Regional medicometry: epistemological bases and case studies in Switzerland

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This article presents the epistemological foundations of regional medicometry and its five criteria: ethical, economic, social, spatial, and temporal. By its global approach, medicometry studies the direct and indirect effects of medical infrastructures and employment on society and its quality of life. Two case studies, one dealing with an urban hospital in Geneva, Switzerland, the other with peripheral hospitals, give a step-by-step example of the multiplier effect approach. Detailed measures of economic and social impacts of hospitals are given to show that medical planning needs a careful and long-term analysis.

INTRODUCTION

Most studies approach the role of health infrastructures from the cost perspective, and attempt to organize health systems in such a way as to keep overall costs at the lowest possible level. They tend to regard health infrastructures as financial burdens on society rather than as economic and social investments. Regional medicometry, conceived in the 1970s by A. Bailly, J. Paelinck and M. Péritat, proposes a broader view of the health system (Bailly, Bridel, and Péritat, 1989; Bailly and Péritat, 1984, 1995). Medicomery is "the application of mathematical and statistical methods to the testing, evaluation, and the prediction of medical regularities in space, in such a manner as to incorporate the viewpoints of all the actors in the health system, and with an overall

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Concern for issues of efficiency and spatial equity” (Bailly and Coffey, 1989; Boyce D et al., 1987). Medicommetry acquired scientific and applied relevance through a series of case studies on the socioeconomic impact of regional hospitals, coordinated networks of health-care infrastructures, health-care policies, new medical techniques, advances in the field of medicine, and the consequences of hospitalization outside the region. This article outlines the epistemological foundations of medicommetry and its methodological contributions to public health. It then demonstrates the operational potential of this methodology by summarizing the results of two recent studies on peripheral and urban hospitals by the Medicommetry Group at the University of Geneva.

THE HEALTH SECTOR: AN ECONOMIC AND SOCIAL INVESTMENT

The concept of modern medicine emerged in the 19th century when studies no longer focused on merely finding cures for diseases but on preventing them. Preventive medicine and public health therefore emerged from this new approach. This transition from the concept of disease to that of health is illustrated in the preamble to the Constitution of the World Health Organization, drafted in 1947. It defines health as “a state of complete physical, mental and social”... Reference is no longer made just to disease, but to well-being as well.

This idea of well-being lies at the heart of regional medicommetry, which proposes a global view of the health system, defining it in terms of five basic conflicting criteria that pervade in the field of health:

**Ethical**
- Quality health care vs. minimal care
- Freedom of treatment vs. rationing

**Economic**
- Medical costs vs. social costs
- Health-care supply vs. patient demand
- Group payments vs. individual payments

**Social**
- Collective vs. individual preferences
- Equality and solidarity vs. individualism and subjectivism

**Spatial**
- National vs. regional objectives
- National vs. regional environment

**Temporal**
- Short term vs. medium-long term
- Continuation of past practices vs. innovation

These criteria are syntheses of prevailing views about the health-care system in epidemiology, economics, geography, health sciences, medicine, and sociology. They also incorporate the views of administrators (for example, hospitals, health insurance agencies, and HMOs), doctors, patients, nurses, and other actors of the health care system (pharmaceutical firms, including politicians at the regional, state, and federal levels). Through three conferences on Medicommetry (1984, 1986, 1988), where all the actors were present, a broad analytic perspective emerged that explicitly identified the principal actors in the system, their specific objectives, and the complex interrelations between the health-care system and the social, spatial, and temporal environment. Emerging from these conferences were five principles and assumptions of medicommetry (Paellinck, 1984):

P1: Models of regional medicommetry should, a priori, be formulated in a spatially interdependent manner.

P2: Spatial relationships are asymmetric so as to take into account the varying endowments of different regions in health-care facilities and pathogenic factors.

P3: Health problems in one area may be explained by causal factors located in other areas.

P4: The nature of spatial interdependencies and interactions between health-care systems and other systems (economic, social...) can be explained by spatial diffusion theories.

P5: All actions in the health-care system, including policies, investments, and diffusion processes, occur in space and time.

Based on these five principles, medicommetry utilizes a global view of the health sector by integrating not only its primary function of preventing diseases and the delivery of health care, but also its multiple secondary impacts on the economic and social system. To achieve this goal, medicommetry examines health-care networks from the point of view of both time and space in order to incorporate and assess the effects of well-being on economic activity in various regions, and on its societal and demographic evolution. The pattern summarized in Figure 1 shows the complex feedback relationship between patient demand and the effects of the regional supply system in the socioeconomic system. In the following section we elaborate on the socioeconomic impact of hospitals in order to illustrate the potential for medicommetry.

