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MARKET STRUCTURE AND TECHNOLOGY: EVIDENCE FROM THE ITALIAN NATIONAL HEALTH SERVICE*

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1. Introduction

In the past few decades health care markets have been deeply affected by two different radical structural changes. On one hand, the rapid pace of technological development and the diffusion of new technologies to providers, by improving the quality of care and introducing new and costlier products, have greatly contributed to cost increasing in health care industry. On the other hand, even in the diversity of national experiences, a clear trend has emerged toward a decentralization of public intervention in health care to sub-national layers of government (regional as well as local bodies). During the '90s radical reforms toward regionalization have reshaped the national health service in Canada, Italy, Spain and Sweden, determining the rise of regional health services differentiated on the basis of organization, institutions and services, and increasing the decisional autonomy of the agents operating in the health care markets, on both the demand and the supply side. On the demand side, patients have gained the right to freely choose the facilities that best meet their requirements of high-quality medical care, whereas on the supply side, hospitals and other health structures, apart from fulfilling a series of essential services, have become more autonomous in concentrating their own resources on specific health care productions started by technological innovations. As a whole, these dramatic changes have greatly contributed to make the functioning of health care markets more similar to the traditional industrial sectors, where it is generally assumed that consumers are free to choose their supplier, suppliers

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are free to choose which product to offer and the quality of it, and technology plays a crucial role.

With reference to the Italian National Heath Service in particular, a series of empirical contributions (Fabbri and Fiorentini 1996, Degli Esposti et al. 1996, Ugolini and Fabbri 1998, Spampinato 2001) has stressed the relevance of the relation between interregional mobility of patients and the technological complexity of health services provided by different Regions: patients are more willing to move far from their territorial area of residence, and therefore to bear the implied costs of transaction, if they need health services characterized by high specialization, thus affecting the structure of health care industry (market concentration).

Industrial organization literature has largely investigated the relationship between technology and market structure. In this regard a standard reference is offered by the theoretical and empirical contribution by John Sutton. A key feature of Sutton's research approach is that industries evolve to distinct market configurations in term of concentration depending upon whether the corresponding products are essentially homogeneous or whether they are differentiated by research and development (R&D) and advertising. Sutton develops his analysis with reference to traditional industrial sectors. However, what argued before about the ongoing dramatic changes in health care suggests, as a promising path of research, to resort to the same interpretative tools to study the structure of medical care markets currently prevailing. In particular, the aim of this work is to test empirically the existence of the relation between technological profiles and market structure claimed by Sutton's theory in a specific economic framework, the one of medical care services provided by the Italian National Health Service.

Our work is organized as follows. In Section 2 Sutton's theoretical framework is briefly discussed. Section 3 describes the data about the health services provided by the Italian National Health Service that is at the basis of our empirical application. Section 4 illustrates the statistical tests developed to try out Sutton's empirical predictions, whereas in Section 5 the relevance of the empirical results is discussed. Section 6 concludes and outlines some possible directions for future research.

2. Technology and market structure: the Sutton's approach

Sutton (1998) investigates the relationship between an industry's R&D intensity (measured by the ratio of R&D spending on sales) to its level of concentration (measured by the combined market share of some specified number of top firms).

Theoretical and empirical literature has at length debated on this relationship without reaching a common view. On the theoretical ground, it was initially the direction of causation (from concentration to R&D intensity, or vice versa) to be disputed[1]. However, starting from the 70's the view that concentration and R&D intensity were both endogenous variables became widely accepted, and therefore they should be simultaneously determined within an equilibrium system. On the empirical ground, no clear consensus appears to emerge in empirical cross-industry analyses about the sign and the form of the relationship between R&D intensity and concentration: beside papers that report a positive correlation, others emphasize a negative relationship or no correlation at all.

The starting point of the theory, developed by Sutton (Shaked and Sutton 1982, 1987; Sutton 1989, 1991, 1998) lies in the observation that R&D (and advertising) outlays can both be considered as sunk costs incurred by the firm with a view to enhance consumers' willingness-to-pay for the firm's product: R&D (and advertising) outlays are choice variables to the firms and so their levels must be determined endogenously as part of the specification of industry equilibrium (endogenous sunk costs).

In particular Sutton focuses on what he calls the *escalation mechanism*. This describes the way in which firms may respond to an increase in the size of the market by raising their R&D spending. In particular α denotes the escalation parameter, that measures the additional profits an entrant firm that spends in R&D more than the incumbent firms operating in an initially fragmented market can attain.

Building on the definition of α and the notion of an equilibrium configuration, Sutton derives a *non-convergence theorem*, that represents the key result of his contribution. According to the *non-convergence theorem*, in any equilibrium configuration it holds that $C_1 \geq \alpha$, that is the one-firm sales concentration ratio C_1 is bounded below by α, independently of the size of the market. Moreover Sutton demonstrates that in any equilibrium configuration the R&D/sales ratio of the firm offering the maximal quality is bounded below in the limit of large economies by α.

The questions to which these results lead are: what are the determinants of α? Can the value of α be related to observable industry characteristics?

In general terms, α can be thought to be a function of two parameters:

- β, a cost parameter which measures the degree to which product quality and consumers' willingness-to-pay rises with R&D spending;

[1] The latter stance is mainly based on appeal to the *structure/conduct/performance* paradigm developed by Bain (1956). Within that paradigm, is it claimed that a one-way chain of causation runs in each industry from *structure* (the level of concentration) to *conduct* (the degree of collusion), and from conduct to *performance* (profitability). Structure, in this setting, is explained by the degree of scale economies in the industry and by observed levels of advertising and R&D outlays relative to industry sales.

- σ, a substitution parameter which measures the strength of the links between different technological trajectories in the market and their associated product groups both on the demand side (substitution) and the supply side (scope economies in R&D).

Fig. 1 illustrates the relationship between α and the parameters β and σ. When β is low (that is R&D is effective and the increase in quality is highly evaluated by the consumers) and σ is high (progress on one trajectory leads to the stealing of consumers from rivals on other trajectories because of relevant scope economies in R&D and close substitutability between different goods associated to various trajectories) then α is high and as a consequence both high R&D intensity and high level of concentration will result. On the other hand if the degree of substitution is low, in spite of the effectiveness of R&D spending, concentration may be low.

However, β and σ are not directly observable. Sutton reformulates the non-convergence theorem in terms of two observable industry characteristics whose joint behavior reveal information about the value of α and thereby places a lower bound on the level of concentration: the industry's R&D/sales ratio and h, an homogeneity index which measures the extent to which the industry's sales are divided among products associated with different technological trajectories. In particular, h represents the share of industry sales accounted by the largest product category.

Two distinct empirical predictions regarding the joint distribution of R&D intensity, concentration, and market segmentation can be derived:

i. if we take a group of industries for which the R&D intensity is high, the lower bound to concentration increases from zero with the h index (see fig. 2);
ii. on the contrary, if we define a control group of industries for which the R&D intensity is low, the lower bound to concentration converges to zero as the size of the economy becomes large, independently of the degree of market segmentation as measured by h (see fig. 3).

The intuition behind these general empirical predictions is as follows. If R&D is ineffective in raising consumers' willingness-to-pay for the firm's products, it can be shown that R&D intensity is necessarily low. So if we construct a set of industry for which the R&D/sales ratio is high, then we know that for this group R&D effectiveness is high. Whether this necessarily implies a high level of concentration depends on the strength of the linkages between sub-markets, that in its turn depends on the scope economies and the degree of substitutability across products associated to different R&D trajectories. Where these are high, concentration will be necessarily high since, if all firms have a low market share, an escalation of R&D spending will be profitable: a high-R&D-spending firm can capture sales from low-R&D-spending rivals on its own trajectory and on others. On the contrary, when the scope economies and the degree of substitutability across products are low, in spite of the effectiveness of R&D spending, concentration may be low: there are many product groups, associated with different R&D trajectories (h is low), and therefore escalation can yield only poor returns.

On the other hand, when R&D intensity is low, the absence of an escalation mechanism involving R&D makes the market able to support an indefinite number of firms, and therefore the theory predicts that the lower bound to concentration is zero independent of h.

In conclusion, in the effort to be as general as possible, the empirical predictions *(i)* and *(ii)* restate the *non-convergence theorem* in a way that places only weak restrictions on observable industry characteristics (R&D intensity, product segmentation, market concentration). This generality is exploited by Sutton (1992, 1998) by following two different paths of analysis: on one hand, by developing a statistical test of his empirical predictions based on data from a selection of industrial sectors; on the other hand, by discussing a series of industry cases (from flow-meters to turbine generators) that, through a detailed collection of qualitative information, enable to go further in probing the validity of the theory, than that which would have been possible solely on the basis of the econometric analysis.

