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Monetary flows for inter-regional health mobility: The case of Italy[1]

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ABSTRACT

This study investigates the dynamics of healthcare mobility in Italy, where citizens have the freedom to access medical treatment across regions. More than half a million patients, primarily from the Southern regions, engage in healthcare mobility, resulting in a total inter-regional transfer of resources amounting to about €3.7 billion in 2019. Leveraging a unique dataset spanning from 2002 to 2019, this research examines financial flows among regions using a network analysis, and identifies the factors influencing monetary flows through a gravity model. Socioeconomic disparities and the availability of specialized services in some regions are the key drivers. Regions with higher healthcare quality and the presence of private licensed hospitals attract more funds. This study offers valuable insights into the intricacies of interregional monetary flows, and finds further evidence of the persistent Italian territorial dualism, which can inform healthcare policy and promote regional equity considerations.

1. Introduction

In the last decades, several European countries have implemented decentralization reforms in their health care systems to promote efficiency, mainly driven by a general trend of gradual recalibration of members' states welfare programmes, which might have resulted, to varying degrees, in a downsizing of national social policies. As a result, in Italy, Spain, Sweden, Denmark, Germany and Austria, greater autonomy has been granted to subnational governments in the provision of public health care services. A subset of these countries including Sweden and Italy has then introduced free patient mobility to stimulate inter-jurisdictional competition *à la Tiebout* (Tiebout, 1956) and promote quality levelling and fair market sharing among jurisdictions. In the long run, and assuming perfect mobility, the Tiebout's "vote-with-your-feet" effect should lead to lower, or even zero, voluntary mobility (Brekke et al., 2012). However, since mobility among regions is conditioned by a number of factors outside the individual control that are not likely to disappear in the next years, the alternative way to eliminate voluntary mobility could be that of providing health services able to satisfy the essential level of assistance in all regions. If not, mobility would easily involve a stratification by income levels, letting people moving only when monetary resources are available to afford the corresponding costs, while at the same time leaving other people without the possibility of accessing proper health care.

The phenomenon of inter-regional mobility affects various countries, particularly those characterized by a decentralized healthcare system. In the past, various regional studies have analysed mobility between regions in Spain (Cantarero, 2006, Perna et al., 2022; Cruz-Martinez et al., 2024) the USA (Werden, 1990), Sweden (Brekke et al., 2016), UK (Dusheiko, 2014). All these studies have highlighted that the main driver of mobility is per capita income, emphasizing that wealthier regions tend to have a higher level of technology and service quality, making their regional healthcare system more attractive. In this context, Italy represents an interesting case of study. Fiscal decentralization and free patient choice were introduced with the reforms of the '90 s and 2001. To date, however, the reforms have not produced the desired

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results and mobility has increased, rather than decreased. From 2002–2019, out-of-region admissions rose from 7 % to 8.9 %, involving more than half a million patients each year seeking medical treatment in regions other than their own. The monetary counterpart of inter-regional patient flows has also been characterised by a steadily increasing overall trend, amounting to about 3.7 billion euros in 2019. In Europe, internal patient mobility is not as pronounced as in Italy. Other cases of healthcare mobility are present, for example in Spain, although at a lower scale, where there are bilateral agreements between different regions to ensure healthcare for their own citizens (Cantarero, 2006; Perna et al., 2022). In Italy, health mobility raises concerns about its ability to contribute to a greater efficiency and territorial equity of healthcare provision. Regions, indeed, significantly differ with respect to the initial endowment of economic resources, social backgrounds, and transport infrastructures; thus, mobility results in the need to proceed with financial compensation schemes among regions that may exacerbate initial differences. Furthermore, the deep financial crisis that has plagued the country over the past decade has further contributed to increase the economic disparities across the country, with inevitable effects on both health supply and demand (Lagravinese, 2015). Inequalities in per capita GDP, education and occupation rates have started to increase again, squeezing available healthcare resources, as well as the quality of uneven healthcare services, and the living conditions of citizens (Lagravinese et al., 2019; Barra et al., 2022). It follows that, even though healthcare mobility is a right to citizens to access health care in any part of the national territory regardless of the region of residence, some of the observed mobility may be unintentional and undesirable, as it is driven by regional disparities in both the quantity and quality of healthcare services. Thus, health mobility may not be a choice, but a state of necessity driven by the need of accessing health provisions that are not available in the region of residence, without involving a willingness to permanently migrate to other regions. It is worth noting that, in a homogeneous national health service – even though composed of regional health systems – unintentional health mobility should disappear in the long-run as the only way of avoiding that the right to access health care be constrained by a heterogenous distribution of health care facilities.

Since we think that health mobility is a significant signal of how a national health service actually works, in this paper we focus on Italian health mobility as a tool for analysing the performance of a decentralized health system and its subnational governments. Obviously, health mobility is not the unique indicator according to which the performance of a national health service can be assessed; to this respect, our analysis is thus limited to one specific dimension. Yet, since health mobility involves people migration across regions due to the lack of adequate health infrastructures, we take the data on health mobility as a significant component of the more general issue of inequality. Moreover, since the Italian dualism between North and South can also be found in other economic dimensions, it is of some importance to understand whether one of the most important social expenditures in Italy might be able to either mitigate or exacerbate that dualism.

Among the early studies that explored the determinants of health mobility in Italy, Levaggi, Zanola**, (2004) suggest that there is a significant effect of the quality of service, with income being a determinant of the quality of services provided. More recently, the focus has shifted to patient data using Hospital Discharge Records. Accordingly, Balia et al. (2018) have argued that the primary factors driving this mobility include regional income, hospital capacity, organizational structure, performance, and technology. Moreover, Balia et al. (2020) conducted a study using Italian hospital discharge records (SDO) related to admissions for digestive system cancer treatments for patients residing in Sardinia and Sicily. Their findings suggest that mobility is more pronounced among younger patients and those with a higher level of education. Additionally, the choice of hospital is significantly influenced by factors that represent the attractiveness of the hospital, with discernible distinctions between local and distant healthcare providers. Bruni et al. (2021) using Italian patient-episode level data on elective Percutaneous Transluminal Coronary Angioplasty procedures over the years 2008–2011 find that a higher propensity for mobility can be attributed to a younger age of patients and a lower perceived quality of residential facilities.

In recent years, several empirical studies have shown a significant correlation between mobility flows and actual/perceived quality (Berta et al., 2021; Berta et al., 2022a,2022b). Moreover, Beraldo et al. (2023) employed a quasi-experimental strategy to assess the impact on patient migration of programs for reorganization, requalification and improvement of the regional healthcare system, finding that outbound mobility was about 24–31 % higher in those regions where a lower quality was detected, and a stricter implementation of such plans was needed.

This paper aims to contribute to the literature on healthcare mobility among Italian regions in three main ways.[2] First, we analyse monetary flows between Italian regions over a lengthy period (2002–2019), collecting a non-public domain database. This represents a novelty in the literature studying health mobility. While the latter focuses exclusively on data on patient flows, we can instead analyse a measure that accounts not only for the volume but also for the cost of services offered. Moreover, monetary flows give immediate insights into territorial disparities and play a crucial role in resource allocation at the regional level that may also contribute to feed inequality.

Second, we use these data to estimate a comprehensive network of regional monetary outflows and inflows. The network analysis allows to study the structural characteristics of a phenomenon with interconnected nodes, i.e. the Italian regions, and provide a broader overview of the financial flows that move annually from one region to another. To the best of our knowledge, this is the first application of network analysis to interregional patient mobility in the healthcare sector for long time span. This allows us to study mobility not only in its static dimension, but to verify its dynamic structure, in this way getting information about the persistence and the pattern of regional differences over time.

Finally, using a comprehensive gravity model with spatial interactions, we try to identify the determinants of monetary flows among regions, to capture dependency relations across regions. A gravity model is here used to identify the regional pattern in the presence of competition among regions in attracting patients. Even though we do not fully specify a theoretical model, it is worth noting that the underlying model of health mobility may be intended as a standard spatial competition model, where patients move between health providers on the basis of economic and social factors as well as of the perceived quality of health provisions (for a recent application to international health mobility see Frischhut and Levaggi, 2024). Assuming this kind of model, the analysis of the consequences and the determinants of health mobility may provide significant insights – even in the presence of health competition – on what role the central government should assume in regulating the architecture of the health service in order to avoid undesired effects on health quality and social welfare, an issue that may also have consequences on how quality is best pursued (see, for example, Kuchinke and Zerth, 2015).

The remainder of the paper is organized as follows: Section 2 provides information on the institutional framework, Section 3 describes the dataset used, Section 4 presents the empirical analysis and the results, and Section 5 concludes our study.

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[2] Our study focuses on regional mobility, which excludes both intraregional mobility (between different facilities within the same region) and cross-border mobility (services provided abroad).

2. Institutional setting

The National Health Service (NHS) was established in 1978[3] to replace a number of health insurance funds with a single public national health fund, financed through sickness contributions and central government tax revenue. The NHS was designed as a multi-layered system to ensure universal access to a comprehensive set of services on an equal basis. The organization involved the Central Government (CG), the Regional Government (RG), and several local health authorities (LHAs), with the CG allocating funds to each RG to guarantee territorial equity in the provision of services. For a long time, this system caused a misalignment between expenditure and funding responsibilities, a problem that the reforms of the ’90s and 2001[4] attempted to solve through the introduction of quasi-markets and fiscal decentralization. The underlying idea was to shift the balance of power in favour of the RGs by splitting providers from purchasers of services and increasing efficiency through free mobility and competition for patients, with the general taxation supplementing regional taxation to cover local financial needs. With regard to the activities of the layers involved in this process, the reforms provided for exclusive power of the CG in defining the essential levels of care to be offered to all citizens (actually set by the Italian Constitution), and exclusive responsibility of RGs for the organization and administration of healthcare; finally, LHAs were intended to be financially accountable for the services delivered to their resident population (Turati, 2013).

In compliance with the principle of free choice, patients are allowed to choose any provider within the Italian territory. As a consequence of this possible choice, payments for out-of-region care give rise to financial transactions between regions of residence and destination on the basis of a conventional flat rate defined – even though in some cases with modifications – by the tariffs related to the Diagnostic Related Groups (DRG). The latter includes the running and full costs of care, with the consequence that the regions experiencing high outflows actually pay for both the treatments supplied to their outgoing patients and the fixed costs of their own health services. As a positive mobility balance represents a net gain for the regions receiving patients, each region has a strong incentive to limit outflows and attract inflows. As a preliminary information for the following analysis, it is worth noting that 80 % of both patients and financial flows among regions is caused by hospital acute care.[5] Its provision is completely free of charge for patients[6] and largely relies on public production supplemented by private licensed hospitals (PLHs), which are allowed to treat patients on behalf of the NHS and are refunded by the LHA (and thus the RG) the patient is enrolled to. However, different contractual schemes apply to public and private licensed hospitals. While the former have a constraint on the maximum number of total admissions but are reimbursed ex-post for any cap overshoot, the latter receive no coverage for budget loss but only resident patients count for the limit. Thus, it follows that PLHs face an incentive to attract out-of-region patients to finance excess production (Brenna and Spandonaro, 2015).

After more than two decades, both mobility and regional financial empowerment have not had the desired effects. As argued above, in the long run free patients’ choice should determine zero voluntary interregional mobility, as competition should stimulate quality levelling and ensure fair market sharing (Gravelle et al., 2014; Brekke et al., 2014; 2016). Instead, the Italian NHS is characterized by high and persistent interregional mobility; this is despite the attempts by the CG to limit it by including exit and attraction rates in the evaluation criteria of regional health performance used to allocate funds among regions (Fabbri and Robone, 2010). As shown in Figures A.1 and A.2 in the Online, patient flows even increase between 2002 and 2019.

With regard to the financial responsibility, the transition to a regionally organized NHS has gone through a period of lack of cost-containment incentives, leading to large budget deficits in many regions. As a result, Financial Recovery Plans (FRP) were introduced in 2004 for regions with significant budget shortfalls to limit access to public national health funds and force such RGs to define consolidation paths.[7] FRP must contain measures to ensure a balanced health budget and measures to rebalance the delivery of LEA. They remain effective for three years and are renewed if the associated goals are not achieved. In this last case, a commissioner may be engaged to set up more constraining plans including tax increases combined with CG transfers cuts (Beraldo et al., 2023). Table A.1 in the Online Appendix shows the regions and years under FRP, as well as any periods with commissioner.

