Perceived quality and formation of inter-regional networks of health care migration

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Abstract

In the paper we test the hypothesis if the perceived quality of the hospital services (medical, assistance and hygienic) can be considered a drive factor of the interregional health migration in the sense that it influence the predicted probability of a ties formation between two regional healthcare systems. At this end several exponential random graph model are estimated introducing the perceived quality as a node-level characteristic. The analysis show that the perceived quality factor in the hospitals services is statistically significant and positively related to the probability to observe ties between two Regions. That homophily effect do not exist between Regions with the same regional healthcare system but the effect appear at level of geographical area. Finally the access factor do not influence this predicted probability, on the contrary, in some case the estimated parameter of the access factor is negatively related to it. Yet, the estimated parameter of the equipment factor is statistically significant and positively related to the predicted probability to observe ties between two Regions in four type of networks on five considered. So, we can conclude that the perceived quality factor in the hospital services is not the only drive factor for the travel for health motivation between two Regions, but also the technological level have a role, meanwhile the access is often negatively related at the predict probability to observe a tie.

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1   Introduction

The health system in Italy is organized on three level of government: central, regional and local, with a strong tendency at the regional's decentralization [(Tediosi, et al., 2009)]. The Regions differ among them in terms of demography, economic development as well as in term of health systems characteristics [(France, et al., 2005)]. These latter differences, likely, was emphasized during the past years[2] when Regions acquired more and more responsibility in managing, financing and organizing their own health systems, so generating a strongly regionalized health system that increased the differences in the quality of the care, in the access in the health services and so on (Skinner, 2012). These two latter aspects are likely some of the main motivations of the migration for health reasons among Regions (Levaggi & Montefiori, 2014). In the economic literature the attention on the health migration [(Gaynor & Town, 2012)]   is linked at the its financial and financing consequences [(Levaggi & Menoncin, 2008)   (Levaggi & Menoncin, 2013)]. Seems however that the regional efficiency differences are, also, one of the motivations of the health migration [(Levaggi & Menoncin, 2008); (Levaggi & Menoncin, 2013)] and the overall welfare [(Balia, et al., 2014); (Brekke, et al., 2014a)]. The interest for the health migration by researchers fall, also, on the analysis of the determinants of the transfer for health motivations [(Levaggi & Zanola, 2004);   (Cantarero, 2006);   (Fattore, et al., 2014); (Brenna & Spandonaro, 2014)] that involve adult as well as infant patient [(Paolella, 2012); (Vajro, et al., 2012)]. The transfer interest different type of care services [(Kwait, et al., 2001); (Nakao, et al., 1986)] and health organizations [(Kwait, et al., 2001)] (as hospitals, acute hospital services, surgical hospital services, speciality visits   and so on). Most of the cited studies above have interested principally the hospital level [among others (Cantarero, 2006);   (Fabbri & Robone, 2008)]; [(Levaggi & Zanola, 2004); (Lippi Bruni, et al., 2008)]. However, in our knowledge, few of them apply Social Network Analysis (SNA) [(Lee, et al., 2011)]. In our knowledge, contrary as happen for the Italy, very high are the applications of the SNA in the health care sector [among others (Jang, et al., 2012)] in others countries. The health migration phenomenon is generally divided in two kinds: the necessary transfer (for example in the case of lack of high specializes facilities) and the transfer based on subjective reasons. In this latter case the patient choice depend to the several factors (socio-economic, subjective evaluation of the quality of the treatment and so on). In both cases the migration flow, by Social Network point of view, create a linkage among the

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[2]We know, among the others, the   art. 2 of the Decree legislative 502/1992 (who assigns at the regions the tasks of services organizations and the power to fix the financing criteria of own health organizations), the art.2. comma (b) of the Law 419/1998 that continue the process of regionalization started with the D.L. 502/1992, the Decree Legislative 112/1998 fix more general intervention to transfer administrative functions at the regions , the Decree Legislative 229/1999 (that confirm and strength the role of the regions in the management of health).

Regions and among their health systems. In fact for example a lot of information are exchanges among the Regions as the clinical, economics and financial information. With the second type of transfers (for subjective reasons) the networks among regional health system could be considered as the result of the patient individual choice. So, the patients' individual judgment on some attribute of the health system or on the health organizations located outside own Region became, almost in logical principle, the drive factor of the transfer. In this paper we test the hypothesis if the perceived quality (based on the discretional individual quality's judgment) in the hospital services (medical, assistance and hygienic) is a drive factor for the interregional health migration. At this end we estimate several exponential random graph model (ERGM). The paper is structured as follow: in section 2 we offer a brief literature review; in section 3 we show the principal components analysis for health variables and the ERGM; section 4 show the ERGM results; finally the section 5 show the discussion and conclusions.

2   Brief literature review

In general we know that the quality of the services is perceived according to the individual judgment that people express in evaluating their attributes. Research interested at the link between the quality of the hospital services and patient migration are in (Chernew, et al., 1998), where for example the authors examine the effect of insurance type on the relationship between hospital attributes and patient flows in California. In general the authors found that the quality have a great effect on the patient flows, although not uniform across markets neither across HMOs. (Luft, et al., 1990) find that hospitals with poorer than expected mortality or complication rates attracted significantly fewer admissions, similar happen in (Hodgkin, 1996). (Skinner, et al., 1977) found that the willingness to obtain treatment at the neighborhood center interest 48% of the interviewed, 52% were not. These response did not vary by demographic or medical characteristics but rather by the patients' stated priorities regarding medical care. Eighty per cent of those willing to change sites stressed convenience of access as a first priority compared with only 17 per cent of those not willing to change. Emphasis on quality of care (45 per cent) or on familiarity with the site (37 per cent) distinguished the group not willing to change. (Moscone, et al., 2012)find that the presence of social interactions across patients who are in lack of official information to rate hospitals may mislead patients in choosing lower providers of care. (Beckert, et al., 2012) found that patient are responsive to the quality. (Moscelli, et al., 2016) among the other things investigate how patient choice of hospital for elective hip replacement is influenced by distance, quality and waiting times. The authors among the others results find that the patients became more likely to travel to a provider with higher quality or lower waiting times. (Phibbs, et al., 1993) found that, in California in the 1993, in the process of the hospital choice, for women the hospital quality tend to be more important for high-risk

