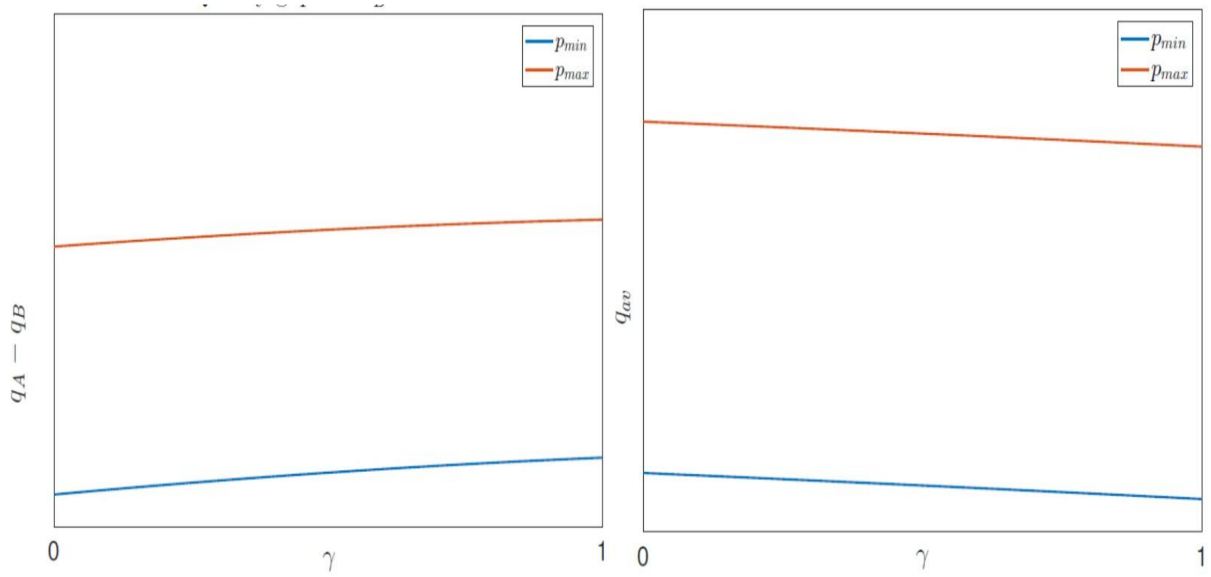

Figure 3: Quality gap and average quality when B is rather inefficient.

When $w_B z < \rho m$ quality in B increases (see Figure 1, right panel) at a higher speed than in A. This implies that the quality gap decreases and average quality increases as shown in Figure 4 and welfare is improving.

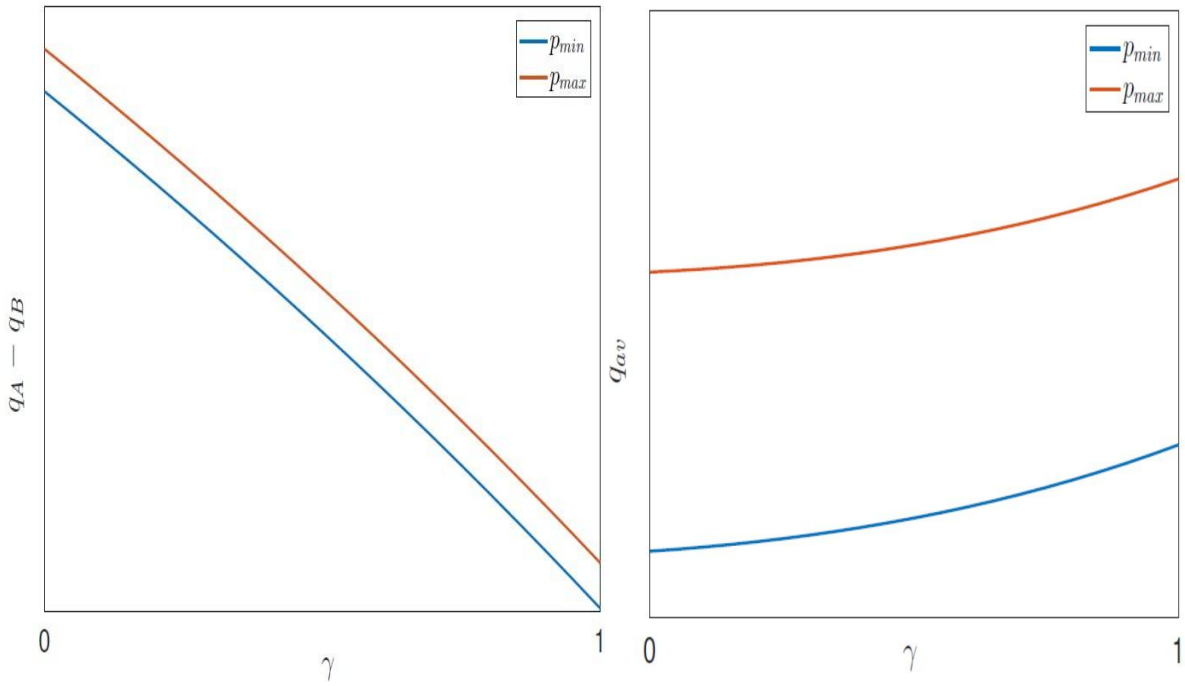

Figure 4: Quality gap and average quality when B is rather efficient

In this case it is possible to show that through an appropriate choice of *p*, the price for mobility across the border, it is possible to get the same quality level in A than under a resource-based grant.

When efficiency is neither too low nor too high, quality in B does not increase enough to increase average quality, the quality gap reduces, patients in B are better off, but the system experiences a reduction in quality of health care. In this case increasing the price p may have countervailing effects so it may not always possible to find a price that allows to increase average quality with an expenditure-based grant.

In **conclusion**, the results presented above show that it is not so easy to disentangle the role of patient mobility and the equalisation grant on quality. First of all, as shown above, an interesting **trade-off** emerges between quality gap and average quality. While the quality gap usually decreases, the same is not true for average quality. In fact, the richer region will respond with a reduction in the price paid for health care for its residents in order to reduce the equalisation grant. On the other hand, the less efficient region may increase or decrease quality according to the level of efficiency in health care provision.

2.4. Discussion

The model above, which realistically portrays patient mobility across borders shows that there does **not** seem to be an **easy answer** to the question of whether patient mobility improves welfare. The first interesting result is that **institutional setting** matters and that a **trade-off** may emerge between **equity** (in terms of quality differences among provided treatments) and **welfare** (finding an allocation that maximise social benefits).

Institutional setting may reflect political choices at national level (as in the case of UK where provision is centralised vs Spain or Italy where it is decentralised), or it may reflect a different framework altogether (mobility at EU level where only the decentralised model can be applied since each country may decide their level of health care provision).

However, since efficiency requires using resources in order to maximise social benefits, this **objective** may not be compatible with a more uniform level of care across regions. Let us turn to the **decentralised** case that better reflects EU patient mobility. Decentralisation with free patients' mobility, increases quality in the more efficient region whenever the cross-border price is higher than the marginal cost, while in region B the effect depends on a comparison of costs and benefits. Policies aimed at reducing patients' mobility may allow to reduce the quality gap, something that seems to support EU law as concerns prior authorisation to be treated abroad (Frischhut & Levaggi, 2015, 2024; Greer et al., 2024).
Likewise, the use of equalisation grants seems to be tricky in this context, although at present this is a less important problem from an EU point of view.

The stylized model described above assumes that the more rich region is also the more efficient; in the real world this may not be the case. However, the results of the model presented above are still valid. For example, an expenditure based grant should never be used if the less efficient region is also the richer one. As shown above, the grant reduces the quality of the richer region and may increase the one of the less rich. If this it the case, an expenditure equalisation grant in a context where the richer region is also the less efficient will undoubtedly increase the gap.

3. Excess capacity

Healthcare organisations face **challenges** that may seriously endanger their future sustainability. Furthermore, austerity at MS level and the economic crisis increase the demand for public spending in other sectors, i.e. they increase the opportunity cost of investing in health care.

Capacity Management (CM), i.e. the ability to find suitable levels of resources to meet demand is increasingly becoming a priority both at hospital and national level (Humphreys et al., 2022; Smith-Daniels et al., 1988). In fact, **too limited** resource capacity is detrimental for the quality of the service (e.g. due to significant rises in waiting times). However, having **too much** idle capacity is equally undesirable given the significant investments required in, e.g. the purchase and maintenance of medical devices, and recurring personnel costs due to sub-optimal use of staff. In some cases, and for some treatments the **quality** (in terms of reduced risk) decreases with the number of annual treatments due to increased experience with the procedure (Mesman et al., 2017). The **literature** has studied the problem mostly with reference to hospital mergers and collaboration among providers (Postma & Roos, 2016; Van der Schors et al., 2021).

In this chapter we argue that some of the capacity management decisions functions could be also managed **at EU level** in order to reduce excess capacity and increase value for money. Furthermore, for the choice of the price it would also be possible to use this instrument to increase **solidarity** among European countries.

In what follows we will discuss how EU intervention and patient mobility may allow to **improve welfare** and make a better use of fixed capacity. The problem will be studied under two different point of view

- Demand pooling
- Supply pooling

In the **first** case (i.e. **demand pooling**), the basic idea is that a treatment requires the use of a technology that has a fixed **capacity** which might not match demand. In particular, the technology may have a capacity that is higher than demand. In this case, if each MS decides to adopt the technology, the sum of excess capacity across several countries (as is the case in Europe) may be quite high. A possible way to avoid this problem is to **pool demand** by making **patients move** across borders to be treated. This solution may be beneficial to both countries under specific circumstances

- the **price** should be convenient and should be lower than the cost to adopt the technology locally

- the **legal agreement** allows the sending country to rely on being able to use the technology abroad in the long run.[58]

The **price** plays an important role in what follows. We propose a very **general model** that allows to set several prices for cross-border treatments, which allows to take into account several factors such as dropouts because of travelling, travelling costs and (possibly) rationing.
In the second case, the demand may fluctuate from one period to the next one and in order to take into account such variability it is necessary to have a higher supply of healthcare. However, as the Covid pandemic has shown, it is possible to pool capacity in order to improve management both in the case where these fluctuations are within a normal range, compared to when they may be high and unexpected.

3.1. Demand pooling

Although healthcare expenditure is mostly publicly funded in Member States (OECD and European Commission, 2016; Paris et al., 2010), per capita composition as well as available medical equipment is quite heterogeneous (Eurostat, 2024a). Since the number of tests per inhabitant is often not in line with this observed heterogeneity, in some countries excess capacity may exist (Eurostat, 2024b)

This evidence calls for better capacity management (CM) decisions. The literature has studied the problem mostly with reference to hospital mergers (Van der Schors et al., 2023) and collaboration among providers (Postma & Roos, 2016; Van der Schors et al., 2021). We propose to use a similar model of collaboration among national governments to achieve a better use of the resource and to reduce unmet needs.

The idea is not new: in the years 2000's the English NHS has persuaded British patients to be treated in France in order to reduce waiting list (Medical Tourism Magazine, 2015; The Connexion, 2018; The Independent, 2002). In this paper we build from this experience to propose to use patient mobility as an extra source of healthcare provision.

Let us assume that a community is divided into **two regions**, A and B where individuals need a specific treatment T. **Demand** is fixed and known, such treatment may or may not require hospitalisation[59] (in other words it may be a diagnostic treatment, some procedure requiring for

[58] Such a legal agreement can, as the case might be, either be a bilateral agreement between the affected MS, or would require a change of EU secondary law.
[59] As mentioned above, under the PMD, hospital treatment triggers prior authorization.

example day hospital or some surgical treatment). What is relevant is that patients must be treated with a technology that has a **fixed capacity** equal to K and a fixed cost F_K, independently of which country it is located. **Marginal costs** to treat patients are country-specific and equal to m_i. The technology has a fixed capacity that can only be replicated. In other words, each technology can be used up to K patient and the only way to treat more than K patients is to adopt two similar technologies. Alternatively, we might think that in one of the two countries or in both demand D_i does not perfectly fit with the production scale of this technology. In other words, $D_i = nK + Q_i$. K patients are treated **locally**, for the **rest** pooling may be necessary. This setting is more realistic than the one we are proposing here, but the results would be the same. For this reason, the model is developed along these lines. On the other hand, in the discussion and the legal implications, we will deal also with the more realistic case[60].
Patients' money equivalent **gain** from a treatment is equal to v and it is homogeneous across patients, i.e all the patients have the same benefit from being treated; if they are not treated, they do not suffer any damage, but their incremental utility is equal to zero. Patients live in two **regions**, A and B, where demand is fixed and equal to $Q_i = A, B$. The **quality** of the treatment offered is the same in both countries: this assumption may be justified with the observation that especially in diagnostic/oncological treatments, the quality of care is determined by the technology use, which we have assumed to be the same in both countries. In this setting, we are going to determine the **best options** to use such technology under the **assumption** that one of the countries has already adopted the technology, a second case where the technology is not used in both countries so that also location is a choice. Finally, we will consider the case of **research and treatment centres** for orphan diseases or for very specialised/experimental treatment, where the EU may decide to pay for the fixed costs.

We assume that $Q_i < K$ so that if a country (or both) take up the technology, **excess capacity** exists. We will start by analysing a framework where $\sum_{i=A,B} Q_i < K$ so that if both countries share the same technology, rationing is not an issue. This assumption will be relaxed in Section 3.3.2 in order to show how rationing can be managed.

If a country decides to take up the technology, it will be able to treat up to K patients, but it will also have to bear an excess capacity equal to $K - Q_i$, which produces an excess fixed cost. For each country the **decision** to uptake the technology **depends** on whether the net benefits of its adoption are higher than the costs, i.e.

[60] See below section 3.4.

$$vQ_i - m_iQ_i - F_K > 0$$

where vQ_i is the money equivalent gain enjoyed in country i by adopting the technology, while $m_iQ_i + F_K$ is the total cost to treat patients with this technology. If both countries adopt the technology, the number of patients that can be potentially treated is $2K$ but only $\sum_{i=A,B} Q_i < K$ will benefit from this expenditure and since $\sum_{i=A,B} Q_i < K$ the costs related to such excess capacity is quite high. With **more** countries, capacity in excess becomes an important issue and managing this excess capacity becomes an important issue, which may **require** some **coordination** from a supra-national authority[61] such as the EU. In what follows we examine two strategies for demand pooling that use patient mobility as an instrument to improve welfare. The first one that we have coined 'centralised decision' (see below, Chapter 3.2.3) assumes that a benevolent 'central planner' sets the price for treatments across the border in order to maximise welfare. The latter may be a simple sum of the welfare of the two regions, or it may be a weighted average, where one of the two has a higher weight. For example, if the central planner would like to pursue solidarity it could increase the weight of the less rich region; in this way the price for the latter would be lower and most of the welfare would accrue to the less endowed region. The case we have defined 'decentralised' (see below, Chapter 3.2.2) foresees a bargaining between the two regions. In this case what is maximised is as before the sum of the welfare of the two regions, but the weights reflect their relative bargaining power, and the more powerful region will be able to get the bigger share of the welfare gain.

3.2. One country has already adopted the technology

Technology adoption is **not symmetric** across countries; for example, for drugs an important gap exists between commercialisation in Europe and the US (Mason et al., 2010; Wallerstedt & Henriksson, 2018; Williams et al., 2025) and the same is true for medical devices and health technologies in general (Hatz et al., 2017; Packer et al., 2006). For this reason, it is quite reasonable to assume that one country may decide for an **early** adoption of a new technology even though $Q_i < K$. Let us then assume that country A has adopted this technology and that $Q_A < K$ The total cost for treatment is

$$C_A = m_AQ_A + F_K$$

and the price to charge for being budget balanced is $p_A = m_A + \frac{F_K}{Q_A}$.

However, if the capacity was fully used, the total cost would increase only by $m_A(K - Q_A)$ so that the price to be charged would be equal to $p_{MIN} = m_A + \frac{F_K}{K}$. i.e. the **unit cost** in country A

[61] See, below, Chapter 3.6.1.

could be lowered, if treatments with the excess capacity can be sold. This is a standard result in the microeconomic literature. The presence of fixed cost, especially when marginal costs are fixed produces **economies of scale** which reduces the average price. It is interesting to note that once the fixed cost has been covered, any extra unit can be charged at a price equal to marginal cost. Hence any price $p > m_A$ is an improvement for country A.

This consideration is important in **setting** the **price** for cross-border treatments. In what follows we present some "equitable" prices, but it would also be possible to combine these prices with some form of **solidarity**, for example the price could be quite close to m_A if the income gap between country B (assumed to the poorer) and country A is significant.
Let us now assume that in another country, B, where a number of individuals Q_B needs the same treatment. The supply is again fixed at K, but now country B has two options:

- send their patients to A;
- treat them locally.

If the technology is offered **locally**, all the patients needing the treatment will ask for it; on the other hand, if **travelling** to A is necessary it may be possible that only a fraction $z_B Q_B$ will choose this option. This is due to non-monetary cost related to moving to another country and depends on the **characteristics** of the **population** as regards age, health literacy, other medical and personal conditions. Travelling cost from B to A may[62] be reimbursed by a MS (since it is their decision not to adopt the technology), but non-financial barriers may reduce demand if treatment is offered abroad. The total cost to treat them locally is

$$C_B = m_B Q_B + F_K$$

while the cost to treat them abroad can be written as:

$$C_M = (p + t) z_B Q_B$$

where $z_B Q_B$ is the number of patients that travels from B to A.
p is the price charged by country A while t are the travelling costs that patients have to pay to be treated abroad. For **hospital care**, Diagnosis-related group (DRG) prices are often set equal for resident and non-residents; in what follows we show that they may be different[63]. From a **policy** point of view, it is interesting to note that a price that depends on the country of residence in this context allows to share benefits in a more equal or solidaristic way. Given that the agreement is at national level, t could be intepreted as an **average cost** that patients must

[62] According to Art. 7 para. 4(2) PMD, the MSA "may [!] decide to reimburse other related costs, such as accommodation and travel costs". See also at note 82.
[63] The wording "different" should of course, from a legal perspective, not amount to discrimination (see Chapter 2.1).

bear (and possibly the national health system must reimburse), not the exact cost that each patient has be reimbursed.

Patients in country B have the same gain as the one treated in A, i.e. the utility of being treated is equal to v. Let us now **split** the **demand** for treatment in country B in two parts: patients that are treated in country A ($z_B Q_B$) and those that will not be treated ($(1 - z_B)Q_B$) because some of them do not want to travel/rationing:

$$Q_B = z_B Q_B + (1 - z_B)Q_B$$

Let us also assume that the price p_B, i.e. the price that is charged by country A to treat cross-border patients is made up of two parts:

- the marginal cost m_A
- a contribution y to the payment of the fixed cost F_K.

Let us then define B 's **total utility** for treating patients in A :

$$U_M = (v - m_A - y - t)z_B Q_B$$

while utility for treating them locally is equal to

$$U = (v - m_B)Q_B + F_K$$

We can then find the **maximum price** that B is willing to pay to give up on the idea to have its own technology and send its patients to A. This is the price that make equal to the utilities, i.e.

$$(v - m_A - y - t)z_B Q_B = (v - m_B)Q_B - F_K$$

The **maximum contribution** can be written as:

$$y = m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{1}{z_B Q_B}F_K$$

so that the **maximum price** that B is open to pay is equal to:

$$p_B = \frac{F_K}{Q_B} + m_B - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + F_K\frac{1-z_B}{z_B Q_B}$$

where the first two terms represents the price that would be charged locally if B was adopting the technology; t is travelling cost, $\frac{(v-m_B)(1-z_B)}{z_B Q_B}$ is a measure of the welfare loss incurred by B because of the patients that decide to give up treatment.