3. Data on interregional monetary flows for health mobility

To analyse interregional monetary flows resulting from patient mobility, we use a matrix of credits and debits for hospital services among Italian regions from 2002 to 2019, provided, after request, by the Italian Ministry of Health. From an economic perspective, active mobility gives rise to a credit for regions, while passive mobility gives rise to a debit. Each year, the region that provides the healthcare service to non-residents is reimbursed by the citizen’s region of residence. In our analysis, since regional data are not separately available for the autonomous provinces of Trento and Bolzano, the corresponding data are aggregated to obtain a single value for the whole region (Trentino Alto Adige). We thus obtain a sample of 20 regions and 380 pairs per year, for a total of 6840 observations.

Fig. 1 introduces an overall picture of these dynamics by showing the total monetary flows and the interregional per capita compensation network of the Italian NHS, this latter to take into account the fact that the total amount of compensation can be affected by both population size and growth. In real terms, the import and export of patients among regions resulted in an average monetary flow of more than 3.5 billion euros, showing a significant increasing trend over years, especially since 2012 (in 2019, 3.7 billion euros). Looking at these data in terms of population, the consistent decline in per capita spending stopped as population growth came to a halt in 2014. Since then, the related value has increased by about 100 euros per inhabitant (in 2019, 1775 euros).

These trends may depend on several drivers, which we select mostly following the existing literature. Those that have never been included in an analysis related to health mobility are the Institutional Quality Index (IQI), the binary variable for Special-Statute regions (SSR), the Caesarean-section (C-section) rate, and the categorical variable for being under FRP with and without commissioner. All variables we use in our analysis are listed in Table 1[8]. Geographical distance, expressed in kilometres, is the most critical and the sole origin-destination (OD) factor we examine. Considered as a proxy for transportation, accommodation, and information costs (Balia et al., 2018), it is expected to exert an adverse effect on OD monetary flows. The other characteristics are captured separately for the origin (O-regions) and destination regions (D-regions) and are divided into contextual and RHS factors. Contextual factors include the demographic and economic characteristics of the region, while RHS factors comprise some of the most relevant attributes of the regional health system (RHS). In the table, O- and D-regions are grouped into the first and fourth quartiles based on outflow and inflow magnitude, respectively.

Regarding contextual factors, population and GDP reflect the wealth

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[3] Law 833/1978.

[4] Legislative Decrees 502/1992, 517/1993, and 229/1999, Constitutional Law 3/2001.

[5] Authors’ own elaborations of the data available for analysis.

[6] Specifically, the provision is free of charge under the presentation of a physician referral and for emergency cases.

[7] Law 311/2004, Law 296/2006.

[8] Table A.3 in the Online Appendix lists the variables along with their definition and data source.

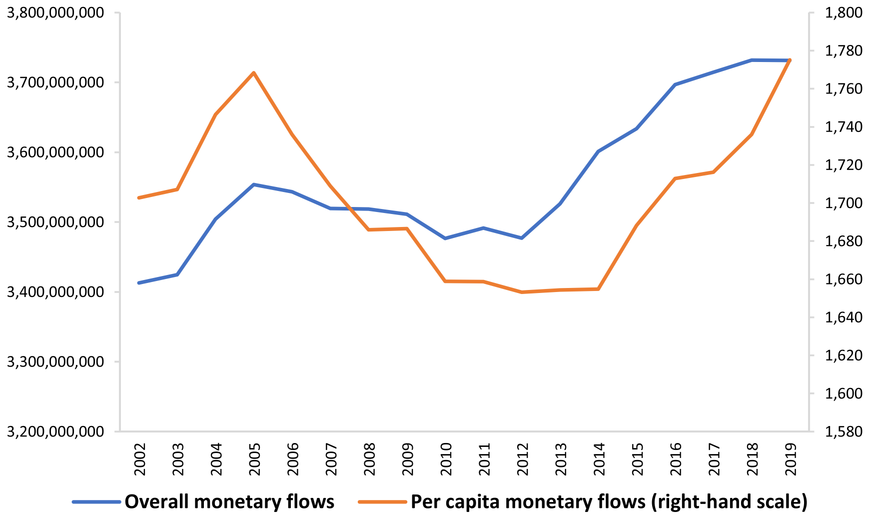

Fig. 1. Interregional compensation network of the Italian NHS: overall and per capita monetary flows. *Note*: monetary flows are expressed in real terms. *Source*: own elaborations on Ministry of Health data

Table 1
Summary statistics by origin-destination flow quartile.

Origin-destination factors				
	Mean	Median	Min	Max
Distance (Km)	469	433	55	1546
Contextual factors				
	Origin		Destination	
	Q1	Q4	Q1	Q4
Flows[a] (× €1000)	57,822	309,070	33,484	458,749
Pop. (× 1000 inhab.)	862	5382	1066	5569
Over 65 (%)	21.21	18.97	19.92	21.58
GDP[a] (× €1 million)	23,426	147,361	23,962	184,356
IQI	0.6344	0.3912	0.5037	0.7186
SSR (%)	80	0	60	0
RHS factors				
	Origin		Destination	
	Q1	Q4	Q1	Q4
C-section rate (%)	32.58	42.23	35.7	29.71
CIP	1.06	1.01	1.05	1.02
CMI	1	0.96	0.97	1.04
TEI	2508	12,178	2579	15,208
Beds in PLHs (%)	13.43	25.68	16.69	17.79
Discharges from specialized f. (%)	14.96	15.21	6.23	19
No FRP	82.22	47.78	84.44	85.56
FRP	5.56	15.56	4.44	1.11
FRP with commissioner	12.22	36.66	11.12	13.33

Note: the table shows summary statistics of contextual and regional health service (RHS) factors for the first (Q1) and fourth (Q4) quartiles of OD per-capita monetary flow distribution. Origin regions in Q1: Sardinia (ITG2), Molise (ITF2), Trentino-Alto Adige (ITH1+ITH2), Friuli-Venezia Giulia (ITH4), Aosta Valley (ITC2). Origin regions in Q4: Apulia (ITF4), Calabria (ITF6), Lazio (ITI4), Liguria (ITC3), Lombardia (ITC4). Destination regions in Q1: Aosta Valley (ITC2), Basilicata (ITF5), Calabria (ITF6), Sardinia (ITG2), Trentino-Alto Adige (ITH1+ITH2). Destination regions in Q4: Emilia-Romagna (ITH5), Lazio (ITI4), Lombardia (ITC4), Toscana (ITI1), Veneto (ITH3). GDP: Gross Domestic Product; IQI: Institutional Quality Index; Public HCE: Public health care expenditures; CIP: Comparative Index of Performance; CMI: Case-Mix Index; TEI: Technology Endowment Index.

[a] Data are deflated by dividing current values by the Eurostat GDP deflator (the reference year is 2010).

and size of the region and are larger for Q4 than Q1 regions, favouring outflows at the origin and inflows at the destination. While overall regional population reflects the internal demand for health care, the share of over-65 residents approximates the need for care of the frailest population group. No large changes in the share of the elderly are observed between regions of different quartiles.

The IQI is a composite indicator ranging from 0 to 1 proposed by Nifo and Vecchione (2014) to measure the quality of governance in Italian regions.[9] This index is structured following a hierarchy framework into five dimensions: voice and accountability, government effectiveness, regulatory quality, rule of law, and control and corruption. As expected, the regions most able to retain patients (Q1 O-regions) and those most able to attract patients (Q4 D-regions) are those with a higher institutional quality.

Finally, SSR is a binary variable indicating Special-Statute regions, included to control for higher levels of independence in the financing and organisation of their SSRs. Not surprisingly, no SSR belongs to the highest quartile of both outflows and inflows.

With respect to RHS factors, C-section rates are used to measures the appropriateness of health care provision (De Luca et al., 2021; Baicker et al., 2006; OECD, 2009). C-section, in fact, is not recommended in the absence of clinical reasons or complications because it is more invasive, riskier, and more expensive than delivering naturally. As expected, greater appropriateness characterises the regions most capable of retaining patients and those most capable of attracting them.

The Comparative Index of Performance (CIP) and the Case-Mix Index (CMI) represent, instead, two important indexes for the evaluation of the regional hospital care (Balia et al., 2018; Ciarrapico et al., 2023). CIP is an efficiency measure and is calculated as the ratio between the average standardized case-mix hospital stay of a given region and the national average hospital stay. No great variations in the CIP are observed by quartile at either origin or destination. The case mix index (CMI) allows for a comparison of the complexity of the case mix treated and is obtained as the ratio between the average weight of the inpatient admission of a given region and the average weight of the inpatient admission in the national case mix. As in the previous case, there are no relevant differences by quartile.

The technology endowment index (TEI) is a composite indicator of the availability and comprehensiveness of the regional technological

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[9] Since data on IQI are only available for years after 2004, a linear interpolation is performed for missing data.

endowment[10] (Balia et al., 2018; Balia et al., 2014a; Balia et al., 2014b). As shown in Table A.4 in the Online Appendix,[11] it is positively correlated to the size and wealth of the regions, which explains why it is higher in Q4 than in Q1 at both origin and destination.

Finally, to assess the concentration of the RHS organizational structure we consider the percentage of beds in PLHs out of the total number of beds and discharges from specialized facilities[12] out of the total number of discharges. The share of private beds does not differ much by quartile at the destination, while it is higher in regions with higher outflows. In contrast, the share of discharges from specialized institutions does not vary at origin, while at destination it is much higher in the regions most able to attract patients.

There is a wide heterogeneity of funds at the regional level. Table 2 shows the distribution of the national healthcare fund (the allocation of the so-called undifferentiated healthcare pre-mobility fund) among the different regions (column A) in the last three years of our analysis (2017–2019). The allocation of the healthcare fund is based on ensuring the fulfilment of LEAs (Essential Levels of Assistance) and is quantified net of regional mobility. The distribution takes into account historical spending, resident population, and average age of residents. Column (B), on the other hand, shows the net resources involved in compensating interregional mobility (credits minus debts). The difference between credits, resulting from active mobility, and debts, the effect of passive mobility, determines the balance of each Region, which is accounted for in the allocation of resources from the National Health Fund for the following year. Therefore, if the balance is positive, the Region will have more resources compared to undifferentiated health care fund; conversely, if the balance is negative, the resources will decrease.

Column C instead shows the weight of mobility relative to the healthcare fund allocated to each region (calculated as B/A *100). In some regions, mobility (column C) does not significantly affect the resources of the National Healthcare Fund (e.g., Piedmont, Umbria, Aosta Valley, Trentino-South Tyrol), where the incidence of mobility is less than 1 % compared to the allocation fund. The situation, however, is very different in other regions, such as Calabria, for example, where in 2019, approximately 281 million euros were used to finance mobility to other regions. This value accounts for about 8 % of the healthcare fund allocated to this region. Other regions, such as Emilia Romagna and Lombardy, instead, benefit from additional resources compared to the National Healthcare Fund as compensation for treatments provided to outside-region patients. However, the table only indicates the size of monetary flows from debtor regions to creditor regions regarding mobility; it does not give any detail on where these monetary flows go. Mobility could indeed be generated by proximity (living near the regional border) or by having residency in one region but working and studying in another. The network analysis and the gravity model addressed in the next section will be useful in dealing with these issues.

4. Empirical analysis

The significant amount of resources caused by health mobility and the territorial consequences of these flows, suggest to analyse patient mobility in some detail. To this purpose, the empirical analysis is divided into two parts. In the first part, we use the Network Analysis to investigate monetary flows between regions; in a second part we use network indices to estimate a gravity model to identify the determinants of mobility. These two parts of the empirical analysis are carried out with the aim of providing a complete picture of health mobility. The network analysis is indeed a valuable tool, in our case, to understand the concentration of monetary flows and to verify the direction of those flows over time. This analysis, indeed, has the advantage of clearly identify – in the health mobility framework – the presence of persistent nodes of attraction, or – if any – how the nodes of attraction may have changed over the years. As it will be explained below, complex network theory is a well-developed technique to identify relevant nodes in any kind of spatial relationship. The gravity model, instead, is used to identify what causes health mobility. Even though apparently disconnected, the complete set of information obtained by the two-stage analysis will provide useful insight to explain not only the territorial pattern of health mobility, but also on what health mobility itself depend. For example, a gravity model may give useful information on whether the monetary flows either increase or decrease with distance among regions, or whether specialization in health provision may play a role in moving people. Thus, even though the use of one of these techniques does not necessarily involve the use of the other, we think that having information on both the determinants of mobility and the size of resources involved by mobility itself is a valuable endowment that may be used by the policy-maker in order to plan policy actions.

4.1. Network analysis

Our network analysis is based on the interregional compensation schemes from 2002 to 2019 provided by the Ministry of Health.[13] In terms of value, this implies that an exporting (or debtor) region refunds money to the region that receives the “foreign” patient (importing or creditor region). The flow of money then corresponds to a flow of patients multiplied by the cost of specific healthcare services. In other words, being a creditor region in value terms is equivalent to importing patients from other regions. The latter will therefore be debtor regions, exporting patients to the rest of Italy.

