Efficiency analysis in public health organizations in Brazil

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Abstract

Purpose – This paper aims to discuss and collect evidence about the hypothesis that, under imperfect information, the multipurpose public organization emulates its peers, arguing that this hypothesis can be fruitful to the study of this kind of organization.

Design/methodology/approach – At IPEC – Instituto de Pesquisa Clínica Evandro Chagas, the clinical research institute affiliated to FIOCRUZ – Fundação Oswaldo Cruz, activities relating to infectious diseases –, e.g. diagnostic exams; outpatient care and patient admissions; teaching and research – are structured in the form of integrated action programs (briefly, PAIs). Taking into account the complexity of this organizational format, this paper applies a mathematical model allowing to define and compute managerial indicators referring to the eight main PAI programs with a view to measure their performance, to investigate whether there are any scale inefficiencies in the eight programs selected as decision-making units (DMUs) and to assess the effectiveness of the whole organizational structure. To accomplish those objectives, the paper employs the so-called DEA models with variable returns to scale – whereby two input and seven output variables were used to represent the eight DMUs.

Findings – Findings suggest that PAIs related to clinical research operated under increasing returns to scale between 2002 and 2006. To that extent, both the choice of PAIs as an organizational format and the current growth strategy at the Institute may be considered adequate.

Originality/value – This approach is valuable to complement the cost minimization analysis of specific activities of multipurpose organizations and has general application to the overall assessment of performance, structures and strategies in these organizations.

Keywords Organizational assessment, Strategy, Public organization, Clinical research, Efficiency analysis, DEA model, Public health, Brazil

Paper type Research paper

1. Introduction

In the framework of economic analysis, the search for efficiency in production will reveal the productive organization via the effects that strategies, structures and decision making impinge upon productive activity so that a productive unit should search for efficiency in resource use and even the so-called managerial public administration is consistent with this principle.

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Due to nowadays interest toward formulating management models whereby managers look for relative efficiency, the focus of modelling has changed toward the use of data envelopment analysis (DEA) to test the generic hypothesis that the search for efficiency is guided by the observation of peer behaviour. This approach is particularly convenient for multipurpose organizations, whose performance requires the solution of internal governance issues under the existence of multiple activities.

As a typical example, issues relating to coordination and commitment are pervasive in the interactions among administrative and medical staffs in health organizations so that internal structures must be considered since the choice and definition of decision-making units (DMUs), as well as in the definition of input and output bundles.

In the case of the Instituto de Pesquisa Clínica Evandro Chagas in Fundação Oswaldo Cruz (IPEC/FIOCRUZ), the hypothesis that organizational growth in the presence of commitment issues requires the promotion of mission-related research has implied that its performance assessment model might be formulated as the assessment of the efficacy of its programs of integrated action (Ações Integradas, briefly PAIs) when using specialized resources.

FIOCRUZ – a scientific and technological (S&T) centennial Brazilian organization – develops research, offers teaching and education programs, produces vaccines, drugs and medicines, provides scientific reference services and disseminates health information. Among the divisions composing FIOCRUZ, IPEC is the unit dedicated to laboratory diagnosis, clinical service, teaching and education, as well as to research on several infectious diseases deemed relevant in terms of public health policy. By the end of 2010 IPEC has been designated the National Institute for Infectology by the Brazilian Minister of Health.

With such an evolution in mind, the present paper intends to build and apply a mathematical model to accomplish four objectives:

(1) to measure the performance of the PAIs programs;
(2) to investigate scale inefficiencies eventually existing in the programs;
(3) to evaluate the efficacy of the new organizational structure; and
(4) to indicate that efficiency analysis provides both explaining power and managerial support concerning the important issue of organizational assessment for multipurpose organizations, either public or not.

The empirical application focusses the health sector, but this particular focus, although important by itself (Emrouznejad *et al.*, 2008; Fare *et al.*, 2008), is immaterial for the conclusions of the proposed approach to organizational assessment.

The text is organized in six sections that follow this introduction. Section 2 presents some prominent facts about the growth and the restructuration of IPEC during 2002-2006. Section 3 summarizes how economic analysis approaches the organization as a productive unit, in addition to presenting the research problem of evaluating the organizational efficacy of PAI programs. The next section discusses methodological steps and highlights the choice of DEA as the main tool for computing managerial indicators that will be used to perform short run efficiency analysis, as well as to evaluate organizational efficacy along the period 2002-2006. Section 5 describes the main findings, relating especially to scale inefficiencies and to returns to scale (RTS). Finally, concluding section (Section 6) takes up some pro-efficiency prescriptions in terms of operating plans for the PAI programs.

