

APPENDIX A

Organization-specific attributes. To control for the possible tendency of larger hospitals to send and receive more patients, two variables are included to capture the human and physical aspects of hospital size. The first variable, *Number of employees*, is measured as the natural logarithm of the total number of employees (clinicians, nurses and other healthcare professionals, and administrative staff) in each hospital. The second variable, *Number of beds*, is measured as the natural logarithm of the total number of staffed beds in each hospital. *Average length of stay*, defined as the expected duration of a patient's stay in a hospital after admission, is used to control for differences between hospitals in resource consumption and utilization. All other conditions being equal, more efficient hospitals will tend to have shorter average lengths of stay (SHI, 1996; YOUNIS, 2003). *Productivity* is measured as the total number of discharges divided by the number of available beds, weighted by the Case Mix Index (WANG et al., 2001), which is used by researchers, administrators and policymakers as an indicator of hospital complexity and resource absorption (FOLLAND et al., 1997). In the context of not-for-profit and public institutions, hospital productivity is typically used as an indicator of hospital performance (MASCIA and DI VINCENZO, 2011). *Occupancy rate* is included to control for differences between hospitals in the actual utilization of available capacity (GAPENSKI et al., 1992; GAYNOR and ANDERSON, 1995; NATH, 1998). This variable is computed by dividing the number of patient days by the total number of staffed beds in each hospital. *Organizational form* is included to capture the institutional diversity of hospitals in the community. This categorical variable ranges from 1 to 6 (1 = LHU hospital; 2 = Hospital trust; 3 = University hospital; 4 = National institute for scientific research; 5 = Classified hospital; 6 = Private accredited hospital). Boundaries of these categories reflect fundamental differences in institutional constraints and ownership structures, which may affect the tendency of hospitals to collaborate. *LHU membership* controls for membership in the twelve LHUs into which the region is partitioned. Members of the same LHU may be more likely to collaborate than members of different LHUs. *Level of care* is a binary variable that takes a value of 1 if the hospital provides specialized consultative care (i.e. tertiary

care) and 0 otherwise (i.e. secondary care). *Metropolitan area* is a binary variable that takes a value of 1 if a hospital is located in Rome and 0 otherwise. This variable is used to control for possible biases towards transferring to and among hospitals located in the broad urban area of Rome. Finally, the variable *Scope of service* is used to control for differences in the range of services offered by hospitals. This variable is measured as the number of medical specialties maintained by each hospital.

Dyad-specific attributes. Features of the relation between pairs of hospitals may affect their propensity to collaborate. For example, patients may be more likely to be transferred between hospitals that have a history of prior collaborations (GULATI, 1995). Therefore, *Prior collaboration* is included as a dyadic attribute that records the number of patients transferred between each pair of hospitals in the previous calendar year. As another example, complementary knowledge and resources may provide the basis for cooperation and mutually advantageous exchange (GULATI and GARGIULO, 1999). A variable that captures *Service complementarity* between pairs of regional hospitals is computed to measure the diverse range of services offered. A two-mode ($n \times m$) matrix is constructed, with the intersection cells between hospitals (in rows) and clinical specialties (in columns) indicating the presence (value = 1) or absence (value = 0) of a given clinical specialty at a given hospital. Euclidean distance coefficients between two generic hospitals i and j are computed as $D_{ij} = \sqrt{\sum_k (x_{ik} - x_{jk})^2}$ to capture the diverse portfolio of k medical specialties offered. The higher the Euclidean distance between two hospitals, the higher their service complementarity.