than low-risk women. At the same time the author found that factor influencing the hospital choice are the same for women covered by private insurance as for those covered by Medicare. So, the authors conclude that the hospital choice factors vary across subgroups.

3   Principal components analysis and the ERG models

All regression models require an adequate number of observations to offer a good parameter estimates. When this is not the case and further an high number of variables are available it is necessary to found a reasonable way to conduct the analysis of interest.   Here we cannot have more than 21 observations with about 30 variables. For the first point no solution is offered, for the second we reduce the number of variables using the principal components analysis (PCA), a typical multivariate analysis (Mardia, et al., 1979). The following 3.1 subsection show the reduction of the variables, meanwhile our ERGM are showed in the subsection 3.2.

3.1 The reduction of the number of the variables
The objective of the PCA is to search a linear combination of a dataset's variables with the largest variance. In the Table 1 below we show our variables of each indicators. For example we have five variables representing the quality indicators, six for the access and functionality, three for the perceived quality and 20 variables for the technological level (using the number of the equipment as proxies) for a total of thirty-four variables. In our ERGM in the subsection 5.2 we will use others control variables together this factors.

Table 1: Variables description. Year 2010.

Indicators	Variables description	Variables
Quality	Rate of hospitalization for chronic obstructive diseases (for 1000 ab.) (1)	RateOfHosObstructiveDis (q1)
	Rate of hospitalization for diabete with complicance (for 1000 ab.) (2)	RateOfHosDiabWithCompl (q2)
	Rate of hospitalization for amputation of lower limb in diabetic patient (for 100000 ab.) (3)	RateOfHosAmpLowerLimbDiab (q3)
	% schizophenifria readmission not programmed on total discharges (4)	%SchizDiseaseDischOnTot (q4)
	% bipolar disease not programmed readhmission on total bipolar discharges (5)	%BipolarDiseaseDischOnTot (q5)
Access and functionality	Rate of hospitalization for not controllate diabete (for 1000 ab.) (1)	RateOfHosNoContr.Diabete (af1)
	Rate of hospitalization for ashma in the adult (for 1000 ab.) (2)	RateHosAsmaAdult (af2)
	Rate of hospitalization for chardiac insuff over 18 (for 1000 ab.) (3)	RateHosChrdiacOver 18 (af3)
	Rate of hospitalization for chardiac insuff over 65 (for 1000 ab.) (4)	RateHosChrdiacOver 65 (af4)
	Rate of hospitalization for influenza in the ancien (for 100000 ab.) (5)	RateHosInluenzaAncien (af5)
	Rate of hospitalization std for correlated alcool patologies (for 100000 ab.) (6)	RateHosFoPatologies (af6)
Perceived Quality	Number of persons satisfy for hospital assistance services (1)	NPsatHospAssServ (pq1)
	Number of persons satisfy for hospital medical services (2)	NPsatHospMedServ (pq2)
	Number of persons satisfy for hospital hygienic services (3)	NPsatHospHygServ (pq3)
Technological equipment	Number of equipment (Tomography Assial Computerized, Ectomograph etc.) in public, accredited private and extra-hospitals facilities.	Nequip (20 variables) equp1,……equip20[3]

At this end we choice to apply the Principal Components (PC) analysis for the variables in Table 1 above.   With it a following weighted average is posed:

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[3]equip1=Analizzatori_multiparametrici_selettivi_extraospedalieri,equip2=Analizzatori_multiparametrici_selettivi_pubblici_privati_accreditati,equip3=Apparecchi_per_emodialisi_extraospedalieri,equip4=Apparecchi_per_emodialisi_pubblici_privati_accreditati,equip5=Camere_iperbariche_pubblici_privati_accreditati,equip6=Camere_iperbariche_extraospedaliere,equip7=Ecotomografi_extraospedalieri,equip8=Ecotomografi_pubblici_privati_accreditati,equip9=Gruppi_radiologici_extraospedalieri,equip10=Gruppi_radiologici_pubblici_privati_accreditati,equip11=Monitor_pubblici_privati_accreditati,equip12=Monitor_extraospedalieri,equip13=T_A_C_pubblici_privati_accreditati,equip14=T_A_C_extraospedaliere,equip15=Tavoli_operatori_extraospedalieri,equip16=Tavoli_operatori_pubblici_privati_accreditati,equip17=Tomografi_a_risonanza_magnetica_extraospedalieri,equip18=Tomografi_a_risonanza_magnetica_pubblici_privati_accreditati,equip19=Ventilatori_polmonari_extraospedalieri,equip20=Ventilatori_polmonari_pubblici_privati_accreditati.

$$\delta^T X = \sum\nolimits_{j=1}^{p} \delta_j X_j \quad \text{so that} \quad \sum\nolimits_{j=1}^{p} \delta_j^2 = 1 \qquad (1)$$