As discussed in Section 1, the aim of this work is to test empirically the existence of the relation between technological profiles and market structure claimed by Sutton's theoretical framework with reference to the medical care services provided by the Italian National Health Service.

3. The Data

The analysis is based on a data-set provided by the Italian Ministry of Health concerning the mobility of patients in the public health sector across Italian Regions. The data reports the health services (including both hospitalization and day-hospital services) offered in 1999 by all the medical care facilities operating within the National Health Service. For any single health service produced, the data-set reports a set of essential information: the corresponding Diagnosis Related Group (DRG) according to the classification adopted by the Italian Ministry of Health, the medical care facilities where the service was provided together with the Region where those facilities were operative, and the Region where the patient resided. The data includes all the 20 Italian

Regions and all the 492 DRGs classified by the Italian Ministry of Health[2]. Moreover, the Ministry of Health groups the DRGs into 25 Main Diagnostic Categories (MDCs) representing specific diagnostic groups[3].

Tab. 1 and tab. 2 classify the medical care services included in the data-set according to the Region where the service was provided (*Region of destination*) and the Region where the patient resided (*Region of residence*), distinguishing between hospitalization and day-hospital services. In 1999 hospitalization services tot up to 10,019,357, of which 6.7% rendered to non-residents in the Region where the hospital providing the service is located. Moreover, the data-set includes 2,493,661 observations referring to day-hospital services; 6.1% of those services are provided to non-residents. Due to incomplete information, some observations have been excluded from the data-set[4], so reducing the number of observations actually considered to 9,932,520 and 2,449,525 for hospitalization and day-hospital services respectively.

Additional information can be derived when the differences in patients' mobility across DRGs are considered. Hence, we define the mobility index *mob* of a single MDC as the complement to one of the ratio between the number of patients treated out of their Region of residence and the total number of patients referred to that MDC, regardless of the Region of residence.

In addition to the data on patients' mobility, our analysis relies on information about the technological intensity of medical care productions. A technological complexity index is defined by the Italian Ministry of Health and the corresponding values are determined for each DRG[5]. This index aims to measure the amount of resources required to offer the health services corresponding to each DRG and is unique for both the hospitalization and the day-hospital services. The technological complexity index is assumed as a reference to compute the DRG fees, on the basis of which the payment system linking Regions, Local Health Authorities and hospitals is regulated. Thus, we consider the technological complexity index of a DRG as a proxy of the technological intensity of that DRG. For a given MDC, the corresponding technological intensity index (*tech)* can be calculated as the weighted mean of complexity index of the DRGs

[2] More precisely no medical care services corresponding to DRG numbers 109, 351, 438 and 474 for the hospitalization services and numbers 109, 168, 169, 185, 186, 187, 391, 438 and 474 for the day-hospital services are included in the data-set referred to 1999, even if those DRG are provided in the classification system adopted by the Ministry of Health.

[3] The MDCs are set by the Ministerial Order issued by the Ministry of Health on 30 June 1997.

[4] In order to perform statistical tests on the data, we have excluded from the data-set those observations that do not report complete information about the corresponding DRG, the hospital where the service is provided, the Region where the hospital is operative and the Region where the patient resides. A number of health services corresponding to DRGs (468, 469, 470, 476, 477, 480, 481, 482 and 483) not included in any MDC have been removed as well.

[5] For 1999 the values of the technological complexity index for each DRG are determined by the Ministerial Order issued by the Ministry of Health on the 30 June 1997.

pertaining that MDC, the weights given by the ratio between the number of patients of that DRG and the total number of patients in the MDC[6].

Tab. 3 reports the number of health services corresponding to each MDC, together with their mobility and technological characteristics. As expected, for all MDCs hospitalization services greatly outnumber day-hospital services. Moreover, both hospitalization and day-hospital services show a strong variability in their size measured in terms of the corresponding number of health services (the coefficient of variation is equal respectively to 0.49 and to 0.40). For example, within hospitalization services, MDC size ranges from 1,317,529 services provided (5 - Malattie e disturbi dell'apparato cardio circolatorio) to 7,399 (22 - Ustioni), whereas for day-hospital services from 279,104 (17 - Malattie e disturbi mieloproliferativi e neoplasie scarsamente differenziate) to 58 (24 - Traumatismi multipli rilevanti). As far as the technological intensity of the MDCs, hospitalization services generally show slightly higher values of the *tech*-index than the corresponding day-hospital services. Moreover, the variability of the *tech*-index is higher for the former group of health services than for the latter group (coefficient of variation respectively equal to 0.54 and 0.42). Finally, turning to health mobility, the Italian Health National System seems to be characterized by a huge interregional mobility of patients, even if strongly differentiated across MDCs (the coefficient of variation equals 0.31 and 0.22 for respectively hospitalization and day-hospital services).

In order to interpret the market structure of the Italian National Health Service through Sutton’s theoretical framework, some correspondences between the theoretical setting discussed in Section 2 and the data just described needs to be established. Thus:

- the classification of health services by MDCs identifies 25 different markets (industries). Within each market, health services referred to each DRG included in that market make up a sub-market (a technological trajectory);
- within each market (sub-market) *regional health firms* corresponding to each Region operate. Each regional health firm is formed by the hospitals localized in that Region offering the health services included in the data-set. Consistently with Sutton's framework, those firms are assumed to maximize the number of patients treated in the Region. The share of each regional health firm in each market (sub-market) is identified by the number of health services provided by that firm over the total number of services in that market (sub-market).

[6] The values of *tech* may obviously differ between hospitalization services and day-hospital services for the same MDC. As a matter of fact, even if a unique technological complexity index is provided for each DRG regardless of the distinction between hospitalization and day-hospital services, the distribution of patients across DRGs within a given MDC is usually different across the two categories of health services.

As discussed in Section 2, the empirical predictions *(i)* and *(ii)* (see fig. 2 and 3) regarding the joint distribution of R&D intensity, concentration, and market segmentation can be derived from Sutton's theoretical framework. In order to test the consistency of the data from the Italian National Health Service with those two empirical predictions, three indexes have to be worked out for each MDC (distinctly for hospitalization services day-hospital services):

- the technological intensity index *tech* as defined before, which is here used as a proxy for the R&D intensity in the MDC;
- the concentration index C_4, defined as the sum of market shares corresponding to the four regional firms providing the largest number of health services in the MDC;
- the homogeneity index h, determined as the fraction of health services corresponding to the largest DRG (in terms of number of health services produced) in each MDC.

Tab. 4 reports the values of *tech*, C_4 and h for each MDC (denoting hospitalization and day-hospital services respectively by h and d) sorted by descending values of *tech*. h ranges from a minimum of 0.108 to a maximum of 0.931, showing a marked variability of the composition by sub-markets across MDCs (coefficient of variation equal to 0.540), with day-hospital services characterized by higher homogeneity in the composition of services than hospitalization services for all MCDs except six (2, 4, 8, 15, 16, 19). C_4 shows much less variability, ranging from a minimum of 0.393 to a maximum of 0.652 (coefficient of variation equal to 0.117), with higher concentration for day-hospital services (average value equal to 0.520) than for hospitalization services (average value equal to 0.451) for all MCDs, except two (9 and 10). The higher level of concentration shown by day-hospital services than by hospitalization services can be partially imputed to the fact that hospitalization services usually imply higher level of transaction costs for *mobile* patients than day-hospital services do, with the consequence that those patients are less motivated to move to other Regions in order to receive high-quality health services. Moreover, the urgency sometimes related to hospitalization services can prevent patients from moving out from their Regions of residence.

4. Empirical results

The consistency of the empirical predictions *(i)* and *(ii)* derived from Sutton's *non-convergence theorem* with the market structure of the Italian National Health Service is tested here by jointly considering the MDCs corresponding to hospitalization services and those corresponding to day-hospital services in order to get a data sample large enough (50 observations) to ensure statistical significance to the test.

Given that the *non-convergence theorem* states different predictions according to the R&D intensity of the considered industries, first of all we have to split our sample of MDCs into two sets, the first one characterized by a relatively high level of technological intensity and a control group for which the technological intensity is relatively low. A rather crude way to proceed is to rank the MDCs by *tech*-index, and to choose as cutoff level the average value (1.044)[7]. Above this level there are 20 MDCs, which we refer to as the high-*tech* MDCs group, while the remaining 30 make up the low-*tech* MDCs group (see tab. 4).