Over time, regional heterogeneity has fostered quality differentials which have nourished a high and persistent interregional patient mobility. Mobility patterns are traditionally characterised by patient flows from southern regions towards hospitals located in very distant regions of central-northern Italy, despite the related costs of travelling. Our work aims to deepen this characterisation applying the complex network theory which has become popular in the field of international trade (An et al., 2014; Fan et al., 2014; Zhang et al., 2014; Tokito et al., 2016; de Andrade and Rêgo., 2018; Cappelli et al., 2023).

The interregional health mobility network is conceptualised using complex network theory, where regions represent the nodes (or vertices) and healthcare expenditures between regions the connections (or edges). Complex network theory allows using specific indicators for analysing the structural characteristics of our network. In traditional analysis of complex networks, one of the most important problems is related to the identification of the importance of nodes, that – in our case – are represented by regions. This importance can be assessed considering the number of connections a node has to other nodes and the related flow of money. In this regard, the weighted degree represents the trade intensity of a regions with other regions, taking into consideration not only the number of connections but also the related amount of value.

There exists an exporting-based network, considering the outgoing edges, and an importing-based network, based on the incoming links. If

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[10] The devices used for the computation are: automated immunochemistry analyser, linear accelerator in radiotherapy, immunoassay analyser, anaesthesia machine, ultrasound imaging system, haemodialysis delivery system, computerized gamma camera, differential haematology analyser, analogue X-ray system, surgical light, monitor, mobile X-ray system, computerized axial tomography (CT), magnetic resonance-imaging (MRI), medical imaging table, continuous ventilator system, digital angiography systems, hyperbaric chamber, mammogram, positron emission tomography (PET), integrated PET-CT, operating table, and two types of panoramic radiography machines.

[11] Tables A.4 in the Online Appendix shows the pairwise correlation coefficients among the variables included in the analysis.

[12] As specialized inpatient facilities we consider University Hospitals, Scientifically-Oriented Inpatient Facilities, and Research Facilities.

[13] As some data are not available at a disaggregated level, the two autonomous provinces of Trento and Bolzano are considered as a single regional health service (*i.e.*, Trentino-Alto Adige).

Table 2
Distribution of the national healthcare fund at regional level.

NUTS 2	Code	2017			2018			2019		
		A	B	C	A	B	C	A	B	C
Piedmont	ITC1	8082	−62	−0.8	8135	−89	−1.1	8203	−51	−0.6
Lombardy	ITC4	17,965	627	3.5	18,157	770	4.2	18,418	784	4.3
Veneto	ITH3	8836	133	1.5	8913	159	1.8	9024	143	1.6
Liguria	ITC3	2959	−35	−1.2	2972	−54	−1.8	2989	−71	−2.4
Emilia-Romagna	ITH5	8093	355	4.4	8164	359	4.4	8264	308	3.7
Tuscany	ITI1	6875	154	2.2	6932	146	2.1	7003	139	2.0
Umbria	ITI2	1634	26	1.6	1644	20	1.2	1656	−4	−0.3
Marche	ITI3	2816	−62	−2.2	2832	−67	−2.4	2854	−43	−1.5
Lazio	ITI4	10,507	−268	−2.6	10,623	−271	−2.6	10,755	−239	−2.2
Abruzzo	ITF1	2402	−74	−3.1	2418	−71	−3.0	2435	−80	−3.3
Molise	ITF2	568	21	3.8	571	23	4.0	574	20	3.5
Campania	ITF3	10,141	−277	−2.7	10,230	−295	−2.9	10,347	−318	−3.1
Apulia	ITF4	7240	−185	−2.6	7296	−182	−2.5	7368	−201	−2.7
Basilicata	ITF5	1031	−17	−1.7	1036	−38	−3.6	1043	−53	−5.1
Calabria	ITF6	3495	−294	−8.4	3522	−318	−9.0	3552	−281	−7.9
Aosta Valley	ITC2	230	−7	−3.1	232	−4	−1.9	234	−2	−0.8
Trentino-South Tyrol	ITH1 + ITH2	1872	−5	−0.3	1897	−12	−0.6	1930	1	0.1
Friuli-Venezia Giulia	ITH4	2251	0	0.0	2267	5	0.2	2290	6	0.3
Sicily	ITG1	8960	−198	−2.2	9022	−235	−2.6	9090	−237	−2.6
Sardinia	ITG2	2991	−73	−2.4	3016	−82	−2.7	3051	−77	−2.5
Total		**108,949**	**−240**	**−0.2**	**109,877**	**−236**	**−0.2**	**111,079**	**−257**	**−0.2**

Note: values are expressed in millions euro at current prices. Column A represents the regional allocation of the National Health Fund. Column B represents the monetary flow for patient mobility. Column C is the ratio of B to A per 100.
Own elaborations on Italian Supreme Audit Institution data

we look at the outgoing edges, then we are estimating the weighted out-degree centrality, representing the export side of the network. If n denotes the number of regions in our problem, the weighted out-degree centrality of region/node i can be defined as follows:

$$weighted\ out\_degree_i = \sum_{j=1}^{n} w_{ij} \tag{1}$$

where w_{ij} is the weight of the link (i, j). The weighted out-degree centrality captures the outreach of a region to the community. A high weighted out-degree centrality indicates that region i exports a lot, aiming to reach all other regions with a certain pervasiveness (all regions are practically connected, but the weight indicates how pervasive the influence of i is). The weighted out-degree centrality, then, captures the level of engagement a region i initiates with members of the community. If a region is characterised by a high weighted out-degree, this implies that it is exporting a lot of money (i.e., patients) to many regions. In this regard, the weighted out-degree centrality identifies those regions whose inhabitants are most dependent on other regions for healthcare. On the contrary, if we look at the incoming links, then we are analysing the weighted in-degree centrality, which displays the import side of the network: importing money from one region is equivalent to importing patients. Consequently, the weighted in-degree centrality represents those regions that are attractive to patients of other regions in terms of healthcare. Formally, being n the overall number of regions, the weighted in-degree centrality of region/node j can be defined as follows:

$$weightedin\_degree_j = \sum_{i=1}^{n} w_{ij} \tag{2}$$

where w_{ij} is the weight of link (i, j). The weighted in-degree centrality measures the number of links – and their amounts – others have initiated with region j. Regions with high weighted in-degree centrality gain attention to their markets among the regions participating in the exchange. Weighted in-degree centrality, thus, captures the community's engagement with them. Those with high weighted in-degree centrality scores can be considered as market hubs since others have exported to them.

The complex network can be displayed in several ways, such as a chord diagram. A chord diagram is a visual representation that depicts the relationships and connections between different nodes (or – in our case – regions). Individual nodes are represented by circular segments arranged along the circumference of a circle. The circle serves as a frame of reference for visualising the relationships between them. Interconnections between regions are represented by lines called chords (hence the name of the diagram). These chords connect two or more circular segments, indicating the interactions between the corresponding regions. The thickness or width of the chords is proportional to the magnitude or strength of the relationship being represented. In this regard, we show the interregional compensation scheme of the Italian NHS according to the absolute real values of money flows between regions (Fig. 2). In order to make the graphical representation of the network more exhaustive, each figure takes into account both the import (weighted in-degree) and export (weighted out-degree) side and macro-regions have been marked by a different colour: northern regions are dark grey, central regions light grey and southern regions and islands light blue.[14] It is important to underline that both sides are representing the same network, highlighting the two sides of the mobility pattern. The length of the segment along the circle identifies the weight of a certain region on the overall network.

The export side of the network identifies the southern macro-region as the main exporter of patients. From this point of view, the North represents the most important destination of all Italian patients, while northern regions export their patients without leaving their macro borders. Focusing on the import side, Lombardia (ITC4) increased its ability to attract patients from other regions over time to the detriment of the central regions and Liguria (ITC3). Southern regions and islands tend to receive patients from adjacent regions with the exception of Abruzzo (ITF1) that is an attractor of patients from Lazio (ITI4). The

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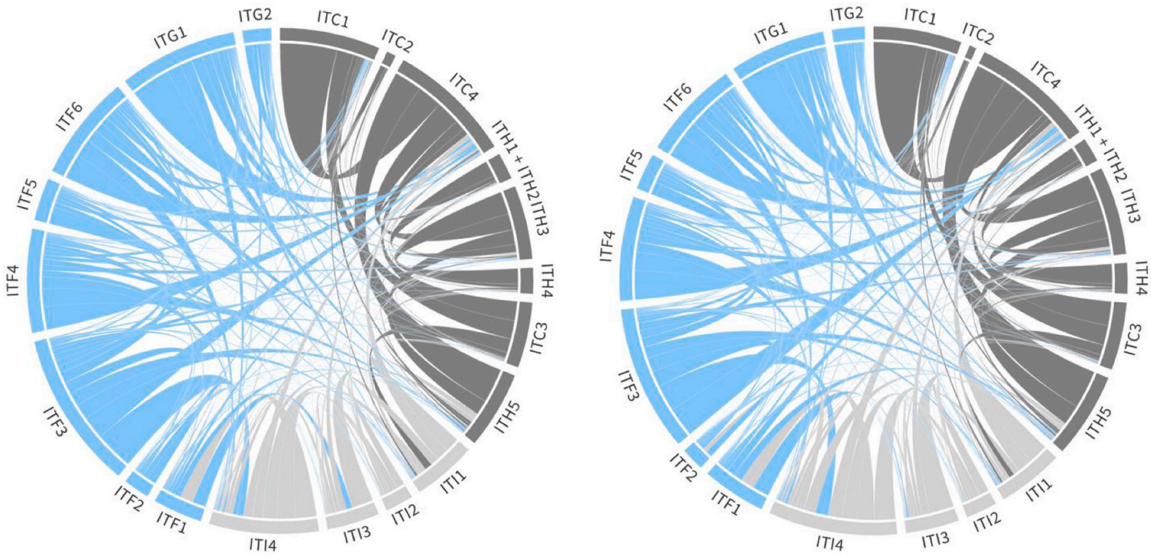
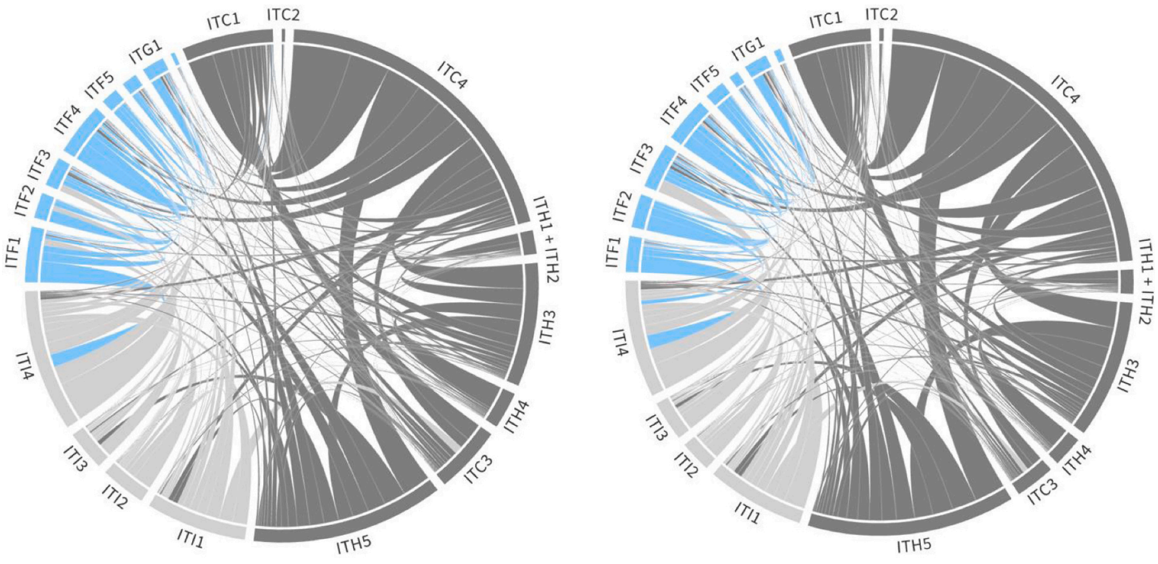
[14] Table A.2 in the Online Appendix shows the NUTS statistical codes used in the Figure.

a) export side (*weighted out_degree*)



2002 **2019**

b) import side (*weighted in_degree*)



2002 **2019**

Fig. 2. Chord diagram: Interregional compensation network of the Italian NHS. Own elaborations on Ministry of Health data

same characterisation applies to the central regions which mutually import patients among them.[15]