THE CONCEPT OF ECONOMIC AND SOCIAL IMPACT OF HOSPITALS

The economic and social impact of a hospital is both direct on the region, and indirect on society. The direct effects (Figure 2) are through the supply of

1. Health care to patients residing within the region, thus limiting the tendency of local patients to seek treatment in other regions.
2. Jobs that not only prevent emigration of qualified local workers, but attract workers from other regions.

Clearly, this direct impact leads to the flow of money and qualified labor into a region. The indirect effects (Figure 3) are in the

1. Economy, by the partial reinjection of financial flows into the region in the form of consumption and salaries, some of which will be spent in the region.
2. Quality of life, by providing access to the high quality of health care and the proximity (accessibility) to the health infrastructures.
3. **Socioeconomic status**, by the generation of jobs that encourage qualified persons to live in the region.

4. **Prestige**, by attracting persons and businesses from other areas, because of the rich cultural life, prosperity, and pleasant living conditions.

**THE IMPACT OF A HOSPITAL IN AN URBAN ENVIRONMENT**

Medicometric analysis provides a broader view of the place occupied by a hospital complex in two important systems: health and the economy (Bailly, 1992). It facilitates better understanding of the implications of a hospital at various social and economic levels. Medicometric analysis also enhances the understanding of the consequences of certain decisions in the field of health. Such insights enable us to implement medium- and long-term strategies that benefit both the hospital and society.

In its bid to offer medical care, a hospital must procure and combine various products that include health-care products and materials, real estate, food, and equipment. The providers of goods and services will, in turn, contribute to the economy of the region through their purchases. An input–output table can be used to calculate the multiplier effects, for employment and income, of a rise in final demand (Aydalot, 1985; Polese, 1994). The more complete the table, the more accurate the calculations.

To determine the direct economic impact of a hospital in Geneva, we calculated multiplier coefficients using matrices that integrate the apportionment of hospital expenditures and the economic structure of the region. These input–output tables give a detailed picture of the relationship of production and exchanges between the various economic actors. This study is based on the input–output table used in Swiss medicometric studies. The table consists of 42 categories that reflect some aspect of Swiss economic activity. Data for these categories are expenditures in each branch of activity in the 42 categories. The 9th column represents the allocation to the health sector. By replacing this column of expenditure by that of a given hospital, we can use the table to calculate the regional multipliers of output, value added, wage bill, and expenditures on consumption. Together with information on the hospital's value of output between intermediate consumption (purchases of goods and services) and value added, one can estimate the effects of these hospital multipliers on the canton. The breakdown of the value of output between intermediate consumption (purchases of goods and services) and value added are based on the 1994 accounts of the hospital (Table 1).

**Estimation of Multipliers**

By replacing the cost structure relating to health by the cost structure of the hospital in the 42 branches of activity covered by the Swiss input–output matrix, we can calculate the following multipliers:

\[
\text{Multiplier of total output: } \sum_{y} h_y = 1.14460,
\]
between the proportion of hospital purchases (in the canton) of the value of total output at the national level (0.08989), and the proportion of local purchases at the national level for the health sector (0.26504), is a constant (0.54) for the other branches of activity.

Based on this constant ratio assumption, the multiplier of expenditures on intermediate consumption in the canton was recomputed:

\[ \sum c_i h_{i} = 0.10979. \]

According to the theory of input-output tables, these various multipliers apply to the final demand. Because we assume that hospital receipts come only from households in or outside the canton, final demand equals the value of output. The following multiplier effects are the result:

Total output of the canton: 48,888,728 x 1.1446 = 55,958,038.
This is an increase of 14.46% of the value of hospital output.

Value added: 48,888,728 x 0.7798 = 38,123,430,
or an increase of 38123430/34644076 = 1.1004, which is 10.04% of hospital value added.

Cantonal wage bill: 48,888,728 x 0.2738 = 13,383,734,
or an increase of 13385734/11876138 = 1.1271, which is 12.71% of hospital salaries disbursed.

Intermediate consumption spending in the canton: 48,888,728 x 1.10979 = 54,256,220,
or an increase of 54256220/49394515 = 1.0979, which is 10.979% of intermediate consumption by the hospital in the canton.

In this section, we estimated the economic impacts of the hospital in the canton. The next section is a case study of a particular hospital.