The partitioning of the sample of MDCs into the high-*tech* and low-*tech* groups makes it possible to stress some preliminary points. For high-*tech* MDCs, the *tech*-index goes from 1.064 to 3.612 (average value equal to 1.465), the h-index from 0.133 and 0.931 (average value equal to 0.425), while the C_4-index ranges from 0.393 and 0.652 (average equal to 0.478). On the contrary, for the low-*tech* MDCs, the *tech*-index ranges from a minimum of 0.455 to a maximum of 0.986 (average value equal to 0.763), the h-index from 0.108 to 0.720 (average value equal to 0.368), while the C_4-index values are between 0.426 and 0.597 (average value equal to 0.491).

Fig. 4 and fig. 5 illustrate the relationship between the C_4-index and the h-index respectively for the high-*tech* and the low-*tech* MDCs. Our interest lies in comparing these scatter diagrams with the predicted lower bounds shown in fig. 2 and fig. 3. As mentioned in Section 2, the theory states that for the high-*tech* group, the lower bound to concentration is an increasing function of h that passes through the origin, whereas for the control group it is zero everywhere. Actually, at a first observational exploration, the data from the Italian National Health Service does not seem to contrast those theoretical predictions: the high-*tech* group does not include observations where high values of h are coupled with low values of C_4 (except for the *22h* MDC (Ustioni - hospitalization services) that may be treated as an outlier), whereas some low-*tech* MCDs are characterized by both low market segmentation and low concentration (refer to Section 5 for more thorough discussion).

This rough empirical evidence encourages us to turn to a formal statistical test procedure in order to try out Sutton's predictions. Notice that Sutton's theory makes no general prediction as to the functional form of the lower bound. However in the limiting case where all sub-markets are completely independent, the theory states that the bound for the high-*tech* group takes the form of a ray through the origin. Thus, making this

[7] Notice that our choice of the cut-off point is to some extent arbitrary and that other criteria could be adopted to define it.

simplifying assumption for the lower bound, we can represent each observation (C_4, h) by the ratio C_4/h and test the prediction that the values of C_4/h, the high-*tech* group of MDCs, are drawn from a distribution whose support is bounded away from zero. A conventional approach in modeling draws from a distribution that has a finite lower bound is to model the observations C_4/h as drawn from a Weibull distribution. In particular, the three parameters Weibull distribution is defined on the domain $t \geq \mu$ by:

$$\text{Prob}\,(T \leq t) = 1 - \exp\left\{-\left[\frac{t-\mu}{\delta}\right]^{\beta}\right\}$$

where $\beta > 0$ and $\delta > 0$. The three constants (β, δ, μ) respectively denote a shape, a scale parameter and a location parameter. Notice that the location parameter μ represents the lower bound to the support of the distribution. If $\mu = 0$ the distribution comes down to a so called two-parameter Weibull.

In order to check whether the observations C_4/h can actually be well described by a Weibull distribution for some parameter values (β, δ, μ), an informal approach is to choose some reasonable value for the location parameter μ (lower bound) and test whether the residuals $R = C_4 / h - \mu$ can be well described as a two-parameter Weibull distribution. This occurs whether a plot of $y = \ln(\ln(1/(1-F(R))))$ against $\ln R$ yields a straight line. Therefore, first of all to calculate *R's* we assume $\mu = 0.1$, that is a value which is slightly inferior to the minimum value of C_4/h. After ranking the *R's* in ascending order, we define their cumulative distribution *F(R)* and come to plot y against $\ln R$ distinctly for high-*tech* and low-*tech* MDC groups. As fig. 6 and fig. 7 illustrate, in both cases the points roughly lie on a straight line: therefore, we can conclude that modeling the observations C_4/h as a three-parameter Weibull distribution is an acceptable assumption for both groups of observations.

Based on this result, we can now turn to test the null hypothesis that the location parameter of the Weibull distribution (which, as mentioned, represents the lower bound) is equal to zero in the high-*tech* MDCs group. In order to test this hypothesis two different approaches can be followed. The first one (Smith 1985) involves the use of a two-step procedure and the joint estimate of all three parameters of the distribution. First of all, it is necessary to make some assumptions regarding the form of the function $b(z)$ that describes the lower bound. Given some parameter family of candidate schedules, it is possible to obtain a consistent estimator of the actual schedule by choosing the parameters to minimize the sum of residuals $(C_4/h)_i - b(z_i)$, subject to the constraint that all residuals shall be non-negative. Secondly, it is necessary to check that the pattern of residuals thus estimated fits the Weibull distribution and that it is not possible to reject the hypothesis $\mu = 0$.

An alternative approach (Mann, Scheuer and Fertig 1973) is to test directly the hypothesis that $\mu = 0$, subject only to the assumption that the observations are drawn from a Weibull distribution with unknown shape (β) and scale (δ) parameters. As this method allows to bypass the estimation of the shape and scale parameters of the distribution and to construct directly a confidence interval for the lower bound, it involves less computational problems than the first approach. Since we are only interested in the location parameter, the Mann-Scheuer-Fertig test appears to be more expedient for the present context.

In general terms, the Mann-Scheuer-Fertig test relies on the properties of the order statistics $X_{i,n}$ of a sample drawn from an extreme value distribution, that is the log transformation of a Weibull distribution. Denote with T a random variable drawn from a two-parameter Weibull distribution (that is, as said before, when $\mu = 0$). Then, the variable $X = \ln T$ is distributed as an extreme value distribution, defined by:

$$\text{Prob}\,(X \leq x) = 1 - \exp\left\{-\exp\frac{x-u}{b}\right\}$$

where $u = \ln\delta\, u$ and $b = 1/\beta$ respectively denote the location and the scale parameters of the extreme value distribution. Now consider the order statistic $X_{i,n}$ of a sample of n observations drawn from the distribution X. In the case that $\mu = 0$, as stressed by Mann, Scheuer and Fertig (1973), "the right-hand tail of the extreme value density function is 'shorter' than that of the usual appropriate alternative distributions, while that of the left-hand tail is 'longer'… Thus the 'upper' gaps between successive order statistics will tend to be smaller than the 'lower' gaps". This is not true if the sample is drawn from the distribution for which $\mu > 0$, since in that case the left-hand tail is attenuated.

As shown by Pyke (1965), the spacings $X_{i+1,n} - X_{i,n}$ between ranked observations from any distribution having a density are asymptotically exponential and asymptotically independent. It follows that the ratios:

$$l_i = \frac{X_{i+1,n} - X_{i+1}}{E(X_{i+1,n}) - E(X_{i+1})}$$

are asymptotically exponentially distributed with mean one and asymptotically independent. Denote the ratios l_i as *leaps* and the numerators $X_{i+1,n} - X_{i+1}$ as *gaps*. To calculate the expected value of order statistics for the standardized extreme value distribution with $\mu = 0$ and $b = 1$ we can resort to the published tables of the expected values of the *reduced* extreme-value order statistics (Mann, Scheuer and Fertig 1973; Balakrishnan and Chan 1992). These values correspond to the expected values of the transformed order statistics $Y_{i,n} = (X_{i,n} - u)/b$. For each successive pair of observations in the sample, calculate the ratio:

$$l'_i = \frac{Y_{i+1,n} - Y_{i,n}}{E(Y_{i+1,n}) - E(Y_{i,n})}$$

Now partition in two the sample of l'_i (in number $n-1$) by setting r as the integer part of *(n - 1)/2*. The test statistic is given by the ratio of the sum of *leaps* in the top half of the sample to the sum of *leaps* over the whole sample, that is:

$$S = \frac{\sum_{i=n-r}^{n-1} l_i'}{\sum_{i=1}^{n-1} l_i'}$$

Considering that S is asymptotically distributed as a Beta distribution, the observed value of S can be compared with percentile values of the Beta distribution with parameters *(n - 1)/2* and *(n – 1)/2* for n odd or *(n – 2)/2* and *n/2* for n even[8]. If the calculated value of S exceeds its tabulated percentile the hypothesis, that the location parameter μ of the associated Weibull distribution is equal to zero, is rejected.
Now apply this procedure to the data from the Italian National Health Service described above. For the group of 20 high-*tech* MDCs the computed value of the test statistic S turns out to equal 0.711, which is just below the critical value at 10% level of significance. So, for high-*tech* MDCs the null hypothesis that the lower bound is equal to zero can be rejected with a confidence of about 90%, and this result is consistent with *(i)* empirical prediction by Sutton. Otherwise, when the control group of 30 low-*tech* MDCs is considered, the computed value of S equals 0.322. This means that we can reject the null hypothesis with a confidence level of just 3,7%: therefore, the null hypothesis that the lower bound is equal to zero cannot be rejected, again consistently with *(ii)* empirical prediction.