4.2. Analysis of the determinants

To analyse the determinants of Origin-Destination (OD) monetary flows for health mobility between pairs of Italian regions, we estimate a random effect (RE) gravity model where the outcome of interest is specified as follows:

$$Y_{OD,t} = \alpha_0 + \alpha_1 DIST_{OD,t} + \sum\nolimits_{i=O,D}\beta_i X_{i,t} + \sum\nolimits_{i=O,D}\gamma_i Q_{i,t-1} + \delta_{OD} + \tau_t + \epsilon_{OD,t} \tag{3}$$

At time t, Y_{OD} is the OD monetary flow representing outflows for the origin region O and inflows for the destination region D. The outcome of interest and all regressors are expressed in logarithms, except binary and percentage variables. $DIST_{OD}$ is the OD distance in kilometres. X_i, with $i = O, D$, is the set of contextual factors reported in Table 1 that include population, over-65 population, GDP, IQI, and a dummy variable for SSRs. Q_i comprises RHS factors, considered with a time lag of one year to avoid endogeneity issues.[16] They are the C-section rate, the CIP, the CMI, the TEI, the percentage of beds in PLHs out of the total number of beds, the percentage of discharges from specialized facilities over the total number of discharges, and two binary variables for undergoing FRP with and without commissioner. The regressors in X_i, and Q_i are the same for both origin and destination regions.[17] δ_{OD} and τ_t capture OD-pair random effects and time fixed effects, respectively, and ε_{OD} is the error term. Compared to the fixed effect (FE) model, this specification has the advantage of allowing the impact of time-invariant determinants to be observed. However, OD-pair random effects are assumed to be uncorrelated with the variables included in the regression, a strong restriction in health economics analyses (Jones, 2000). To relax this assumption, we perform the Mundlak correction and model the OD-pair random effects as a linear function of all time-varying regressors averaged over time. This results in a Conditional Random Effect (CRE) model, that has been proven to yield equivalent FE and RE estimators (Mundlak, 1978). In this way, we are able to control for an unrestricted number of unobserved variables, such as past migration flows (Balia et al., 2018; Berta et al. 2022a,2022b), political similarity between origin and destination regions (Balia et al., 2018), and social capital characteristics at the local level (Ciarrapico et al., 2022).

A further econometric problem is given by the independence among observations assumed in the RE and CRE models, a strong assumption in the case of health mobility and related monetary flows. As mentioned earlier, distance is a key driver in choosing the place of care because of the high transportation and accommodation costs that individuals face. Consequently, the characteristics of neighbouring regions can play a crucial role in generating spill-overs and determining OD monetary flows. This is well demonstrated by the results of the network analysis (Fig. 2) and the maps shown in Figure A.3 in the Online Appendix, which illustrate the geographic distribution of unconditional per-capita monetary flows of Italian region in 2019. Further confirmation is then provided by the results obtained by performing the Moran's I test for spatial correlation, that we run on monetary flows for each year of observation.[18] As shown by the p-values reported in Table 3, the null hypothesis of independent and identically distributed error terms has to be rejected, confirming the theoretical hypothesis of spatial interactions and indicating the importance of accounting for them. However, a model in which solely OD distance is controlled for is inadequate and produces biased estimates when monetary flows interact spatially (Griffith and Jones, 1980).

Table 3

Moran's I test on monetary flows by year 2002–2019.

Year	Moran's I test (p-value)
2002	0.0010
2003	0.0002
2004	0.0001
2005	0.0000
2006	0.0000
2007	0.0000
2008	0.0000
2009	0.0000
2010	0.0000
2011	0.0000
2012	0.0004
2013	0.0005
2014	0.0059
2015	0.0102
2016	0.0168
2017	0.0097
2018	0.0040
2019	0.0022

Note: the table shows the p-value of the Moran's I test performed monetary flows, for each year of observation.

In order to capture dependency relations, we follow the existing literature (Fabbri and Robone, 2010; Balia et al., 2018; Berta et al., 2022b; Ciarrapico et al., 2023) and estimate a spatial model. In particular, we rely on a CRE Spatial Durbin Model (CRE-SDM) and include a spatial lag of the dependent and independent variables. In the presence of omitted variables correlated with regressors, this approach leads to unbiased estimates and allows valid inferences to be drawn about the effects of interest (LeSage and Kelley Pace., 2008). Our final specification is given by[19]:

with

$$\begin{aligned} Y_{OD,t} = {} & \alpha_0 + \alpha_1 DIST_{OD,t} + \sum_{i=O,D}(\beta_i X_{i,t} + \gamma_i Q_{i,t-1}) \\ & + \sum_{i=O,D}(\chi_i W_i Y_i + \nu_i W_i X_i + \eta_i W_i Q_{i,t-1}) + \delta_{OD} + \tau_t + \epsilon_{OD,t} \\ \delta_{OD} = {} & \sum\nolimits_{i=O,D}(\zeta_i \quad \overline{X_i} + \theta_i \overline{Q_i}) + \sum\nolimits_{i=O,D}(\psi_i W_i \overline{Y_i} + \phi_i W_i \overline{X_i} + \lambda_i W_i \overline{Q_i}) + \mu_{OD} \end{aligned} \tag{4}$$

where the bar symbol indicates the variables averaged over time for Mundlak correction.[20] W is a row-standardized spatial weight matrix of

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[15] The import/export details for each region are reported in Figure A.2 in the Online Appendix, while Figure A.4 in the Online Appendix (from panel 1 to panel 3) shows the interregional compensation scheme of the Italian NHS according to three different dimensions: (1) absolute real values of money flows between regions adjusted for distance; (2) absolute real values of money flows between regions adjusted for population; (3) absolute real values of money flows between regions adjusted for distance and population.

[16] This causes the loss of the first year of observation (2002) and thus a reduction in the sample size from $20 \times 19 \times 18 = 6840$ to $20 \times 19 \times 17 = 6460$.

[17] We also control for the number of high-educated individuals and employee, household income, and patient satisfaction with the RHS. Since they are not statistically significant in any specification, we remove them from the analysis.

[18] As in the empirical strategy, we run the test using a row-standardized spatial weighting matrix of inverse OD distances. Its elements are equal to zero when the origin region s equal to the destination regions and below the inverse of the median distance.

[19] We also estimate two alternative models, one with spatial lags applied only to the destination variables and the other with spatial lags applied only to the origin variables. Likelihood ratio tests show that our preferred specification is more suitable than the first case, while it is not so for the second. However, given the statistical significance of at least one spatially-lagged coefficient and the strong similarity of the results, we opt for the most comprehensive model.

[20] To preserve estimation efficiency, time averages are included only for variables for which a positive share of variance is explained within the OD pair (Mundlak, 1978).

inverse OD distances,[21] whose elements are equal to zero when $O = D$ and below the inverse of the median distance. It follows that the strength of the interaction decreases as the distance between neighbouring regions increases and cancels beyond the median distance. As neighbouring regions include both origin and destination neighbours, we build an origin-specific matrix (W_O) and a destination-specific matrix (W_D) and multiply each of them by the corresponding Y_i, X_i, and Q_i. Setting $Z_i = Y_i,\ X_i,\ Q_i$ and $\Omega_i\ = \chi_i,\ \nu_i,\ \eta_i$, $\Omega_O W_O Z_O$ captures origin-based spatial dependence relations using an inverse-distance weighted average of Z_O of origin O neighbours. In practice, forces in Z_O leading to monetary outflows from neighbours of origin region O to destination region D may produce spill-over effects and determine part of the outflows from origin region O to destination region D. Similarly, $\Omega_D W_D Z_D$ captures destination-based interactions between inflows of region D and forces in Z_D of neighbours.[22] For all models, we apply the RE maximum likelihood estimator.

4.2.1. Results

Table 4 shows the results estimated according to the specifications described in the previous section: RE (model 1), CRE (model 2), CRE-SDM (model 3). As described by the likelihood ratio (LR) tests reported at the bottom of the table, the coefficients of time-averaged variables included in model 2 are jointly statistically significant, as are the spatial lags added in model 3. This provides strong evidence that the CRE-SDM model is more suitable than the CRE model, that in turns perform better than the RE specification. For an easier visualization of the table, we divide the results into three sections: Section 1 relates only to the OD-pair variable, distance, while Sections 2 and 3 are for origin- and destination-region variables, respectively; each of the latter two sections is then again separated into two panels, one for direct (panel a) and one for indirect effects (panel b). As the dependent variable and regressors are log-transformed, we interpret the coefficients as direct or indirect elasticities.

Largely unchanged across models, OD monetary flows decrease with increasing distance. Regarding the effects of origin-region characteristics, Section 2, panel a allows us to identify factors that increase the ability of origin regions to retain patients and, thus, decrease monetary outflows. A small subset of factors remains statistically significant in model 3. A 10 % increase in GDP causes a reduction of 3.05 %[23] in monetary outflows. High GDP can be conceived as a proxy for region overall wealth, translating into high-quality healthcare and an increased ability to retain patients. Lower outflows are also observed for SSRs, with the related dummy included to avoid bias from comparing regions with different independence levels, especially on the financing side (Bordignon et al., 2020). Further investigations reveal that our result is mainly driven by northern SSRs[24] (Friuli Venezia Giulia, Trentino South Tyrol, and Valle d'Aosta). As their health systems are financed mostly from their own revenues with no recourse to the national health fund, the CG has limited power to direct and constrain their health legislation, effectively expanding their autonomy and making them subject to less effective cost-containment policies (Balduzzi et al., 2018). This could lead to greater supply of healthcare services and, consequently, greater ability to retain patients. Another factor influencing monetary outflows is hospital supply. This is measured as the percentage of beds in PLHs to total beds to capture the effect of public-private mix in the availability and distribution of health services. We find that a 10 % increase in the share of PLH beds reduces outflows by about 3.90 %. The results of the analysis can be explained by the number of PLH beds per region. The regions that show an higher percentage of PLH beds per region are Calabria (33 %) and Campania (31 %). However, these regions also have the highest patient mobility towards other regions. At the same time, other regions like Lazio, Emilia Romagna, and Lombardy have a high percentage of private beds (20 %-26 %) compared to other regions, with very low patient mobility. This means that having a high number of private beds is not necessarily an indicator of better service. It depends on the type of region and the type of service that private facilities offer. An other possible explanation is that, in the high-complexity and more expensive segment, the licensed private sector has market shares of more than 40 %, especially in broadly distributed specialties but more profitable, such as orthopaedics, oncology, and cardiac surgery (Petracca et al., 2016). Also, in regions where private providers are strong competitors to their public counterpart, patients select hospitals by quality and penalize facilities farther away (Martini et al., 2022). Then, in line with Beraldo et al. (2023), we find that regions under FRP with commissioner face larger monetary outflows than those with no restrictions and oversight. The reason is that such regions experience greater restrictions and reductions in the resources available for healthcare.

Section 2, panel b, shows spill-overs from O-regions neighbours. At the origin, regions are more able to retain patients when they are located close to regions with high CIP, and thus higher inefficiencies, and fewer discharges from specialized facilities. Surprisingly and in contrast to the results found in the other sections, high percentages of PLH beds in neighbouring regions are also associated with higher patient retention of the origin region, a finding that is not immediately interpretable. Further investigations show that this result is driven by outflows directed toward northern regions and indicate that patients prefer not to move to the North if nearby regions offer extensive private healthcare services.[25] Moreover, especially in the North, the regions with a higher percentage of private hospital beds are Veneto and Lombardy, which border, among other regions, with Emilia-Romagna. The latter, however, has the highest percentage of public hospital beds. These three regions, regardless of the healthcare system adopted, report a higher

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[21] Instead of inverse distances, the matrix of spatial weights could contain ones for neighbouring regions and zeros otherwise. We chose the first option so as not to exclude from the analysis the two Italian island regions, Sardinia and Sicily. Their exclusion would lead to the loss of $2 \times 18 \times 18 = 684$ observations which, in turn, could generate selection bias in the estimation results. Regardless of this, as shown in LeSage and Pace, (2014), regressors effects and inferences are not sensitive to the use of a particular weight matrix: if two weight matrices are highly correlated (as in the case of the inverse distance and the contiguity matrices, or different specifications of the inverse distance matrix), it would seem difficult to reach materially different conclusions about the partial derivative impact of changes in the explanatory variables on the dependent variable.

[22] A third type of dependence may be reflected in the matrix $W = W_O{\cdot}W_D$, capturing origin-destination dependence and any relation between neighbours of the origin O and neighbours of the destination D (LeSage and Pace, 2008). We include $\xi W Y_{OD,t}$ in our preferred specification, but the parameter ξ is not statistically significant.

[23] To calculate the effects of coefficients on monetary flows for percentages higher than 1 %, we apply the formula $(1.x^{\eta} - 1) \times 100$, where x is the percentage increase of interest and η the coefficient reported in the table. For example, if we are interested in the effect of a 10 % increase in GDP on $Y_{OD,t}$, we calculate as follows: $(1.10^{-0.3252} - 1) \times 100 = 3.05$.