Provided that $F_K\frac{1-z_B}{z_B Q_B} - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) - t < 0$,for B it is more convenient to send patients to country A. For A, the **minimum acceptable price** is equal to m_A , i.e. the price should cover the marginal costs.

3.2.1. Price setting

For $p_B = \frac{F_K}{Q_B} + m_B - t + F_K\frac{Q_0}{Q_M(Q_M+Q_0)} - \frac{(v-m_B)Q_0}{Q_M} > m_A$ pooling treatment in country A allows to **maximise welfare** in both countries. The price chosen determines how this **gain** can be **split** between the two countries. In this respect, we can think about two main ways in which price is determined

- **Decentralised** decision (see also below, Chapter 3.2.2): The two countries decide the price through a bargaining. In this case the relative weight of welfare in both countries depends on the relative bargaining power of the two countries.
- **Centralised** decision (see also below, Chapter 3.2.3): A benevolent planner decides to maximise the joint (weighted) welfare of both countries. This may be considered as a sort of **equitable** price since it allows to split the gains from sharing the technology fairly among the two countries.

From an algebraic point of view, the two approaches can be treated in the same way since the objective function can be written in the same way. The starting point is to define two prices for the use of such technology: one paid by country A and another one paid by country B:

$p_A = m_A + x$

$p_B = m_A + y$

In order to share the gain equally, it is important to define the extra gain that each MS has in sharing the technology. Let us then define for each country their welfare differential. We will start with B for which it is easier to define such difference.

What about the welfare difference for B? Country B has to compare the welfare for sending patients abroad with what would be gained by treating them locally. The option to send them abroad will have a monetary cost equal to $p_B + t$ and a welfare cost in terms of the patients that give up treatment equal to $(v - m_B)(1 - z_B)Q$ on the other hand they will avoid to pay $\left(m_B + \frac{F_K}{Q_B}\right) Q_B$, i.e. the cost to run the technology. The welfare difference can be written as:

$$W_B = (v - p_B - t) z_B Q_B - \left(v - m_B - \frac{F_K}{Q_B}\right) Q_B$$
$$= -z_B Q_B (m_A - p_B)$$

What about the welfare difference for A? For A the welfare has more elements. The same number of patients is treated, but their cost increases by $m_A(z_B Q_B)$. Furthermore, in order to define an equitable sharing of the welfare benefits it is also necessary to define a price p_A for treatments by residents.

The welfare difference can be written as follows:

$$W_A = (vQ_A - m_A(Q_A + z_B Q_B) - p_A Q_A + p_A Q_A + p_B z_B Q_B - F_K) - \left((v - m_A)Q_A - F_K\right)$$

$= -z_B Q_B (m_A - p_B)$.

3.2.2. Decentralised solution

In the present legislation framework, the solution proposed below is the only one that is compatible with EU legislation. According to Art. 168 para. 7 TFEU, the Member States are

responsible for the "definition of their health policy and [⋯] the organisation and delivery of health services and medical care", as well as "the management of health services and medical care and the allocation of the resources assigned to them". In fact, due to this allocation of competences between EU and Member States, only the latter can set prices for health care services.

Following the existing **literature** (Gamba et al., 2020; L. Levaggi & Levaggi, 2021, 2024a, 2024c), we assume that the price is set through a **Nash bargaining** process between the countries. The bargaining strength determines how the welfare gain is shared between the two countries, and the price is instrument. In our case the bargaining strength is represented by α.

In analytical terms, the bargain may be written as the solution to a **maximisation problem** where the objective function is represented by the total welfare difference under the constraint that both MS have a **gain** and that the **budget** is **balanced**, i.e. the prices charge is able to meet cost. As concerns the first set of constraints, we have already defined above the **price ranges** for which demand pooling is beneficial to both MS.

To meet the second constraint, we can define the price for **each treatment**, where p_A is the price for residents and p_B the one for cross-border patients.

$p_A = m_A + x$

$p_B = m_A + y$

Since the price incorporates **marginal costs**, it is sufficient to share the **fixed costs** between the two regions, i.e. to find a fixed unit cost share x and y for which the fixed costs are alway covered. The following constraint allows to reach this objective:

$xQ_A + yz_BQ_B = F_K$

This implies that y should be **equal** to $y = \frac{F_K - xQ_A}{z_BQ_B}$

The problem is to find p_A and p_B in order to maximise weighted total welfare

$$Max_{p_B} W_A + W_B = \alpha\, ln\big(-z_BQ_B(m_A - p_B)\big) + (1-\alpha)\, ln\big((m_B - t - p_B)z_BQ_B - (v - m_B)(1 - z_B)Q_B + F_K\big)$$

$$s.t$$

$$p_B = m_A + y$$

$$m_A \le p_B \le$$

$$y = \frac{F_K - xQ_A}{z_BQ_B}$$

where $\alpha \in [0,1]$ is the bargaining power of MS A. Substituting the two constraints into the objective function, we can obtain an **unconstrained maximisation**. The First Order Conditions can be written as:

$$\frac{\partial(W_A + W_B)}{\partial x} := 0$$

and the optimal solution is

$$x = \frac{1-\alpha}{Q_A} F_K + Q_B \alpha \frac{z_B}{Q_A}(m_A - m_B + t) + \alpha \frac{Q_B(1-z_B)}{Q_A}(v - m_B)$$

Substituting back into the constraint we can define y as:

$$y = \alpha \left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B} \right)$$

Prices can be written as:

$$p_A = m_A + \frac{1-\alpha}{Q_A} F_K + Q_B \alpha \frac{z_B}{Q_A}(m_A - m_B + t) + \alpha \frac{Q_B(1-z_B)}{Q_A}(v - m_B)$$
$$p_B = m_A + \alpha \left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B} \right)$$

which satisfy the second constraint that both regions should be willing to **pool demand**. In fact, for $\alpha = 0$, $p_A = m_A + \frac{1-\alpha}{Q_A} F_K$ and $p_B = m_A$, which is exactly the minimum chargeable price for cross-border mobility. A in this case pays the same price it would have to bear if no patients were moving from B to A.

On the other hand, if $\alpha = 1$ prices would be $p_A = m_A + \frac{Q_B}{Q_A}\left(z_B(m_A - m_B + t) + (1 - z_B)(v - m_B)\right)$ and $p_B = m_B + \frac{F_K}{z_B Q_B} - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B)$ which are within the acceptable interval.

3.2.3. Centralised solution

In what follows we present a second solution that could be implemented should EU be able to set prices. Although at present this solution is not viable, we think it is important to present it so that in the final discussion we can highlight the relative merits of using such procedure. For a centralised solution, a **benevolent regulator** would maximise total welfare, possibly with some weights. The objective can be written as in the problem above so that the solution is exactly the same.

$$p_A = m_A + \frac{1-\alpha}{Q_A} F_K + Q_B \alpha \frac{z_B}{Q_A}(m_A - m_B + t) + \alpha \frac{Q_B(1-z_B)}{Q_A}(v - m_B)$$
$$p_B = m_A + \alpha \left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B} \right)$$

3.3. Both countries have not yet adopted the technology.

3.3.1. Introduction

Let us assume that a new technology is available either for **treatment or** for **diagnostic**. As in the previous section, it requires a fixed investment F_K and may allow to treat a fixed number of patients.

In this case if both countries decide to take up the technology, they may treat up to K patients locally, but with an excess capacity equal to $K - Q_i$ which produces an excess fixed cost. If both countries adopt the technology, the number of patients that can be potentially treated is $2K$ but only $\sum_{i=A}^{B} Q_i$ will benefit from this expenditure and the **costs** related to such excess capacity may be quite high. In this case, since the technology has not been adopted, we will first decide its **location** and then how the **benefits** can be **shared**. Provided such benefits are positive for both countries, this solution is going to be superior to adopting the technology locally. Let us then decide **where** to locate the technology. For taking such decision, we may use two different approaches:

- **Cost minimisation**: the location is chosen in order to minimize the total cost of provision.
- **Welfare maximisation**: the location is chosen in order to maximise total welfare in both regions.

If **all** the patients that are eligible for treatment will choose to be treated, independently of the location of the lab/technology, the two approaches would reach the same result. This must not necessarily be true if a **part** of patients give up treatment because of travelling, especially if this share is asymmetrical across countries. For example, let us assume that the patients needing treatment in both countries are the same, but patients in B are less willing to travel than the residents in A. In this case the costs for **locating** the technology in A may be lower not because of efficiency, but simply because of the drop in the number of treatments due to the dropout in B.

In what follows we present the **more interesting** case where **some** patients give up treatment and for this case, we think that **welfare maximisation** should be used **rather than cost** minimisation. However, from a practical perspective while costs may be observed, the **dropout** rate may be more **difficult** to be predicted.

Annex 2.2.1 records the case where **all** the patients get treated. In what follows we present the more interesting case where in both countries a share $(1 - z_i)$ of patients **give up** treatment if they have to go abroad.

Locating the technology/lab when $\boldsymbol{Q_A + Q_B < K}$: Let us first assume that the sum of the demand in A and B is lower than the fixed capacity. In this case, rationing is not an issue. The first thing to decide is **where** to locate the technology. We will assume that although $\boldsymbol{Q_A}$ patients in $\boldsymbol{A}$ need treatments, only $\boldsymbol{z_A Q_A}$ are open to travel to $\boldsymbol{B}$ so that, if the technology is located in $\boldsymbol{B}$, $\boldsymbol{(1 - z_A)Q_A}$ patients will decline treatment. On the other hand, $\boldsymbol{Q_B}$ patients need treatment and are willing to be treated if the technology is locate in $\boldsymbol{B}$, but only $\boldsymbol{z_B Q_B}$ are open to travel to $\boldsymbol{A}$ so that $\boldsymbol{(1 - q_B)Q_B}$ are not treated. This is a problem similar to the one that is faced when two facilities[64] have to be merged and the decision maker has to choose the location. T Finally, the model will be analysed in the light of the current EU legislation to ensure its practical feasibility.

The **first** interesting question[65] that arises in this context is what should be the **objective** that the decision makers pursue in choosing the best location, namely cost minimisation or welfare maximisation. Should all the individuals choose to travel, the two objectives would give the **same** result, because in this case in fact cost minimisation corresponds to welfare maximisation. However, when some individuals give up treatment and especially when this decision is not symmetric (i.e. $\boldsymbol{z_A \neq z_B}$), the two **results** may be **different**.

Welfare maximisation takes into account the increase in welfare that patients get from being treated and the cost. In this respect, patients dropping because they do not to travel to another country are an opportunity cost that has to be weighed against the actual costs. **Cost minimisation** takes into account only actual cost and in this respect a dropout is in fact a gain because by giving up treatment they drive their cost to zero.
We think that welfare maximisation should be the **informing criterion** because it takes into account the welfare losses determined by dropout. Let us then write the welfare function if the technology is located in A[66]:

[64] On terminology, see at note 118.

[65] On the second question, see at the end of this chapter.

[66] Since individuals that do not get treated receive no utility, but no loss we can simply take into account the welfare gain of those the move from B to A.

$$W^A = v(Q_A + z_B Q_B) - m_A(Q_A + z_B Q_B) - F_K - t z_B Q_B$$

and if it is located in B

$$W^B = v(Q_B + z_A Q_A) - m_B(Q_B + z_A Q_A) - F_K - t z_A Q_A$$

We can then find the marginal cost m_A for which the two total welfares are equal, i.e.

$W^A = W^B$

$v(Q_A + z_B Q_B) - m_A(Q_A + z_B Q_B) - F_K - t z_B Q_B = v(Q_B + z_A Q_A) - m_B(Q_B + z_A Q_A) - F_K - t z_A Q_A$

i.e.

$$m_A^W = \frac{Q_A(1 - z_A) - Q_B(1 - z_B)}{Q_A + z_B Q_B} v + \frac{z_A Q_A + Q_B}{Q_A + z_B Q_B} m_B - \frac{z_B Q_B - z_A Q_A}{Q_A + z_B Q_B} t$$

The formula above can be **interpreted as follows**: it is more convenient to locate the technology in A if the price to treat patients there is lower than a threshold that depends on the marginal cost in B (m_B) minus the travel costs (t), both weighed by the different number of patients treated and travelling. The third element Is $\frac{Q_A(1-z_A)-Q_B(1-z_B)}{Q_A+z_B Q_B} v$ which measures the difference (in terms of opportunity cost) of the different level of dropouts we get according to whether the technology is in A or B.

On the contrary, if **cost minimisation** is the criterion, as shown in Annex 2.2.2. the price that makes the two location indifferent is $m_A^C = \frac{z_A Q_A + Q_B}{Q_A + z_B Q_B} m_B - \frac{z_B Q_B - z_A Q_A}{Q_A + z_B Q_B} t$ which can be higher or lower than m_A^W depending on the sign of $\frac{Q_A(1-z_A)-Q_B(1-z_B)}{Q_A+z_B Q_B} v$.

The **second** interesting question is related to how to set the **price** in order to share the gains from demand pooling in an equitable way between the two countries.

3.3.2. Setting the price

Let us then assume that $m_A^W \leq \frac{Q_A(1-z_A)-Q_B(1-z_B)}{Q_A+z_B Q_B} v + \frac{z_A Q_A + Q_B}{Q_A+z_B Q_B} m_B - \frac{z_B Q_B - z_A Q_A}{Q_A+z_B Q_B} t$ so that the technology should be located in A. Let us define the price by a **bargaining solution**, which, as before, corresponds to the maximisation of total (weighted) welfare by a benevolent regulator[67]. As before, the problem is to find p_A and p_B so that

$$Max_{p_B} W_A + W_B = \alpha \, ln\big(z_B Q_B (p_B - m_A)\big) + (1 - \alpha) \, ln\big((v - p_B - t) z_B Q_B - (v - m_B) Q_B + F_K\big)$$

$$s.t$$

$$p_B = m_A + y$$

$$y = \frac{F_K - x Q_A}{z_B Q_B}$$

[67] See Annex 2.2.2 for a derivation of the welfare difference.

where the second constraint allows to be budget balanced. The derivation of the solution is presented in Annex 2.2.1. Prices can be written as:

$$p_A = m_A + + \frac{1-\alpha}{Q_A} F_K + \alpha \frac{Q_B(1-z_B)}{Q_A}(v - m_B) + \alpha \frac{z_B Q_B (m_A + t - m_B)}{Q_A}$$

$$p_B = m_A + \alpha \left(\frac{F_K}{z_B Q_B} + (m_B - t - m_A) - \frac{Q_B(1-z_B)(v-m_B)}{z_B Q_B} \right)$$

For an equitable allocation of the welfare gains $\left(\alpha = \frac{1}{2}\right)$ we can write:

$$p_A = m_A + \frac{1}{2}\frac{F_K}{Q_A} + \frac{1}{2}\frac{Q_B(1-z_B)}{Q_A}(v - m_B) + \frac{1}{2}\frac{z_B Q_B (t + m_A - m_B)}{Q_A}$$

$$p_B = m_A + \frac{1}{2}\frac{F_K}{z_B Q_B} - \frac{1}{2}\frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) - \frac{1}{2}(m_B - t - m_A)$$

Let us now assume that although $Q_i < K$ so that if a country (or both) take up the technology excess capacity exists, $Q_A + Q_B > K$. which means that **rationing** may be possible in equilibrium. The rationing is a certainty if all the patients want to be treated and this case is presented in Annex 2.2.2.

In the more realistic case, where **only** a **fraction** of patients may be **willing to travel** abroad in order to receive care, two scenarios may be proposed:

- A first case where patients **dropout** allows to reduce demand enough to avoid rationing. If this is the case, the analysis is equal to what is presented in Annex 0;
- A more interesting case is instead represented by the case where the constraint on the quantity is biting because $Q_i + z_i Q_j > K$, i.e. **supply** (the maximum capacity of the facility) is **lower** than demand.

In what follows we use the same approach presented above. Since the convenience to merge demand depends on the price, we will first determine the **location** that maximises total welfare and the set of **prices** that share the benefits equally, we will then discuss under which **conditions** the solution is viable.

Locating the facility when $\boldsymbol{Q_A + Q_B > K}$: We will assume that although Q_A patients in A needs treatments, only $z_A Q_A$ are open to travel to B so that if the technology is located in B $(1 - z_A)Q_A$ patients will not be treated. On the other hand, Q_B patients need treatment and are willing to be treated if the technology is locate in B, but only $z_B Q_B$ are open to travel to A so that $(1 - q_B)Q_B$ are not treated. In order to show the more general case, we assume that both $z_A Q_A + \ Q_B$ and $z_B Q_B + \ Q_A < K$ so that no matter which region is chosen rationing has to be

implemented. In what follows, we assume that rationing is imposed on actual demand (i.e. on the number of patients that are willing to receive treatment).

Let us then write the **welfare difference** function if the technology is located in A[68]:
In this case, the number of treatment demanded is equal to $Q_A + z_B Q_B > K$. With proportional rationing the number of patients treated is $r_A(Q_A + z_B Q_B) = K$ and the welfare if patients are treated in A can be written as:

$$W^A = (v - m_A) r_A (Q_A + z_B Q_B) - F_K - t r_A z_B Q_B$$

and if it is located in B

$$W^B = (v - m_B) r_B (Q_B + z_A Q_A) - F_K - t r_B z_A Q_A$$

We can then find the **marginal cost** ma for which the two total welfares are equal, i.e.

$$W^A = W^B$$
$$(v - m_A) r_A (Q_A + z_B Q_B) - F_K - t r_A z_B Q_B = (v - m_B) r_B (Q_B + z_A Q_A) - F_K - t r_B z_A Q_A$$

The level of the marginal price for which this is true is equal to:

$$m_A^W = \frac{r_A Q_A (1 - z_A) - r_B Q_B (1 - z_B)}{Q_A + z_B Q_B} v + \frac{r_B (z_A Q_A + Q_B)}{Q_A + z_B Q_B} m_B - \frac{r_A z_B Q_B - r_B z_A Q_A}{Q_A + z_B Q_B} t$$

As shown in Annex 2.2.2, the level of marginal price for which technology should be located in A under cost minimisation would be equal to $m_A^C = \frac{z_A Q_A + Q_B}{r_A (Q_A + z_B Q_B)} r_B m_B - \frac{r_A z_B Q_B - r_B z_A Q_A}{Q_A + z_B Q_B}$ which may be higher or lower than m_A^A according to the sign of $\frac{r_A Q_A (1 - z_A) - r_B Q_B (1 - z_B)}{Q_A + z_B Q_B} v$ which measures the welfare loss incurred by both regions because of dropout. As we can note in this case, the opportunity cost is different because the effect of rationing may be different according to whether the technology is going to be located.