[8] For samples including less than 25 observations the approximation provided by the Beta distribution becomes unsatisfactory. However, Monte Carlo estimates for small samples are reported by Mann, Scheuer and Fertig (1973).

5. Evaluation

As stressed before, the theoretical framework developed by Sutton places only a weak restriction on the data (see the empirical propositions *(i)* and *(ii)*): the lower bound to concentration increases with the product homogeneity for those industries characterized by high technological intensity. Therefore, to be consistent with the theory, high technological intensity and low product segmentation should be necessarily coupled with high market concentration. The statistical analysis developed in Section 4 shows that this requirement is satisfied when the technological characteristics and market structure of the Italian National Health Service are considered (at least in the case of the complete sample).

However, the significance of this result needs to be discussed more thoroughly. Considering the graphs reported in fig. 4 and fig. 5, which illustrate the relationship between the C_4-index and the h-index respectively for the high-*tech* and the low-*tech* MDCs, we can divide those diagrams in two areas in relation to the level of the h-index. According to the empirical predictions *(i)* and *(ii)*, only the observations characterized by high values of h may differentiate the group of the high-*tech* MDCs from that one of the low-*tech* MDCs. Therefore, we choose to focus on the right part of the two graphs, that is on the MDCs characterized by high levels of h: we refer to those MDCs as *critical*. The basic characteristics of the *critical* MDCs (and of the main DRG corresponding to each of them) are reported in tab. 5.

So, when we confine the analysis to the *critical* MDCs only, as already stressed in Section 4, a difference clearly emerges in the comparison between the high-*tech* group and the low-*tech* group: in the former one the majority of the *critical* MDCs are characterized by high C_4, while in the latter group they are characterized by both low and high C_4 values. The absence of MDCs where high h values are coupled with low levels of C_4 in the high-*tech* group is the element which mainly differentiate the two groups and allows us to accept the Sutton's hypothesis.

Turning first to the low-*tech* group, four *critical* MDCs can be identified in the low concentration area (see the area highlighted by a dotted line in fig. 5): 14d (Gravidanza, parto e puerperio - day hospital), 15h (Malattie e disturbi del periodo neonatale - hospitalization), 20h (Abuso di alcol/droghe e disturbi mentali organici indotti - hospitalization), and 2h (Malattie e disturbi dell'occhio - hospitalization). All those MDCs share a common feature: the technological intensity appears very low, lower than most of MDCs belonging to the same group (the values of *tech* for those MDCs are all below the median value of the low-*tech* group equal to 0.767). In particular, these

sectors rank respectively first, third, sixth and fourteenth amongst the MDCs sorted by ascending values of *tech*. Looking now at the observations characterized by high concentration, we have to draw attention to six *critical* MDCs (see the area highlighted by a solid line in fig. 5): 23d (Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari - day-hospital), 23h (Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari – hospitalization), 2d (Malattie e disturbi dell'occhio - day-hospital), 20d (Abuso di alcol/droghe e disturbi mentali organici indotti - day-hospital), 15d (Malattie e disturbi del periodo neonatale - day-hospital), and 17d (Malattie e disturbi mieloproliferativi e neoplasie scarsamente differenziate - day-hospital). It is interesting to remark that those MDCs show *tech*-index values on average higher than the corresponding values in the group of observations falling in the low concentration area. In fact, those high concentration-MDCs rank respectively second, fifth, eleventh, twelfth, twentieth and twenty-third amongst the MDCs sorted by ascending values of *tech*, and for two of those MDCs (15d and 17d) the *tech*-index takes values higher than the median value in the low-*tech* group. These remarks suggest the existence of a positive and significant correlation between C_4 and *tech* within the subset low-*tech* MDCs characterized by high levels of *h*-index. As a matter of fact, the correlation index results to be equal to 0.45.
This empirical evidence may offer some suggestions to explain the reason of the strong variability in concentration shown by the high *h*-index MDCs in the low-*tech* group. Looking at high technology as a barrier to entry in the markets, the low-*tech* sectors present weak barriers to entry which allow almost all *regional health firms* to operate in them, with resulting low levels of concentration. Identical but opposite considerations seems to hold for those that, even if that fall in the low-*tech* group, are characterized by stronger technological barriers to entry.
Finally, turning to the high-*tech* group, three *critical* MDCs can be selected (see the area highlighted by a solid line in fig. 4): 22d (Ustioni - day hospital), 25d (Infezioni da H.I.V - day hospital) and 24d (Traumatismi multipli rilevanti - day hospital). Notice that all those MDCs are highly technological intensive sectors also if compared to the other MDCs in the high-*tech* group: if we sort all the MDCs by descending values of *tech*, these critical MDCs rank respectively eighth, fifth and second. Furthermore, the values of *tech* for all those MDCs are quite above the median value of the high-*tech* group (1.292). As it has been shown previously, these *critical* MDCs are unambiguously characterized by high levels of concentration. This may be explained considering the remarkable technological content which characterizes these sectors, which constitutes a dramatic barrier to entry that hinders the majority of *regional health firms* to operate in these sectors.

6. Final remarks

A key feature of Sutton's theory is that industries evolve to distinct market configurations in term of concentration depending upon whether the corresponding products are essentially homogeneous or whether they are differentiated by research and development (R&D) and advertising. This paper aims to test empirically the consistency of the technological profiles and market structure of health care sector in Italy with Sutton's predictions. The results of the analysis offer some empirical support in differing relationships between industry concentration levels and technological characteristics across health care productions.

However, the relevance of this outcome needs to be validated by further research in order to overcome some limitations affecting the initial analysis. An interesting perspective that should be adequately investigated is to focus on health interregional mobility, that is to confine the analysis only to the sub-sample of health services provided to patients not resident in the Region where those services were produced. Testing Sutton's predictions on mobile patients only would allow to investigate the robustness of these predictions. Another interesting future path of research may consist in modifying some of the empirical proxies applied to the theoretical framework. For example, it would be more realistic to assume the hospitals (and the other medical care facilities directly in charge of health services production within the National Health Service) instead of *regional health firms* to represent the theoretical concept of firm.

References

Bain J.S. (1956), *Barriers to New Competition*, Cambridge, Harvard University Press.

Balakrishnan N. and P.S. Chan (1992), "Extended Tables of Means, Variances and Covariances of Order Statistics from the Extreme Value Distribution for Sample Size up to 30", *Report*, Department of Mathematics and Statistics, McMaster University, Hamilton, Canada.

Degli Esposti G., M. Rimondi, G. Virgilio and C. Ugolini (1996), "Matrici di mobilità per DRGs: analisi descrittiva ed applicazioni per la programmazione e le politiche sanitarie regionali", *Mecosan*, 19, 53-62.

Fabbri D. and G. Fiorentini (1996), "Mobilità e consumo sanitario: metodi per la valutazione di benessere", *Mecosan*, 19, 37-52.

Mann N., E. Scheuer and and K. Fertig (1973), "A New Goodness-of-Fit Tst for the Two-Parameter Weibull or Extreme-Value Distribution with Unknown Parameters", *Communications in Statistics*, 2, 383-400.

Pyke R. (1965), "Spacings", *Journal of Royal Statistical Society*, 3, 395-449.

Shaked, A. and J. Sutton (1982), "Relaxing Price Competition through Product Differentiation", *Review of Economic Studies*, vol. 49, 3-13.

Shaked, A. and J. Sutton (1982), "Product Differentiation and Industrial Structure", *Journal of Industrial Economics*, vol. 36, 131-146.

Spampinato G.C. (2001), "Mobilità sanitaria regionale e federalismo", Politiche sanitarie, 2, 44-56.

Sutton, J. (1989), "Endogenous Sunk Costs and Industrial Structure"", in G. Bonanno and D. Brandolini (eds.), *Market Structure in the New Industrial Economics*, Oxford, Oxford University Press.

Sutton, J. (1991), *Sunk Costs and Market Structure*, Cambridge, MIT Press.

Sutton, J. (1998), *Technology and Market Structure*, Cambridge, MIT Press.

Ugolini C. and D. Fabbri (1998), "Mobilità saniatria ed indici di entropia", *Mecosan*, 26, 9-24.