The weighting vector $\delta = (\delta_{1,\dots,}\delta_p)^T$ can be optimized choosing it in a way to maximize the variance of the projection $\delta^T X$,i.e, choose δ according to:

$$\max_{\{\delta : \|\delta\| = 1\}} Var(\delta^T X) = \max_{\{\delta : \|\delta\| = 1\}} \delta^T Var(X)\delta \qquad (2)$$

The "direction" of δ is given by the eigenvectors γ_1 corresponding to the largest eigvalue λ_1 of the covariance matrix $\sum Var(X)$. So, the projection above captures the majority of the variance in the data. The (2) is the first PC $y_1 = y_1^T X$, orthogonal to the direction γ_1 we found the second linear combination with the highest variance $y_2 = y_2^T X$, the second PC and so on. In this manner we have centered the variable X in order to obtain a zero mean PC variable Y. The following Table 2 show the eigenvectors of the some components calculated for each indicators as stated in the Table 1 above.

Table 2: The eigenvectors and the cumulative variance of the PC.

Indicators	Variables	Eigenvectors			
		PC1	PC2	PC3	PC4
Quality	q1	**0,987233**	**0,156683**	-0,01317	0,025355
	q2	**0,157217**	**-0,97618**	0,141781	-0,011
	q3	0,023596	-0,02698	-0,3491	-0,914
	q4	-0,00369	**0,147582**	0,893145	-0,27308
	q5	0,00918	-0,00311	0,245252	-0,29879
Std. dev.		46,1057	12,18833	5,570988	2,381468
Proportion of variance		**0,91867**	**0,0642**	0,01341	0,00245
Cumulative proportion var.		**0,91867**	**0,98287**	0,99628	0,99873
Access and functionality	af1	0,009648	**-0,2057**	0,047206	0,949062
	af2	0,005085	-0,04011	-0,029	0,188303
	af3	**0,253772**	**0,931597**	0,175035	0,19244
	af4	**0,967155**	**-0,24346**	-0,03774	-0,06225
	af5	0,004435	-0,03917	0,030176	0,12807
	af6	-0,00852	**-0,16553**	0,981814	-0,08071
Std. dev.		234,9283	30,23026	22,93286	8,368498
Proportion of variance		**0,97302**	**0,01611**	0,00927	0,00123
Cumulative proportion vari.		**0,97302**	**0,98913**	0,9984	0,99964
Perceived quality	pc1	**-0,59911**	0,454436	0,65921	
	pc2	**-0,52253**	0,401903	-0,75195	
	pc3	**-0,60665**	-0,79496	-0,00333	
Std. dev.		27,06289	4,257463	2,572136	
Proportion of variance		**0,96732**	**0,02394**	0,00874	
Cumulative proportion vari.		**0,96732**	**0,99126**	1	
Equipment	equip1	0,048041	**-0,45193**	0,236761	-0,33364
	equip2	0,056446	-0,03378	0,26189	-0,12268
	equip3	0,072582	**-0,74831**	-0,01698	0,19815
	equip4	**0,234414**	**0,235864**	0,662692	-0,39179
	equip5	0,000903	-0,00562	0,000769	-0,0032
	equip6	0,00073	0,000331	-0,00447	-0,00094
	equip7	0,049828	**-0,17109**	0,017296	-0,16546
	equip8	**0,256941**	0,081371	0,146364	-0,00924
	equip9	0,030147	**-0,12763**	0,073852	-0,09952
	equip10	0,082039	-0,02448	0,176065	0,040677
	equip11	**0,861585**	0,029892	-0,0608	0,377907
	equip12	0,0364	**-0,34357**	0,080214	0,15364
	equip13	0,024458	-0,02884	0,050109	-0,01216
	equip14	0,006603	-0,0487	0,013118	-0,04121
	equip15	0,00313	-0,01734	-0,00848	-0,00391
	equip16	**0,156797**	-0,04356	-0,09376	-0,08361
	equip17	0,008202	-0,02215	-0,0021	-0,01871
	equip18	0,015901	0,00668	0,019538	0,015085
	equip19	0,009865	0,002759	-0,15989	-0,20957
	Equip20	**0,298056**	0,036343	-0,57453	-0,64967
Std. dev.		2238,843	563,6463	252,8538	184,4095
Proportion of variance		**0,92085**	**0,05837**	0,01175	0,00625
Cumulative proportion vari.		**0,92085**	**0,97922**	0,99096	0,99721

For convenience in the Table 2 we report the information for the first four components, the eigenvectors and the proportion of variance. As we can note, for example, the first component PC1 in the case of quality indicators is essentially the sum of the q1 and q2 variables (see Table 1). The second PC2, always for the quality, is the difference among the sum of the q1 and q4 variables and q2 variable. The weighting of the PCs tells us in which directions, expressed in original coordinates, the best variance explanation is obtained. A measure of how well the components explain variation is given by the proportion indicated, always in the Table 2, for each indicator. For example always for the quality indicator the first component PC1 explain the 91,87 % of the variation (proportion of variance). The first two (the cumulative proportion) explain the 98,29 % of the variation[4], but the PC 2 add very few in terms of its variance (6,4%). In all cases, for the things as soon as said, we will use only the first component PC1. We consider satisfactory the 90%. The resulting transformed variables using the PC1 are the following:

$$Facquality = 0,9847233 \times q1 + 0,157217 \times q2 + 0,023596 \times q3 - 0,00369 \times q4 + 0,00918 \times q5$$

$$Facaccess = 0,009648 \times af1 + 0,005085 \times af2 + 0,253772 \times af3 + 0,967155 \times af4 + 0,004435 af5 \\ - 0,00852 \times af6$$