For $m_A < \frac{z_A Q_A + Q_B}{r_A (Q_A + z_B Q_B)} r_B m_B - \frac{r_A z_B Q_B - r_B z_A Q_A}{Q_A + z_B Q_B} t$ the best alternative is to locate the technology in A. As before, the problem is to find p_A and p_B that allows to maximise the welfare of the two countries under the constraint that the fixed and variable costs are covered. As in the previous example, the benchmark on which to evaluate the welfare difference is adopting a separate technology in each country.

$$Max_{p_B} W_A + W_B = \alpha \, ln\big((p_B - m_A) r_A z_B Q_B - (v - m_A)(1 - r_A) Q_A\big) + (1 - \alpha) \, ln\big((v - p_B - t) r_A z_B Q_B - (v - m_B) Q_B + F_K\big)$$

$$s.t$$
$$p_B = m_A + y$$
$$y = \frac{F_K - x r_A Q_A}{r_A z_B Q_B}$$

[68] Since individuals that do not get treated receive no utility, but no loss we can simply take into account the welfare gain of those that move from B to A.

Where the first constraint is the definition of the price and the second (given that $p_A = m_A + x$) allows to reach budget balance. The solution in terms of optimal prices can be written as:

$$p_A = m_A + \frac{1-\alpha}{r_A Q_A} F_K - \frac{Q_A(1-\alpha)(1-r_A)}{r_A Q_A}(v - m_A) + \frac{\alpha Q_B(1-r_A z_B)}{r_A Q_A}(v - m_B) + \alpha r_A z_B Q_B \left(\frac{t - m_B + m_A}{r_A Q_A}\right)$$

$$p_B = m_A + \left(\alpha \frac{F_K}{r_A z_B Q_B} + \alpha(m_B - m_A - t) + \frac{Q_A(1-\alpha)(1-r_A)}{r_A z_B Q_B}(v - m_A) - \frac{\alpha Q_B(1-r_A z_B)}{r_A z_B Q_B}(v - m_B)\right)$$

For $\alpha = \frac{1}{2}$ we can write:

$$p_A = m_A + \frac{F_K}{2 r_A Q_A} - \frac{Q_A(1-r_A)}{2 r_A Q_A}(v - m_A) + \frac{Q_B(1-r_A z_B)}{2 r_A Q_A}(v - m_B) + r_A z_B Q_B \left(\frac{t - m_B + m_A}{2 r_A Q_A}\right)$$

$$p_B = m_A + \frac{1}{2}\left(\frac{F_K}{r_A z_B Q_B} + (m_B - m_A - t) + \frac{Q_A(1-r_A)}{r_A z_B Q_B}(v - m_A) - \frac{Q_B(1-r_A z_B)}{r_A z_B Q_B}(v - m_B)\right)$$

In Annex 2.2.2 we also show that these prices are compatible with the welfare difference for both countries being higher than zero, i.e. both countries are willing to pool resources. Likewise in this case, prices take explicitly into account the different effect that rationing is going to have on the welfare difference in both regions.

3.4. Discussion

The model presented above, although very simple, allows to draw some interesting **policy implications**. Although the cost to provide the treatment is the same for residents and non-residents, price differentiation may allow to distribute the **benefits** of pooling in a more **equitable** way. This is true, no matter which is the specific objective of price setting, i.e. **solidarity** (where making one of the regions to pay less may seem more acceptable because the objective in this case is to reduce the financial burden of the less rich region), an **equitable division** of the benefits of pooling (i.e. a price that allows to increase welfare in both regions in the same way), or a **bargaining** between the two regions (i.e. the price reflects the relative strength and skills of regions in bargaining for getting the highest possible part of the gains deriving from pooling). In actual fact, price differentiation is always a superior option, no matter which objective should be pursued. This is because in pooling demand the benefits and the costs of this option are **asymmetric**.

Let us consider the case presented above. As discussed earlier, region **A** has no welfare losses provided that the price paid by B is at least equal to the marginal cost m_A. This is not true for **B**, whose patients have to pay an extra price t to be treated. From a welfare point of view, it is

irrelevant who is paying this cost (the patient or the MS: it represents a **drain of resources**). Furthermore, some patients may decide to give up treatment if the latter is available only across the border and this furtherly reduces the welfare of country B. However, our model shows that these **welfare losses** may be partially compensated with the price system. The amount (hence the partial compensation) depends either on the bargaining power of the two regions (in a decentralised solution) or by the objectives of the central planner (in a centralised solution).

$$p_A = m_A + \frac{1-\alpha}{Q_A}F_K + Q_B\alpha\frac{z_B}{Q_A}(m_A - m_B + t) + \alpha\frac{Q_B(1-z_B)}{Q_A}(v - m_B)$$
$$p_B = m_A + \alpha\left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B}\right)$$

For example, let us consider $\alpha = 0$ which implies that all the power (in decentralisation) is upon B. In this case the price in B is equal to ma (the marginal cost), while in A it is exactly equal to the price without cross-border mobility. The welfare gain in A is zero, i.e. the whole gain is allocated to B. This solution in a centralised system may represent a solution that realises the maximum degree of solidarity. Region B is asked to pay the minimum price compatible with budget balance. This also means that a uniform price in both regions is not equitable from a welfare point of view. In what follows we compare a reimbursement based on a standard cost-based model such as a DRG/average DRG average-based costing (Leister & Stausberg, 2005; O'Reilly et al., 2012).

To better understand this point, let us rewrite the equations for an **"equitable" price**, i.e. a set of p_A, p_B for which the welfare gain is **split equally** among the two countries.

$$p_A = m_A + \frac{1}{2Q_A}F_K + \frac{z_B Q_B}{2Q_A}(m_A - m_B + t) + \frac{Q_B(1-z_B)}{2Q_A}(v - m_B)$$
$$p_B = m_A + \frac{1}{2}\left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B}\right)$$

As shown in Annex 2.2.2. a uniform price would imply to set $p_B = p_A = m_A + \frac{F_K}{Q_A + z_B Q_B}$ and the difference in welfare deriving from this policy could be written as:

$$W_A - W_A^u = \frac{z_B Q_B(m_B - t - m_A) - (1-z_B)(v - m_B)Q_B}{2} + \frac{1}{2}F_K\frac{Q_A - z_B Q_B}{Q_A + z_B Q_B}$$

$$W_B - W_B^u = \frac{1}{2}(v - m_B)(1-z_B)Q_B - \frac{1}{2}z_B Q_B(m_B - t - m_A) - \frac{1}{2}F_K\frac{Q_A - z_B Q_B}{Q_A + z_B Q_B}$$

Which can be positive or negative according to the parameters?

Finally, as shown above, $z_B Q_B$ may be equal to Q_B or it can be lower for two reasons:

- some patients may decide not to be treated abroad;
- the capacity $K - Q_A$ is not enough to treat them all $(K - D_A = Q_M < Q_B)$.

difference with price equal for both.

It is interesting to note that in the model we propose, these elements are taken into account in the price. To show this, let us consider the equation below and in particular the price for B.

$$p_A = m_A + \frac{1}{2Q_A}F_K + \frac{z_B Q_B}{2Q_A}(m_A - m_B + t) + \frac{Q_B(1 - z_B)}{2Q_A}(v - m_B)$$
$$p_B = m_A + \frac{1}{2}\left(m_B - m_A - t - \frac{Q_B(1 - z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B}\right)$$

Even in a setting where benefits are split equally, we see that the **price** is equal to the marginal cost minus the marginal price difference for the two options $(m_B - m_A)$ minus the travel cost t and another element price reduction $\frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B)$, which represents a compensation for the loss in utility in B due to either rationing or dropout. These elements are **weighted** by the importance that the welfare of B has with respect to A (in this case for an equitable price ½). The intuition behind this result is that in pooling demand, the benefits and the costs of this option are asymmetric. Provided that the price paid by B is at least equal to the marginal cost m_A, the only welfare loss suffered by A derives from **rationing**. Patients in B, on top of rationing, have to pay an **extra price** to be treated and some may give up treatment because of non-monetary costs.

From the **EU perspective**, it is interesting to understand, which system would prevail in price system. In a **decentralised** system it is the bargaining power of the two countries that determines the outcome. For example, let us set $\alpha = 0;\ \beta = 0$ in equation which implies that all only the welfare difference in B is considered. In A the price will be equal to the one without cross-border mobility and the welfare gain in A is zero. As α increases, also the price and the welfare difference in A goes up. This implies that benefits will be shared according to the relative bargaining power of the two countries, i.e. α. At **decentralised** level these objectives may be in contrast with solidarity (i.e. a favourable price for the more disadvantaged country). In a **centralised** system the regulator could impose the price, but the practical application of this principle depends on whether the super-national regulator has the economic and legal power to do so. At EU level, for example this is not possible at present, and this may mean that the

objective of solidarity may be difficult to be pursued in capacity pooling.[69] This calls for a possible proposal to allow more power from EU to suggest prices especially when patients move from low to high income countries.

Another interesting aspect from a policy point of view, the choice of the objective, may make a difference in determining the **location** of the technology. In particular, in a context where dropout is asymmetric, choosing the location that minimises cost may not imply that the most efficient location has been chosen, unless per patient cost is chosen. In fact, what is compared is **expenditure** in A and B and the latter depends on the price charged but also on the number of treatments required. When capacity is not fully used, the difference in the dropout rate may drive this difference. On the contrary, **welfare maximisation** allows to take into account the welfare loss of individuals that give up treatment because they must travel cross-border. Also, in this case (and in the opposite way with respect to cost minimisation), the region with higher dropouts may be the one where the technology is located. The final element that can be considered is **rationing**; in our approach we have used a uniform rationing based on actual demand.

In fact, other alternatives may be viable. Since moving, either from A to B or viceversa make some patients give up care, the country where the lab is not located already suffers rationing because of this decision. It might be more equitable to impose rationing on the potential demand $Q_A + Q_B$, but in this case if the rationing is lower than the dropout, the technology will not be fully used and some patients in the country where the technology is located will not be able to access the technology. It is however interesting to note that the price takes this into account through the term.

3.5. Relevant EU legal framework and analysis

In addition to what has been covered above in Chapter 2.1 (i.e. quality and international state-of-the-art, ERNs, values of solidarity and equity, including non-discrimination[70]), in the following, the legal framework relevant for our model of excess capacity shall be clarified.

As mentioned above, the EU legal framework consists of the constitutional framework (i.e. EU **primary law**) and the relevant EU secondary law, i.e. EU regulations and EU directives. This constitutional framework grants the Member States the legal authority to decide on the

[69] See note at note 71.

[70] On non-discrimination, see also in the following.

organisation and financing of their healthcare systems.[71] Despite this responsibility of EU Member States, there are basically two documents of EU **secondary law** that provide two legal possibilities to seek treatment abroad, the PMD and the SSCR.[72] Patient mobility can typically be distinguished in unplanned (emergency) and planned care (Mullan et al., 2022). Besides emergency care, the SSCR principally provides for **planned** care that requires **prior authorisation**, while the PMD essentially requires prior authorisation for **hospital** care (and in case of cost-intensive infrastructures)[73], but not in case of outpatient care.[74] In what follows, we will highlight some key issues of the present EU legal framework, as a change to EU primary law is not a realistic option. Therefore, we will focus on what can be achieved under the **existing** framework of EU **secondary** law (i.e. PMD and SSCR) and to what extent this framework would need to be adapted.[75]

In case of **planned** cross-border treatment, the **initiative** originates primarily from the patient, or at best from the responsible doctor.[76] As long as it is the free decision of the patient, the Member State nudging the patient to seek treatment abroad would not be an issue. In the *Smits and Peerbooms* case, the ECJ has accepted that in case of treatment received in a hospital, planning must be possible concerning "the number of hospitals, their geographical distribution, the mode of their organisation and the equipment with which they are provided, and even the nature of the medical services which they are able to offer"[77]. These planning activities are legitimate insofar as they pursue the objective of "ensuring that there is sufficient and permanent

[71] According to Art. 168 para. 7 TFEU, this includes the "definition of their health policy and [⋯] the organisation and delivery of health services and medical care", as well as "the management of health services and medical care and the allocation of the resources assigned to them".

[72] The SSCR is linked to the free movement of workers and the PMD to the freedom of services.

[73] See note 13.

[74] For further details, see, for example, Frischhut & Levaggi, (2023) 15-29.

[75] Please note: A change to EU **primary** law requires unanimous agreement among all 27 Member States. Depending on each Member State's constitutional requirements, this may involve only the approval by the executive branch of powers (i.e. government), or it may also require involvement of the legislative branch of power (i.e. parliament), or even a referendum. In contrast, changes to EU **secondary** law follow a different procedure: they basically require a proposal from the European Commission, followed by approval from both the European Parliament and the Council of Ministers. See also below, Chapter 4.6.

[76] This may be the case if the doctor has a better overview of treatment options abroad or, for example, if the patient is in a coma. For the latter situation, see ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, paras. 31-35.

[77] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 76.

access to a balanced range of high-quality hospital treatment in the State concerned"[78]. Besides quality[79], likewise the objective of controlling the costs has also been accepted by the ECJ.[80]

While based on these considerations the ECJ has accepted prior authorization to **avoid outflows** of patients that put a health system at risk, in our opinion this should also be possible to **encourage** such outflows and to support a **joint effort** of two or more Member States "to avoid the phenomena of hospital overcapacity, imbalance in the supply of hospital medical care and logistical and financial wastage"[81]. Or in other words, instead of keeping patients from going abroad, the same planning rationale (in terms of quality and cost) should also allow to encourage patients to access services at **joint facility** in another Member State.

Travelling costs may be reimbursed by a Member State as it can freely decide to pay for such cost.[82] The only limitation is a principle of **non-discrimination**, according to which the decision to pay for travel and accommodation cost occurred in their country then also triggers the obligation to pay for such cost in case of cross-border treatment.[83] In other words, the Member States can freely decide to pay (or not to pay) for such cost occurred within their own country, but if they do so, then based on the principle of non-discrimination they also have to pay for it in cross-border situations. In case Member State want to nudge patients to seek treatment abroad, they would be well advised to offer the relevant information and to cover travel (and eventually also accommodation) costs, a comprehensive package, so to speak. Under the SSCR, the MSA could ask for prior authorization via the S2 form.

Hence, in this situation **capacity management** can lead to a situation where two (or more) Member States decide to operate one supply centre in one Member State.[84] The legitimate aim

[78] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 78.
[79] See Chapter 2.1.
[80] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 79: the "desire to control costs and to prevent, as far as possible, any wastage of financial, technical and human resources".
[81] ECJ judgment of 12 July 2001, Case C-157/99, *Smits and Peerbooms*, ECLI:EU:C:2001:404, para. 106.
[82] According to Art. 7 para. 4(2) PMD, the MSA "may [!] decide to reimburse other related costs, such as accommodation and travel costs".
[83] See Chapter 2.1.
[84] Such cooperation would also be in line with the principle of sincere cooperation (Art. 4 para. 3 TEU).

to plan hospital treatment can then overrule patients' aspirations to receive treatment close to home, if this centre is the only available facility.

As mentioned above, EU primary law forbids unjustified **discrimination** (i.e. unjustified differentiation) based on nationality (Art. 56 TFEU)[85] and EU secondary law discrimination based on race or ethnic origin[86] as well as based on sex[87].[88] Hence, based on this, for the above-mentioned situation each Member State could decide which **individual patients** are moving, provided that the differentiation is based on objective and evidence-based criteria. This situation assumes that the Member State – in line with the above-mentioned planning requirement – organizes and selects, which patients shall move.

On the other hand, a Member State could decide to offer **all patients** the option of moving or being treated in their country of residence. If everybody prefers not to travel, a **waiting list** will start to form, and patients will have to travel abroad unless they are prepared to wait a very long time. While the above-mentioned planning requirement allows Member States to operate a system of waiting lists, according to the *Watts* case they have to take into account the individual and medical situation of each patient.[89]

Based on what has been stated so far and provided that a Member State uses objective criteria, it could **speculate** that some patients would not take the burden of travelling abroad and offer them this treatment locally. For example, the elderly or fragile patients with multiple ailments

[85] Space precludes a detailed analysis of the impact of the EU's Charter of Fundamental Rights (CFR, Consolidated version: OJ 2016 C 202/389) in this regard – always provided that its field of application (Art. 51 para. 1 CFR) is given: From the fields where the ECJ has accepted also to bind private entities to the CFR (i.e. a so-called horizontal effect), only the prohibition of discrimination on grounds of religion (Art. 21 para. 1 CFR) but not the other (annual period of paid leave, Art. 31 para. 2 CFR) would be of relevance (from a procedural perspective, the right to an effective judicial remedy could be of relevance, Art. 47 CFR). See (Kopetzky, 2025).

[86] Racial Equality Directive.

[87] Gender Equality Directive.

[88] As mentioned above, discrimination based on religion, disability, age, or sexual orientation should have been covered (note 50), but the planned directive was not realized (note 51).

[89] ECJ judgment of 16 May 2006, Case C-372/04, *Watts*, ECLI:EU:C:2006:325, para. 119: "objective medical assessment of the patient's medical condition, the history and probable course of his illness, the degree of pain he is in and/or the nature of his disability".

might be less willing to travel, whereas younger might not see this as a burden. Paying for **travelling** expenses could be used as a **nudging** to motivate patients to seek treatment abroad.

Finally, two **countries** – for example Italy and Austria – could **negotiate** that Italian patients must go to Austria. However, a challenge may arise if a patient is offered to go to Austria but does not want to do so. For whatever reason, this patient could find a facility in another country, for example France, which offers this treatment. How does EU law **balance** the patient's **aspiration** to seek treatment in France, while Italy wants her to be treated in Austria? Under EU law, the patient is entitled to seek treatment abroad in case the treatment is part of the basket of care and cannot be given in due time.[90] In the *Petru* case, the ECJ has clarified that the impossibility to get treatment abroad has to be determined "by reference to all the hospital establishments in the Member State of residence that are capable of providing the treatment in question".[91] Possibly this clarification (all hospitals in this country) **could be extended** to facilities operated by two (or more) Member States even if outside its (their) territory. However, the country is still under the obligation to provide the treatment without undue delay.[92]

3.6. Pooling with uncertain demand

The Covid-19 pandemic has shown effects of bed shortages across Europe: apart from a higher **mortality rate**, when bed occupancy increased above a specific threshold, it was necessary to **lockdown the economy** to stop the contagion growth (OECD 2020; Lupu and Tiganasu 2022). For these events and (more effectively) when the increase in the demand occurs in a subset of countries, **planning** bed excess capacity **at EU level** may be beneficial for all the countries. The number of unused beds decreases, while the availability in case of need may increase.

Capacity planning can be performed at several levels on either a strategic or **operational** level. In the latter case, the **capacity** is **fixed,** and demand has to be managed in order to use the resource in the best possible way. On the contrary, **strategic** decisions are taken in a **long-run**

[90] "The authorisation shall be accorded where the treatment in question is among the benefits provided for by the legislation in the Member State where the person concerned resides and where he/she cannot be given such treatment within a time limit which is medically justifiable, taking into account his/her current state of health and the probable course of his/her illness"; Art. 20 para. 2 SSCR.

[91] ECJ judgment of 9 October 2014, Case C 268/13, *Petru*, ECLI:EU:C:2014:2271, para. 34. On this case, see (Frischhut & Levaggi, 2015).