[24] We replicate our estimation by substituting the dummy variable for SSRs with a categorical variable distinguishing among ordinary-statute regions, northern SSRs, and southern SSRs. At origin, while the latter have a positive non statistically significant effect of monetary outflows, northern SSRs present a negative coefficient. At destination, southern SSRs have a negative coefficient, indicating smaller ability in attracting patients, while no statistically significant coefficient is observed for northern SSRs.

[25] Unfortunately, it is not possible to define whether this result is driven by a specific direction of flows (South-North, North-Centre, and North-North) since an estimation made with such a small subsample generates results that are not statistically significant. The most plausible hypothesis, however, is that it is mainly the South-North and North-Central flows. If this is the case, it would follow that patients from southern and central Italy prefer not to travel north, and thus not to travel long distances, if the share of beds in private hospitals in neighbouring regions is high.

Table 4
Estimation results.

	(1)			(2)			(3)		
	RE			**CRE**			**CRE-SDM**		
1. OD variable									
Distance	−1.2907	***	(0.081)	−1.3582	***	(0.079)	−1.3892	***	(0.078)
2. Origin variables									
(a) Direct effects									
Population	1.8818	***	(0.160)	1.2733	***	(0.230)	0.1867	***	(0.340)
Over 65	−0.2646	*	(0.140)	0.2656	*	(0.140)	0.0549		(0.190)
GDP	−0.7268	***	(0.110)	−0.4337	***	(0.120)	−0.3252	**	(0.140)
IQI	−0.0466	***	(0.015)	−0.0267	*	(0.016)	−0.0056		(0.020)
SSR	−0.1766		(0.120)	−0.8046	***	(0.190)	0.6440	**	(0.320)
C-section$_{t-1}$ (%)	0.0015		(0.002)	0.0005		(0.002)	−0.0016		(0.002)
CIP$_{t-1}$	0.0523		(0.110)	0.0494		(0.120)	0.0113		(0.130)
CMI $_{t-1}$	−0.2223	***	(0.120)	−0.2180	*	(0.130)	−0.1680		(0.140)
TEI $_{t-1}$	−0.0180		(0.036)	−0.0276	*	(0.036)	−0.0674		(0.042)
PrivateBeds$_{t-1}$ (%)	−0.0966		(0.140)	−0.3343	**	(0.150)	−0.4184	**	(0.160)
Specialized$_{t-1}$ (%)	0.0620		(0.051)	0.0464		(0.051)	−0.0330		(0.055)
FRP	−0.0144		(0.013)	0.0193		(0.013)	0.0013		(0.014)
FRP - Commissioned	0.0505	***	(0.018)	0.0382	**	(0.018)	0.0660	***	(0.020)
(b) Indirect effects									
Y							−0.0256		(0.170)
Population							0.1191		(0.410)
Over 65							0.1258		(0.380)
GDP							−0.0334		(0.280)
IQI							0.0822		(0.077)
SSR							−1.7390		(1.900)
C-section$_{t-1}$ (%)							0.0039		(0.005)
CIP$_{t-1}$							−0.8476	*	(0.460)
CMI $_{t-1}$							−0.4938		(0.350)
TEI $_{t-1}$							0.0028		(0.140)
PrivateBeds$_{t-1}$ (%)							−1.8381	***	(0.520)
Specialized$_{t-1}$ (%)							0.5381	***	(0.200)
FRP							−0.0024		(0.037)
FRP - Commissioned							−0.0196		(0.055)
3. Destination variables									
(a) Direct effects									
Population	−1.3292	***	(0.160)	−1.6809	***	(0.230)	−1.6915	***	(0.240)
Over 65	1.9628	***	(0.140)	1.9489	***	(0.140)	1.9791	***	(0.140)
GDP	0.3117	***	(0.110)	−0.0798		(0.120)	−0.1126		(0.130)
IQI	0.1264	***	(0.015)	0.1175	***	(0.016)	0.1208	***	(0.016)
SSR	−0.1804		(0.120)	−0.3724	***	(0.190)	0.4724	**	(0.210)
C-section$_{t-1}$ (%)	−0.0037	**	(0.002)	−0.0025		(0.002)	−0.0023		(0.002)
CIP$_{t-1}$	−0.4888	***	(0.110)	0.5027	***	(0.120)	0.5051	***	(0.120)
CMI $_{t-1}$	0.0833		(0.120)	−0.1966		(0.130)	−0.2189	*	(0.130)
TEI $_{t-1}$	0.1309	***	(0.036)	0.1129	***	(0.036)	0.1064		(0.036)
PrivateBeds$_{t-1}$ (%)	1.2156	***	(0.140)	1.2164	***	(0.150)	1.2071	***	(0.150)
Specialized$_{t-1}$ (%)	0.1234	**	(0.051)	0.1319	***	(0.051)	0.1294	**	(0.051)
FRP	−0.0282	**	(0.013)	−0.0201		(0.013)	−0.0186		(0.013)
FRP - Commissioned	−0.0793	***	(0.018)	−0.0739	***	(0.018)	−0.0750	***	(0.018)
(b) Indirect effects									
Y							0.0322		(0.031)
Population							0.0651		(0.180)
Over 65							0.1030		(0.210)
GDP							−0.2498	*	(0.140)
IQI							0.0418		(0.068)
SSR							−0.0458		(0.095)
C-section$_{t-1}$ (%)							0.0005		(0.003)
CIP$_{t-1}$							0.3971		(0.540)
CMI $_{t-1}$							−0.3007		(0.450)
TEI $_{t-1}$							0.0051		(0.002)
PrivateBeds$_{t-1}$ (%)							−0.6421		(0.470)
Specialized$_{t-1}$ (%)							0.1652		(0.210)
FRP							0.0793		(0.078)
FRP - Commissioned							−0.0971		(0.078)
Time FE	Yes			Yes			Yes		
Time-averaged	No			Yes			Yes		
Constant	−4.2131	***	(1.200)	3.1011		(1.900)	5.6112		(2.400)
σ_δ	0.9102	***	(0.035)	0.8300	***	(0.030)	0.7941	***	(0.029)
σ_ϵ	0.2292	***	(0.002)	0.2284	***	(0.002)	0.2273	***	(0.002)
ρ	0.9404	***	(0.035)	0.9296	***	(0.005)	0.9242	***	(0.005)
Log-likelihood	−713.05			−656.93			611.78		
LR test				112.25		***	90.30		***
N	6460			6460			6460		

Note: the table shows the effects of the regressors included in Xi and Qi estimated while controlling for time fixed effects (FE) and Origin-Destination (OD) pairs random effects (RE) and according to different specifications: RE, Correlated Random Effects (CRE), CRE Durbin Spatial Model (CRE-SDM). GDP: Gross Domestic Product; IQI:

Institutional Quality Index; SSR: Special-Statute Region; FRP: Financial Recovery Plan; CIP: Comparative Index of Performance; CMI: Case-Mix Index; TEI: Technology Endowment Index. σ_δ: standard deviation of δ_{OD}; σ_ϵ: standard deviation of $\epsilon_{(OD,t)}$; ρ: fraction of variance due to δ_{OD}. LR: likelihood ratio. Standard errors in parentheses.* p<0.1, ** p<0.05, *** p<0.01.

quality of healthcare service compared to other Italian regions. This result suggests that if the public healthcare service works properly, it is not strictly necessary to relocate to other regions. Finally, a low discharge rate from specialized institutions in neighbouring regions also disincentivizes health care mobility and reduces monetary outflows.

Differently from the above findings, at destination (Section 3) several factors keep their statistical significance in model 3, although only the GDP of nearby regions generates spill-over effects (Section 3, panel b), with the ability to attract patients increasing with proximity to low-wealth regions. The use of monetary data as the outcome of interest allows for new insights into destination variables. Results can be interpreted not only as the ability to attract out-of-region patients, but also as reflections of the mechanisms through which regions generate revenue from mobility. Consistently with some previous evidence (Brenna and Spandonaro, 2015; Balia et al., 2020), our findings point to specialization as the main determinant of monetary inflows. Specifically, a 10 % increase in discharges from specialized facilities results in increased inflows of slightly more than 1.2 %. The largest effect is found for the share of PLH beds, where a 10 % rise leads to a 12.2 % increase in inflows. As mentioned above, PLHs have a large market share in high-complex sectors. It follows that, for a given number of incoming patients, monetary inflows rise due to the higher cost of care offered in these types of hospitals. Moreover, as described in Section 2, PLHs are more likely to face incentives to attract patients. Mechanisms of attraction are found in reduced waiting times and increased length of admissions (Berta et al., 2021), with both factors requiring more hospital beds. Insights into mobility for specialization are also offered by the CMI coefficient, which reflects the heterogeneity of care offered in each destination region. It is negatively correlated with monetary inflows, suggesting that the ability to attract and generate revenue from mobility is not determined by the supply of care for a wide range of diseases, but rather by the provision of highly specialized care for specific conditions for which patients are willing to travel. This is confirmed by the results on cancer and surgery found by Balia et al. (2018). Among other RHS factors, being under FRP with commissioner and CIP also drive monetary inflows, both presenting a negative correlation.

Regarding contextual characteristics, a 10 % increase in population leads to reduced monetary inflows of nearly 14.88 %, probably due to a saturation of the RHS and a patients' preference for short waiting times (Bruni et al., 2021). The finding on the over-65 population, positively associated with inflows, also relates to the productive capability of the health system. If attractiveness depends on the supply of specialized care and the latter is usually directed to younger groups, regions with larger elderly cohorts have lower domestic demand for these types of care and shorter waiting lists, favouring inflows. In line with the above findings, SSRs present a negative coefficient, a result mainly driven by southern regions.[26] Finally, a 10 % increase in IQI, which summarizes different dimensions of the quality of institutional environment, causes an increase in inflows of about 1.16 %. This is not surprising, as institutional quality has been found to positively affect public sector performance (Alesina and Tabellini, 2007, 2008; Mauro, 1998). Specific to the healthcare field, De Luca et al. (2021) find that high institutional quality reduces inappropriateness of hospital services. In turn, this could lead to higher patient inflows.

5. Conclusions

Patient mobility is particularly relevant both in economic and social terms, as it impacts regional financial resources and, at the same time, involves only citizens with higher incomes who can independently move to facilities with better services. The results of our study indeed demonstrate that greater mobility occurs between regions with lower income levels and regions with higher income levels. In Italy, this phenomenon of patient mobility involves every year more than half a million patients (mostly from Southern regions to Northern regions) who seek medical care in regions different from their place of residence. This factor, in addition to indicating a perceived low quality in the regions of origin, significantly diminishes the resources available to these regions. In fact, since the right to healthcare is universally guaranteed in Italy, each citizen can independently decide in which facility to receive treatment. However, this implies that at the end of the year, the services provided outside the region are funded by the regions of residence. This financing process only exacerbates the differences between poor and wealthy regions.

It should come as no surprise that healthcare mobility, especially hospital admissions, intersects with significant social issues and is strongly influenced by them. This is a trend that has intensified over the years, leading to an increasing gap between the North and South of the country. The healthcare system's financing system should also be reconsidered. The current financing system should be rethought in order to reduce disparities and enable consistent care across the entire national territory. The primary taxes (the surtax on central personal income tax (RPIT) and for the regional tax on productive activities (RTPA)) that currently fund the Italian healthcare system appear to respond differently to the economic cycle, favouring the wealthier regions, especially those in the north (Lagravinese et al., 2019). The behaviour of regional taxes and monetary flows for health mobility may increase the Italian North–South gap.

At this point, it is necessary to rethink regional health financing, which is currently based mainly on population and includes a correction factor for the average age. Instead, regions should be funded based on actual needs, taking into account health demand and increasing resources in more deprived areas, as is done in the English system, for example (Gravelle et al., 2003; WHO, 2008).

Furthermore, starting from 2002, the Italian healthcare system has been decentralized, transferring significant powers to regions, but due to infrastructural and income disparities, there is a noticeable trend of patients relocating from the Southern to the Northern regions, especially when specialized services are not available (or available at low quality) in their own region. The availability of essential public services, such as hospitals and healthcare in general, has not only become highly uneven across different areas but also, in some cases, severely inadequate, particularly affecting certain locations (rural or peripheral areas). The separation between financing responsibilities and expenditure responsibilities in the provision of Essential Levels of Care has created a significant incentive for the uncontrolled growth of Italian health expenditure. This division has also historically fostered expectations of bailouts in the behavior of regional authorities. A decentralized and fragmented system like the one in Italy also does not help promote equitable access for the entire population. The lack of alignment between spending responsibilities and available resources further exacerbates these disparities and discourages local politicians from being accountable for the efficient use of public resources (Rodríguez-Pose and Vidal-Bover, 2024).