**TABLE 1: Composition of Hospital Expenditures**

<table>
<thead>
<tr>
<th></th>
<th>France</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermediate consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within the canton of Geneva</td>
<td>4,394,515</td>
<td>8.99</td>
</tr>
<tr>
<td>Elsewhere in Switzerland</td>
<td>8,789,861</td>
<td>20.01</td>
</tr>
<tr>
<td>Abroad</td>
<td>14,244,852</td>
<td>29.14</td>
</tr>
<tr>
<td>Value added</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries paid in Geneva (canton)</td>
<td>11,876,138</td>
<td>24.29</td>
</tr>
<tr>
<td>Salaries paid outside Geneva (canton)</td>
<td>7,625,931</td>
<td>15.60</td>
</tr>
<tr>
<td>Social contributions</td>
<td>3,514,000</td>
<td>7.19</td>
</tr>
<tr>
<td>Mortgage interests</td>
<td>825,000</td>
<td>1.79</td>
</tr>
<tr>
<td>Depreciation</td>
<td>1,702,000</td>
<td>3.68</td>
</tr>
<tr>
<td>Subsidy</td>
<td>-9,000</td>
<td>-0.20</td>
</tr>
<tr>
<td>Operating balance</td>
<td>9,110,007</td>
<td>18.63</td>
</tr>
<tr>
<td>Value of output</td>
<td>48,888,728</td>
<td>100.00</td>
</tr>
</tbody>
</table>

where \( H = (I - AD)^{-1} \), and \( AD \) is a matrix of the coefficients of the use of local goods and services in which the \( j \)th column, health, relates to the hospital.

**Multiplier of value added:** \[ \sum a_i h_y = 0.7798, \]
where the \( a_i \)s are the value-added coefficients calculated for Switzerland, with the exception of the coefficient for the health sector, which is the coefficient of the hospital, or 70.86%.

**Multiplier of salaries paid in Geneva:** \[ \sum c_i h_y = 0.2738, \]
where the \( c_i \)s are the coefficients of salaries in the various branches of activity in the Swiss matrix, with the exception of the health sector, for which the salary coefficient is the coefficient relating to salaries paid to residents in the canton by the hospital, or 24.29%.

**Multiplier of expenditures on intermediate consumption in the canton:** \[ \sum c_i h_{i} = 0.1446, \]
where the \( c_i \)s are the coefficients of intermediate consumption of local goods and services for Switzerland, with the exception of the coefficient relating to health, which is the coefficient for the hospital's intermediate purchases in the canton, or 8.989%. This multiplier is overvalued, because the coefficient of intermediate consumption of local goods and services relates to, apart from the health sector, purchases made within the country and not within the canton. In order to adjust for this, we assumed that the ratio

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APPLIED GEOGRAPHIC STUDIES
THE ECONOMIC IMPACT OF A GENEVA HOSPITAL

The Geneva hospital under study generates more than 22 million Swiss francs (CHF) in direct and indirect monetary flows in the canton (Figure 4). In addition, it attracts revenue estimated at CHF 5,003,144 from outside the canton of Geneva. With the use of this information, the following questions are explored. What is the socioeconomic impact of this hospital? What does it contribute to the canton of Geneva? It would be impossible to give a single response to these questions. Consequently, they are discussed in terms of quality of life, the indirect benefits of the hospital, and the hospital’s contribution to public finance in the canton.

Benefits to the Quality of Life

Benefits at the social and psychological levels are difficult to measure. Because it has a network of hospitals including the hospital under study, the health-care system in the canton of Geneva is able not only to respond effectively to strong local demand, but also to improve the image of the canton and thereby its desirability, which is an important factor of regional development. Moreover, the technical and professional capital and its high level of technological development boost the level of skills in the canton, and this also influences the quality of life and image of the canton.

1 The canton is an autonomous political region, similar to the province of Canada or the state in the U.S.A. There are 26 cantons in Switzerland.

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According to our estimates, between 16 and 32 million francs would otherwise be spent outside the canton without this hospital. This margin stems from two assumptions regarding the role another hospital would play as a substitute in the provision of emergency care.

Expenditures

The study of expenditures and the calculation of multiplier effects show that the economic activity of the hospital generates indirect benefits to the tune of 14.5 million francs, in terms of monetary flows, and 399 full-time positions, in terms of employment.

Revenues

By calculating tax revenues (approximately 7 million francs), we can estimate the share of the hospital’s contribution to public finances. This sum, which is already high, may be even higher because a portion of this money is again spent in the canton of Geneva in the form of salaries and consumption. In order to give a true assessment of the impact of fiscal revenues on the canton of Geneva, we should also calculate the multiplier effects of spending on consumption and salaries, which no longer depend on the structure of hospital spending, but on the structure of cantonal expenditures.