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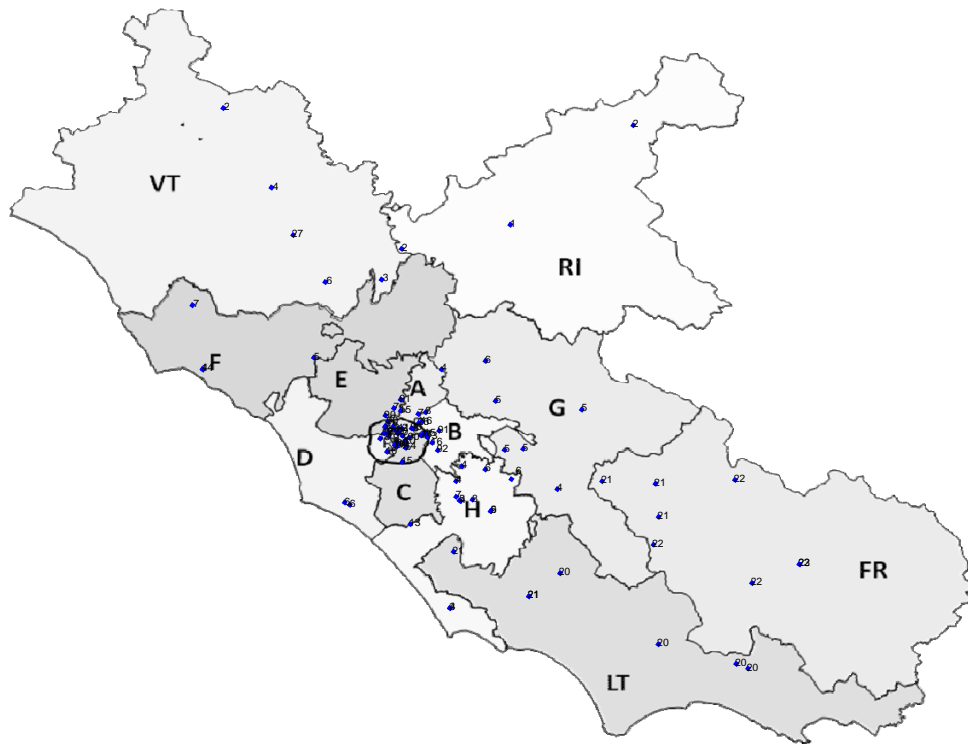
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TABLE A1: Descriptive statistics and correlation matrix

	Mean	Std. Dev.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Interorganizational collaboration	1.87	12.71	0	512	-													
2 Niche Overlap	0.08	0.1	0	0.91	0.08	-												
3 Geographical Proximity	50.77	39.51	0	222.60	0.11	0.00	-											
4 Past collaboration	1.61	12.69	0	525	0.11	0.00	0.10	-										
5 Service Complementarity	2.91	1.02	0	5.92	0.13	0.06	0.10	0.10	-									
6 Level of care	0.79	0.41	0	1	-0.09	0.01	-0.17	-0.07	-0.56	-								
7 Number of Employees	5.38	1.38	0	7.98	0.11	0.06	0.08	0.10	0.65	-0.42	-							
8 Number of Staffed Beds	4.66	1.37	0	7.57	0.12	0.07	0.11	0.11	0.62	-0.39	0.66	-						
9 Average Length of Stay	2.14	1.94	0	12.50	-0.01	-0.06	0.14	-0.01	0.10	-0.18	0.01	0.03	-					
10 Productivity	19.14	15.96	0	101.41	-0.02	0.12	0.16	-0.03	0.12	-0.23	0.03	-0.01	0.20	-				
11 Occupancy Rate	16.79	14.28	0	84.30	-0.01	-0.01	-0.11	-0.01	0.01	0.05	0.04	0.00	-0.02	-0.05	-			
12 Organizational Form	0.36	0.5	0	1	-0.04	0.02	-0.15	-0.03	-0.23	0.39	-0.19	-0.19	-0.12	-0.11	0.02	-		
13 LHU Membership	0.08	0.3	0	1	0.12	0.00	0.26	0.10	-0.02	0.16	-0.02	0.01	0.01	-0.03	-0.03	0.09	-	
14 Metropolitan Area	0.23	0.4	0	1	0.12	-0.01	0.58	0.11	0.18	-0.23	0.14	0.15	0.18	0.14	0.00	-0.14	0.19	-
15 Scope of Service	10.52	8.63	1	39	0.12	-0.38	0.03	0.09	0.53	-0.35	0.42	0.41	-0.05	-0.04	-0.01	-0.11	0.01	0.10

Notes: All variables are in dyadic form (8,190 dyads)

FIGURE A2: Geographical map of Lazio



Note: Territorial boundaries identify the articulation of the regional health system in Local Health Units; Dots indicate where the sampled hospitals are located

FIGURE A3: Network of patient transfer relations among hospitals in the region



Note: Each node (dot) represents one hospital and each tie (link) represents an existing collaborative patient transfer relation among node pairs. The dimension of ties is proportional to the number of transferred patients between hospitals. Hospitals' location is determined using a spring-embedding heuristic, multidimensional scaling algorithm, with proximity indicating the extent to which two hospitals are connected directly and indirectly through mutual partners (Borgatti, 2002).