$$Equipfac = 0,048040739 \times equip1 + 0,056446428 \times equip2 + 0,072581851 \times equip3 + 0,234414287 \\ \times equip4 + 0,000902865 \times equip5 + 0,000730282 \times equip6 + 0,049828286 \times equip7 \\ + 0,256940868 \times equip8 + 0,030147039 \times equip9 + 0,082038846 \times equip10 \\ + 0,861585254 \times equip11 + 0,036399509 \times equip12 + 0,024457929 \times equip13 \\ + 0,006603286 \times equip14 + 0,003129933 \times equip15 + 0,156796728 \times equip16 \\ + 0,008201663 \times equip17 + 0,015901045 \times equip18 + 0,009864836 \times equip19 \\ + 0,298055982 \times equip20$$

$$Facpercqual = -0,5991 \times pq1 - 0,52253 \times pq2 - 0,60665 \times pq3$$

To calculate the factors the data are extract   partially[5] to the Health For All (HFA)[6] data base and partially[7] to the "*Rapporto SDO. Rapporto sull'attività di ricovero ospedaliero 2010*"[8].

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[4] In our case for each indicators the variables are express in the same measure, so we avoid the problem of the not scale invariant of the PCA.

[5] The informations on the hospital (public and private) and extra-hospital equipment, and the percentage of satisfied hospital services people (as our variable proxy on the perceived quality in the hospital services).

[6] www .istat.it/it/archivio/14562.

[7] Info on inter-regional hospital migration, access and functionality, quality.

[8] www.salute.gov.it

3.2 The ERGM model

The ERGM is a statistical model for network structure and characteristics [(Hunter, et al., 2008)], so inferential hypotheses can be tested. With the ERGM the characteristics of the actors and local structural proprieties can be used to predicts the proprieties of the whole network. The model is employed to predict the probability of a tie between the actors conditional the rest of the network:

$$P(y_{ij} = 1 | Y_{ij}^c) = \left(\frac{1}{c}\right) \exp\left\{\sum_{k=1}^{K} \theta_k z_k(y)\right\} \tag{3}$$

Where:

θ_k = are the coefficients of the network statistics of interest

z_k = are the k statistics

$\frac{1}{c}$ = is a simple normalizing constant that assure that probability stay within 0 and 1

The (1) indicate that the model is predicting the probability of a ties between actors i and j, conditional the rest of the network (all other ties)[9]. For each network we estimate the null model (that include the only *edges* term) and others specifications as in Table 3 below.

Table 3: The models specification

	Model 1 (null)	Model 2 (null +..)	Model 3 (Model2+)	Model 4 (Model2+..)	Model 5 (Model2+..)	Model 6 (Model2+..)
Networks						
	Edges	Facpercqua	Facaccess	+homophily system type effect	Equipfac	+homophily area
ARO (AIC)	64.9	58.07	60.04	57.38	56.01	56.84
ADH(AIC)	131.4	113	114.9	113.8	92.67	103.2
RRO (AIC)	405.2	400	397.2	402	312.3	388.4
RDH (AIC)	583.1	571.4	558	571.1	428.8	564.9
LTRO (AIC)	573.2	560.7	547.3	562.5	466.9	551.8

The Model 1 is the null model that include only the edges terms as covariates. The null model can be saw as the logistic transformation of the edges parameter,

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[9] In the models can be added several predictors that fall into one of four categories: node-level predictors, dyadic predictors, relational predictors, and local structural predictors.

which gives the overall density of the networks . The others models consider principally the node-level characteristics. For example, for us, the perceived quality indicators in the hospital services is a characteristic of the regional health system (the network node). However, our node-level characteristics are be changed with the factors calculated in the subsection 3.1. Each model it has been estimated five time one for each type of network (acute in ordinary regime, acute in day hospital regime, rehabilitative in ordinary regime, rehabilitative in day hospital regime, long-term in ordinary regime). With the actor-level characteristics we test if a particular characteristics affect the likelihood of observing a tie. When we can test if the characteristics of the both actors in dyad may influence the probability of observing a ties between this two actors we can use a dyadic-level predictors (Morris, et al., 2008). To choice which model is doing better of the explaining the data than the null model we show the AIC (Akaike Information Criteria), under the rule that a lower AIC is better. So, for example, the Model 2 is doing better than the Model1 in all cases (Acute in Ordinary Regimes (ARO), Acute in Hospital Regime (ADH), Rehabilitative in Ordinary Regime (RRO), Rehabilitative in Day Hospital Regime (RDH), Long-Term in Ordinary Regime (LTRO)). Although, the AIC difference between the two models is higher for the ADH. This mean that the Model2 explain the data better in the ADH network than in all others type of networks.

4 The ERGM results

In this section we report the result of the ERGM model and discuss it. For each model we report the probability of a tie formation (plogis) and the estimated parameters for the all others models in Table 3. The results are in the Table 4,5,6,7 below.

Table 4: The null model (Model 1). Year=2010.

Model1	Estimate	Std. Error	MCMC %	p-value	plogis
ARO (edges)	4,234106	0,411163	0	2,55E-22	0,985714
ADH(edges)	3,295837	0,262934	0	7,87E-31	0,964286
RRO(edges)	1,478102	0,125477	0	7,28E-28	0,814286
RDH(edges)	0,104858	0,097724	0	0,283889	0,52619
LTRO(edges)	0,326684	0,098895	0	0,001037	0,580952

Table 5: ERGM Model 2. Year=2010.