FIGURES AND TABLES

Fig. 1 Determinants of α

Technology

Effectiveness of R&D spending

Willingness-to-pay for a rise in technical performance

$$\beta \rightarrow \alpha\,(\beta, \sigma) \leftarrow \sigma$$

Scope economies in R&D

Substitutability in consumption across product varieties

Tastes

Fig. 2 Lower bound for high R&D intensity industries

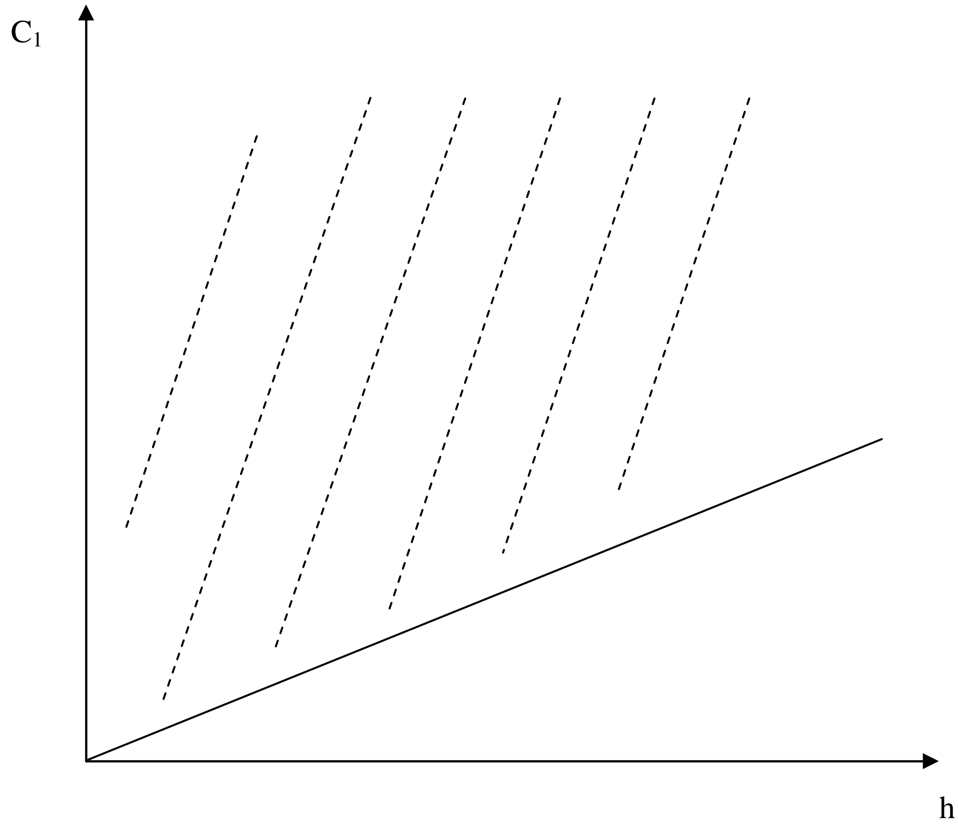


Fig. 3 Lower bound for low R&D intensity industries

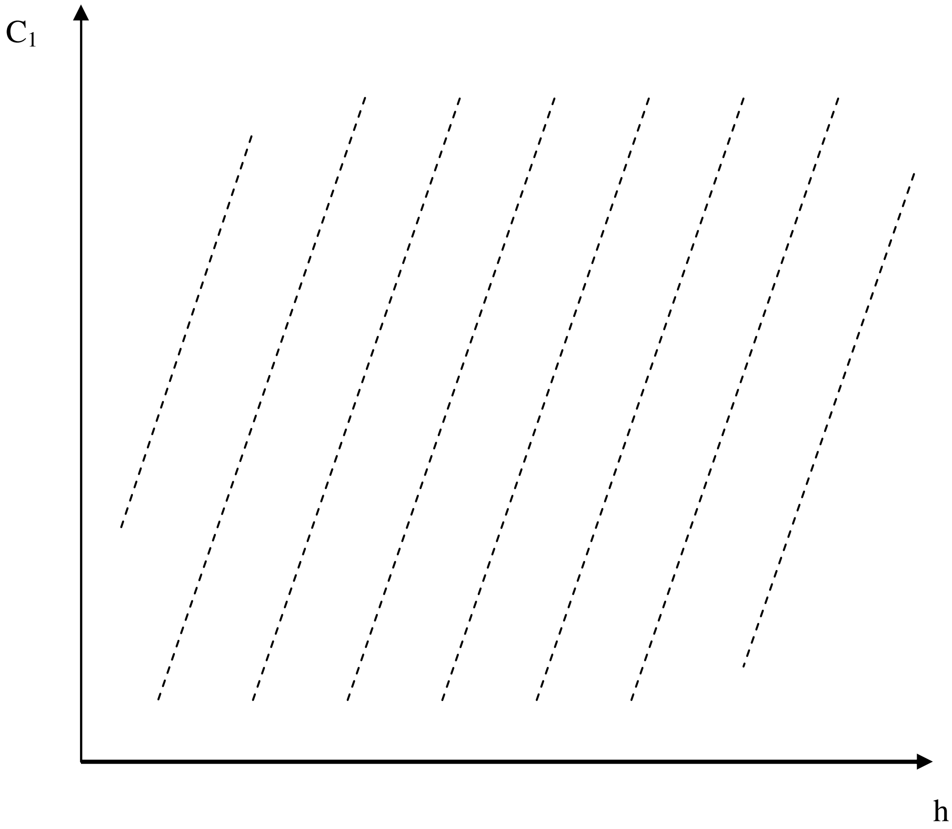


Fig. 4 Market concentration and product homogeneity in high-*tech* MDCs

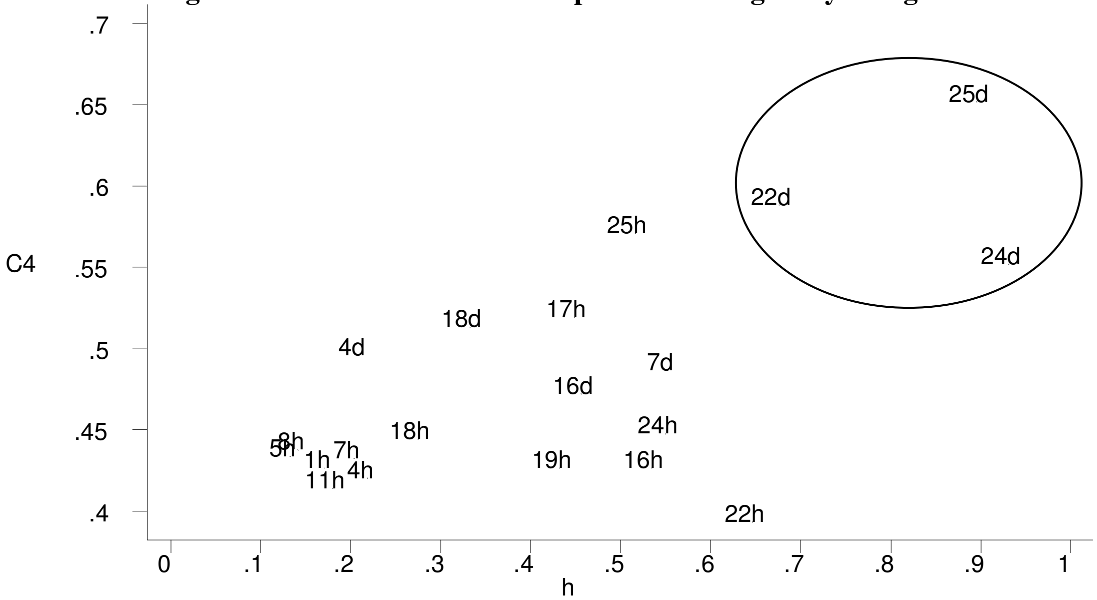


Fig. 5 Market concentration and product homogeneity in low-*tech* MDCs

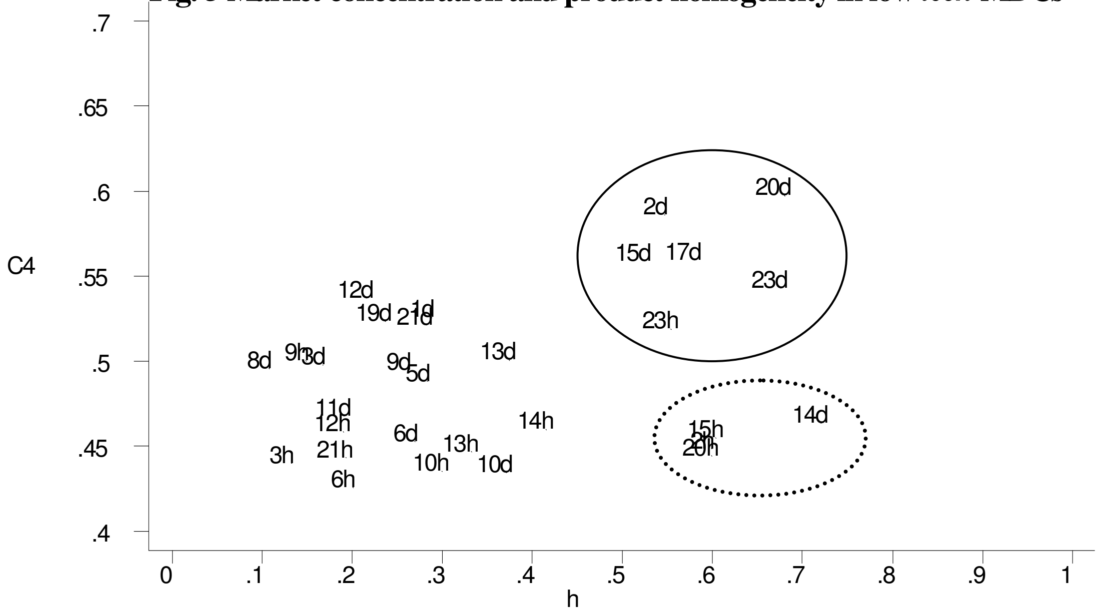


Fig. 6 y against lnR for high-*tech* MDCs

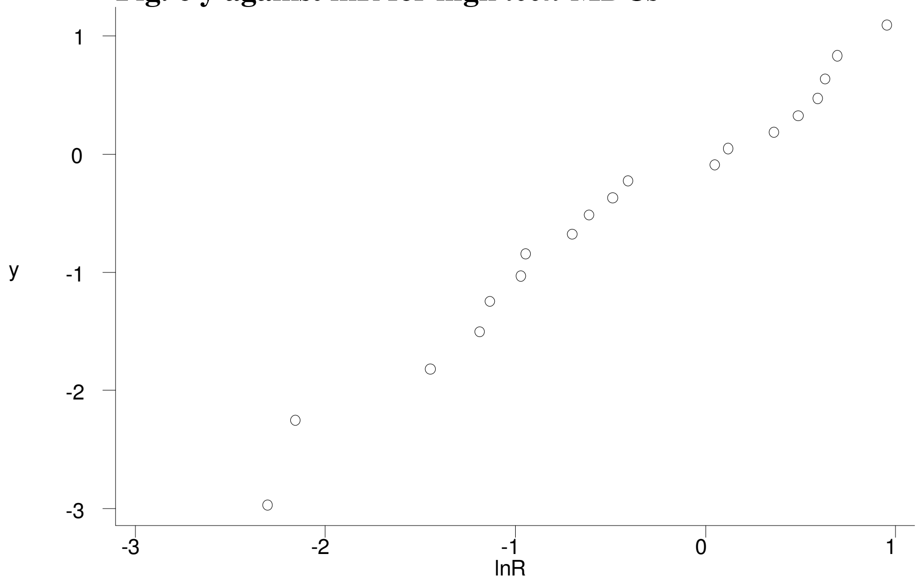
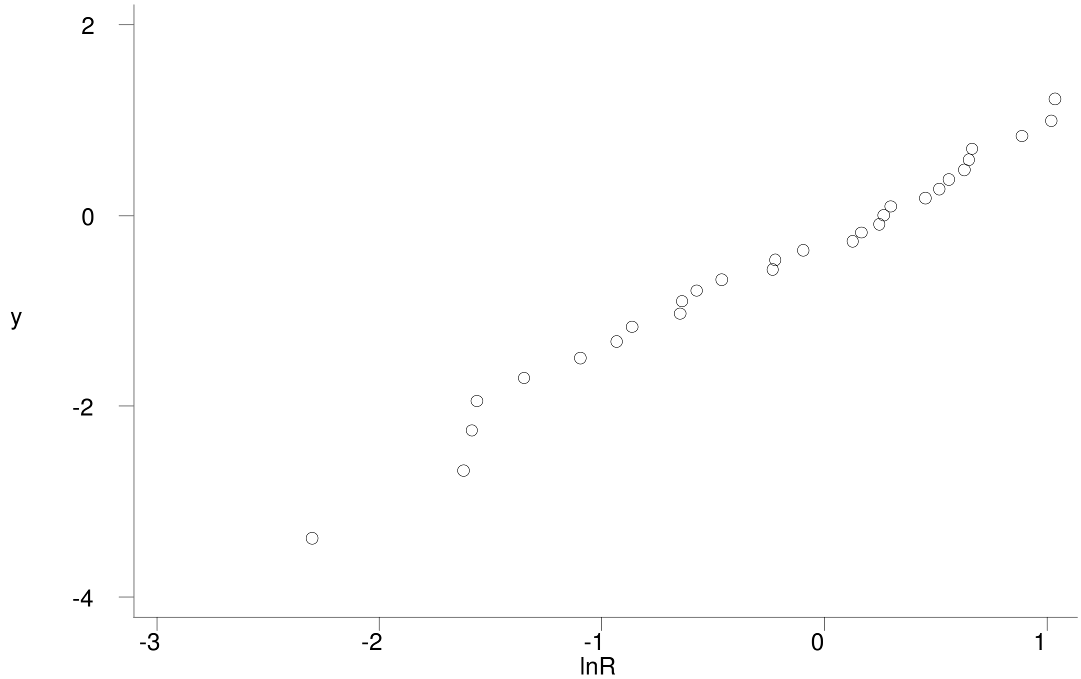


Fig. 7 y against lnR for low-*tech* MDCs



Tab. 1 Residence/destination matrix for hospedalization services (1999)

Region of destination	Region of residence																				Total
	Piemonte	Valle d'Aosta	Lombardia	Trentino Alto Adige	Veneto	Friuli Venezia-Giulia	Liguria	Emilia Romagna	Toscana	Umbria	Marche	Lazio	Abruzzo	Molise	Campania	Puglia	Basilicata	Calabria	Sicilia	Sardegna	
Piemonte	606 873	2 045	12 408	130	465	214	8 848	1 081	851	142	276	751	204	119	2 194	2 001	568	2 944	3 359	625	646 098
Valle d'Aosta	991	15 910	275	5	17	7	84	44	41	4	5	49	6	4	16	23	4	74	35	37	17 631
Lombardia	27 483	813	1 509 276	2 069	6 779	1 430	6 460	16 023	5 044	928	2 406	3 917	1 703	653	10 004	10 542	1 925	10 184	18 075	2 845	1 638 559
Trentino A.A.	239	13	4 986	174 631	4 480	358	289	1 123	415	69	178	640	96	27	368	404	39	220	389	152	189 116
Veneto	1 345	84	13 562	7 307	715 538	7 067	679	7 519	1 699	278	987	1 915	593	148	2 717	3 247	379	1 996	7 633	817	775 510