2. Background

In Brazilian S&T institutions, since the years 1990s a wider managerial autonomy coexisted with greater resource restrictions and with larger expenses by those organizations in managerial tools directed to internal definition of priorities, to accountability issues and to the search for efficiency and efficacy. Accordingly, the change in the management model at FIOCRUZ (Fundação Oswaldo Cruz), since 1994, resulted in both managerial decentralization and restructuration at IPEC.

At the same time, since the uncertainty concerning infectious diseases was aggravating, responsiveness by the public sector became more demanding. Public health responsiveness depends on the existence of flexible organizations – such as IPEC – carefully conceived with multipurpose scope and anticipating abilities that will be employed in future production and diffusion of knowledge, in diagnosis and in healthcare relating to a spectrum of target priority areas pertaining to health policy.

From 1985 on IPEC revitalized several laboratories (namely pathological anatomy, bacteriology, hemotherapy, immunology, mycology, parasitology and clinical pathology), the outpatient clinic, the day-hospital service, the admission service (30 beds) and the constitution of clinical research cohorts.

Since 1999 IPEC adopted an organizational structure comprising several PAIs with a view toward enhancing the interaction among those activities, accumulating reputation and mobilizing resources for the development of clinical research on infectious diseases. In consequence of restructuring, during 2002-2006 IPEC has experienced a significant budget increase of about 151 percent, therefore being able to diversify and expand its overall activities. Specifically, when healthcare activities –, i.e. diagnostic and patient care – are considered, a quantity increase of circa 20 percent was obtained in the biennium 2005-2005.

Looking at the evidence provided in Table I for the whole set of programs developed during 2002-2004, it can be seen that both research and service objectives pertaining to the "extended" format seem to be balancing. The structural change at IPEC aiming to integrate research activities and medical assistance through PAI programs was actually evident in 2004 when the relative frequency of consultations accompanied by medical registers with respect to total assistance provided under PAIs' attendance protocols remained quite high – about 80 percent – whereas the relative frequency of subsequent visits in total consultations of these programs reached 77 percent.

In 2006 output yielded 243,730 exams, 13,381 consultations by infectologists, 2,870 day-hospital assistances, 4,374 admissions-day, 64 papers in indexed periodicals, 19 MSc dissertations and 745 inclusions of patients into clinical research databases. In particular, regarding the activities of outpatient clinical service – namely, diagnosis and care – there was an increase in the quantity of service provided amounting to some 20 percent during 2005-2006.

Consultations	2002	2003	2004
With registers/total ("relative service")	83.42	80.09	79.71
Follow up/total ("relative research")	71.95	78.65	76.83

Source: Jorge *et al.* (2006, p. 15)

Table I. Number of PAI consultations by grouping variable – 2002-2004

In that same period IPEC implemented diversified PAIs with a view to gaining reputation as a S&T institution and to building the image required for having access to increased resources for clinical research on infectious diseases. There were 14 PAIs in 2006, whose majority has been nationally recognized as reference centres on infectious diseases in diverse layers of SUS, the national public health system.

The effectiveness of this new organizational format also became clear in terms of the importance of assistance provided via PAI programs when compared to overall IPEC assistance activities in 2006; at the same time the non-structured programs matched a significant weight only in a restricted subset of the activities (Table II). As a matter of fact, once a specific PAI program is delimitated by the composition and boundaries of the patient cohort monitored through the database of that program, Table II shows that not only each of the identified programs has included all kinds of activities – namely, research, teaching, diagnostic examination and treatment activities – but that, taken together, the eight PAI programs were almost entirely responsible for each of these activities on its own.

The present paper argues that the organizational restructuration of IPEC, starting in 1999, has been necessary to sustain growth not only by simply increasing the budget, but also through ensuring an efficient internal (re)distribution of budgetary resources among the programs. Therefore, in order to assess the efficacy of the management model, the paper will:

- build up and interpret managerial indicators (IGs) computed from a DEA model that covers a subset of selected PAIs; and
- apply those IGs for investigating the presence and the nature of scale inefficiencies in that subset of programs.

Findings from both items are expected to allow for pro-efficiency prescriptions for IPEC.