[92] ECJ judgment of 16 May 2006, Case C-372/04, *Watts*, ECLI:EU:C:2006:325.

perspective, where **capacity** is a **variable** factor. Capacity planning in health care is very important, but rather complicated by the presence of **uncertainty** in the system. Efficiency requires to match capacity and demand, but this is not easy when **both** entities are **uncertain**. This is especially true for demand that may present "normal" fluctuations across time or may present sudden, unexpected peaks as during a pandemic event. The two events may however need different instruments from a governance point of view.

Short-term flexibility in capacity management are often dealt with through pure Operational Research (OR) instruments such as over-capacity, cross-trained personnel that can move across units, patients temporarily moved from one ward to another or, when this option is available, external staffing agencies but they usually increase expenditure and may reduce quality and access to health care (Fagefors et al., 2020b, 2024). A more cost-efficient proactive tool for short-term flexibility management is an **internal capacity pool** (Kuntz et al., 2015). A capacity pool is a general capacity that can be allocated to parts of the system where the temporary need for resources is unusually high, and this allows to understand the nature of such capacity: it is related to some facilities that may be interchangeably uses across treatments. A good example quite often used in this literature is either general nursing staff or hospital beds.

Pandemic events require the use of the same statistical instrument, but the definition of excess capacity is more complicated due to the high variability in demand, as the COVID pandemic has shown. For these events, usually each country has to adopt a pandemic plan that however may prove to be insufficient.

3.6.1. The legal status quo

As a reaction to the pandemic and as one element of the European Health Union (EHU)[93], the EU has amongst others[94] updated the previous rules on **serious cross-border threats to health** and upgraded them to an EU regulation, i.e. Regulation (EU) 2022/2371 on serious cross-border

[93] See, for example, (Frischhut, 2023).

[94] See, for example, (Delhomme & Hervey, 2023; Delhomme & Van Os, 2025; Hervey & De Ruijter, 2020).

threats to health (SCBHRR).[95] Similarly as the previous rules[96], also this EU regulation follows an "**all-hazards-approach**"[97] and covers (Art. 2 SCBHRR) threats of biological origin (communicable diseases, antimicrobial resistance and healthcare-associated infections related to communicable diseases, biotoxins etc.), threats of chemical origin, threats of environmental origin (including those due to the climate), threats of unknown origin, and events which may constitute public health emergencies of international concern (PHEIC) under the International Health Regulations (IHR). Hence, a very **broad approach** that can cover various situations of 'uncertain demand'.

In order to address these serious cross-border threats to health and the consequences thereof, the SCBHRR, amongst others, lays down **rules on prevention, preparedness and response planning**, including preparedness plans at **Union** (see Art. 5 SCBHRR) and national (see Art. 6 SCBHRR) levels, as well as reporting (see Art. 7 SCBHRR) and assessing (see Art. 8 SCBHRR) preparedness at national level (Art. 1 SCBHRR).[98] Both the Union and the national plans can be importance when it comes to health system **capacities**[99].

Art. 6 SCBHRR on '**national** prevention, preparedness and response **plans**' foresees not only that MS "**liaise** with each other within the [Health Security Committee (HSC)] and **coordinate** with the Commission in order to seek **coherence** with the Union prevention, preparedness and response plan to the largest possible extent", but also mentions that these national plans may include elements concerning "**capacities** and **resources** laid down in the **Union** prevention, preparedness and response **plan**"[100]. Such national plans on capacity can also include the issue

[95] Regulation (EU) 2022/2371 of the European Parliament and of the Council of 23 November 2022 on serious cross-border threats to health and repealing Decision No 1082/2013/EU [see below note 96], OJ 2022 L 314/26.

[96] Decision No 1082/2013/EU of the European Parliament and of the Council of 22 October 2013 on serious cross-border threats to health and repealing Decision No 2119/98/EC, OJ 2013 L 293/1, repealed by OJ 2022 L 314/26 (i.e. the SCBHRR).

[97] See for example (Frischhut & Greer, 2017).

[98] The SCBHRR addresses a broad range of other tools (e.g. joint procurement), networks, etc., which will not be covered here for reasons of space.

[99] Art. 3 para. 13 SCBHRR defines capacity as follows: "'health system capacity' means the degree to which a health system maximizes its performance on the following **six** health system core **components** or building blocks: (i) service delivery, (ii) health workforce, (iii) health information systems, (iv) access to medical countermeasures, (v) financing, and (vi) leadership/governance; for the purposes of this Regulation, this definition applies only to the parts of health system components or building blocks affected by serious cross-border threats to health" (emphases added).

[100] Art. 6 para. 2 SCBHRR (emphases added).

of excess capacity. The corresponding EU plan shall "promote an effective and **coordinated** response" (Art. 5 para. 1 SCBHRR) and "promote effective **synergies**" between the MS, the Commission and the European Centre for Disease Prevention and Control (ECDC) (Art. 5 para. 2 SCBHRR).[101]

In our context of pooling capacities (in a preventive way) when demand is uncertain (a pandemic, etc.), Art. 5 para. 4 SCBHRR emphasises that "Union prevention, preparedness and response plan shall include cross-border **interregional preparedness** elements to support aligned, multi-sectoral, cross-border public health measures, in particular considering **capacities for** surveillance, testing, contact tracing, laboratories, training of healthcare staff and **specialised treatment or intensive care** across neighbouring regions"[102]. The importance of cross-border **interregional** levels is also highlighted in Art. 7 SCBHRR on the reporting[103] on prevention, preparedness and response planning. In these reports, concerning **capacities**, MS shall also address the "assessments of **risks** and capacities to determine **priorities** for **emergency** preparedness", as well as "an overview of the **impact** of serious cross-border threats to health on the **provision and continuity of healthcare services** for other diseases and conditions during public health emergencies".[104]

As addressed elsewhere in this report, there can be a need for **coordination at supra-national level**.[105] Art. 5 para. 6 SCBHRR only refers to "technical assistance" that the **Commission** may provide, "at the Member States' request", "to support the development of their staffing plans in order to address specific healthcare needs". However, we argue that in this context of the rules established by the SCBHRR, the Commission could also provide more coordination for MS, which want to share excess capacities. In doing so, the Commission should also take into account the (general and health) value of **solidarity**. A helpful tool in identifying room for cooperation between MS in this context of pooling of capacity in case of uncertain demand can also be "**stress**

[101] Emphases added.

[102] Emphases added.

[103] On the assessment (Art. 8 SCBHRR) concerning the reporting (Art. 7 SCBHRR), see also Commission Delegated Regulation (EU) 2024/1232 of 5 March 2024 supplementing Regulation (EU) 2022/2371 of the European Parliament and of the Council as regards assessments of the state of implementation of national prevention, preparedness and response plans and their relation with the Union prevention, preparedness and response plan, OJ L, 2024/1232.

[104] Art. 7 para. 1 lit b II SCBHRR; emphases added.

[105] See, above at notes 17 and 61 and below at note 108.

tests, **simulation** exercises and in-action and after-action reviews", which are addressed in the EU prevention, preparedness and response plan.[106]

3.6.2. Our proposal

In this part we draw on the literature to define a possible way to deal with **short-term** flexibility. The literature on excess capacity mainly draws on the so-called modern portfolio theory, a mathematical framework for selecting profitable portfolios of financial assets through the comprehensive analysis of risk-return trade-offs of a portfolio, which basically show how **diversification** may allow to reduce the risk (Gupta & Markowitz, 2012; Markowitz, 1952). When several sources of variation are aggregated, the effect of the variation will decrease (Markowitz, 1952) and in health care this may mean that by **aggregating wards** it is possible to reduce the need for excess capacity.

Fagefors et al. (2020b) show that **pooling** may be an efficient approach to manage and organize capacity in healthcare. The benefits of pooling are stronger when there is a lower correlation in capacity requirements between units allocated to the same pool. This means units with complementary demand patterns are ideal for forming pools. Aggregating various sources of variation can significantly reduce their overall effect, thus lessening the need for and cost of safety capacity. They use a numerical example using fictitious data, which illustrates different capacity pool configurations and how mean-variance analysis can be performed. The paper provides an important theoretical baseline for how mean-variance analysis can be used to determine the organization of capacity pools. However, some of this literature in using straight portfolio theory assumes that the capacity can be pooled at no cost. This may not be the case. Apart from treatments whose capacity cannot be pooled with other treatments (for example an ICU unit), (Song et al., 2020) found that off-service placement of medical/surgical patients was associated with a **22.8% increase in remaining hospital length of stay** (LOS) and a **13.1% increase in the likelihood of 30-day hospital readmission.** Lim et al., (2024) further investigated "spillover effects" and found that on-service patients experience **substantial negative spillover effects from off-service placement**. They quantified this, stating a **10-percentage point increase in the mean proportion of patients placed off service led to a 10.9% increase in length of stay** for the focal patient. These negative effects are primarily attributed to **challenges in coordination between physicians and nursing staff**. Lim et al. (2024) noted that this process friction can result in an **additional 10.9 beds being occupied**

[106] Art. 5 para. 5 SCBHRR; emphases added.

each day in their study hospital. These studies underscore that despite the theoretical capacity utilization benefits of off-service placement, its **operational and clinical drawbacks are not well established** and may call for other models of capacity pooling.

These examples relate to what we could define "**horizonal**" pooling, i.e. capacity shared within the same hospital by different wards designed for different treatment. Another possible avenue is to explore what we could define **vertical** pooling, i.e. pooling capacity for the same treatment across hospitals or countries. In this case the cost (in economic term) would be represented by travelling cost and (possibly) dropout. In what follows we examine the model that in theory could also be applied to capacity pooling across different countries.

3.6.3. The model

Let us make a simple example. Suppose that for a specific treatment the expected number of patients is equal to 100, but this number is uncertain. In other words, patients may be less or more, and their distribution follows the normal distribution in Figure 5:

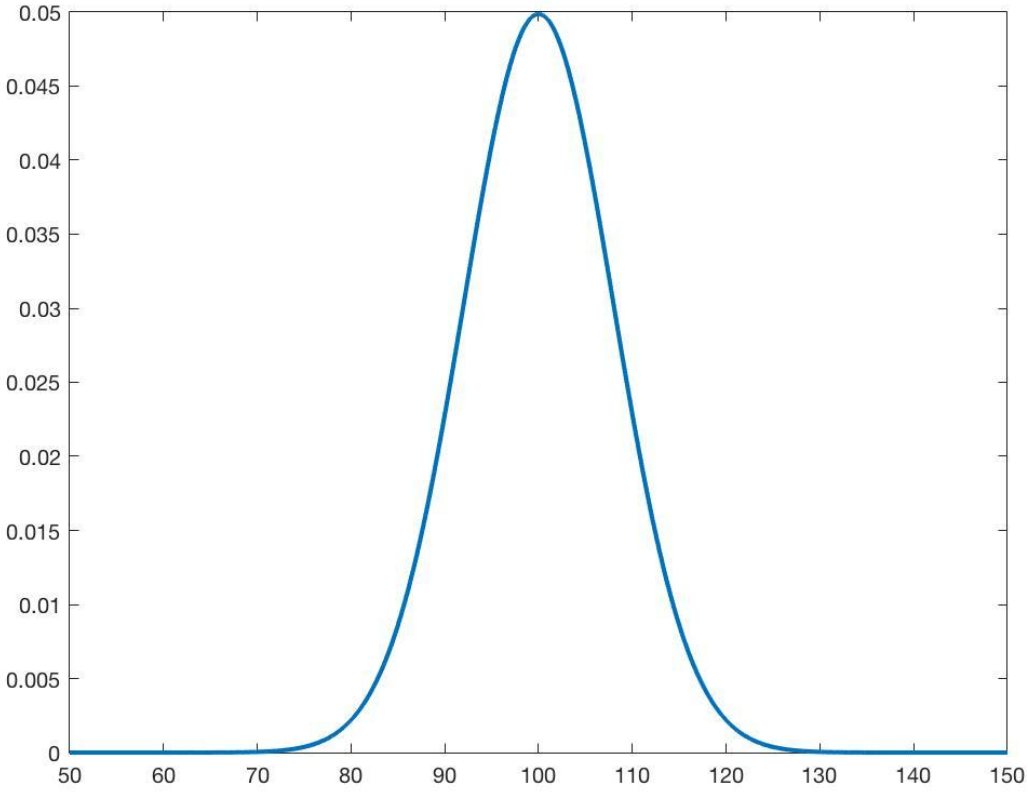

Figure 5: The distribution of the probability of the patients

Let us also assume that the variance is equal to 64 so that the standard error is 8. Let's also assume that the decision maker wants to be sure to treat all the patents with a probability of

95% (in other words, patients may not be treated with a probability of 5% the capacity will have to be set higher than 100). In particular, given the properties of the normal distribution we known that if we increase the expected value by 1.645 times the variance with the resulting capacity we will be able to cope with. In our case this means that by setting a capacity to 100+8*1.645=113,16 the regulator may be able to cope with demand in 95 out of 100 cases as shown in Figure 6:

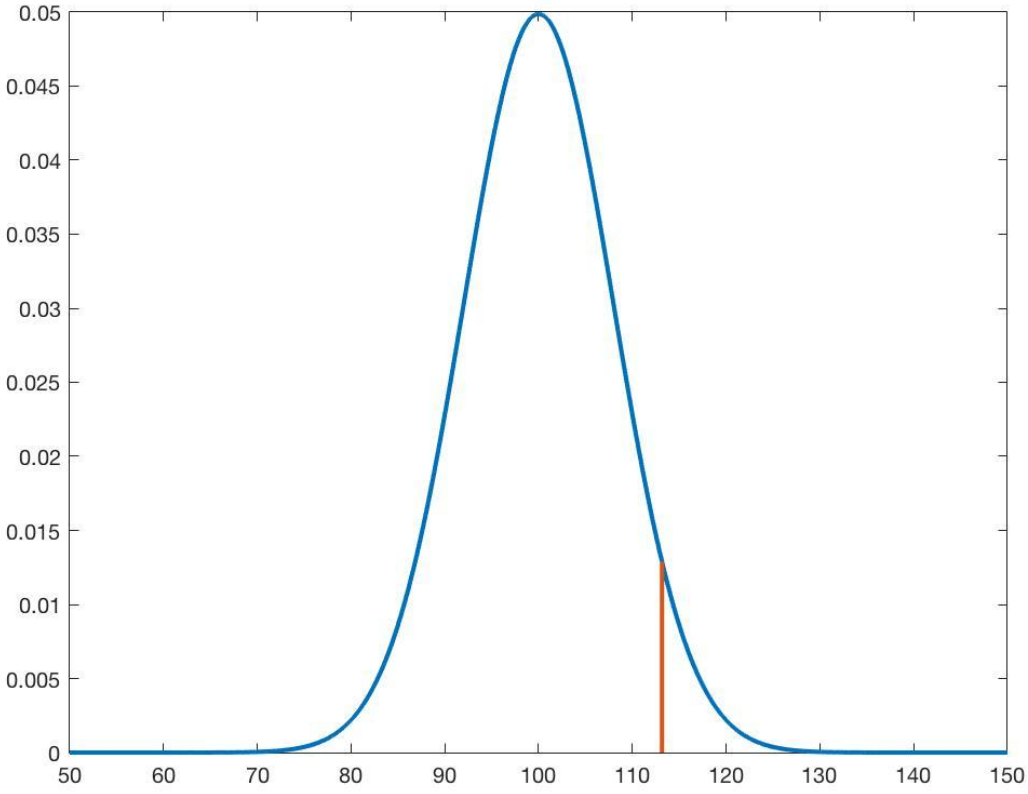

Figure 6: 5% tail of the normal distribution. By choosing a bed capacity to the right of the red line the probability of being able to treat all the patients is above 95%.

Excess capacity has of course a **cost**, which is represented by the capacity in excess that the regulator will not use, but it will have to be paid for. In order to reduce such capacity, the literature often proposes as a model that of "**horizontal pooling**", by which we mean that patient from different wards (i.e. in need of different treatments) are pooled together to define capacity. As shown in the previous section, this method has two limits:

A) The extra cost borne: a) for the patient that are treated outside their elective ward (i.e. patients from neurology that are admitted to medicine) and b) for patients in the elective ward due to the presence of patients with different ailments.

B) Pooling is possible if the resource is flexible enough to be adapted to the different treatments (for example, ICU beds may be used for other treatments, but bed in other wards cannot be used for ICU patients).

For these reasons, it may be more efficient to use what we define "**vertical** mobility" i.e. patients with the same ailment but living in the catchment area of another hospital. In this case the cost of care is the same (apart from differences in efficiency, but there are no spillovers costs in Lim et al. (2024) definition).

Let us then assume that in another country/hospital the same treatment is offered to a similar catchment population (expected patients equal to 100, normal distribution, variance 64). In this case also this decision maker should set its capacity to 113,16 to be sure, with a 95% probability, of being able to treat all the patients.

Let us now assume that the two decision makers pool their patients and their risk together. In this case, the normal distribution on which to evaluate the capacity has a mean of 200 and a variance that depends on how the two distributions are correlated. Let us assume they are not correlated. In this case the variance of the distribution is equal to 64+64=128 and the standard error is equal to $8\sqrt{2}$, which implies a facility with a total capacity of 218.62<226.32.

Such capacity may be distributed among the two decision units. An equitable share (109.31) implies that both units will face the same fixed cost while some patients may have to travel from one to the other go receive care. If the allocation is not symmetric the authority with less capacity is going to have a lower fixed cost, but a higher transport cost.

If the two distributions are correlated (if demand is high in A it is probable that it is high also in B) the gain in overall capacity is lower, but pooling is still possible, and the gain depends on how big the fixed cost related to the excess capacity is if compared with travel costs.
As in the previous models it is possible to define an equitable price in a very similar way to the one described in Section 3.3.2 and solidarity may be enhanced if the cost related to excess capacity are borne by richer countries (provided that the latter are sensibly higher than travel costs).

This system has of course some legal implications that need to be identified and solved: for example, if because of exceptional circumstances (as partially in the case of the Covid-19

pandemic) both countries need to access the spare capacity, which patients should use the beds first? The above-mentioned existing possibilities under the Regulation (EU) 2022/2371 on serious cross-border threats to health (SCBHRR).[107] However, for this mobility which at present is not in place, fitting this model into this legal framework may be of paramount importance.

For the management of a **pandemic** event, the solutions are more complex. The modelling techniques are quite similar to the one described above, but the definition of an ideal excess capacity is usually more uncertain, since it may be difficult, even drawing from past experience to foresee demand in such event. In this case however, pooling capacity and resources at a supra-national level could be even more strategically important. A possible solution could be to envisage a **two-part payment system,** where the EU pays for fixed capacity costs and each country pays for its use. While it is clear that Member States might be reluctant, the **EU budget** could pay the **fixed** cost for up to a specific number of beds in each country, while the **running** costs (when the beds are actually used) would be settled through a **country agreement** based on a cross-national tariff. In this case, each country could decide whether to invest in extra capacity or pay for using excess beds.

For the management and the finance of such excess capacity, apart from the above-mentioned Regulation (EU) 2022/2371 on serious cross-border threats to health, it may be possible to use a structure similar to **European Research Networks**, with the difference that the network would consist of hospitals in different countries and the wards involved would be those that are foreseen to be under stress in case of a pandemic event.