ECONOMIC AND SOCIAL MULTIPLIERS: THE BROAD PICTURE

The multiplier concept has been widely used in other studies on Swiss hospitals located in peripheral regions. The multipliers for purchases of goods and services vary, and are usually between 1 and 2, depending on the region and the economic activities under consideration. A value close to 1 shows that the indirect benefits of purchases of goods and services in the region are very weak; when the multiplier is close to 2, total expenditure on goods and services in the region is doubled, which implies a very strong influence on the overall regional economic system.

In the regions studied (districts), multipliers for the purchases of goods and services have values ranging between 1.23 and 1.26. These regions are small and offer few goods and services indispensable to the functioning of hospitals; most purchases are made outside the district, in the canton. A high multiplier on the cantonal level frequently corresponds to a weak multiplier on the district level. Such is the case of peripheral hospitals that have values of 1.26 in the district and 1.50 in the canton, or 1.23 in the district and 1.66 in the canton. This implies that it is chiefly the economy of the canton that derives benefits from the operations of the hospital network in the cases studied.

The economic benefits of the hospital’s activities are also channeled through direct and indirect salary disbursements. Thus, the salary multiplier indicates that the activity of the hospital is not only the source of salaries paid out by the hospital, but also of salaries disbursed through other branches of activity. A value of 1.10 indicates, for example, that the increase in the wage bill is 10%. Direct and indirect salaries trigger demand for goods and services that will be even stronger, because the "leaks," namely, savings and spending outside the region, are weak.

The multipliers should be considered in terms of their effect on the economy of the district and canton. However, this must be complemented by consideration of the frequency levels of hospital visits (visits to local or nonlocal hospitals) and the effect of
hospitals on jobs and the quality of life in the region. The ability to be treated in the local language, and according to the local religion and culture, is an important element in the life of a region. Medico-metry actually takes these into account, over and beyond mere economic calculations.

District hospitals are useful at the social, spatial, and temporal levels. In cases of illnesses treatable in a district hospital, patients may be hospitalized on the spot; it is a matter of security for the population because it avoids displacements toward centers outside the area (particularly for the elderly). Inversely, the absence of a hospital is regarded as a drawback, in much the same way as a lack of other service infrastructures, such as schools and postal services. If hospital facilities are taken away from peripheral regions, which are already geographically disadvantaged, these regions will witness a deterioration in their quality of life, because their inhabitants will need to look elsewhere for the amenities they cannot find locally. The presence of hospital personnel in the region enriches the economic, cultural, and social life of the region, because these workers are skilled and highly educated.

Hospitals, as a business, provide employment and offer training opportunities for young people. What is more, because of their wealth of human resources, they strengthen the level of qualification of the labor market in the district (trained and qualified personnel) and, at the same time, contribute to the maintenance and growth of the population.

High-quality infrastructure is a major advantage for the image of a district. The existence of a hospital is one of the prime incentives a district can offer to encourage economic activity and the establishment of companies, and the development of resident dependent functions. Image has come to play a crucial role in competition and in the search for comparative advantages.

Therefore, all investment decisions pertaining to the opening and closing of hospitals must take into account both the economic position of the district and the canton, and the social and cultural features of the area served. The district hospital is a useful economic and social infrastructure.

One goal for the future is to rationalize functions (networks of coordinated health care) so as to make them more effective and, in particular, in order to better treat problems related to the aging of the population, on condition that the hospital is regarded as an economic and social investment for the peripheral regions that often have minimal infrastructures. Hospital planning can therefore only be carried out within a global perspective, integrating the spatial and local dimensions and the future envisaged for the districts concerned.

CONCLUSIONS

At a time when budgetary constraints are compelling cities and states to reduce public hospital expenditures, the medico-metric approach leads to results that demonstrate the economic and social role of the health sector, as we have shown in the two above-mentioned examples. These studies enable the development of future scenarios, in order to provide networks of coordinated health care, taking into account new technologies and the aging of populations. These activities clearly illustrate that, in the area of health, it is possible to reason in terms of investments and not of costs, economic multipliers, nor expenses. Because of such studies, regional hospitals have been able to demonstrate their role in the economy and life in a given area. Only a global view of regional health

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systems can foster effective treatment of issues relating to medical infrastructures in a context of sustainable development within the health sector.

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