Today, while some advantaged areas still enjoy reasonable public

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[26] See note 29.

service provision, regions often labeled as "left behind" by government policies are also the ones most likely to suffer from underfunded and deteriorating public services (Rodríguez-Pose, 2018). This disparity has significant political repercussions: for instance, Stroppe (2023) has demonstrated that poor public service provision can lead to "geographies of discontent," where citizens lose trust in the government, fueling political polarization.

The data available since 2002 have also shown us that mobility has not stopped over time. Despite the healthcare reform that decentralized the healthcare system on a regional basis, granting more powers to the regions has not dampened the mobility phenomenon. Indeed, our findings have clearly shown how financial flows are almost always unidirectional, with substantial resources moving from the South to the North, and involving the same Southern regions that should retain these resources to make the healthcare system more suitable for the needs of their citizens. The results of these differences in terms of services also have evident repercussions on the varying life expectancy between regions. The latest data provided by the Italian National Institute of Statistics (ISTAT)[27] reports that the life expectancy at birth in Italy is 82.6 years. In all the regions of Northern Italy, this average value is exceeded, with the highest being in the province of Trento at 84.2 years. In contrast, in all the regions of Southern Italy, with the exception of Piedmont and Valle d'Aosta, life expectancy is below the national average, with the lowest being in Campania at 81 years.

At this point, after more than twenty years since the federal reform, it is necessary to consider whether it makes sense to maintain a decentralized system that generates such a significant regional imbalance. Or, alternatively, whether it would be desirable to undergo a phase of re-centralization of powers and greater control over performance at the central level.

CRediT authorship contribution statement

raffaele lagravinese: Writing – review & editing, Writing – original draft, Supervision, Data curation, Conceptualization. **Giovanni carnazza:** Writing – original draft, Visualization, Methodology, Data curation. **irene Torrini:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Paolo Liberati:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

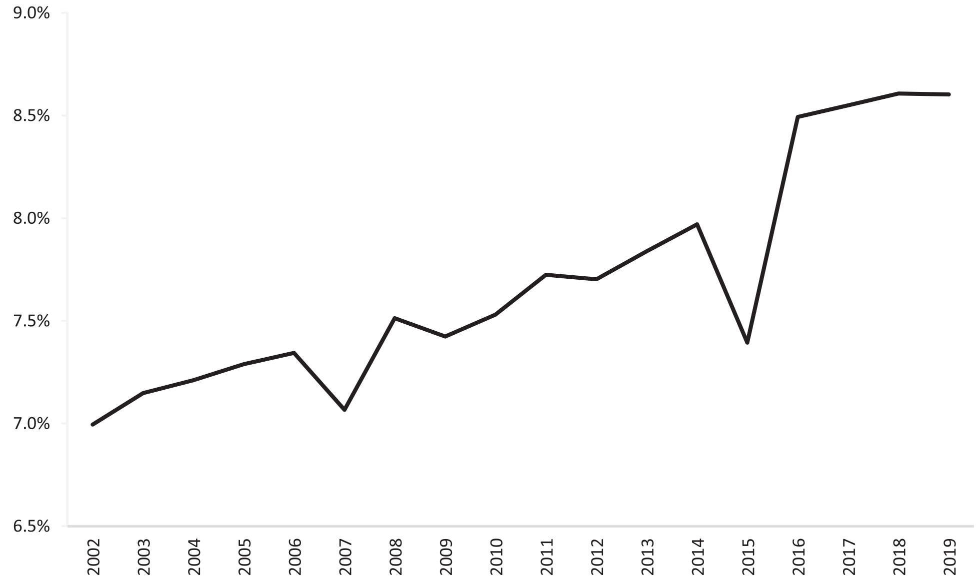

Figure A.1. – Percentage of out-of-region to total admissions by year.

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[27] Tavole di mortalità: Speranza di vita alla nascita con Italia copie (istat.it)

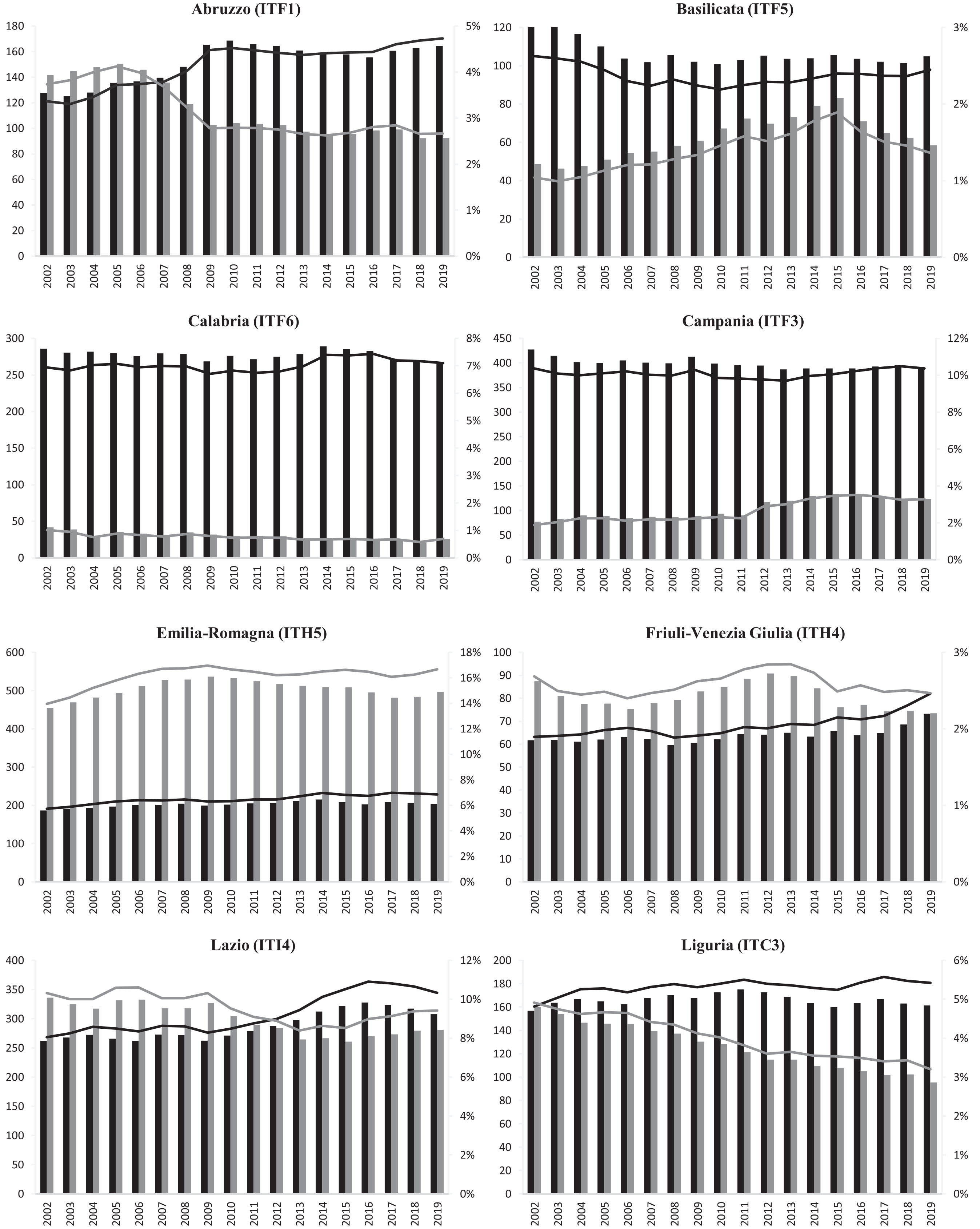


Figure A.2. – Interregional compensation exports and imports of the Italian NHS *Note*: export and import values are expressed in million euros and in real terms.

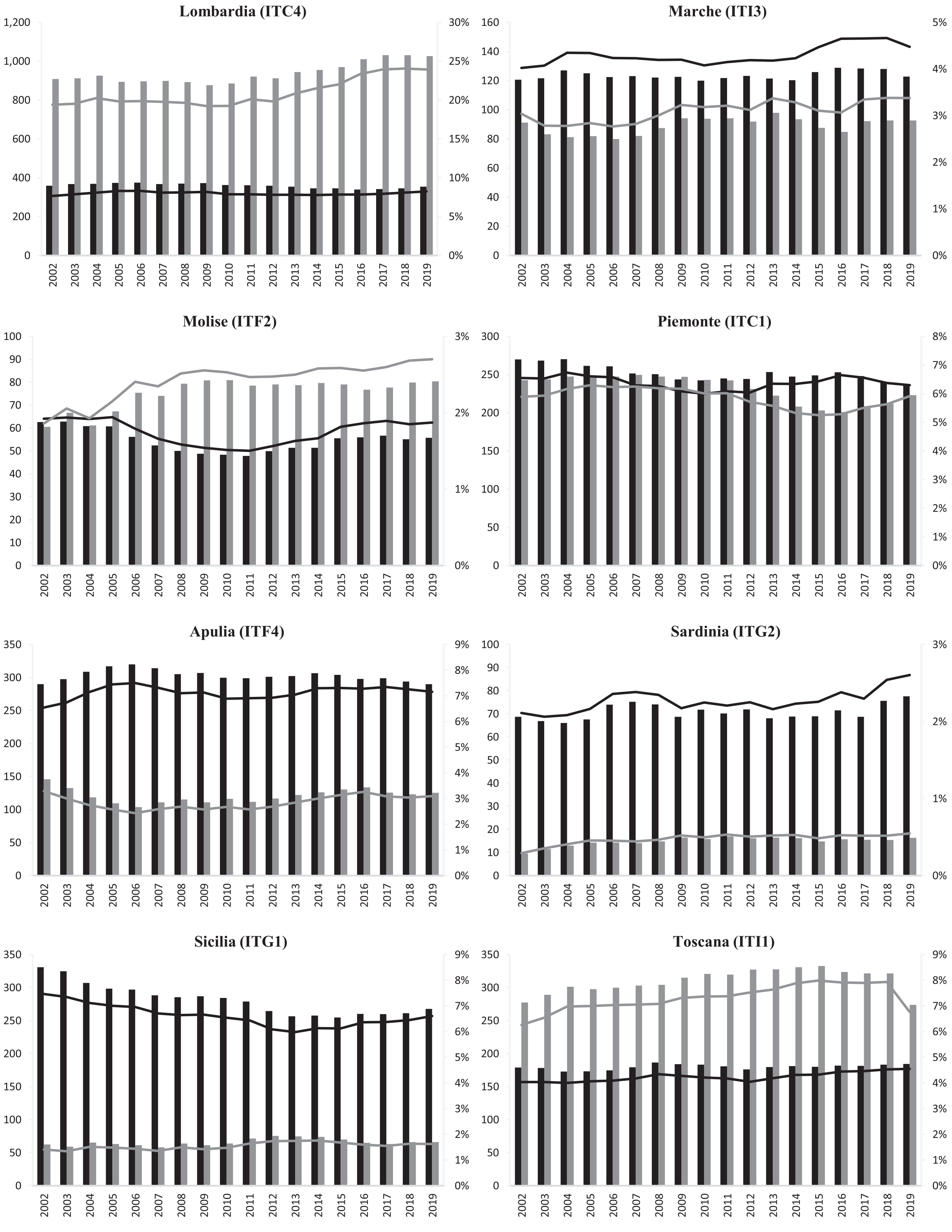
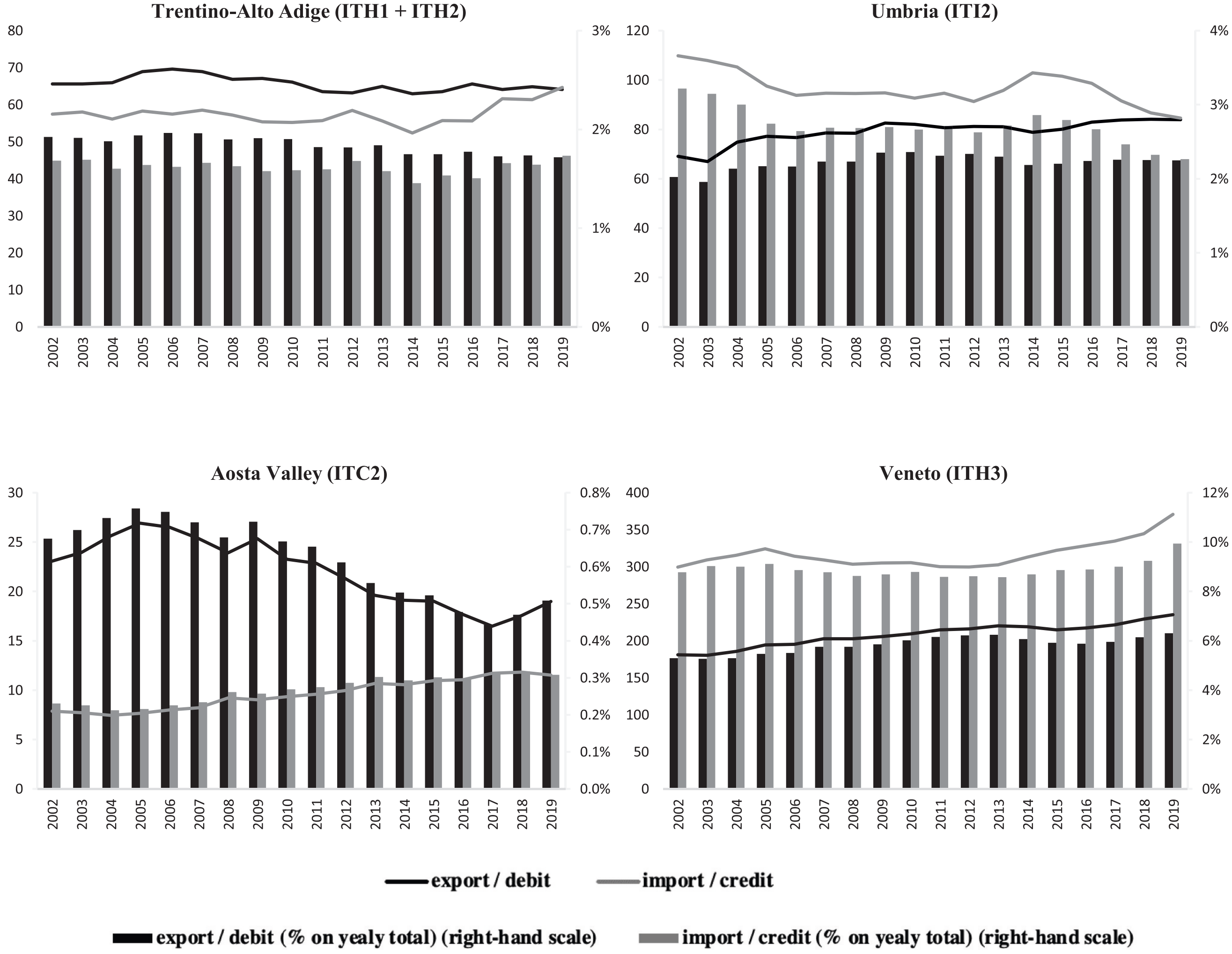