Friuli V.G.	200	8	804	216	10 881	178 373	108	463	443	112	103	477	82	55	627	558	60	282	1 095	129	195 076
Liguria	9 416	236	5 976	144	416	118	259 440	1 399	3 898	101	183	718	281	65	2 123	1 645	287	2 130	3 465	1 264	293 305
Emilia R.	2 049	72	14 752	895	5 757	840	2 201	646 447	6 403	1 337	12 341	3 407	3 300	718	6 537	8 168	1 326	5 912	6 980	1 256	730 698
Toscana	1 105	150	2 515	200	709	251	6 544	2 314	518 326	3 562	878	7 407	742	354	7 473	3 301	1 149	4 411	4 820	1 016	567 227
Umbria	124	4	315	30	119	37	80	274	3 465	130 077	2 307	9 673	668	108	866	851	243	947	377	135	150 700
Marche	297	8	1 033	76	252	96	93	2 914	608	1 311	242 789	2 177	8 191	432	792	2 410	155	336	674	97	264 741
Lazio	673	40	1 364	162	623	225	371	767	2 665	3 714	1 900	836 695	7 134	3 047	23 348	5 824	2 022	8 726	6 572	1 973	907 845
Abruzzo	311	12	877	44	157	55	102	414	258	443	2 215	8 760	251 760	4 586	1 631	2 876	190	356	341	74	275 462
Molise	82	1	168	7	33	14	19	73	50	24	44	2 081	1 620	50 845	6 656	3 244	167	57	66	4	65 255
Campania	712	15	1 683	104	428	178	173	885	798	168	229	4 209	335	883	921 951	2 100	3 891	2 017	1 131	184	942 074
Puglia	1 272	11	2 739	146	623	191	199	1 155	461	96	445	1 893	1 128	2 388	7 028	796 372	15 203	3 008	1 362	120	835 840
Basilicata	173	5	290	13	39	14	29	98	71	13	23	244	41	13	3 705	2 162	89 694	2 174	99	12	98 911
Calabria	1 006	54	1 777	71	225	63	232	469	290	44	112	1 222	66	26	1 822	539	1 655	354 052	2 711	39	366 475
Sicilia	751	15	1 683	77	338	125	288	487	371	43	64	722	66	15	448	308	79	3 978	781 328	108	791 294
Sardegna	471	21	861	148	268	217	214	261	282	40	48	699	160	9	204	87	22	52	297	263 179	267 540
Total	655 573	19 517	1 577 344	186 475	748 147	189 873	286 453	684 210	546 439	142 506	267 533	887 656	278 176	64 495	1 000 510	846 662	119 058	403 856	840 809	274 066	10 019 357