Model2	Estimate	Std. Error	MCMC %	p-value	plogis
ARO (edges)	9,488123	2,16552	0	1,49E-05	0,999927
Facpercqual	0,033318	0,011882	0	0,005281	
ADH(edges)	8,442294	1,399474	0	3,56E-09	0,999791
Facpercqual	0,03301	0,007868	0	3,32E-05	
RRO(edges)	2,750677	0,507518	0	1,01E-07	0,940465

	Estimate	Std. Error	MCMC %	p-value	Plogis
Facpercqual	0,009139	0,003439	0	0,008169	
RDH(edges)	1,47735	0,39243	0	0,000191	0,815697
Facpercqual	0,010114	0,002795	0	0,000333	
LTRO(edges)	1,761283	0,400123	0	1,36E-05	0,854681
Facpercqual	0,010513	0,002821	0	0,00022	

The first point that we can note in the Table 5 is that the perceived quality factor is positively and significantly associated with the probability of observing a tie between two hospitals located in different Regions. Remembering that here a ties is the hospitals interregional heath migration this mean that the perceived quality of hospitals services (pq1,pq2 and pq3 variables in the Table 1) is positively associated with the probability that the health migration occur between two different regional healthcare systems (located in two different Regions). The plogis column in Table 5 indicate the probability that there is a migration flow for health motivations between two different Regions where one of it have a double level of perceived quality (our perceived quality factor) in the hospitals services compared with another. Comparing the plogis for the null model (Table 4) and model 2 (Table 5) the two very important things to note are the higher difference in the plogis in the case of the RDH and LTRO networks. For these two networks, and in part for the RRO, the values are more higher than the overall density (the plogis column in the Table 4). This can be interpreted that for these networks the perceived quality of the hospitals services are a strong drive factor in the transfer between two Regions for health motivation in the case of rehabilitative in day hospital regime and long-term care. In these networks the perceived quality to do the difference. In the healthcare sector the access at the health services is important as well as the quality (perceived or objective). In the following Table 6 we show the probability in ties formation (remember that in our case are the transfer for health motivations) in presence of access characteristics at node-level other than the perceived quality in the hospital services.

Table 6: ERGM Model 3. Year=2010.

Model3	Estimate	Std. Error	MCMC %	p-value	Plogis
ARO (edges)	8,559924	6,199615	0	0,168105	0,99981
Facpercqual	0,031965	0,014553	0	0,028605	
Facaccess	0,000271	0,001708	0	0,87382	
ADH(edges)	9,578047	4,086669	0	0,019561	0,999933
Facpercqual	0,034687	0,009737	0	0,00041	
Facaccess	-0,00033	0,001103	0	0,765948	
RRO(edges)	6,401123	1,772503	0	0,000342	0,998365
Facpercqual	0,014371	0,004264	0	0,00082	
Facaccess	-0,00106	0,000487	0	0,029964	
RDH(edges)	6,59532	1,402127	0	3,48E-06	0,998657
Facpercqual	0,017488	0,003474	0	7,16E-07	
Facaccess	-0,0015	0,00039	0	0,000141	
LTRO(edges)	6,962899	1,429511	0	1,58E-06	0,99907
Facpercqual	0,018037	0,003526	0	4,77E-07	
Facaccess	-0,00152	0,000395	0	0,000143	

As first thing, in the Table 3 we note that this model (Model3) perform better than the null model but not always this happen if compared with Model2 (with only perceived quality factor actor-level characteristics). In fact this model is not better of the Model2 in the case of ARO and ADH networks. In general the probability of a ties formation between two Regions is not influenced by the access (the estimated parameter of the access factor is statistically not significant) in the case of ARO and ADH network, meanwhile the access negatively influence the ties formation probability in the case of RRO,RDH and LTRO (although the parameter in these case is statistically significant is very low). The plogis column report the predict probability (the logistic transformation of the estimated parameters) of observing ties when two regional healthcare system belong the same dyad have different values of the two factors. Specifically one of it have, compared with the other, a double level of access and hospital services perceived quality[10]. With the Model 4homo we test if ties (remember always that here a tie is the hospital interregional transfers for health motivations) are more or less likely between Regions with similar regional healthcare system [11] (homophily effect). The frequencies of the observed ties among and between Regions with different type of regional healthcare system in each type of networks are showed below in the Table 7. The information in the Table 7 in this contest can be interpreted as the relative frequencies of the in-flow (the entry flow) and out-flow (the outgoing flow) between Regions in the case of the care received in the hospital located outside own residential Region, do not excluding the intra-regional health migration (the diagonal values) (in other words our networks have the loops).

Table 7: Relative ties frequency for type of health system. Year=2010.

	Network ARO				
	To				
From	Type 1 (INTEGR.	Type 2 (HYBRID-SEMI_INTEGRATED)	Type 3 (HYBRID-SEMI_SEPARATED)	Type 4 (SEPARATED	Total
Type 1	38	63	28	7	136
Type 2	63	72	36	9	180
Type 3	26	36	12	4	78
Type 4	7	9	4	0	20
Total	134	180	80	20	414
	Network ADH				
Type 1	35	61	27	7	130
Type 2	60	72	36	9	177
Type 3	26	36	12	4	78
Type 4	7	9	4	0	20
Total	128	178	79	20	405

[10] All this double values are obtained multiply for two the corrisponded estimated parameters of the ERGM in the logistic transformation.
[11] Here we consider four type of regional healthcare systems based on the proportion of public directly managed hospitals beds: separate (less than 1%), integrate (more than 66%), hybrid-semi-integrated(40-66%) and hybrid-semi-separate (20-40%).