4. Research, reference networks and rare diseases

4.1. Rationale

As mentioned above, Art. 168 para. 7 TFEU tasks the Member States, not the EU, with the "definition of their health policy and [⋯] the organisation and delivery of health services and medical care", as well as "the management of health services and medical care and the allocation of the resources assigned to them". While EU law has some noteworthy impact on health law (Peers & Barnard, 2023; Tamara K, 2024), nonetheless the EU's role for these basic questions of organising and financing of health systems remains limited. Due to this **limited competence** of the EU in the field of public health, the key question is always what can be achieved within the

[107] See above, Chapter 3.6.1.

existing legal framework and how to generate genuine added value. Ultimately, effective **cooperation** among Member States remains the cornerstone for addressing shared challenges and maximising the Union's impact.

Innovation and research are among the most important strategies to reduce the burden of diseases. **Research** requires fixed investments that may be better organised at supra-national level.[108] At the same time, the treatment for some ailments, especially in the oncological area, (European Commission -Directorate General for Health and Food & Safety, 2025) require up-to-date protocols in order to ripe the effects of **innovation**. Finally, another area where **collaboration** among EU partners may be important is for the treatment of rare diseases. Here the number of individuals is quite low in each country but becomes significant when pooled together.

As already mentioned above, **rare diseases** are medical conditions that affect a small fraction of the population.[109] In the EU, "it is estimated that 6-8% of citizens live with one of the several thousand known rare diseases".[110] With the advent of **personalised medicine**[111], the number of rare diseases is going to increase because, by definition, personalised care targets increasingly small numbers of patients. For this reason, rare diseases **range** today from the "classical" ailments such as cystic fibrosis, Duchene and other genetic disorders (Pogue et al., 2018; Thomas Liji, 2024) to specific cancers treatments that are appropriate only for patients with specific characteristics. Their treatment **requires** important **investments** that usually are not justified by the number of patients in a single country because of the investment necessary to set up both research and treatment centres. While the average burden for the high-prevalence diseases is about €7000 per patient per year (PPPY), the average burden of the rare diseases is about €107 000 PPPY, according to recent estimates (Andreu et al., 2023) an increase of more than 15 times.

[108] See, above, Chapter 3.6.1.

[109] Recital 55 PMD (see also at note 33), referring to Regulation (EC) No 141/2000 of the European Parliament and of the Council of 16 December 1999 on orphan medicinal products, OJ 2000 L 18/1, as amended by OJ 2019 L 198/241, Art. 3 para. 1 lit. a.

[110] (European Commission -Directorate General for Health and Food & Safety, 2025) p. 4.

[111] On this topic, see, for example: (Hartlev, 2021; Prainsack, 2018).

At present there are 24 networks across Europe with about 1000 full members working on a wide range of ailments including bone disorders, childhood cancer and immunodeficiency [112]; However, the budget rules have not been set in a convincing manner and such mobility may be underfinanced (European Commission -Directorate General for Health and Food & Safety, 2025; European Court of Auditors, 2019).

With the above-mentioned advent of personalised care and precision medicine, the number of rare conditions may somehow increase since genetic medicine often allows to find specific subgroups of patient that respond better to targeted treatments (Naithani et al., 2021; National Institute of Health, 2025; Schork, 2015; Wang & Wang, 2023) and it may be even more important than in the past to create a **network** across Europe to treat these patients.

In addition, new digital developments (internet, etc.) have improved the **collaborative scenario** in rare disease research. The advent of multiple collaborations from research institutes have been established over the years to collaborate and exchange knowledge and expertise for the advancement of rare disease research.

1998 is an important year for patient mobility, as the first ECJ cases have emerged as of this year.[113] When this case-law was codified in the PMD, the question was what this EU Directive should comprise apart form a mere summary of the principles developed by the ECJ in its case-law. Quite early on the idea of "centeres of reference" was launched.[114] In 2011, ERNs[115] where then enshrined in the **PMD** (see next Chapter) and finally created in 2017 "as a collaborative framework that brings together experts and resources"[116] in the EU and beyond.

In the drafting phase of the PMD, in a paper of the then Spanish Council presidency, these centres were referred to as "Centers of reference/excellence"[117], Art. 12 PMD now refers to European Reference Networks (ERNs). In terms of **terminology**, a 'network'[118] implies more of a virtual

[112] For a complete list see https://erica-rd.eu/about/european-reference-networks/
[113] Case C-158/96 *Kohll v Union des caisses de maladie* ECLI:EU:C:1998:171.
[114] On the historic details see (Palm, 2013) pp. 2-4.
[115] On ERNs in general, see (Azzopardi-Muscat & Brand, 2015; Héon-Klin, 2017; Tumiene et al., 2021).
[116] (European Commission -Directorate General for Health and Food & Safety, 2025), p. 4.
[117] (Palm, 2013) p. 3.
[118] Also defined as "a group people who exchange information and contacts for professional or social purposes"; ("Oxford Dictionary of English," 2010), p. 1193.

connection of physically displaced entities, whereas a 'centre'[119] implies more of a joint physical presence. Therefore, in the following, as a meta term, we are referring to 'facilities', when addressing both physical centres and virtual networks.

How to classify ERNs? They are virtual networks[120] that bring together medical specialists across Europe[121] to address rare or difficult diseases and disorders that require highly specialized healthcare.[122] The question is, if ERNs are sufficient to allow an equitable access to care across the EU? A recent Eurordis survey (EURORDIRS, 2021) showed that patients have to travel across borders to get care and that they have to bear the cost of information (they have to acquire themselves information on research centres) and travelling expenses, despite the PMD. Hence, let's turn to this PMD and the legal framework it provides.

4.2. Legal frameworks

The PMD provides for rules on ERNs in Art. 12. In line with Art. 168 TFEU, the main responsibility lies with the MS, who are **not obliged** to participate and only stipulates "voluntary participation". The Commission shall only "support Member States in the development" of ERNs. Art. 12 para. 3 PMD only encourages MS to **facilitate** the development of ERNs in two ways: **First**, "by connecting appropriate healthcare providers and centres of expertise throughout their national territory and ensuring the dissemination of information towards appropriate healthcare providers and centres of expertise throughout their national territory", and **second**, by "fostering the participation of healthcare providers and centres of expertise" in ERNs.

How should ERNs look like and what should be their **tasks**? Art. 12 para. 1 PMD mentions that ERNs can be set up "in particular in the area of rare diseases" [123], but the wording "in particular" plus the competence of the Member States in this field (also emphasized in Art. 12 para. 6 PMD) also allows for ERNs in other fields. It has been emphasized in literature that the PMD does not provide a clear definition, but "merely lists the objectives and characteristics for ERNs to qualify

[119] Also defined as "a place or group of buildings where a specified activity is concentrated ("Oxford Dictionary of English," 2010), p. 282.

[120] European Commission: European Health and Digital Executive Agency, (2024),p.9.

[121] This surpasses the EU27, and also includes for example, Norway, Iceland, etc. See European Commission: European Health and Digital Executive Agency, (2024) p.23.

[122] (European Commission: European Health and Digital Executive Agency, 2024).

[123] On rare diseases see also Art. 13 PMD.

as such".[124] In Art. 12 para. 2, the PMD lists various **objectives**, where an ERN shall have at least three of this list of eight objectives, including enhancing cooperation and innovation in specialised healthcare, pooling knowledge on prevention, improving diagnosis and treatment quality, optimising resources, fostering research and training, facilitating expertise mobility and best practice sharing, developing quality benchmarks, and supporting MS lacking sufficient patients, technology, or expertise. In this context, the Commission emphasizes their high level of specialisation, a clear and transparent management system, patient centred care and specific procedures for patients' complaints, a multidisciplinary approach, they should foster teaching, training and of course collaboration with other centres (European Commission, 2014b, 2014a).

Who can in general be a **member** of an ERN? Art. 12 para. 1 PMD refers to ERNs "between healthcare providers and centres of expertise in the Member States". For the participation and contribution of individual members of such a network, the PMD refers to "the legislation of the Member State where the members are established". The **application procedure** is quite detailed, and each prospective ERN has to prove to possess specific characteristics, some of which applies to all the centres and basically declines the characteristics seen above and some specific requisites that depend on the specific network. It is for the Commission, via delegated legislation[125], to define the **specific criteria and conditions** that ERNs must fulfil and the conditions and criteria required from healthcare providers wishing to join an ERN. As a legal framework for the details to be provided by the Commission, Art. 12 para. 4 lit. a PMD stipulates that ERNs must demonstrate expertise in patient care, adopt a multidisciplinary approach, produce and apply good practice guidelines, contribute to research, provide training, and collaborate nationally and internationally.

Art. 12 para. 4 lit. b PMD tasks the Commission to develop and publish **criteria** for **establishing and evaluating** ERNs.[126] Apart from these delegated legislation, Art. 12 para. 4 lit. c PMD tasks the Commission to facilitate the exchange of information and expertise in relation to the

[124] (Palm, 2013) p. 5.

[125] See Commission Delegated Decision 2014/286/EU of 10 March 2014 setting out criteria and conditions that European Reference Networks and healthcare providers wishing to join a European Reference Network must fulfil, OJ 2014 L 147/71.

[126] See Commission Implementing Decision 2014/287/EU of 10 March 2014 setting out criteria for establishing and evaluating European Reference Networks and their Members and for facilitating the exchange of information and expertise on establishing and evaluating such Networks, OJ 2014 L 147/79, as amended by OJ 2019 L 200/35.

establishment of ERNs and their evaluation. In this respect, Commission Implementing Decision (EU) 2019/1269 has foreseen the introduction of the **Clinical Patient Management System** (CPMS), a secure IT tool for "the exchange of knowledge and expertise across borders allowing health care professionals to work with a multidisciplinary approach"; however, the "[l]ow uptake of this tool by practitioners, due to technical difficulties and lack of time, requires revision and improvement to make this tool more user-friendly and intuitive".[127] Nowadays the European **Health Data Space** (EHDS)[128] also establishes a "unified framework for cross-border data exchange", which has the "potential to harmonize the regulatory disparities among national health systems, thereby facilitating the seamless access and sharing of clinical data within the ERN system".[129]

4.3. Provision of information

The EHDS foresees the primary (e.g. for patients) and secondary (e.g. for research) use of data. Likewise, also in case of ERNs the question has to be addressed if **patients** are **directly or indirectly** affected or involved in ERNs.[130] Individual patients "cannot directly access" ERNs, however with their consent "healthcare providers can exchange information and consult the appropriate ERN under national health systems".[131] The idea behind these networks is to **spread knowledge** and to allow to share state-of-the-art treatment across Europe. While the increasing number of facilities is necessary given the number of ailments, it also means that the network is becoming increasingly **complex** to manage so that some patients' association are questioning the fairness in access for all the patients. EURORDIRS (2021) proposes the results of a survey among rare diseases patients showing that 86% of people living with a rare disease are **willing to travel** to another country to receive medical treatment, versus 49% in the general EU population. However, to access cross-border healthcare, the patient is responsible for

[127] (European Commission: European Health and Digital Executive Agency, 2024) p. 55.

[128] Regulation (EU) 2025/327 of the European Parliament and of the Council of 11 February 2025 on the European Health Data Space and amending Directive 2011/24/EU [i.e. the PMD] and Regulation (EU) 2024/2847, OJ L, 2025/327.

[129] European Commission: European Health and Digital Executive Agency, (2024),p. 53.

[130] (European Commission: European Health and Digital Executive Agency, 2024) p. 54 emphasizes the following: "To ensure the optimal impact of this partnership, it is vital to create concise organizational tools and guidelines that facilitate and streamline the collaboration. These guidelines must specify when and how patients should be involved in various ERN activities, such as research initiatives and the development of clinical guidelines. This approach will ensure that patient involvement is meaningful and significant, leading to solutions that benefit patients."

[131] European Commission -Directorate General for Health and Food & Safety, (2025).

overcoming many of the bureaucratic, financial and information obstacles such as the lack of **awareness and information** about how to access care in another country. Patient must gather information through their personal contact and the latter can be incomplete. The financial and bureaucratic burden often falls on the patient, and, in some case, cross-border users have felt to be discriminated by the medical staff of the country where the facility is located, who have preferred to prioritize their citizens. According to EURORDIRS, the **investment** made by the EU, although important, is **not sufficient** to finance adequately the ERNs so that they had to downscale their objectives.

Exchange of information between providers has to be seen in the **broader context** of the **PMD**'s rules on information, which provides the following: When it comes to **information**, Art. 6 PMD on **national contact points** (NCPs) for cross-border healthcare has been drafted at the time to tackle the challenge of information asymmetries. A 2007 Eurobarometer study[132] had identified the lack of information "about the availability and quality of medical treatment abroad" as one of the three main reasons why patients do not travel to another EU country to receive medical treatment there (Gallup Organisation for Health and Consumer Protection Directorate-General, 2007). While information might be available for healthcare professionals or concerning one's own country, patients seeking treatment abroad face various challenges. These **challenges** can be linked to a lack of knowledge about a health system as such, specific providers, but can also linked to language problems. The idea of Art. 6 PMD is to overcome these challenges by having at least one national contact point that should serve as an information hub. NCPs shall not only provide information to patients but cooperate with each other and the Commission. The information[133] to be provided relates to both the MST (Art. 4 PMD) and to the MSA (Art. 5 PMD).

In case of the **MST** the information to be provided covers "information concerning healthcare providers, including, on request, information on a specific provider's right to provide services or any restrictions on its practice, information referred to in Article 4(2)(a), as well as information on patients' rights, complaints procedures and mechanisms for seeking remedies, according to the legislation of that Member State, as well as the legal and administrative options available to settle disputes, including in the event of harm arising from cross-border healthcare" (Art. 6

[132] This 2007 study can be seen as an important step on the way to the 2008 Commission proposal, leading to the PMD, finally adopted in 2011.

[133] According to Art. 6 para. 5 PMD, this information "shall be easily accessible and shall be made available by electronic means and in formats accessible to people with disabilities, as appropriate".

para. 3 PMD). In case of the **MSA** the information to be provided concerns patients' rights and entitlements to cross-border healthcare, including substantive (costs) and procedural questions of reimbursement (Art. 6 para. 4 PMD and Art. 5 lit. b PMD).

4.4. Status quo of ERNs: numbers, financing, etc.

At the moment, in terms of **numbers** there are "24 existing ERNs and 836 HCPs [i.e. Healthcare Provider ERN member]"[134], which "include 1 613 specialised centres located in 382 hospitals across 27 Member States and Norway".[135] The Commission has qualified ERNs as "valuable forums for healthcare professionals, patient organisations, and stakeholders to work together to address the challenges of rare diseases".[136] While ERNs focus on rare diseases and despite the common legal framework (see Chapter 4.2), general statements are difficult, because of the diversity of national health systems.[137] ERN are virtual networks, i.e. they do not have a physical location. We can somehow imagine them as the sum of physical locations across MS, which are combined and coordinated together by the existence of this virtual reference network.

Despite the development of ERNs since 2017, it has been criticized that the **budget** rules have not been set in a convincing manner and they may require additional financial resources (European Court of Auditors, 2019). The EU is **financing** research in health care through some programmes that are mostly related to basic research, such as EU4health[138] and the Horizon Europe programme[139]. The ERNs are instead the instrument the EU is using at present to tackle the problem of rare diseases. The **EU4Health** programme aims at financing projects that should improve health and has a budget of 5.3 million euro for the period 2021-2027, while the **Horizon Europe** programme can be considered the instrument by which the EU finances research and innovation.

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[134] European Commission: European Health and Digital Executive Agency, (2024) p. 20.

[135] European Commission -Directorate General for Health and Food & Safety, (2025) p. 7.

[136] (European Commission: European Health and Digital Executive Agency, (2024), p. 51.

[137] (Expert Panel on Effective Ways of Investing In Health (EXPH)., 2018), p. 4.

[138] Regulation (EU) 2021/522 of the European Parliament and of the Council of 24 March 2021 establishing a Programme for the Union's action in the field of health ('EU4Health Programme') for the period 2021-2027, and repealing Regulation (EU) No 282/2014, OJ 2021 L 107/1.

[139] Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013, OJ 2021 L 170/1, as amended by OJ L, 2024/795.

The existing **NCPs** (on information, see above Chapter 4.3) could also be used as information hubs for other purposes. At the moment, the strategy is to finance providers, but it may well be that **other strategies** may prove to be more effective. For example, it may be worth to investigate whether to **finance** this **mobility** with the same mechanisms that may be envisaged for excess capacity (see above, Chapter 3). In this context, we think that the principle of **solidarity** may be quite important so that differential prices may also be foreseen for patients moving from countries with a different income level. In the following we first study the pricing options for a research centre that, as in the case of the new available technology, has a **fixed capacity** K and **demand** in both countries is **fixed**. For a research centre and for treating orphan diseases, a two-region model is not realistic and for this reason, an **ad hoc** model has been developed.

4.5. The model

The theoretical model presented in this section aims at studying the best strategy to determine the number of facilities (i.e. research and treatment centres) for rare diseases. In what follows, we start by describing an environment where all the facilities are physical facilities.

In order to keep the model as general as possible, we assume that the facility may deliver three different services:

1. **Basic research** into the ailment that it is necessary to treat. Most rare diseases still need a sizeable investment to study the best way to understand their causes and their treatment. With the advent of personalised medicine several oncological conditions may be defined rare diseases because of the stratification of patients.
2. Issuing best practice therapeutical path or **consultancy services** for either to medical staff to discuss the best course of action for a single patient, or possibly patients (through telemedicine).
3. **Treating patients**. In some cases, 1) and 3) are quite interlinked since in medicine most of the very innovative treatments are often experimental.

The objective is to determine the number of facilities that are going to be necessary to maximise welfare and to suggest when the facility does not simply do pure research some payment scheme for the services provided.

We start by describing the population that need treatment.

Patients live in several **regions** (total number c) each one having a fixed population p_i and an average income equal to Y_i. To make the model more tractable, let us **assume** that they live on a circle of circumference equal to 1 as shown in Figure 7

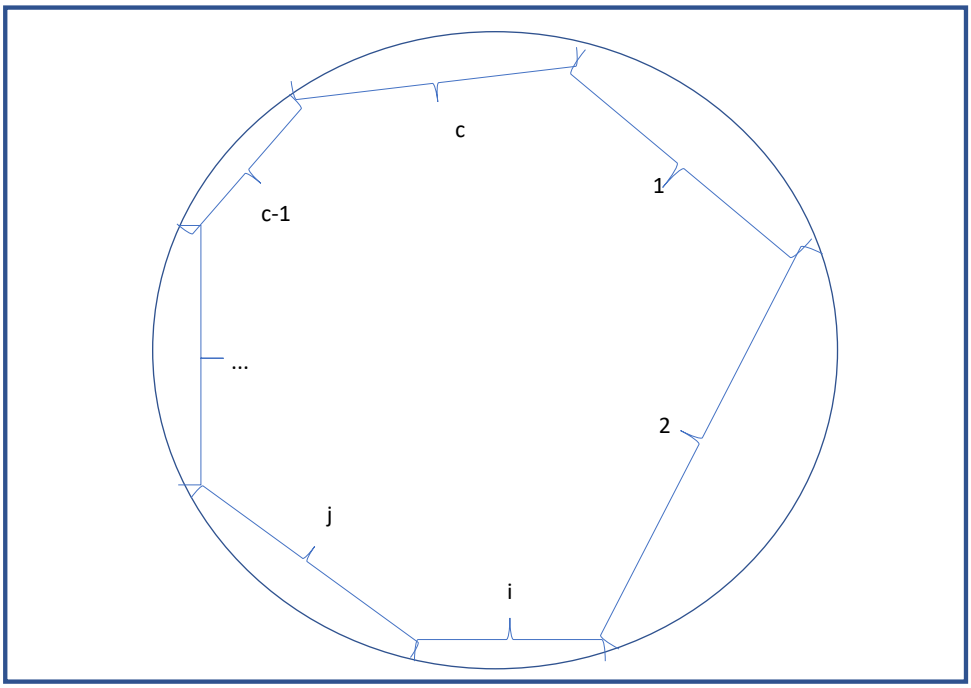

Figure 7: The location of the regions on the circle.