Figure A.2. (*continued*).


Trentino-Alto Adige (ITH1 + ITH2)

Umbria (ITI2)

Aosta Valley (ITC2)

Veneto (ITH3)

Figure A.2. (*continued*).

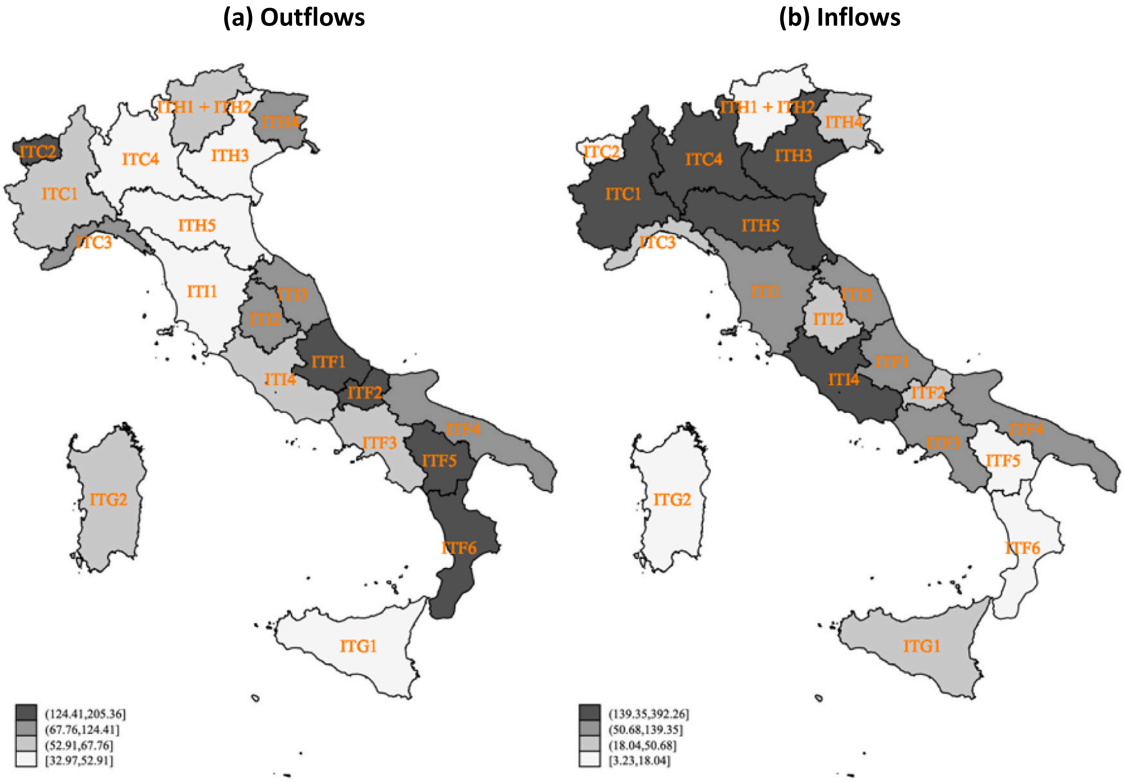
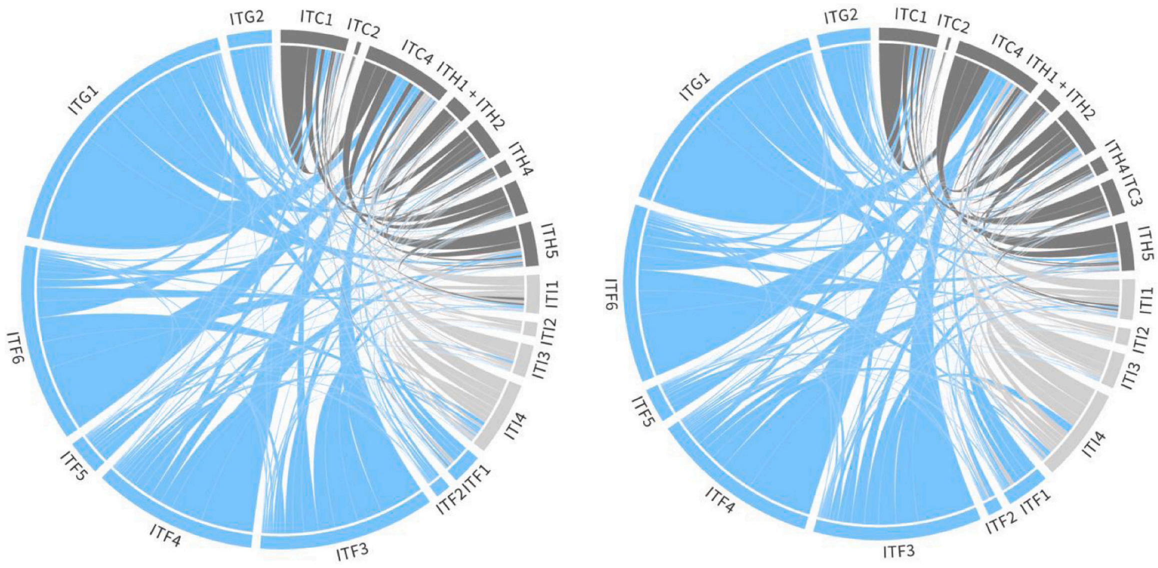


Figure A.3. – Geographic distribution of unconditional per-capita monetary flows of Italian region in 2019. *Note*: increasing colour intensity corresponds to increasing values of origin per-capita monetary outflows (panel a) and destination per-capita monetary inflows (panel b). The distribution of monetary flows × €1 million is divided into the four quartile-bounded groups listed in the legends.

1) adjusted for distance

a) export side (weighted out_degree)


2002 **2019**

b) import side (weighted in_degree)

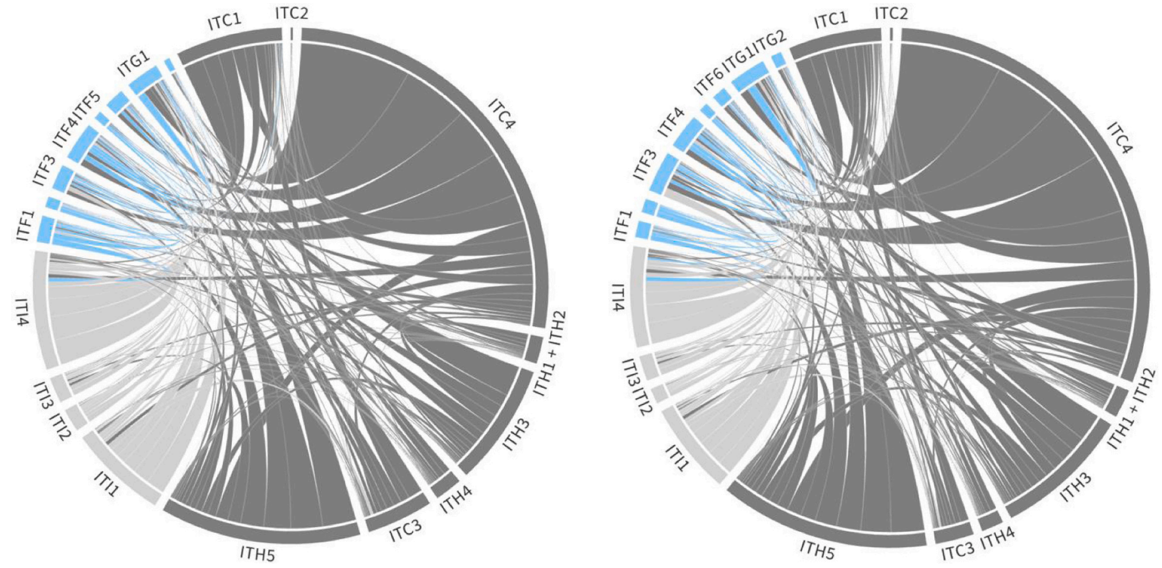
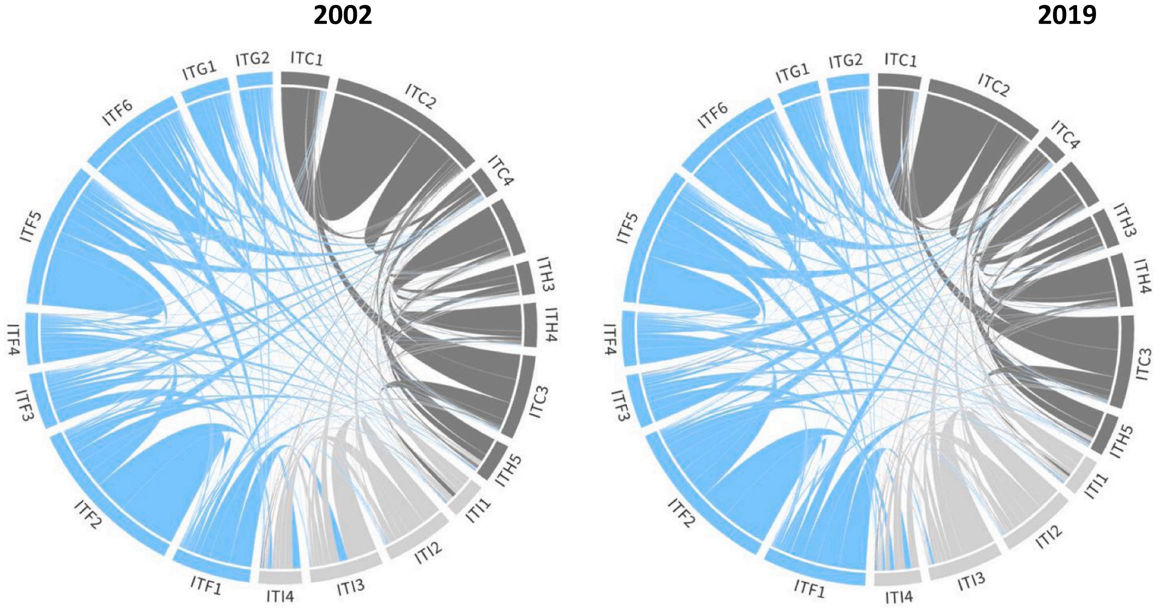

2002 **2019**

Figure A.4. – Alternative chord diagrams: Interregional compensation network of the Italian NHS. *Note*: (1) for each pair of regions, the real values of the money flow are multiplied by the distance between the corresponding centroids (a centroid represents the geometric center of all the points in a geometric shape): as distance increases so does the weight that a given money flow has on the entire network; (2) the export of patients depends not only on distance but also on the number of inhabitants of a given region. For this reason, we divide the export value by the population of the region of origin. In this way, we normalise the network by the population size of the different regions; (3) since the previous aspects can potentially play a joint role, we adjust the money flows by multiplying them by distance and dividing them by population.