		Network RRO				
Type 1	23	46	24		7	100
Type 2	47	68	32		9	156
Type 3	17	33	12		4	66
Type 4	7	9	4		0	20
Total	94	156	72		20	342
		Network RDH				
Type 1	11	16	10		4	41
Type 2	22	55	28		8	113
Type 3	13	23	7		4	47
Type 4	7	9	4		0	20
Total	53	103	49		16	221
		Network LTRO				
Type 1	14	38	17		4	73
Type 2	25	49	27		8	109
Type 3	7	25	8		4	44
Type 4	5	9	4		0	18
Total	51	121	56		16	244

In the Table 7 we see that the most frequent transfer are observed between the Type 1 and Type 2 in the case of ARO, ADH,RRO (in other words between the integrated and hybrid semi-integrated regional health care systems). Between Type 1,2,3(hybrid semi-separated), for RDH and LTRO. This table can be useful to generate hypotheses about dyadic relationship that can be tested with ERGM. And in fact the homophily effect that we tested with Model 4 is if the same type of regional healthcare system are more likely to transfer patient among itself (in others words the likelihood of a ties when both the Regions have the same type of regional healthcare system) . At first glance as we can see in the Table 3 above, the Model 4 not added nothings of more of the Model2 in terms of data fitting. Meanwhile the estimations in the Table 8 show that any homophily effect exist, despite the fact all the parameters of interest are not statistically significant.

Table 8: ERGM Model 4 homo. Year=2010

Model 4	Estimate	Std. Error	MCMC %	p-value	plogis
ARO (edges)	9,632232	2,045392	0	3,39E-06	0,999745
Facpercqual	0,030204	0,011187	0	0,007218	
Systype-homo	-1,41981	0,89409	0	0,113045	
ADH(edges)	8,493814	1,375614	0	1,58E-09	0,999644
Facpercqual	0,031964	0,00777	0	4,69E-05	
Systype-homo	-0,61754	0,557627	0	0,268742	
RRO(edges)	2,738833	0,512139	0	1,47E-07	0,942933
Facpercqual	0,009156	0,003441	0	0,008096	
Systype-homo	0,047623	0,277599	0	0,863873	
RDH(edges)	1,39378	0,395761	0	0,000476	0,851288
Facpercqual	0,010222	0,002798	0	0,000292	
Systype-homo	0,330519	0,218795	0	0,13164	
LTRO(edges)	1,787415	0,40555	0	1,33E-05	0,847712
Facpercqual	0,010502	0,002823	0	0,000227	
Systype-homo	-0,09165	0,219142	0	0,675984	

In other words to have the type of regional health system do not influence the probability of transfer for health motivations between two Regions. And however would be negatively related to the probability of a ties among similar regional health care systems (the estimated parameter of the Systype-homo covariate). To predict the probability for the ties formations between two regional health system both with the same level of perceived quality and one of it with a technological level double those of the other, we estimate the Model 5. As showed in the Table 3 this latter Model fit very well if compared with its predecessors. The parameter estimates and plogis of the model are in the following Table 9.

Table 9: ERGM Model 5. Year=2010.

Model 5	Estimate	Std. Error	MCMC %	p-value	plogis
ARO (edges)	6,907594	2,38518	0	0,003978	0,99903
Facpercqual	0,000412	0,000254	0	0,104656	
Equipfac	0,026073	0,011945	0	0,029608	
ADH(edges)	4,551977	1,634723	0	0,005604	0,98983
Facpercqual	0,00084	0,000271	0	0,002074	
Equipfac	0,023512	0,008412	0	0,005431	
RRO(edges)	-0,50179	0,667079	0	0,45234	0,37812
Facpercqual	0,000618	8,48E-05	0	1,55E-12	
Equipfac	0,002409	0,003901	0	0,537164	
RDH(edges)	-1,4264	0,536975	0	0,008202	0,19515
Facpercqual	0,000545	5,89E-05	0	1,21E-18	
Equipfac	0,007859	0,003334	0	0,018867	
LTRO(edges)	-0,49482	0,50435	0	0,327109	0,38096
Facpercqual	0,000412	5,07E-05	0	4,98E-15	
Equipfac	0,008119	0,003157	0	0,010453	

Although in the RDH and LTRO networks the Equipment factor is positively correlated with the probability to observe a ties and is statistically significant, the probability to observe a ties when both the regional health care systems have the same perceived quality level and one of his have a double level of equipment (the plogis for RDH and LTRO network) is very low. In the remaining networks an interesting effect of the equipment level on the probability to observe a ties is in the ADH network, where the probability to observe a ties between two regional health care system with the same level of perceived quality and a double level of equipment is very high (plogis column for ADH network). For the ARO network this probability is also very high, but the equipment parameter is statistically significant at 5%. Finally the Model 6 test the homophily effect at geographical area, in other words the ties probability formation between two regional health system with the same level of perceived quality in the hospital services and to belong at the same geographical area (Nord, Centre, South). In the following Tables 10 and 11 we show the relative frequencies matrix and the ERGM estimates.

Table 10: Relative ties frequency for geographical area. Year=2010.

Network ARO	To			
From	North	Centre	South and Isles	Total
North	88	40	69	197
Centre	38	12	28	78
South and Isles	69	28	42	139
Total	195	80	139	414
Network ADH				
North	86	39	66	191
Centre	37	12	28	77
South and Isles	67	28	42	137
Total	190	79	136	405
Network RRO				
North	82	33	61	176
Centre	33	12	28	73
South and Isles	39	21	33	93
Total	154	66	122	342
Network RDH				
North	55	22	41	118
Centre	19	11	19	49
South and Isles	24	11	19	54
Total	98	44	79	221
Network LTRO				
North	58	23	45	126
Centre	21	9	19	49
South and Isles	28	14	27	69
Total	107	46	91	244

Table 11: ERGM Model 6. Year=2010.