In each country a fraction $z_i p_i$ of citizens is affected by an ailment that may be classified as a rare disease (z<0,0005) so that the **total number** of individuals that are affected by this ailment is equal to

$$Q = \sum_{i=1}^{c} z_i p_i$$

The **number of patients** need the treatment is fixed/predictable and there is no uncertainty on the number. The treatment is **specific** either for a disease that requires innovative research or for a rare disease. **Total income** across these countries is equal to

$$Y = \sum_{i=1}^{c} p_i Y_i$$

where Y_i is the average income in country i. Throughout the exposition we will be using **linear taxes** and linear **utility** function so that we can concentrate on average values and we can ignore the distribution of resources within each country. This assumption allows to concentrate on cross country disparities

As mentioned above treating these rare conditions may require up to **three different activities**:

- pure **research**, which has a fixed cost equal to F, independently of the number of individuals for which it is carried out;
- an **information/dissemination cost**, which may be related to drafting protocols to treat the condition, to supply with information regarding the disease, possibly also using **telemedicine**. This cost is assumed to be proportional to the number of individuals that use that specific research centre and it is equal to l ;
- a **treatment cost**, which is quadratic in the number of individuals that need to be treated. This cost is related to the actual treatment of patients, which has to be made at the research centre/hospital premises and can be written as $m(Q_i)^2$ where Q_i is the number of individuals treated. The cost increases in more than proportionally to patients to take into account possible diseconomies that may arise when the number of patients increases.

Finally, we **assume** the existence of a **quality-related cost** that is increasing in the level of quality produced T, but as in (Levaggi & Levaggi, 2020, 2023) it is assumed to be a fixed cost $\frac{s}{2}T^2$. Individuals derive utility from their **net income** (which is given by the difference between gross income and the cost they have to pay to provide health care to the individuals that are affected by a rare disease) and the **net utility** of patients that use health care, which is in turn given by the difference between the utility of care (which also depends on the quality and the private cost to receive it). In other words, we can write **utility for community** i as

$$U_i = y_i(1 - t_i) + v + \phi(T_k - \rho C(n))z_i p_i$$

where $v > 0$ is the patient's gross utility of being treated (mostly assumed to be high enough for all the users to seek care), ϕ measures the marginal utility of quality. **Quality** is assumed to be observable, but non verifiable above a specific threshold, which is often normalised to zero. We assume that quality evaluation is the same across individuals and across regions. This assumption is reasonable for rare diseases that usually have an important impact on individuals' quality of life. Finally, $\rho C(n)$ represents the **private cost** that patients incur into getting care. It is mainly related to travel cost which can be linear or quadratic in the distance travelled. In our approach they depend more on the number of **research** and **treatments centres** that are going to be opened. To show the **relationship**, let us make a specific example.

Let us **assume** that only one **facility** is going to be opened on the circle, where the entire population lives and that costs are proportional to the distance so that $4c$ represents the

marginal cost to travel. In order to **minimise the distance** to be travelled, it will have to be located anywhere on the circle, since in this way ½ of the population travel to this centre in the clockwise direction and the other half in the anticlockwise one. If we open two centres, provide they are located at exactly the opposite place on the circle, the distance is halved and so on so that we can write $C(n) = \frac{c}{n}$ as shown in Annex 3.

Finally, ρ is a parameter that in our approach takes the value of 0 or 1 according to whether the patient has to bear these costs (for a research centre with no treatment or for information/diagnosis that can be done with telemedicine it would be equal to zero).
In what follows, we will study the decision on the **number** of research centres and the **quality** to be provided. We will start with a **centralised** decision maker (Chapter 4.5.1) that maximises the utility of all the regions and we will then see how an equilibrium can be reached with a **decentralised** solution (Chapter 4.5.2).

4.5.1. Centralised decision

Let us assume that a benevolent planner at central level would like to maximise the **utility** of all the citizens across communities. In doing so, we assume that the cost to finance the research centres is split into three parts:

- **financing research**, which is paid through a linear income tax τ equal across countries.
- a reimbursement for the '**information**' treatment, which is paid according to marginal cost.
- a reimbursement for **treatment** paid according to average cost.

Let us **assume** that n is the number of labs that are going to be opened and that they all have the same size (assumption in line with city above)
For each lab the cost can be written as
$\left(F + \frac{s}{2}T^2\right) + lQ_i + mQ_i^2$
and since the lab are equal in size we can write
$\left(F + \frac{s}{2}T^2\right) + l\frac{Q}{n} + m\frac{Q^2}{n^2}$
i.e. the total cost is equal to
$n\left(F + \frac{s}{2}T^2\right) + lQ + m\frac{Q^2}{n}$
so that $\tau = \frac{n\left(F+\frac{s}{2}T^2\right)}{Y}$
The cost to treat patients with **telemedicine** is equal to l while the average cost for each patient is equal to $m\frac{Q^2}{n^2}$

This means that in each country a tax t_i has to be raised to pay for treatment. The country specific tax rate is equal to:

$t_i = \frac{\left(l+m\frac{Q}{n}\right)Q_i}{p_i Y_i}$

so that the net income is equal to

$p_i Y_i(1-\tau-t_i)$.

Utility for each country can be written as

$\left(v+\phi(T-\rho\frac{c}{n})\right)z_i p_i = \left(v+\phi(T-\rho\frac{c}{n})\right)Q_i$

so that welfare in country i can be written as:

$p_i Y_i(1-\tau-t_i)+\left(v+\phi(T-\rho\frac{c}{n})\right)Q_i$

The **problem** for the centralised planner is to **maximise welfare** across countries and to keep a balanced budget, i.e.

$$Max_{n,T} W = \sum \quad p_i Y_i(1-\tau-t_i)+\left(v+\phi(T-\rho\frac{c}{n})\right)Q_i$$

$$ss.t.$$

$$\tau = \frac{n\left(F+\frac{s}{2}T^2\right)}{Y}$$

$$t_i = \frac{\left(l+m\frac{Q}{n}\right)Q_i}{p_i Y_i}$$

From the solution presented in Annex 3.2 we can show that

$$n = \frac{1}{2Fs}\sqrt{2FsQ(2Qms+2\phi\rho cs-Q\phi^2)}$$

$$T = \phi\frac{Q}{ns}$$

which depends on the parameter. In general, we can see that provided the fixed costs are not too high, only one research lab may be right choice.

In fact, for

$$F < Q(Qm+\phi\rho c)-\frac{Q^2\phi^2}{2s}$$

the choice would be to have **only one research centre**. The probability of needing to replicate the facility depends on the cost structure. For example, for an ailment that needs research and an information/telemedicine centre it is always optimal to have a **single centre**. On the contrary when treatment at the facility is necessary and travel cost are quite high; it may be necessary to replicate the facility at the cost of an increase in expenditure.

When **several** centres are necessary, they should be **positioned** so that travelling cost is minimized. It is also interesting to note that the solution in terms of location and number of centres is independent of the rules chosen to split the costs as shown in Annex 3.2 This result depends on the **assumption** of linear utility, but from a policy point of view it means that solidarity (for example by choosing lower tax rates and/or differentiated prices) could be pursued with no cost from an efficiency point of view.

Finally, it is interesting to note that the lower the fixed cost F, the higher the number of centres that are optimal, which also means that patients will have to travel less to be treated. In this respect, and especially with the new technologies that allows to spread the knowledge and to collaborate even at long distance, it may be interesting from a practical point of view to study whether the research centre F should be a physical unit located in one place or it could instead be a virtual unit whose different (physical) subunits could instead be located across different facilities. This point becomes extremely relevant later, when we discuss what the EU is doing at present.

4.5.2. Decentralised decision

When a central planner does not exist, or as in the case of the EU, it has not got the legal power to make decisions as concerns health care for MS, a decentralised solution is likely to occur. In general, such solution may arise under two different scenarios:

- **simultaneous** solution
- **sequential** solution

The **first** scenario represents the case where nobody has already set up a facility, and the countries decide to set up a joint venture to treat these patients. In this case the **number** of research centres and their **quality** would be set using a model quite similar to the one described above. If countries, as in the example above, have the same preferences for **quality**, the simultaneous solution is likely to **replicate** the centralised one. **Prices** (hence taxes at local level) may on the contrary be **different** since they may be set through a bargaining between countries and if some of them have more bargaining power than others they may get better value for money.

The second, i.e. **sequential**, solution may not allow to get a 'First Best' solution both in terms of **number** of research centres and location of the facilities to minimize **travelling cost**. In this case in fact one (or some countries) decide to set autonomously a research centre, which will be

placed in the most favourable position for that country. This may lead to duplicates in the centres and/or higher travelling costs. The problem is less serious for research centres, where travelling cost is not an issue, but its quality and access may still be an issue.

It is especially for research centres that the EU, as we have noticed above, has been playing a more proactive role by financing ERN centres. The role of the EU is compatible with the theoretical framework we have described above, since it finances the public good part of the health care research. As noted above, additional research facilities may increase the cost of research and may undermine quality. However, ERN centres, although separated entities, through collaboration may become a virtual unique centre. This requires a strict governance of that at present may have not been fully implemented.

4.6. Analysis

The governance and regulation of patients' mobility for the treatment of rare diseases is quite **challenging**, since it requires collaboration at several levels. Likewise, different objectives require different actions. The **results** of the model above show that from the pure research point of view, as well as when consultancy services should be provided, centralising the provision in a unique centre would be the best actions, since in this way it would be possible to minimise the cost. In fact, **primary research** is a public good, i.e. a good that is non rival in consumption and that once produced can be made available to anybody and for this reason its production should be centralised. **Consultancy services** are **partly public** goods themselves (a best practice may be replicated to all the patients at no cost and nowadays with the advent of artificial intelligence even its translation in other languages is not a problem). Consultancy services to study the best treatment for a patient are **private goods** because they cannot be used for other patients but usually involve constant marginal costs and can be done by the same facility that does research. Furthermore, with the advent of telemedicine, consultation may be done online with virtually no cost for the patients. On the contrary, **treatment** usually needs patient to move and from this point of view facilities scattered across countries would allow to reduce transport cost and possibly to increase access by patients. The formula presented above allows to balance these two objectives but still creates a trade-off between cost and proximity to the patients.

In this respect, the creation of ERN by the EU via the 2011 PMD may be considered an important innovation in the governance of rare diseases and in general in balancing pure research activities with patients' treatment. The idea behind ERN is that for **research** one could switch from a physical unique centre to a **virtual** unique one through a network that allows all the physical

facilities to coordinate their efforts in order to avoid the problem of several physical and independent facilities, i.e. the replication of the same fixed costs. Through the network the research centre is unique only in a virtual sense and it represents the exact sum of the laboratories in the different countries (i.e. there are no replications) and this solution represents a big welfare improvement, which allows to sensibly reduce the trade-off between centralising research few centres (in order to exploit economies of scale and avoid cost replication) and the need to treat patients as close as possible to their home.

The **number** of centres may be tailored on treatment (by balancing fixed costs for equipment with travel costs), while the network produces the basic research and the guidelines and consultancies services. From a strict economic point of view, the basic research part may be financed by a supra-national authority or at central level in any case, since each country has the same benefit from it. Consultancy and treatment costs can be defined either by a centralised procedure as the one described in Chapter 3.3.2 or a decentralised one. However, the **key success factor** of this model is its **governance**, since coordination and spreading of information is essential for its success.

The EU has adopted such a model in their design of European Reference Networks (ERN), but their actual implementations seem still a bit lagging behind. In this respect, the new actions the EU has undertaken to increase the resource of ERN and their governance seem to go in the right direction. Recently the EU has foreseen an additional grant for about EUR 77.4 million (around EUR 3 250 000 million for each ERN) relating to ERNs' work (until the end of September 2027) on improving consultations, patients' registries, training and communication activities. In order to promote better cross-border access to health data (for all the patients, but ERN will greatly benefit) the EHDS[140] has been launched and it is currently under implementation (European Health Data Space Regulation (EHDS) -, n.d.). Finally, the integration of the ERNs into national health systems will be improved through the development of national plans for rare diseases via the Joint Action JARDIN[141], with funding of EUR 18.75 million (Directorate-General for Health and Food Safety, 2024; Eurordis, 2024).

The practical application of this model would **not require changes to EU law**, neither to EU primary law (which would be a mission impossible anyway), nor to EU secondary law (more

[140] See at note 128.

[141] JARDIN is a Joint Action on integration of ERNs into national healthcare systems.

realistic but strongly depending on the content of the proposal). The PMD, which has established ERNs, respects the MS competence for financing and organisation of their health systems, as participation in ERNs is voluntary. ERNs are foreseen "in particular in the area of rare diseases" (Art. 12 para. 1 PMD), hence from a legal point of view they can be easily applied to other diseases. Likewise, above-mentioned fact that there is no ERN definition and only a selection of three out of eight objectives[142], makes this instrument more flexible.

In general, while some ERN seems to work proficiently (Casareto et al., 2024), some patient associations raise doubt about their actual impact because patients have often to find information on ERNs on their own so that the fairness in access for all the patients is somehow at stake (EURORDIRS, 2021).

5. Conclusions

Patients' mobility is increasingly important across Europe. At the same time, **health resources** are **under strain** because of both an increase in the cost to provide health care, the surge of other expenditure such as military one, and the possible decrease in resources due to tariffs and duties. Given this present strain on health resources, the theme may become even more topical in the near future.

At present, most of the mobility is **patient driven**, i.e. it is driven by patients' aspiration to get better, closer, and/or cheaper health care in a foreign country. Such mobility is highly regulated, and it is often seen by MS as a problem, since it may create extra costs due to resources that are set aside for treatments that individuals will receive in another country. In this report we started from quality-driven mobility to study whether patients' mobility may instead be a source for a better use of scarce resources.

Our report started from a simple demand. Patients-driven mobility may increase **quality** and reduce quality gaps across MS?. The question is very important from a policy point of view, because if mobility could boost quality, there would be room to incentivize it, in spite of the extra costs. To answer this question, we have developed a theoretical model and have run a survey of the literature. The theoretical model shows that patients' mobility has **little impact** on quality and in some cases, it may also have non-desirable effects, as it may reduce quality in the region

[142] Note 124.

where it is already lower. Where some positive effects exist, they are often obtaining in a context where such mobility is regulated. In this respect the present legislation and limits to patients' mobility make sense on economic grounds. The second important question is then to explore in which cases cross border patients' mobility is viable and welfare improving.

An area where gains are possible is represented by **border mobility** due to proximity, i.e. the case where patients move because they are closer to health care facilities in foreign countries than in their own. We have not explicitly dealt with it in this report since another report within WP5 will focus on this aspect.

Capacity management is another area where patients' mobility could be used and encouraged more than at present. In this case, MS decide either to treat patients abroad (as in the supply driven excess capacity case) or to pool resource together in order to meet some unexpected needs (as in demand driven excess capacity). In this report we have identified at least two interesting areas, namely

- **Supply**-driven excess capacity,
- **Demand**-driven excess capacity.

The first instance occurs when **supply** requires a capacity that cannot be tailored to demand. In this case we have shown that demand pooling may improve welfare, and we have also suggested a way to define prices. In this way different objectives can be reached, namely equity and solidarity, two of the EU's health values. However, for prices reflecting equity and solidarity, the latter should be determined at supra-national level (the EU in our case) but this is not fully compatible with the present legislation, which gives the MS the full power as concerns setting quantity and prices for health care. As a corresponding change in EU primary law (i.e. that the EU could set prices) is not realistic in the near future, we suggest focussing on incentives, so that MS adhere to this price on a voluntary basis. At the same time, contracts between MS allow to use spare capacity in an optimal way. However, at present, there does not seem to be a systematic use of such mobility, and we propose a more proactive role of the EU by, for example, setting a registry for such capacity in excess. The present legislation on patients' mobility could accommodate for a systematic use of such instrument, but the agreements across MS require the knowledge of where there are an excess capacity and an excess demand.

As per the second instance, in the past few decades, the number of **hospital beds** has been drastically **reduced** in most western countries in order to improve efficiency. The reduction has

however not been so uniform across Europe. In 2018, Germany was the nation with the highest bed per capita in 2018 (eight beds per 1,000), followed by Bulgaria and Austria. Most European countries have between three and seven hospital beds per 1,000 population, but numbers are lower in Sweden, Denmark, Iceland and the United Kingdom (OECD/European Union, 2020). However, this reduction means that if **demand** increases for some fluctuations or some unexpected reasons, the health care system goes immediately under stress. For this reason, another area where patients' mobility could improve welfare is to **pool** demand **and** to **determine excess capacity** across MS by balancing the savings determined by the reduction in the extra beds and patients travelling costs. Also, in this case we suggest some pricing schemes that could be used to regulate such mobility and how legal aspects could be taken into account.

The final area we have analysed, which could benefit from patients' mobility is the treatment of **orphan diseases**, which require sunk investments in specific technologies for a limited number of patients. In actual fact, as we have shown in this report, the EU is trying to pursue an interesting strategy that may allow to balance patients' aspirations to be treated as much as possible close to home with the need of avoiding replications in sunk investments. The theoretical model we propose shows that a trade-off exists between pursuing efficiency in basic research (which would require a unique research centre) with patients need to avoid too long travelling. In this case the idea of **ERNs** may be winning, provided its implementation is **supported by** a good **governance**. Countries with less technology/resources may benefit from their use, especially if the centres are financed at EU level and each country may send their patients to be treated for free/at marginal cost. However, at present the road to get a full coordination seems to be quite long.

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Annex 1 – Benchmark model for quality: patients' mobility is not allowed

We start with a benchmark model where mobility between the two regions is not allowed, and no grant is foreseen. In this case, competition between the providers only occurs at local level. For region A, the game is solved by backward induction, with the regulator acting as the Stackelberg leader. From and the profit function of the two providers in region A is:

$$\Pi_j = (p_A - c_A)\left(\frac{1}{4} + \frac{\beta}{2m}(q_j - q_{-j})\right) - \frac{1}{2}\theta_A q_j^2, \quad j = 1,2, \ -j = 2,1$$

where q_{-j} is the quality set by the other provider in the same region. Given the reimbursement price p_A, the first order conditions imply that

$$q_1 = q_2 = \frac{\beta}{2m\theta_A}(p_A - c_A) =: \quad q_A.$$

The optimal p_A is set by the regulator by solving the problem:

$$\max_{p_A \geq c_A} \left(r_A(1 - t_A) + 4\int_0^{\frac{1}{8}} (\beta q_A - ms + v)ds + \frac{1}{2}(p_A - c_A) - \theta_A q_A^2 \right)$$

$$s.t. \quad t_A r_A = p_A \frac{1}{2}, \quad q_A = \frac{\beta}{2m\theta_A}(p_A - c_A), \quad \frac{1}{4}(p_A - c_A) - \frac{\theta_A}{2}q_A^2 \geq 0.$$

Under the existence condition $m \geq \frac{\beta^2}{4\theta_A}$ the following solution is found:

$$p_A^b = c_A + \frac{m}{2}, \quad q_A^b = \frac{\beta}{4\theta_A}.$$

In region B, quality q_B solves of the following maximisation problem:

$$\max_{q_B \geq 0} \left(r_B(1 - t_B) + 4\int_0^{\frac{1}{8}} (\beta q_B - m\ s + v)ds - \frac{w_B}{8} \right)$$

$$s.t. \quad t_B r_B = \frac{c_B}{2} + \theta_B q_B^2$$

and by standard calculations it is:

$$q_B^b = \frac{\beta}{4\theta_B}.$$

Since by hypothesis $\theta_A < \theta_B$, quality is higher in the high-skill region.