Activity	Chagas	Dengue	HTLV	LTA	Mycosis	Toxoplasmosis	Tuberculosis	HIV	Non-PAI
Scientific output (number)	2.8	5.5	5.3	16.3	16.4	4.8	10.8	22.6	15.5
Cohort inclusions (number)	27.7	4.6	1.3	1.7	2.4	0.3	11.8	50.2	0.0
Egressed students (number)	10.0	5.4	30.9	5.4	7.0	8.5	10.0	10.0	12.8
Consultations (number)	16.1	3.1	2.5	3.7	21.0	2.5	11.6	36.7	2.6
Admissions (number)	5.8	1.4	10.6	6.0	7.5	0.0	4.0	59.7	5.0
Exams (number)	10.1	4.1	8.2	10.2	15.6	3.1	6.3	36.8	5.7
Medicine expenditure	13.0	6.3	10.8	8.1	9.8	9.7	6.5	29.4	6.4
Nourishment expenditure	6.7	1.9	10.1	6.5	9.8	0.9	4.7	53.8	5.6
Administrative expenditure	7.5	3.6	7.6	11.1	15.4	3.0	5.6	39.3	6.9

Source: Jorge *et al.* (2006, p. 25)

Table II.
Percent distribution of activities by PAI programs: 2006

3. Analytical foundations

In the framework of economic analysis production is performed aiming at the efficient use of available resources. In addition, the search for efficiency in production will reveal the productive organization via the effects that organizational instances – such as strategies, structures and decision making – impinge upon productive activity (Milgrom and Roberts, 1992). The search for efficiency explains the organization, expresses its *raison d'être* and configures its rationality. It is therefore not surprising that economic analysis prescribes that – as an economic organization – a productive unit should search for efficiency in resource use (Varian, 2006). According to the modern theory of public organizations, even the so-called managerial public administration is consistent with the principles, prescriptions and policies associated to economic analysis (Bresser Pereira, 1996).

If complete information prevailed, the objective function postulated in the neoclassical short run equilibrium theory would be sufficient to attain efficiency. Although still present in the everlasting neoclassical model, the assumption that economic agents (e.g. managers) possess complete information has nonetheless been mostly abandoned by economic analysis. On the contrary, one prominent alternative, the so-called internal economy of organizations, indeed incorporates the assumption of information asymmetry (Varian, 2006) when depicting the interactions among other agents and the manager within the organization, hence the interest toward formulating management models whereby the search for efficiency is pursued under the informational assumption that there may exist "type X inefficiencies" (Leibenstein, 1966) that escape from manager's control.

Under this modified framework organizational performance is assumed to develop under the corresponding hypothesis that managers look for relative efficiency. Correspondingly, the focus of modelling has changed toward the use of nonparametric models – such as DEA – to test the generic hypothesis that the search for efficiency is guided by the observation of peer behaviour (Mantri, 2008) instead of by the maximization of a (neoclassical) production function. In addition the corresponding database is a cross-section of organizational units, that is, a fixed organizational structure and a variable ("technical") combination of inputs and outputs. The conventional approach by (stochastic) production functions gives place to the nonparametric frontier approach whereby production frontiers are computed from empirical comparisons among observed organizational units.

This approach is particularly convenient for multipurpose organizations, an important class of "real world" entities whose performance would hardly be captured by a single production function, and much more so since the solution of internal governance issues under the existence of multiple activities that compete for scarce internal resources will very likely require for "mutual adjustment" (Mintzberg *et al.*, 2002).

The construction and application of empirical models allowing to assess both managerial and organizational performance (Jorge *et al.*, 2006) in the short run – including the analysis of efficiency gains – may then be encouraged with a view toward the analysis of multipurpose organizations operating with fixed capital stock in mutual adjustment (intraorganizational) contexts. As a typical example, issues relating to coordination and commitment are pervasive in the interactions among administrative and medical staffs in health organizations, since either market solutions (i.e., competitive prices) or hierarchy solutions (rules and regulated prices) do not adequately cope with mutual adjustment issues, so that health organizations will have to rely on other kinds of mechanisms, e.g. other internal structures, well designed incentives – in order to ensure both health professionals' incentives and reconcilement between management goals and consumers' interests (Varian, 2006).

When modelling organizational assessment on the basis of efficient performance, internal structures are important beyond their strategic significance and must be considered since the choice and definition of DMUs, as well as in the definition of input and output bundles. These latter definitions, that are particularly important in the case of DEA models, have been discussed by Ozcan (2008) and Sherman and Zhu (2006) and will be further treated in the following section.