Model 6	Estimate	Std. Error	MCMC %	p-value	plogis
ARO (edges)	11,72514	2,792276	0	3,28E-05	1
Facpercqu	0,050939	0,016716	0	0,002455	
Homo.are	1,978716	1,156113	0	0,087728	
ADH(edges)	11,50347	1,966121	0	9,9E-09	0,90568
Facpercqu	0,056607	0,012008	0	3,31E-06	
Homo.are	2,604579	0,844517	0	0,002177	
RRO(edges)	3,234147	0,587492	0	6,46E-08	0,98825
Facpercqu	0,014918	0,004212	0	0,000442	
Homo.are	1,153579	0,337081	0	0,000682	
RDH(edges)	1,57816	0,404719	0	0,000112	0,90568
Facpercqu	0,012421	0,002986	0	3,86E-05	
Homo.are	0,646601	0,225507	0	0,00435	
LTRO(edges)	1,928238	0,421506	0	6,3E-06	0,93834
Facpercqu	0,013507	0,003099	0	1,65E-05	
Homo.are	0,753666	0,234954	0	0,001441	

In the Table 10 the most frequent dyad in all the networks are inside North area and between North and South and Isles. Contrary at the case of the type of the system (see Table 8) here the estimates parameters of the Homo.area covariate

(Table 11) is positively and statistically significant. So, the probability of observing a ties between two Regions with one of it with the double perceived quality and both belong the same geographical area (homophily effect) is very high in all networks.

5   Conclusion

In this paper we tested if the perceived quality in the hospital services (medical, assistance and hygienic) is a drive factor for the people's transfers for health motivations between two Regions. To test this we estimates several ERGM starting with the null model and adding at the perceived quality factor (in the Model2 in the Table 3) others covariates (in the factor form). Some of these covariates interest the access and functionality in the hospital services meanwhile others consider the equipment level in the hospitals and in the extra-hospital facilities. The ERG Model 2 offer a significant statistical evidence that the perceived quality in the hospital services influence the predict probability of the transfer's decision of the citizen for health motivations. In other words, this mean to create a linkage between the regional health care systems belong two different Regions. As point out in the paper this conclusion can be considered fully true when the transfer is based on the discretional individual choice, but for us can be considered partially true when the transfer is of different nature (for example when the decision is mediated by third part). In fact we assume that in this latter case very often the final decision is always to the patient. For us, in this latter case (of mediated decision) the individual judgment on the quality of the hospital services (the perceived quality) play a role less important than in the first case of transfer[12] described above but always related to the final decision of the patient. These conclusions cannot be assumed in the situations where the transfer is constraints at special case for example in the case of high specialized hospital care that should be carried out by facilities located in few Regions (and however we believe are a little proportion of the transfer). Our attention fall in the interregional hospital migration in the case of ordinary and day hospital regime for the hospital acute' s care, as well as in the rehabilitative and long-term regime of hospital care. However, for each type of network we used the same perceived quality indicators and do not consider the time dimension. In other words we cannot distinguish the effects of the perceived quality for each type of hospital services in each regime of hospital care and cannot control for the change of the individual judgment over the time. This can be considered a limit of the study. To overcame the first of the outlined limits we would need to gather data on the perceived quality on the

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[12] Is importat to add that the motivations of the transfer for health motivation are determined by others factors, other then perceivad quality as the asimmetric information, lack of confidence in the regional skills and facilites and so on. This mean that a proportion of the outflow can be avoid.

hospital services (medical, assistance and hygienic) for each in each type of regimes of care (ordinary and day hospitals) and for the different type of care (acute, rehabilitative, long-term). To overcame the second of this limit we need a panel version of the ERGM. Is however for us and interesting starting point for further analysis in this topic using the SNA methodology. The analysis of the estimated parameters of the ERGM models (their sign and significance) and its logistic transformation to suggest us to conclude that the perceived quality of the hospitals services is a drive factor in the transfer between Regions for health motivation in the case of different hospital type of care and regime (Model2 results in the Table 5). However Model 3 and 5 suggest us to conclude that other driver factor in the predicted probability of a ties formation (here the transfer for health motivation between two Regions) is the level of equipment but not the level of access and functionality. Yet, the Models 4 and 6 suggest us to conclude that the predicted probability of the formation of a ties between two Regions is driven to the perceived quality of the hospitals services when one of it have a double level of perceived quality in the hospital services but is not influenced to the fact that the Regions have the same type of the healthcare system and however influenced by the same geographical area (in other words this is the homophily effect). Yet, the access and functionality do not influence the probability of a ties formation between Regions, on the contrary in about all networks (ADH,RRO,RDH,LTRO) influence negatively the predicted probability (see Table 6) of a ties formation. All the analysis are conduct with R (Douglas, 2015).

References

[1] Balia, S., Brau, R. & Marrocu, E., *FREE PATIENT MOBILITY IS NOT A FREE LUNCH.*. s.l.:Crenos.(2014)
[2] Beckert, W., Christensen, M. & Collyer, K.. Choice of NHS-funded hospital services in England. *Economic Journal*, **Volume 122**,(2012), pp. 400-417.
[3] Brekke, K. R., Gravelle, H., Siciliani, L. & Straume, O. R., 2014a. Patient Choice, Mobility and Competition Among Health Care Providers. In: *Health Care Provision and Patient Mobility. Health Integration in the European Union.* s.l.:Springer-Verlag.
[4] Brenna, E. & Spandonaro, F.,*Does federalism induce patients' mobility across regions? Evidence from the Italian experience.*. Roma: Università Cattolica del Sacro Cuore.(2014)
[5] Cantarero, D. Health care and patient's migration across Spanish regions. *The European Journal of Health Economics*, **7**(2),(2006), pp. 114-116.