2) adjusted for population

a) export side (weighted out_degree)



b) import side (weighted in_degree)

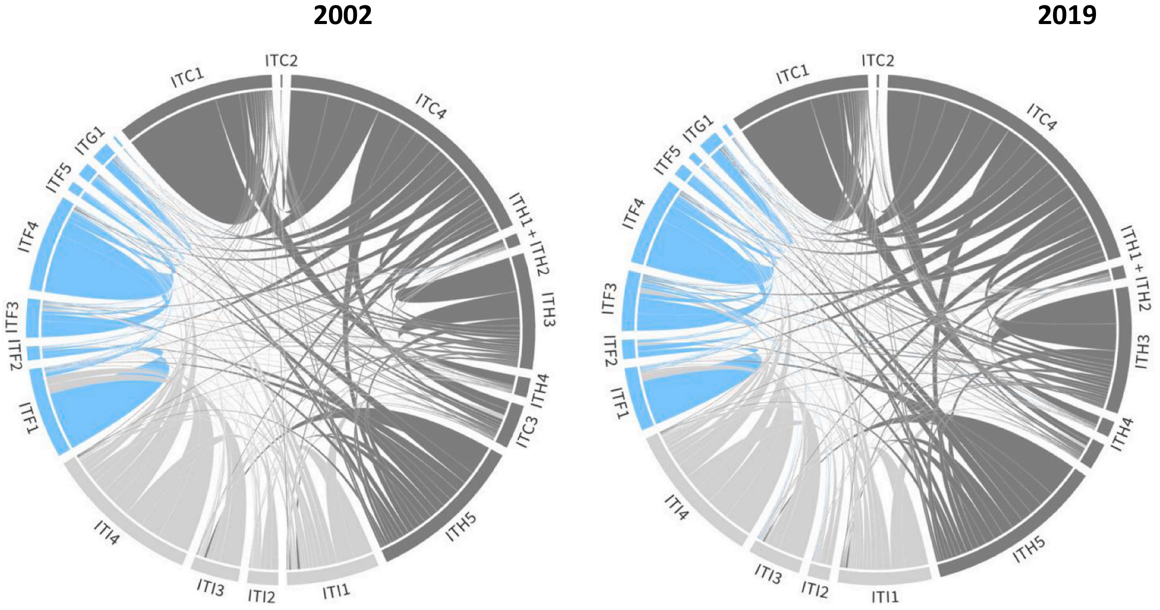
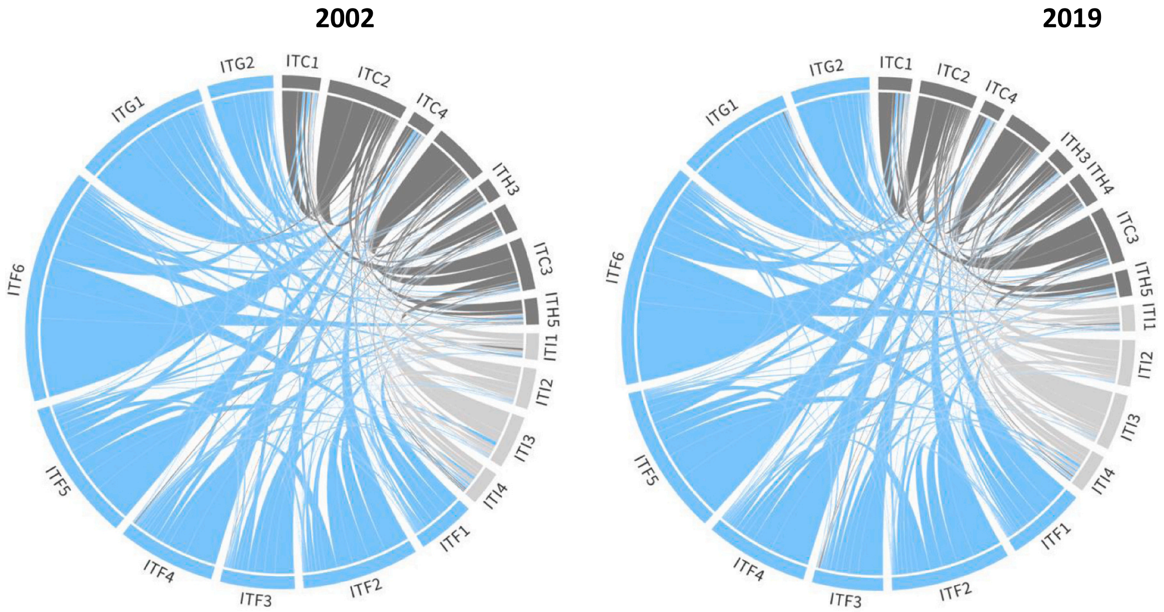


Figure A.4. (*continued*).

3) adjusted for distance and population

a) export side (weighted out_degree)


2002 **2019**

b) import side (weighted in_degree)

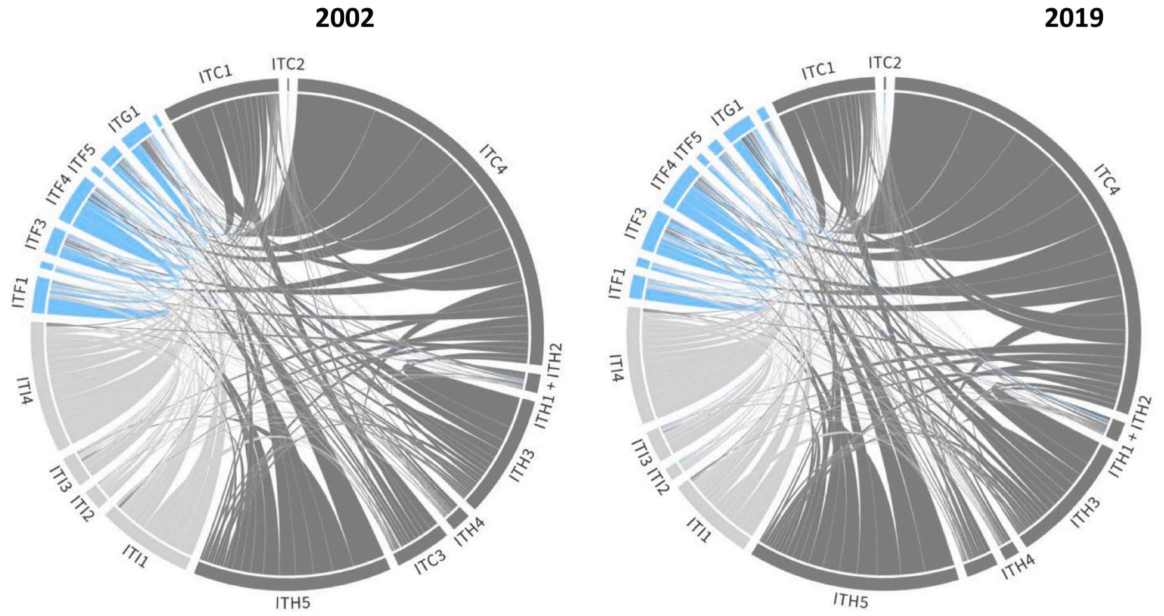

2002 **2019**

Figure A.4. (*continued*).

Table A.1
Regions and years under FRP

	Years	Years with commissioner
Abruzzo	2007–2019	2007–2016
Apulia	2010–2019	
Calabria	2009–2019	2010–2019
Campania	2007–2019	2009–2019
Lazio	2007–2019	2008–2019
Liguria	2007–2009	
Molise	2007–2019	2009–2019
Piedmont	2010–2015	
Sardinia	2007–2009	
Sicily	2007–2019	

Note: The table shows the regions and the years under financial recovery plans (FRP) and the years with commissioner, if any. Source: Ministry of Health.

Table A.2
Legend: NUTS statistical regions of Italy

NUTS 1	NUTS 2	Code
Northern Italy	Piedmont	**ITC1**
	Aosta Valley	**ITC2**
	Liguria	**ITC3**
	Lombardy	**ITC4**
	Trentino-South Tyrol	**ITH1 + ITH2**
	Veneto	**ITH3**
	Friuli-Venezia Giulia	**ITH4**
	Emilia-Romagna	**ITH5**
Central Italy	Tuscany	**ITI1**
	Umbria	**ITI2**
	Marche	**ITI3**
	Lazio	**ITI4**
Southern and Insular Italy	Abruzzo	**ITF1**
	Molise	**ITF2**
	Campania	**ITF3**
	Apulia	**ITF4**
	Basilicata	**ITF5**
	Calabria	**ITF6**
	Sicily	**ITG1**
	Sardinia	**ITG2**

Note: NUTS 1 represents the groups of regions, while NUTS 2 represents the regions (Trentino-South Tyrol includes the two autonomous provinces of Trento and Bolzano).

Table A.3
List of variables

Contextual factors			
Population	Overall population	2002–2019	Eurostat
Population over 65	Population over 65 relative to the total population	2002–2019	Eurostat
GDP	Regional gross domestic product	2002–2019	Eurostat
IQI	Institutional Quality Index	2004–2019	Nifo and Vecchione, (2004)
SSR	Binary variable for Special-Statute Regions	2002–2019	Authors' calculation
RHS factors			
C-section rate (%)	Ratio of caesarean sections to total deliveries	2002–2019	Ministry of Health
CIP	Comparative Index of Performance: Ratio between the average standardized case-mix hospital stay of a given region and the national average hospital stay	2002–2019	Ministry of Health
CMI	Case-Mix Index: Ratio between the average weight of the inpatient admission of a given region and the average weight of the inpatient admission in the national case mix	2002–2019	Ministry of Health
TEI	Technology Endowment Index: Composite indicator of the availability and comprehensiveness of the regional technological endowment	2002–2019	Ministry of Health
Private beds (%)	Ratio of beds in private hospitals to total beds	2002–2019	Ministry of Health
Specialized (%)	Ratio of discharges from specialized hospitals to total discharges	2002–2019	Ministry of Health
FRP	Categorical variable for regions that: 1) are not under Financial Recovery Plan (FRP); 2) are under FRP; 3) are under FRP with commissioner.	2002–2019	Authors' calculation

Note: the table shows the variables used in the analysis along with their description, period of availability, and data source. GDP: Gross domestic product. IQI: Institutional Quality Index. HCE: Healthcare expenditures. C-section: Caesarean section. CIP: Comparative Index of Performance. CMI: Case-Mix Index. TEI: Technology Endowment Index.

Table A.4
Pairwise correlation coefficients

	Outflows	Inflows	Pop.	Over 65 pop.	GDP	IQI	C-section (%)	CIP	CMI	TEI	Private Beds (%)	Specialized (%)
Outflows	**1.000**											
Inflows	−0.023 *	**1.000**										
Pop.	0.248 *	0.452 *	**1.000**									
Over 65 pop.	0.234 *	0.487 *	0.982 *	**1.000**								
GDP	0.199 *	0.534 *	0.935 *	0.960 *	**1.000**							
IQI	−0.108 *	0.221 *	−0.045 *	0.068 *	0.207 *	**1.000**						
C-section (%)	0.104 *	−0.204 *	0.047 *	−0.086 *	−0.195 *	−0.815 *	**1.000**					
CIP	−0.077 *	−0.033 *	−0.142 *	−0.131 *	0.001	0.297 *	−0.223 *	**1.000**				
CMI	−0.078 *	0.206 *	−0.019	0.060 *	0.156 *	0.635 *	−0.530 *	0.088 *	**1.000**			
TEI	0.211 *	0.493 *	0.941 *	0.975 *	0.952 *	0.145 *	−0.138 *	−0.089 *	0.116 *	**1.000**		
Private Beds (%)	0.187 *	0.070 *	0.451 *	0.388 *	0.301 *	−0.482 *	0.362 *	−0.230 *	−0.499 *	0.340 *	**1.000**	
Specialized (%)	0.039 *	0.156 *	0.232 *	0.269 *	0.270 *	0.112 *	−0.073 *	−0.039 *	0.239 *	0.327 *	0.052 *	**1.000**

Note: the table shows pairwise correlation coefficients among continuous variables included in the analysis. * $p<0.1$

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