Annex 2 – Capacity Management

2.1. A has adopted the technology

2.1.1. Decentralised solution

Let us start by finding the price for a bargaining setting where the relative power of A is equal to α. The welfare difference can be written as follows:

$$W_A = (vQ_A - m_A(Q_A + z_BQ_B) - p_AQ_A + p_AQ_A + p_Bz_BQ_B - F_K) - \big((v - m_A)Q_A - F_K\big)$$
$$= -z_BQ_B(m_A - p_B)$$

$$W_B = (v - p_B - t)z_BQ_B - \left(v - m_B - \frac{F_K}{Q_B}\right)Q_B$$
$$= (m_B - t - p_B)z_BQ_B - (v - m_B)(1 - z_B)Q_B + F_K$$

For a bargaining solution, the bargaining strength determines how the welfare gain is shared between the two regions, and the price is instrument. In analytical terms (see) we can write this bargain as the solution to a maximisation problem where the objective function is represented by total welfare. Let us define:

$p_A = m_A + x$
$p_B = m_A + y$

so that the constraint in this problem is represented by budget balance. Since the price incorporates marginal costs, it is sufficient to share the fixed costs between the two actors, i.e. to find a fixed unit cost share x and y for which the fixed costs are alway covered. The following constraint allows to reach this objective:

$xQ_A + yz_BQ_B = F_K$

This implies that y should be equal to:

$y = \frac{F_K - xQ_A}{z_BQ_B}$

The problem is to find p_A and p_B in order to maximise weighted total welfare where the weights determine the relative bargaining power of the two regions.

$$Max_{p_B} W_A + W_B = \alpha\, ln\big(-z_BQ_B(m_A - p_B)\big) +$$
$$(1 - \alpha)\, ln\big((m_B - t - p_B)z_BQ_B - (v - m_B)(1 - z_B)Q_B + F_K\big)$$
$$s.t$$
$$p_B = m_A + y$$
$$y = \frac{F_K - xQ_A}{z_BQ_B}$$

Substituting the two constraints into the objective function, we can obtain an unconstrained maximisation. The F.O.C can be written as:

$$\frac{\partial(W_A + W_B)}{\partial x} \;:\; \frac{\alpha Q_A}{-F_K + xQ_A} - \frac{(1 - \alpha)Q_A}{-Q_Bz_Bt - z_BQ_Bm_A + xQ_A - Q_Bv + Q_Bz_Bv + Q_Bm_B} = 0$$

and the optimal solution is

$$x = \frac{1 - \alpha}{Q_A}F_K + Q_B\alpha\frac{z_B}{Q_A}(m_A - m_B + t) + \alpha\frac{Q_B(1 - z_B)}{Q_A}(v - m_B)$$

Substituting back into the constraint we can write:

$$y = \alpha\left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B}\right)$$

Prices can be written as:

$$p_A = m_A + \frac{1-\alpha}{Q_A}F_K + Q_B\alpha\frac{z_B}{Q_A}(m_A - m_B + t) + \alpha\frac{Q_B(1-z_B)}{Q_A}(v - m_B)$$
$$p_B = m_A + \alpha\left(m_B - m_A - t - \frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{F_K}{z_B Q_B}\right)$$

For an equitable allocation $\alpha = \frac{1}{2}$ we can write

$$p_A = m_A + \frac{1}{2}\frac{F_K}{Q_A} + \frac{1}{2}\frac{m_A - m_B + t}{Q_A}z_B Q_B + \frac{1}{2}\frac{v - m_B}{Q_A}(1-z_B)Q_B$$
$$p_B = \frac{1}{2}m_A + \frac{1}{2}\frac{F_K}{z_B Q_B} - \frac{1}{2}\frac{Q_B(1-z_B)}{z_B Q_B}(v - m_B) + \frac{1}{2}(m_B - t)$$

which is the result presented in the text.

2.1.2. Welfare difference with respect to uniform price

For an equitable price the welfare differences can be written as:

$W_A = -z_B Q_B(m_A - p_B)$
$= \frac{z_B Q_B(m_B - t - m_A) + F_K - (1-z_B)(v-m_B)Q_B}{2}$

For A and

$W_B = (m_B - t - p_B)z_B Q_B - (v - m_B)(1 - z_B)Q_B + F_K$
$= \frac{z_B Q_B(m_B - t - m_A) + F_K - (1-z_B)(v-m_B)Q_B}{2}$

For B.

A uniform price would imply to set $p_B = p_A = m_A + \frac{F_K}{Q_A + z_B Q_B}$.

The welfare difference could be written as:

$W_A^u = -z_B Q_B(m_A - p_B)$
$= z_B Q_B \frac{F_K}{Q_A + z_B Q_B}$
$W_B^u = (m_B - t - p_B)z_B Q_B - (v - m_B)(1 - z_B)Q_B + F_K$
$= (m_B - t - m_A)z_B Q_B - (v - m_B)(1 - z_B)Q_B + F_K \frac{Q_A}{Q_A + z_B Q_B}$

$$W_A - W_A^u = \frac{z_B Q_B(m_B - t - m_A) - (1-z_B)(v-m_B)Q_B}{2} + \frac{1}{2}F_K\frac{Q_A - z_B Q_B}{Q_A + z_B Q_B}$$

$$W_B - W_B^u = \frac{z_B Q_B(m_B - t - m_A) + F_K - (1-z_B)(v-m_B)Q_B}{2} - \left((m_B - t - m_A)z_B Q_B - (v - m_B)(1 - z_B)Q_B + F_K\frac{Q_A}{Q_A + z_B Q_B}\right)$$

$$W_B - W_B^u = \frac{1}{2}(v - m_B)(1 - z_B)Q_B - \frac{1}{2}z_B Q_B(m_B - t - m_A) - \frac{1}{2}F_K\frac{Q_A - z_B Q_B}{Q_A + z_B Q_B}$$

2.2. Technology not yet adopted and $Q_A + Q_B < K$

2.2.1. No dropouts

In this first case we assume that no matter where the technology is going to be located, patients are willing to accept treatment so that total demand is always equal to $\boldsymbol{Q_A + Q_B}$. It can be used as benchmark to understand some of the decisions that public decision makers have to make in this context.

The first choice to make is where to locate the technology. The decision may be made with the objective of minimising cost or maximising welfare. In this case where there is no dropout, the solution is the same as shown below.

2.2.2. Cost minimisation

In order to minimise the cost, it is necessary to define the level of the expenditure to be borne under the two alternatives:

For running the technology in A the cost is:

$m_A(Q_A + Q_B) + F_K + tQ_B$

while for running the technology in B

$m_B(Q_A + Q_B) + F_K + tQ_A$

Since fixed costs are the same, we can be determined the best alternative in in terms of marginal price. In particular, we can find the marginal price in A, m_A for which expenditure is the same:

$m_A(Q_A + Q_B) + F_K + tQ_B - (m_B(Q_A + Q_B) + F_K + tQ_A)$

$$m_A = m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$$

hence for any $m_A < m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$ the best alternative is to locate the technology in A.

2.2.3. Welfare maximisation

In this case it is necessary to compare total welfare under the two alternatives. When the technology is located in A total welfare can be written as:

$(v - m_A)(Q_A + Q_B) - F_K - tQ_B$

while for running the technology in B

$(v - m_B)(Q_A + Q_B) - F_K - tQ_A$

As before, we can find the level of ma for which welfare is the same:

$(v - m_A)(Q_A + Q_B) - F_K - tQ_B = (v - m_B)(Q_A + Q_B) - F_K - tQ_A$

$$m_A = m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$$

For $m_A < m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$ the best alternative is to locate the technology in A. This is the same solution that was obtained for cost minimisation, and the reason is that since nobody drops, cost minimisation and welfare maximisation are driven by cost in both cases.

2.2.4. Price setting

For $m_A < m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$, the technology is located in A. Let us now see how prices can be defined in order to share welfare benefits.

As before, we start with a bargaining solution which is the more general one.
The welfare difference in A and B can be written as:

$$W_A = (vQ_A - m_A(Q_A + Q_B) - F_K - p_A Q_A + p_A Q_A + p_B Q_B) - \left(v - m_A - \frac{F_K}{Q_A}\right) Q_A$$
$$= Q_B(p_B - m_A)$$
$$W_B = (v - p_B - t)Q_B - \left(v - m_B - \frac{F_K}{Q_B}\right) Q_B$$
$$= (m_B - t - p_B)Q_B + F_K$$

The problem is to find p_A and p_B so that the weighted welfare is maximised:

$$Max_{p_B} W_A + W_B = \alpha\, ln\big(Q_B(p_B - m_A)\big) + (1 - \alpha)\, ln\big((m_B - t - p_B)Q_B + F_K\big)$$
$$s.t$$
$$p_B = m_A + y$$
$$y = \frac{F_K - xQ_A}{Q_B}$$

Substituting the two constraints into the objective function we can solve it as an unconstrained maximisation. The F.O.C can be written as:

$$\frac{\partial(W_A + W_B)}{\partial x} \;:\; Q_A \frac{-\alpha m_B Q_B + \alpha t Q_B + \alpha m_A Q_B + F_K - xQ_A - \alpha F_K}{(-F_K + xQ_A)(-m_B Q_B + tQ_B + m_A Q_B - xQ_A)} = 0$$

and the unit fixed costs can be written as:

$$x = \frac{1 - \alpha}{Q_A} F_K + \alpha(m_A + t - m_B)\frac{Q_B}{Q_A}$$
$$y = \alpha\left(m_B - t - m_A + \frac{F_K}{Q_B}\right)$$

Prices can be written as:

$$p_A = m_A + \frac{1 - \alpha}{Q_A} F_K + \alpha(m_A + t - m_B)\frac{Q_B}{Q_A}$$
$$p_B = m_A + \alpha\left(m_B - t - m_A + \frac{F_K}{Q_B}\right)$$

Substituting in the welfare gain these equilibrium prices we can find whether they are viable for the lowest bargaining power for A ($\alpha = 0$) and B ($\alpha = 1$).

$$W_{A\ :\ \alpha=0} = Q_B(m_A - m_A) = 0$$
$$W_{B\ :\ \alpha=1} = \left(-\left(m_B - t + \frac{F_K}{Q_B}\right) - t + m_B\right) Q_B + F_K = 0$$

For $\alpha = \frac{1}{2}$ we can write:

$$p_A = m_A + \frac{1}{2Q_A}F_K + \frac{1}{2}(m_A + t - m_B)\frac{Q_B}{Q_A}$$
$$p_B = m_A + \frac{1}{2}\left(m_B - t - m_A + \frac{F_K}{Q_B}\right)$$

2.2.5. Dropouts

As shown in the text we now assume that a fraction $z_i \quad i = A, B$ give up treatment if they have to travel abroad in order to be treated. In this case, as shown below, locating the technology with the objective of minimise cost may not correspond to the choice that would be taken if welfare was maximised.

2.2.6. Cost minimisation

If location is decided using a cost minimisation objective cost are

$$C^A = m_A(Q_A + z_B Q_B) + F_K + tz_B Q_B$$
$$C^B = m_B(Q_B + z_A Q_A) + F_K + tz_A Q_A$$

We can then find the marginal cost ma for which the two total welfares are equal, i.e.

$$C^A = C^B$$
$$m_A(Q_A + z_B Q_B) + F_K + tz_B Q_B = m_B(Q_B + z_A Q_A) + F_K + tz_A Q_A$$

$$m_A^C = \frac{z_A Q_A + Q_B}{Q_A + z_B Q_B} m_B - \frac{z_B Q_B - z_A Q_A}{Q_A + z_B Q_B} t$$

2.2.7. Welfare maximisation

If location is decided using a welfare maximisation objective, we can write

$$W^A = (v - m_A)(Q_A + z_B Q_B) - F_K - tz_B Q_B$$
$$W^B = (v - m_B)(Q_B + z_A Q_A) - F_K - tz_A Q_A$$

We can then find the marginal cost ma for which the two total welfares are equal, i.e.

$$W^A = W^B$$
$$(v - m_A)(Q_A + z_B Q_B) - F_K - tz_B Q_B = (v - m_B)(Q_B + z_A Q_A) - F_K - tz_A Q_A$$

$$m_A^W = \frac{Q_A(1 - z_A) - Q_B(1 - z_B)}{Q_A + z_B Q_B} + \frac{z_A Q_A + Q_B}{Q_A + z_B Q_B} m_B - \frac{z_B Q_B - z_A Q_A}{Q_A + z_B Q_B} t$$

2.2.8. Setting the price

Let us then assume that $m_A \leq \frac{Q_A(1-z_A)-Q_B(1-z_B)}{Q_A+z_B Q_B} v + \frac{z_A Q_A+Q_B}{Q_A+z_B Q_B} m_B - \frac{z_B Q_B - z_A Q_A}{Q_A+z_B Q_B} t$ so that the

technology should be located Let us define the price by a bargaining solution. The welfare difference in the two regions can be written as:

$$W_A = (vQ_A - m_A(Q_A + z_BQ_B) - F_K - p_AQ_A + p_AQ_A + p_Bz_BQ_B) - \left(v - m_A - \frac{F_K}{Q_A}\right)Q_A$$
$$= z_BQ_B(p_B - m_A)$$
$$W_B = (v - p_B - t)z_BQ_B - \left(v - m_B - \frac{F_K}{Q_B}\right)Q_B$$
$$= (v - p_B - t)z_BQ_B - (v - m_B)Q_B + F_K$$

As before, the problem is to find p_A and p_B so that

$$Max_{p_B} W_A + W_B$$
$$= \alpha\, ln\big(z_BQ_B(p_B - m_A)\big) + (1 - \alpha)\, ln\big((v - p_B - t)z_BQ_B - (v - m_B)Q_B + F_K\big)$$
$$s.t$$
$$p_B = m_A + y$$
$$y = \frac{F_K - xQ_A}{z_BQ_B}$$

where the second constraint allows to be budget balanced.
Substituting the two constraints into the objective function we can obtain an unconstrained maximisation. The F.O.C can be written as:

$$\frac{\partial(W_A + W_B)}{\partial x} : Q_A \frac{-\alpha v z_B Q_B + \alpha m_A z_B Q_B + \alpha t z_B Q_B + \alpha Q_B v - \alpha m_B Q_B + F_K - xQ_A - \alpha F_K}{(-F_K + xQ_A)(-vz_BQ_B + m_A z_B Q_B - xQ_A + tz_BQ_B + Q_B v - m_B Q_B)} = 0$$

from which we can write

$$x = \alpha \frac{z_BQ_B}{Q_A}(m_A + t - m_B) + \frac{1 - \alpha}{Q_A}F_K + \alpha \frac{Q_B(1 - z_B)(v - m_B)}{Q_A}$$
$$y = \alpha\left(\frac{F_K}{z_BQ_B} + \frac{z_BQ_B(m_B - t - m_A) - Q_B(1 - z_B)(v - m_B)}{z_BQ_B}\right)$$

Prices can be written as:

$$p_A = m_A + + \frac{1 - \alpha}{Q_A}F_K + \alpha \frac{Q_B(1 - z_B)}{Q_A}(v - m_B) + \alpha \frac{z_BQ_B(m_A + t - m_B)}{Q_A}$$
$$p_B = m_A + \alpha\left(\frac{F_K}{z_BQ_B} + (m_B - t - m_A) - \frac{Q_B(1 - z_B)(v - m_B)}{z_BQ_B}\right)$$

For $\alpha = \frac{1}{2}$ we can write:

$$p_A = m_A + \frac{1}{2}\frac{F_K}{Q_A} + \frac{1}{2}\frac{Q_B(1 - z_B)}{Q_A}(v - m_B) + \frac{1}{2}\frac{z_BQ_B(t + m_A - m_B)}{Q_A}$$
$$p_B = m_A + \frac{1}{2}\frac{F_K}{z_BQ_B} - \frac{1}{2}\frac{Q_B(1 - z_B)}{z_BQ_B}(v - m_B) - \frac{1}{2}(m_B - t - m_A)$$

Substituting in the welfare gain these equilibrium prices we can find whether they are viable for the lowest bargaining power for A ($\alpha = 0$) and B ($\alpha = 1$).

$$W_{A\ :\ \alpha=0} = z_B Q_B (m_A - m_A) = 0$$
$$W_{B\ :\ \alpha=1} = \left(v - \left(\frac{F_K}{z_B Q_B} + (m_B - t) - \frac{Q_B(1-z_B)(v-m_B)}{z_B Q_B}\right) - t\right) z_B Q_B - (v - m_B) Q_B + F_K = 0$$

2.3. New technology/lab $Q_A + Q_B > K$

Since $Q_A + Q_B > K$ it is necessary to devise a system to ration care. In this case we can use a proportional and equal rationing system for both regions so that only a fraction r of patients is allowed to receive care, i.e.

$$r(Q_A + Q_B) = K$$

2.3.1. No dropouts

As before we start with the decision choice for a case where patients decide to be treated irrespective of the location of the technology.

2.3.2. Cost minimisation

In order to minimise the cost, it is necessary to find the expenditure to be borne under the two alternatives:

For running the technology in A the cost is:

$$m_A r(Q_A + Q_B) + F_K + trQ_B$$

while for running the technology in B

$$m_B r(Q_A + Q_B) + F_K + trQ_A$$

Since fixed costs are the same, we can be determined the best alternative in in terms of marginal price. In particular, we can find the marginal price in A, m_A for which expenditure is the same:

$$m_A r(Q_A + Q_B) + F_K + trQ_B = m_B r(Q_A + Q_B) + F_K + trQ_A$$
$$m_A = m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$$

so that for any $m_A < m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$ the best alternative is to locate the technology in A.

2.3.3. Welfare maximisation

In this case it is necessary to compare total welfare under the two alternatives. When the technology is located in A total welfare can be written as:

$$(v - m_A) r(Q_A + Q_B) - F_K - trQ_B$$

while for running the technology in B

$(v - m_B)r(Q_A + Q_B) - F_K - trQ_A$

As before, we can find the level of ma for which welfare is the same:

$$(v - m_A)r(Q_A + Q_B) - F_K - trQ_B = (v - m_B)r(Q_A + Q_B) - F_K - trQ_A$$
$$m_A = m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$$

Hence for $m_A < m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$ the best alternative is to locate the technology in A. This is the same solution that was obtained for cost minimisation, and the reason is that since nobody drops, cost minimisation and welfare maximisation are driven by cost in both cases.