Tab. 2 Residence/Destination matrix for day-hospital services (1999)

Region of destination	Region of residence																				Total
	Piemonte	Valle d'Aosta	Lombardia	Trentino Alto Adige	Veneto	Friuli Venezia-Giulia	Liguria	Emilia Romagna	Toscana	Umbria	Marche	Lazio	Abruzzo	Molise	Campania	Puglia	Basilicata	Calabria	Sicilia	Sardegna	
Piemonte	206 564	939	2 601	35	143	47	2 377	356	206	27	58	249	59	23	570	669	188	794	1 031	208	217 144
Valle d'Aosta	480	4 653	29			3	15	8	5			10	2		4	18		21	11	6	5 265
Lombardia	8 709	144	433 296	446	2 128	289	1 453	4 515	1 178	174	509	910	342	103	1 976	2 163	452	2 008	3 432	511	464 738
Trentino A.A.	22	3	325	21 965	413	11	26	92	26	8	16	59	11	2	40	31	5	33	52	20	23 160
Veneto	322	7	3 607	1 812	222 939	2 690	139	2 206	440	82	340	529	154	48	694	917	122	441	1 551	180	239 220
Friuli V.G.	29	1	114	37	3 487	41 744	15	69	65	15	25	99	9	16	129	97	15	59	198	34	46 257
Liguria	3 874	111	1 505	52	139	27	102 649	490	2 542	49	71	238	101	28	855	509	106	714	1 241	441	115 742
Emilia R.	326	15	4 215	161	2 067	172	373	216 832	1 206	195	2 615	603	605	162	1 115	1 737	284	1 154	1 033	175	235 045
Toscana	321	17	718	49	166	87	2 936	594	134 406	1 162	324	1 776	151	80	1 211	610	224	1 045	2 143	249	148 269
Umbria	42	1	109	16	26	8	34	79	1 795	48 641	941	4 942	124	27	259	221	63	277	161	39	57 805
Marche	38	3	140	13	40	5	15	614	71	220	49 939	367	1 674	56	145	292	27	69	171	43	53 942
Lazio	73	5	195	21	68	28	50	119	523	796	388	147 428	1 593	719	3 384	1 195	478	1 701	931	335	160 030
Abruzzo	23		87	12	21	3	13	38	30	21	299	1 465	37 435	691	138	261	16	30	20	7	40 610
Molise			1									172	7	1 897	204	49	1	3	1		2 335
Campania	95	1	260	14	55	24	29	120	99	39	37	973	82	247	198 885	383	1 269	622	193	31	203 458
Puglia	101	4	255	16	72	23	12	112	68	10	52	218	79	120	341	116 525	1 532	352	57	10	119 959
Basilicata	32		42	2	8	1	5	11	13	1	8	43	4	2	898	481	13 413	231	11	1	15 207
Calabria	96	5	174	6	26	10	32	46	41	6	12	122	8	8	160	79	240	58 156	456	9	59 692
Sicilia	160	4	350	14	71	16	165	87	82	10	20	205	19	4	85	56	16	403	194 213	31	196 011
Sardegna	55	2	129	25	23	25	19	36	47	9	12	98	10		46	19	1	15	39	89 162	89 772
Total	221 362	5 915	448 152	24 696	231 892	45 213	110 357	226 424	142 843	51 465	55 666	160 506	42 469	4 233	211 139	126 312	18 452	68 128	206 945	91 492	2 493 661

Tab. 3 MDCs definition and their technological and mobility characteristics

MDC number	MDC description	*number of services*				*tech*				*mob*			
		hospitalisation services		day-hospital services		hospitalisation services		day-hospital services		hospitalisation services		day-hospital services	
		#	%	#	%	index	normalized (*)	index	normalized (*)	index	normalized (*)	index	normalized (*)
1	Malattie e disturbi del sistema nervoso	749 909	7.55	140 041	5.72	1.25	108.03	0.93	99.20	0.07	104.22	0.09	134.85
2	Malattie e disturbi dell'occhio	399 098	4.02	164 820	6.73	0.75	64.99	0.71	76.58	0.10	132.44	0.11	162.38
3	Malattie e distrurbi dell'orecchio, del naso, della bocca e della gola	487 673	4.91	73 485	3.00	0.66	57.51	0.66	71.28	0.07	95.17	0.06	94.76
4	Malattie e disturbi dell'apparato respiratorio	649 106	6.54	97 203	3.97	1.28	110.38	1.11	118.66	0.05	71.28	0.05	78.20
5	Malattie e disturbi dell'apparato cardio circolatorio	1 317 529	13.26	180 880	7.38	1.39	120.22	0.92	98.85	0.07	90.97	0.06	84.65
6	Malattie e disturbi dell'apparato digerente	1 033 330	10.40	139 684	5.70	0.97	84.04	0.78	83.48	0.05	66.82	0.06	82.61
7	Malattie e disturbi epatobiliari e del pancreas	375 608	3.78	97 067	3.96	1.38	119.67	1.06	114.11	0.06	87.67	0.07	102.11
8	Malattie e disturbi del sistema muscolo-scheletrico e del tessuto connettivo	1 215 884	12.24	224 646	9.17	1.07	92.84	0.79	84.43	0.09	129.45	0.07	109.88
9	Malattie e disturbi della pelle, del tessuto sotto-cutaneo e della mammella	411 961	4.15	182 944	7.47	0.82	71.28	0.81	87.10	0.07	95.89	0.05	74.96
10	Malattie e disturbi endocrini, nutrizionali e metabolici	199 065	2.00	153 269	6.26	0.96	82.96	0.80	85.72	0.11	153.06	0.07	98.59
11	Malattie e disturbi del rene e delle vie urinarie	440 048	4.43	135 916	5.55	1.11	96.23	0.94	101.32	0.07	100.49	0.08	110.91
12	Malattie e disturbi dell'apparato riproduttivo maschile	181 363	1.83	52 830	2.16	0.95	82.62	0.76	81.11	0.06	86.60	0.05	75.15
13	Malattie e disturbi dell'apparato riproduttivo femminile	326 725	3.29	115 382	4.71	0.85	73.14	0.58	61.84	0.07	91.99	0.06	89.88
14	Gravidanza, parto e puerperio	777 313	7.83	143 661	5.86	0.68	59.26	0.45	48.77	0.04	49.65	0.07	105.63
15	Malattie e disturbi del periodo neonatale	438 645	4.42	6 433	0.26	0.53	46.03	0.82	87.45	0.03	41.64	0.05	69.63
16	Malattie e disturbi del sangue, degli organi emopoietici e del sistema immunitario	88 909	0.90	71 905	2.94	1.32	114.64	1.18	126.38	0.06	82.15	0.06	88.07
17	Malattie e disturbi mieloproliferativi e neoplasie scarsamente differenziate	234 577	2.36	279 104	11.39	1.31	113.15	0.87	92.95	0.13	178.29	0.07	110.09
18	Malattie infettive e parassitarie	73 967	0.74	12 541	0.51	1.16	100.54	1.07	114.64	0.05	74.58	0.06	95.16
19	Malattie e disturbi mentali	244 149	2.46	44 286	1.81	1.07	93.01	0.99	105.69	0.07	94.12	0.08	118.54
20	Abuso di alcol/droghe e disturbi mentali organici indotti	36 668	0.37	1 667	0.07	0.65	56.30	0.72	76.92	0.08	110.78	0.05	78.66
21	Traumatismi, avvelenamenti e effetti tossici dei farmaci	102 763	1.03	15 708	0.64	0.75	64.87	0.67	72.08	0.07	102.50	0.09	127.85
22	Ustioni	7 399	0.07	493	0.02	1.88	162.98	1.37	146.79	0.09	125.39	0.08	116.56
23	Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari	113 019	1.14	81 021	3.31	0.61	52.88	0.51	54.94	0.10	140.45	0.08	122.51
24	Traumatismi multipli rilevanti	9 711	0.10	58	0.00	3.61	312.50	2.40	257.05	0.08	105.87	0.05	76.21
25	Infezioni da HIV	18 101	0.18	34 481	1.41	1.85	159.94	1.42	152.67	0.06	88.50	0.06	92.17
		9 932 520	100.00	2 449 525	100.00	1.16	100.00	0.93	100.00	0.07	100.00	0.07	100.00