[6]   Chernew, M., Scanlon, D. & Hayward, R. Insurance type and choice of hospital for coronary artery bypass graft surgery. *Health Services Research*, **Volume 33**,(1998), pp. 447-466.

[7]   Douglas, A., 2015. *A User's Guide to Network Analysis in R.* s.l.:s.n.

[8]   Fabbri, D. & Robone, S.,The geography of hospital admission in a National Health Service with patient choice: evidence from Italy.(2008).

[9]   Fattore, G., Petrarca, G. & Torbica, A., Traveling for care: Inter-regional mobility for aortic valve substitution in Italy. *Health Policy*, (2014).

[10] France, G., Taroni, F. & Donatini, A.. The Italian health-care system. *Health Economics*, **Volume 14**,(2005), pp. 187-202.

[11] Gaynor, M. & Town, R. Competition in health care markets.In: T. G. P. P. B. M. V. Pauly, a cura di *Handbook of Health Economics.* Amsterdam: Elsevie,(2012).

[12] Hodgkin, D. Specialized services offerings and patients' choice of hospital: the case of cardiac catherization. *Journal of Health Economics*, **15**(3),(1996), pp. 305-332.

[13] Hunter, D.R., et & al.,. ergm: a package to fit, simulate and diagnose exponential-family models for networks. *J Stat Softw*, **24**(3),(2008).

[14] Jang, H. L. & An, J.-Y. Application of Social Network Analysis to Health Care Sectors. *Healthc Inform Res.*, **18**(1), (2012),pp. 44-5.

[15] Kwait, J., Valente, T. & Celentano, D. Interorganizational relationships among HIV/AIDS service organizations in Baltimore: a network analysis. *J.UrbanHealth:Bull. N.Y.Acad.Med*, **Volume 78**, (2001),p. 468–87.

[16] Lee, B. et al. Social Network Analysis of Patient Sharing Among Hospitals in Orange County,California. *Research and Practice*, 11(4),(2011).

[17] Levaggi, R. & Menoncin, F. Fiscal federalism, Patient Mobility and Soft Budget Constraints in Italy.*Politica Economica*, **Volume 3,** (2008).

[18] Levaggi, R. & Menoncin, F.,Soft budget constraints in health care: evidence from Italy.. *European Journal of Health Economics*, **Volume 14**,(2013), pp. 725-737.

[19] Levaggi, R. & Montefiori, M., *Health Care Provision and Patient Mobility.* New York: Springer, (2014).

[20] Levaggi, R. & Zanola, R.,Patient's migration across regions: the case of Italy.*Applied Economics*, **36**(16),(2004), pp. 1751-1757.

[21] Lippi Bruni, M., Nobilio, L. & Ugolini, C.,The analysis of a cardiological network in a regulated setting: a spatial iterations appraoch. *Health Economics*, **Volume 17**,(2008), pp. 221-233.

[22] Luft, et al., 1990. Does Quality influence choice of hospitals. *Journal of the American Medical Association*, **263**(21), pp. 2899-2906.

[23] Mardia, K. V., Kent, J. & J.M., B., *Multivariate Analysis.* London: Academic Press.(1979)

[24] Morris, M., Handcock, M. & Hunter, D.,Specification of exponential family random graph models: terms and computational aspects. *J Stat Softw*, (2008),pp. 1548-7660.

[25] Moscelli, G., Siciliani, L., Gutacker, N. & Gravelle, H.,Location, quality and choice of hospital: Evidence from England 2002–2013. *Regional Science and Urban Economics*, (2016),pp. 112-124.

[26] Moscone, F., Tosetti, E. & Vittadini, G., Social interaction in patients' hospital choice: evidence from Italy. *J. R. Stat. Soc. A Stat. Soc*, **175**(2),(2012), pp. 453-472.

[27] Nakao, K., Milazzo-Sayre, L., Rosenstein, M. & Manderscheid, R., Referral patterns to and from inpatient psychiatric services:a social network approach. *Am.J.PublicHealth*, **76**(7),(1986), p. 755–60.

[28] Paolella, G., Pediatric health mobility: is it only an Italian problem?. *Translational Medicine*, **4**(6), (2012),pp. 57-61.

[29] Phibbs, C. et al., Choice of hospital for delivery: a comparison of high-risk and low-risk women. *Health Services Research*, **28**(2), (1993), pp. 201-222.

[30] R Core Team. R (2016): a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. URL, http://www.R-project.org.

[31] Skinner, J.,Causes and Consequences of Regional Variations in Health Care. In: *Handbook of Health Economics.* s.l.:Elsevier (2012).

[32] Skinner, T., Scott, D. & Gorry, G.,Factor affecting the choice of hospital-based ambulatory care by the urban poor. *American Journal of Public Health*, **67**(5),(1977), pp. 439-445.

[33] Tediosi, F., Gabriele, S. & Longo, F.,Governing decentralization in health care under tugh budget constraint: What can we learn from the Italian experiences?. *Health Policy*, **Volume 90**, (2009),pp. 303-312.

[34] Vajro, P. et al.,Characterization and burden of Campania children health migration across Italian regions during years 2006-2010: chance and/or necessity?. *Italiana Journal of Pediatric*, **38**(58),(2012).