2.3.4. Price setting

For $m_A < m_B + \frac{t(Q_A - Q_B)}{Q_A + Q_B}$, the technology is located in A. Let us now see how prices can be defined in order to share the welfare benefits.

As before, we start with a bargaining solution which is the more general one.

The welfare difference in A and B can be written as:

$$W_A = (vrQ_A - m_A r(Q_A + Q_B) - F_K - p_A rQ_A + p_A rQ_A + p_B rQ_B) - \left(v - m_A - \frac{F_K}{Q_A}\right) Q_A$$
$$= rQ_B(p_B - m_A) - (v - m_A)Q_A(1 - r)$$
$$W_B = (v - p_B - t)rQ_B - \left(v - m_B - \frac{F_K}{Q_B}\right) Q_B$$
$$= (-p_B - t + m_B)rQ_B - (v - m_B)Q_B(1 - r) + F_K$$

The problem is to find p_A and p_B so that

$$Max_{p_B} W_A + W_B = \alpha\, ln(rQ_B(p_B - m_A) - (v - m_A)Q_A(1 - r))$$
$$+(1 - \alpha)\, ln\big((m_B - t - p_B)rQ_B - (v - m_B)Q_B(1 - r) + F_K\big)$$
$$s.t$$
$$p_B = m_A + y$$
$$y = \frac{F_K - xrQ_A}{rQ_B}$$

Substituting the two constraints into the objective function we can obtain an unconstrained maximisation. The F.O.C can be written as:

$$\frac{\partial(W_A + W_B)}{\partial x} : \frac{\alpha Q_A r}{-F_K + Q_A(xr + (v - m_A)(1 - r))} + \frac{(1 - \alpha)Q_A r}{Q_B(m_B - v(1 - r) - (m_A + t)r) + xrQ_A} = 0$$

from which we can write:

$$x = \frac{\alpha Q_B(1-r)}{rQ_A}(v-m_B) + \frac{-Q_A(1-\alpha)(1-r)}{rQ_A}(v-m_A) + \frac{1-\alpha}{rQ_A}F_K + \alpha r Q_B\left(\frac{t-m_B+m_A}{rQ_A}\right)$$
$$y = \frac{\alpha}{rQ_B}F_K - \frac{\alpha Q_B(1-r)}{rQ_B}(v-m_B) + \frac{Q_A(1-\alpha)(1-r)}{rQ_B}(v-m_A) + \alpha(m_B-m_A-t)$$

Prices can be written as:

$$p_A = m_A + \frac{\alpha Q_B(1-r)}{rQ_A}(v-m_B) - \frac{Q_A(1-\alpha)(1-r)}{rQ_A}(v-m_A) + \frac{1-\alpha}{rQ_A}F_K + \alpha r Q_B\left(\frac{t-m_B+m_A}{rQ_A}\right)$$
$$p_B = m_A + \frac{\alpha}{rQ_B}F_K - \frac{\alpha Q_B(1-r)}{rQ_B}(v-m_B) + \frac{Q_A(1-\alpha)(1-r)}{rQ_B}(v-m_A) + \alpha(m_B-m_A-t)$$

For $\alpha = \frac{1}{2}$ we can write:

$$p_A = m_A + \frac{1}{2}\frac{Q_B(1-r)}{rQ_A}(v-m_B) - \frac{Q_A(1-r)}{2rQ_A}(v-m_A) + \frac{1}{2}\frac{F_K}{rQ_A} + \frac{1}{2}rQ_B\left(\frac{t-m_B+m_A}{rQ_A}\right)$$
$$p_B = m_A + \frac{1}{2}\frac{F_K}{rQ_B} - \frac{1}{2}\frac{Q_B(1-r)}{rQ_B}(v-m_B) + \frac{1}{2}\frac{Q_A(1-r)}{rQ_B}(v-m_A) + \frac{1}{2}(m_B-m_A-t)$$

Substituting in the welfare gain these equilibrium prices we can find whether they are viable for the lowest bargaining power for A ($\alpha = 0$) and B ($\alpha = 1$).

$$W_{A\ :\ \alpha=0} = rQ_B\left(m_A + \frac{Q_A(1-r)}{rQ_B}(v-m_A) - m_A\right) - (v-m_A)Q_A(1-r) = 0$$
$$W_{B\ :\ \alpha=1} = \left(-(\frac{F_K}{rQ_B} - \frac{1-r}{r}(v-m_B) + m_B - t) - t + m_B\right)rQ_B - (v-m_B)Q_B(1-r) + F_K = 0$$

2.3.5. Dropouts

Let us turn to the more realistic case that the total number of patients treated depends on where the technology is going to be located. In particular

The first thing to decide is where to locate the technology. As before we use a proportional and equal rationing system for both regions. However, in this case the level of rationing is country-specific because a different number total number of patients may require care depending on where the technology is located.

$r_B(z_A Q_A + Q_B) = K$

$r_A(z_A Q_A + Q_B) = K$

2.3.6. Cost minimisation

In order to minimise the cost, it is necessary to find the expenditure to be borne under the two alternatives:

For running the technology in A the cost is:

$m_A r_A(Q_A + z_B Q_B) + F_K + t r_A z_B Q_B$

while for running the technology in B

$m_B r_B(z_A Q_A + Q_B) + F_K + t r_B z_A Q_A$

Since fixed costs are the same, we can be determined the best alternative in in terms of marginal price. In particular, we can find the marginal price in A, m_A for which expenditure is the same:

$$m_A r_A(Q_A + z_B Q_B) + F_K + t r_A z_B Q_B = m_B r_B(z_A Q_A + Q_B) + F_K + t r_B z_A Q_A$$
$$m_A = \frac{z_A Q_A + Q_B}{r_A(Q_A + z_B Q_B)} r_B m_B - \frac{r_A z_B Q_B - r_B z_A Q_A}{Q_A + z_B Q_B} t$$

2.3.7. Welfare maximisation

For $m_A < \frac{z_A Q_A + Q_B}{r_A(Q_A + z_B Q_B)} r_B m_B - \frac{r_A z_B Q_B - r_B z_A Q_A}{Q_A + z_B Q_B} t$ the best alternative is to locate the technology in A.

2.3.8. Price setting

The welfare difference in ^{A} and ^{B} can be written as:

$$W_A = (v r_A Q_A - m_A r_A(Q_A + z_B Q_B) - F_K - p_A r_A Q_A + p_A r_A Q_A + p_B r_A z_B Q_B) - \left(v - m_A - \frac{F_K}{Q_A}\right) Q_A$$
$$= (p_B - m_A) r_A z_B Q_B - (v - m_A)(1 - r_A) Q_A$$
$$W_B = (v - p_B - t) r_A z_B Q_B - \left(v - m_B - \frac{F_K}{Q_B}\right) Q_B = (v - p_B - t) r_A z_B Q_B - (v - m_B) Q_B + F_K$$

The problem is to find p_A and p_B so that

$$Max_{p_B} W_A + W_B = \alpha \ln\left((p_B - m_A) r_A z_B Q_B - (v - m_A)(1 - r_A) Q_A\right)$$
$$+ (1 - \alpha) \ln\left((v - p_B - t) r_A z_B Q_B - (v - m_B) Q_B + F_K\right)$$
$$s.t$$
$$p_B = m_A + y$$
$$y = \frac{F_K - x r_A Q_A}{r_A z_B Q_B}$$

Substituting the two constraints into the objective function we can obtain an unconstrained maximisation. The F.O.C can be written as:

$$\frac{\partial(W_A + W_B)}{\partial x} : \frac{\alpha r_A Q_A}{-F_K + x r_A Q_A + Q_A v - v r_A Q_A - Q_A m_A + m_A r_A Q_A} - \frac{(1-\alpha) r_A Q_A}{-v r_A z_B Q_B + m_A r_A z_B Q_B - x r_A Q_A + t r_A z_B Q_B + Q_B v - Q_B m_B} = 0$$

and the solution in terms of x and y can be written as

$$x = \frac{1-\alpha}{r_A Q_A} F_K - \frac{Q_A(1-\alpha)(1-r_A)}{r_A Q_A}(v - m_A) + \frac{\alpha Q_B(1 - r_A z_B)}{r_A Q_A}(v - m_B) + \alpha r_A z_B Q_B \left(\frac{t - m_B + m_A}{r_A Q_A}\right)$$

$$y = \frac{\alpha F_K}{r_A z_B Q_B} + \alpha(m_B - m_A - t) + \frac{Q_A(1-\alpha)(1-r_A)}{r_A z_B Q_B}(v - m_A) - \frac{\alpha Q_B(1 - r_A z_B)}{r_A z_B Q_B}(v - m_B)$$

Prices can be written as:

$$p_A = m_A + \frac{1-\alpha}{r_A Q_A} F_K - \frac{Q_A(1-\alpha)(1-r_A)}{r_A Q_A}(v - m_A) + \frac{\alpha Q_B(1 - r_A z_B)}{r_A Q_A}(v - m_B) + \alpha r_A z_B Q_B \left(\frac{t - m_B + m_A}{r_A Q_A}\right)$$

$$p_B = m_A + \left(\alpha \frac{F_K}{r_A z_B Q_B} + \alpha(m_B - m_A - t) + \frac{Q_A(1-\alpha)(1-r_A)}{r_A z_B Q_B}(v - m_A) - \frac{\alpha Q_B(1 - r_A z_B)}{r_A z_B Q_B}(v - m_B)\right)$$

For $\alpha = \frac{1}{2}$ we can write:

$$p_A = m_A + \frac{F_K}{2 r_A Q_A} - \frac{Q_A(1-r_A)}{2 r_A Q_A}(v - m_A) + \frac{Q_B(1 - r_A z_B)}{2 r_A Q_A}(v - m_B) + r_A z_B Q_B \left(\frac{t - m_B + m_A}{2 r_A Q_A}\right)$$

$$p_B = m_A + \frac{1}{2}\left(\frac{F_K}{r_A z_B Q_B} + (m_B - m_A - t) + \frac{Q_A(1-r_A)}{r_A z_B Q_B}(v - m_A) - \frac{Q_B(1 - r_A z_B)}{r_A z_B Q_B}(v - m_B)\right)$$

Substituting in the welfare gain these equilibrium prices we can find whether they are viable for the lowest bargaining power for A ($\alpha = 0$) and B ($\alpha = 1$).

Annex 3 – Research centres

3.1. Transport cost as a function of the number of facilities

Let us consider a community that is distributed along a circle of length one as in the Figure below.

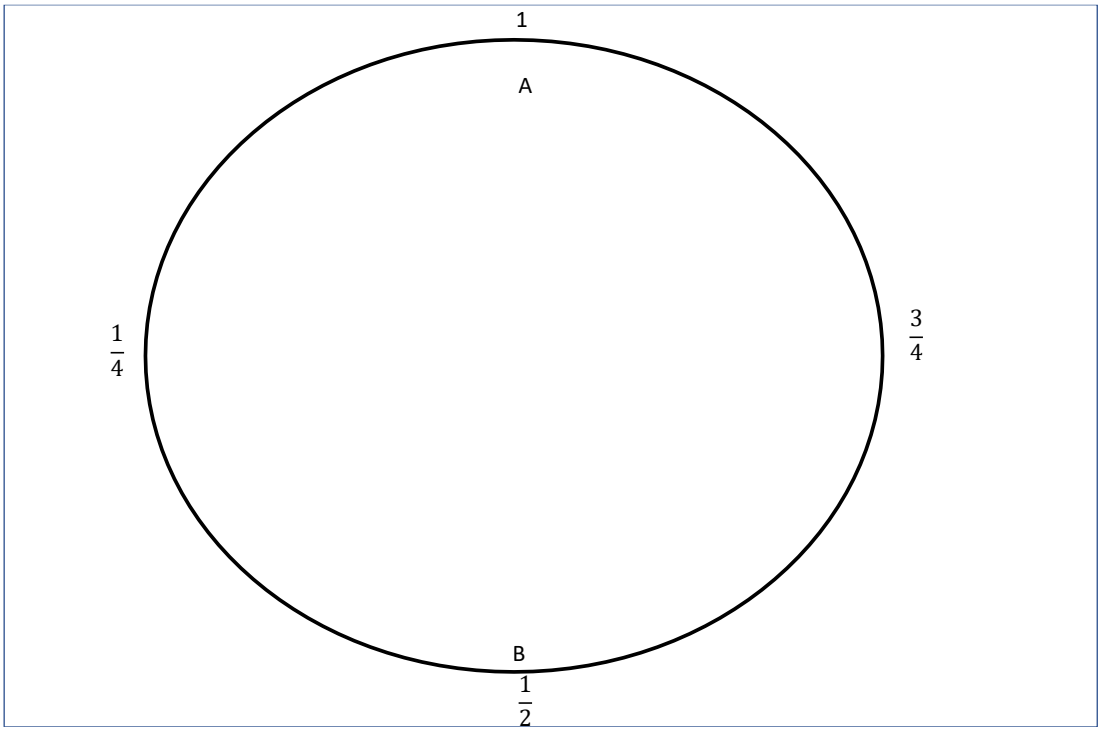

Figure: A3

To simplify matters let us also assume that the community is made of a mass of individuals equal to one. Patients to travel to the facility where they will be treated have to bear a unit cost equal to 4 m , which has then to be multiplied by the distance travelled.

One facility.

In this case it is not important where the facility is located. Let us assume that the place is A as in Figure A3

Patients located in $\frac{1}{2}$ are the further apart and the travel cost is equal to

$$2\int_0^{\frac{1}{2}} 4m\left(\frac{1}{2}-x\right)dx = m$$

With two facilities, we can locate them in A and B. In this case individuals that are located in $\frac{1}{4}$ and $\frac{3}{4}$ are the further apart and the total cost can be written as:

$$4\int_0^{\frac{1}{4}} m\left(\frac{1}{4}-x\right)dx\,4 = \frac{1}{2}m$$

For three facilities we can write

$$6\int_0^{\frac{1}{6}} 4m\left(\frac{1}{6}-x\right)dx = \frac{1}{3}m$$

and in general

$$2n\int_0^{\frac{1}{2n}} 4m\left(\frac{1}{2n}-x\right)dx=\frac{m}{n}$$

3.2. Optimal number and quality level of research centres

For each lab the cost can be written as

$$\left(F+\frac{s}{2}T^2\right)+lQ_i+mQ_i^2$$

and since the lab are equal in size we can write

$$\left(F+\frac{s}{2}T^2\right)+l\frac{Q}{n}+m\frac{Q^2}{n^2}$$

i.e. the total cost is equal to

$$n\left(F+\frac{s}{2}T^2\right)+lQ+m\frac{Q^2}{n}$$

so that $\tau=\frac{n\left(F+\frac{s}{2}T^2\right)}{Y}$

The cost to treat patients with telemedicine is equal to l while the average cost for each patient is equal to $m\frac{Q^2}{n^2}$

This means that in each country an additional tax t_i has to be raised to pay for treatment and telemedicine

$$t_i=\frac{\left(+l+m\frac{Q}{n}\right)Q_i}{p_iY_i}$$

The utility enjoyed by healthcare is equal to

$$\left(v+\phi(T-\rho\tfrac{c}{n})\right)z_ip_i$$

$$\left(v+\phi(T-\rho\tfrac{c}{n})\right)Q_i$$

Utility for each country can be written as

$$\left(v+\phi(T-\rho\tfrac{c}{n})\right)z_ip_i=\left(v+\phi(T-\rho\tfrac{c}{n})\right)Q_i$$

so that welfare in country i can be written as:

$$p_iY_i(1-\tau-t_i)+\left(v+\phi(T-\rho\tfrac{c}{n})\right)Q_i$$

The problem for the centralised planner is to maximise welfare across countries and to keep a balanced budget, i.e.

$$Max_{n,T}W=\sum\quad p_iY_i(1-\tau-t_i)+\left(v+\phi(T-\rho\frac{c}{n})\right)Q_i$$

$$ss.t.$$

$$\tau=\frac{n\left(F+\frac{s}{2}T^2\right)}{Y}$$

$$t_i=\frac{\left(l+m\frac{Q}{n}\right)Q_i}{p_iY_i}$$

Substituting the constraints in the welfare function we can write

$$\sum p_iY_i\left(1-\frac{n\left(F+\frac{s}{2}T^2\right)}{Y}-\frac{\left(l+\frac{Q}{n}\right)Q_i}{p_iY_i}\right)+\left(v+\left(\varphi\left(T-\rho\frac{c}{n}\right)\right)\right)Q_i$$

Summing up we obtain

$$W = \left(1 - n\frac{F+\frac{1}{2}sT^2}{Y}\right)\sum p_i Y_i - \left(l + m\frac{Q}{n}\right)\sum Q_i$$

Which can be written as:

$$W = \left(1 - n\frac{F+\frac{1}{2}sT^2}{Y}\right)Y - \left(l + m\frac{Q^2}{n}\right) + \left(v + \phi(T - \rho\frac{c}{2(n)})\right)Q$$

The FOC to obtain the maximum of the function can be written as:

$$\frac{\partial W}{\partial n} = 0: \frac{1}{2}\frac{-2Fn^2 - sT^2n^2 + 2mQ^2 + 2\phi\rho cQ}{n^2} = 0$$
$$-F - \frac{1}{2}sT^2 + Q\frac{mQ + \phi\rho c}{n^2} = 0$$
$$\frac{\partial W}{\partial T} = 0 \ : -nsT + \phi Q = 0$$

From the FOC we can obtain a system of two equations in two unknowns

$$-F - \frac{1}{2}sT^2 + Q\frac{mQ + \phi\rho c}{n^2} = 0$$
$$-nsT + \phi Q = 0$$

The solution can be written as:

$$n = \pm\frac{1}{2Fs}\sqrt{-2FsQ(Q\phi^2 - 2Qms - 2\phi\rho cs)}$$
$$T = \phi\frac{Q}{ns}$$

If a Central or supernational Government decides to make every region pay more equally for all the services (in other words all the services are free at the point of use, and they are financed with a linear tax at a uniform rate across regions) the tax rate will be equal to:

$$\mathrm{t} = \frac{n\left(F+\frac{s}{2}T^2\right)+lQ+m\frac{Q^2}{n}}{Y}$$

The utility can be written as before

$$\left(v + \phi(T - \rho\frac{c}{n})\right)z_i p_i$$
$$\left(v + \phi(T - \rho\frac{c}{n})\right)Q_i$$

while the welfare will be equal to:

$$p_i Y_i(1 - t\ ) + \left(v + \phi(T - \rho\frac{c}{n})\right)Q_i$$

Total welfare is equal to:

$$W = \left(1 - \frac{n\left(F+\frac{s}{2}T^2\right)+lQ+m\frac{Q^2}{n}}{Y}\right)Y + \left(v + \phi(T - \rho\frac{c}{2(n)})\right)Q$$

$\frac{\partial W}{\partial n} = 0: \; : \; \frac{1}{2}\frac{-2Fn^2 - sT^2n^2 + 2mQ^2 + 2\phi\rho cQ}{n^2}$

$\frac{\partial W}{\partial T} = 0: \qquad -nsT + \phi Q$

Whose solution is equal to

$n = \pm\frac{1}{2Fs}\sqrt{-2FsQ(Q\phi^2 - 2Qms - 2\phi\rho cs)}$

$T = \phi\frac{Q}{ns}$

i.e. the same as the problem presented above.