(*) = index * 100 / mean(index)

Tab. 4 Technogical intensity, homogeneity and market concentration of the MDCs

	MDC number	MDC description	*tech*	*h*
high-*tech* MDCs	24h	Traumatismi multipli rilevanti - hospitalization	3.612	0.550
	24d	Traumatismi multipli rilevanti - day-hospital	2.397	0.931
	22h	Ustioni - hospitalization	1.884	0.647
	25h	Infezioni da HIV - hospitalization	1.848	0.516
	25d	Infezioni da HIV - day-hospital	1.424	0.895
	5h	Malattie e disturbi dell'apparato cardio circolatorio - hospitalization	1.389	0.133
	7h	Malattie e disturbi epatobiliari e del pancreas - hospitalization	1.383	0.204
	22d	Ustioni - day-hospital	1.369	0.675
	16h	Malattie e disturbi del sangue, degli organi emopoietici e del sistema immunitario - hospitalization	1.325	0.535
	17h	Malattie e disturbi mieloproliferativi e neoplasie scarsamente differenziate - hospitalization	1.308	0.448
	4h	Malattie e disturbi dell'apparato respiratorio - hospitalization	1.276	0.219
	1h	Malattie e disturbi del sistema nervoso - hospitalization	1.248	0.171
	16d	Malattie e disturbi del sangue, degli organi emopoietici e del sistema immunitario - day-hospital	1.179	0.456
	18h	Malattie infettive e parassitarie - hospitalization	1.162	0.274
	11h	Malattie e disturbi del rene e delle vie urinarie - hospitalization	1.112	0.180
	4d	Malattie e disturbi dell'apparato respiratorio - day-hospital	1.107	0.209
	19h	Malattie e disturbi mentali - hospitalization	1.075	0.432
	8h	Malattie e disturbi del sistema muscolo-scheletrico e del tessuto connettivo - hospitalization	1.073	0.142
	18d	Malattie infettive e parassitarie - day-hospital	1.069	0.333
	7d	Malattie e disturbi epatobiliari e del pancreas - day-hospital	1.064	0.552
low-*tech* MDCs	19d	Malattie e disturbi mentali - day-hospital	0.986	0.236
	6h	Malattie e disturbi dell'apparato digerente - hospitalization	0.971	0.201
	10h	Malattie e disturbi endocrini, nutrizionali e metabolici - hospitalization	0.959	0.299
	12h	Malattie e disturbi dell'apparato riproduttivo maschile - hospitalization	0.955	0.190
	11d	Malattie e disturbi del rene e delle vie urinarie - day-hospital	0.945	0.191
	1d	Malattie e disturbi del sistema nervoso - day-hospital	0.925	0.288
	5d	Malattie e disturbi dell'apparato cardio circolatorio - day-hospital	0.922	0.283
	17d	Malattie e disturbi mieloproliferativi e neoplasie scarsamente differenziate - day-hospital	0.867	0.580
	13h	Malattie e disturbi dell'apparato riproduttivo femminile - hospitalization	0.845	0.332
	9h	Malattie e disturbi della pelle, del tessuto sotto-cutaneo e della mammella - hospitalization	0.824	0.149
	15d	Malattie e disturbi del periodo neonatale - day-hospital	0.815	0.524
	9d	Malattie e disturbi della pelle, del tessuto sotto-cutaneo e della mammella - day-hospital	0.812	0.262
	10d	Malattie e disturbi endocrini, nutrizionali e metabolici - day-hospital	0.799	0.370
	8d	Malattie e disturbi del sistema muscolo-scheletrico e del tessuto connettivo - day-hospital	0.787	0.108
	6d	Malattie e disturbi dell'apparato digerente - day-hospital	0.778	0.270
	12d	Malattie e disturbi dell'apparato riproduttivo maschile - day-hospital	0.756	0.216
	2h	Malattie e disturbi dell'occhio - hospitalization	0.751	0.599
	21h	Traumatismi, avvelenamenti e effetti tossici dei farmaci - hospitalization	0.750	0.193
	20d	Abuso di alcol/droghe e disturbi mentali organici indotti - day-hospital	0.717	0.680
	2d	Malattie e disturbi dell'occhio - day-hospital	0.714	0.547
	14h	Gravidanza, parto e puerperio - hospitalization	0.685	0.415
	21d	Traumatismi, avvelenamenti e effetti tossici dei farmaci - day-hospital	0.672	0.282
	3d	Malattie e distrurbi dell'orecchio, del naso, della bocca e della gola - day-hospital	0.665	0.167
	3h	Malattie e distrurbi dell'orecchio, del naso, della bocca e della gola - hospitalization	0.665	0.133
	20h	Abuso di alcol/droghe e disturbi mentali organici indotti - hospitalization	0.651	0.599
	23h	Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari - hospitalization	0.611	0.554
	13d	Malattie e disturbi dell'apparato riproduttivo femminile - day-hospital	0.577	0.375
	15h	Malattie e disturbi del periodo neonatale - hospitalization	0.532	0.604
	23d	Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari - day-hospital	0.512	0.676
	14d	Gravidanza, parto e puerperio - day-hospital	0.455	0.720
		Average value (simple mean)	1.044	0.391

Tab. 5 Information about the *critical* MDCs

	MDC					main DRG		
	num	description	*h*	*C4*	*tech*	num	description	*tech*
low-tech MDCs (high *C4*)	23h	Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari - hospitalization	0.554	0.519	0.611	467	Altri fattori che influenzano lo stato di salute	0.451
	2d	Malattie e disturbi dell'occhio - day hospital	0.547	0.586	0.714	39	Interventi sul cristallino con o senza vitrectomia	0.755
	15d	Malattie e disturbi del periodo neonatale - day hospital	0.524	0.559	0.815	390	Neonati con altre affezioni significative	0.500
	17d	Malattie e disturbi mieloproliferativi e neoplasie scarsamente differenziate - day hospital	0.580	0.560	0.867	410	Chemioterapia non associata a diagnosi secondaria di leucemia acuta	0.523
	20d	Abuso di alcol/droghe e disturbi mentali organici indotti - day hospital	0.680	0.597	0.717	435	Abuso o dipendenza da alcol/farmaci o disintossicazione o altro trattamento sintomatico senza CC	0.640
	23d	Fattori che influenzano lo stato di salute ed il ricorso ai servizi sanitari - day hospital	0.676	0.543	0.512	467	Altri fattori che influenzano lo stato di salute	0.451
low-*tech* MDCs (low *C4*)	2h	Malattie e disturbi dell'occhio - hospitalization	0.599	0.449	0.751	39	Interventi sul cristallino con o senza vitrectomia	0.755
	20h	Abuso di alcol/droghe e disturbi mentali organici indotti - hospitalization	0.599	0.444	0.651	435	Abuso o dipendenza da alcol/farmaci o disintossicazione o altro trattamento sintomatico senza CC	0.640
	15h	Malattie e disturbi del periodo neonatale - hospitalization	0.604	0.455	0.532	391	Neonato normale	0.204
	14d	Gravidanza, parto e puerperio - day hospital	0.720	0.464	0.455	381	Aborto con dilatazione e raschiamento, mediante aspirazione o isterotomia	0.448
high-*tech* MDCs	22d	Ustioni - day hospital	0.675	0.588	1.369	460	Ustioni non estese senza intervento chirurgico	0.955
	25d	Infezioni da H.I.V. - day hospital	0.895	0.652	1.424	490	H.I.V. Associato o non ad altre patologie correlate	1.315
	24d	Traumatismi multipli rilevanti - day hospital	0.931	0.552	2.397	487	Altri traumatismi multipli rilevanti	2.210