Concerning public organizations involved in strategic research on health (Rovere, 1997), the hypothesis that organizational growth in the presence of commitment issues requires the promotion of mission-related research (Bisang and Katz, 1996) has implied, in the case of IPEC, that its performance assessment model might be formulated as the assessment of the efficacy of its PAIs when using specialized resources (e.g. people, medicaments, hospital materials and reagents), in accordance to the idea that PAI structure efficacy means precisely PAIs' potential contribution to mission-related health research – that is, research additionally engaged in objectives associated to teaching and to medical assistance, shortly "strategic research" (Gibbons *et al.*, 1994). In efficiency analysis, the choice of PAIs as DMUs (as has been the choice in this paper) represents a methodological departure *vis à vis* the traditional approach, where DMUs have a physically objective existence – for example, a plant, a hospital, an intensive care unit (Gattoufi *et al.*, 2004). Since PAIs regularly develop research activities, the internal structure represented by PAIs differs from both general hospitals and academic medical centres (Ozcan, 2008) and is fully justified as the chosen DMU for the proposed model. In addition, the pooling of units and time periods is also a novelty to the extent that DEA models usually employ a cross-section of production units to analyse relative efficiency (Coelli *et al.*, 1998).

The endogenous growth school helps in the consistent choice of the nature of RTS to be adopted in the model proposed in this paper. Indeed those authors identify a number of assumptions as alternatively equivalent to the short run equilibrium assumption provided by neoclassical authors, namely:

- knowledge is a free good;
- technical change is exogenous;
- efficiency is absolute;
- RTS are constant;
- there is no disequilibrium cum inefficiency in the short run; and
- decision makers agents have complete information.

Therefore, any assumptions contrary to the preceding ones indicate the elements that characterize short run disequilibrium and imperfect competition (Romer, 1994). This is specially convenient for the present model formulation since both the assumption of constant RTS and the class of DEA-CCR may be discarded when modelling the efficiency frontier (Charnes *et al.*, 1981). Correspondingly the assumptions of managerial learning, of variable RTS, of accumulated learning and of heterogeneity in production may be mantained and the use of the class of DEA-BCC models is justified (Banker *et al.*, 1984).

Again, to the extent that accumulating knowledge is involved in the comparison of assumptions, it is worth noting that the learning curve model (Rosemberg, 1976) guarantees that, in an innovating organization such as IPEC, its growth process encompasses short run learning and becomes subject to variable RTS independently of fixed investment and permanent materials.

4. Method

When studying any production process in a given organization, if a production unit uses the same resources but yields greater quantities of output than another unit, it will be considered "relatively more efficient", no matter how formally the productivity problem is analyzed. Analogously if the production unit uses less resources and yields the same output.

Due to several problems arising in regard to the interpretation of the IGs, in the literature about organizational evaluation the comparison between organizational units is performed via the identification of the efficiency frontier, that is, the *locus* of all "equally best productive combinations of inputs and outputs". Once identified the frontier, the performance of a specific organization may be evaluated by assessing the relative position of the component units relatively to each other and to the frontier.

DEA, a name for a class of mathematical programming models, has long been applied to a broad range of situations involving the economics of management (Coelli *et al.*, 1998), either in the public sector (Fox, 2002; Smith and Street, 2005; Afonso *et al.*, 2006) or in private business, including nonprofit organizations (Vakkuri, 2003).

The so-called nonparametric models of frontier adjustment, such as DEA, represent the efficiency frontier as the best observed practices, that is, as the maximum output obtained from an input bundle when considering all the empirically observed organizational units in the population studied. Hence, those models assume that there may occur non-allocative inefficiencies in the production process. Those inefficiencies may result from reasons outside managerial control so that they do not constitute "technical problems" in the sense of either production technology or production management.

Following the selection of appropriate performance indicators and the application of DEA method, the paper evaluates to what extent the new organizational format has been adequate, during the period of study, as a basis for allocative decisions in a "complex" organization such as IPEC – that is, a multipurpose organization using specialized resources and subject to various conflicts of interest.

Regarding the specific objectives of production management, namely the assessment of whether the operating plans currently directed to expansion should be adjusted, the paper analyses whether the increase in scale resulted in efficiency losses for the PAIs. For that purpose data were collected on inputs and outputs associated to the eight main programs of IPEC for the period 2002-2006, as displayed in Table II: Chagas disease, DFA/dengue, HIV, HTLV, LTA, mycosis, toxoplasmosis, and tuberculosis. In terms of the application of DEA, each program has been considered a DMU.

Concerning the choice of inputs and outputs five points deserve mention. First, despite the lack of standard conceptualization of inputs and outputs, the choice of PAIs as DMUs implied the choice of both two among the three main categories chosen as inputs in the relevant literature – "hour-doctor" for the labor input and "expenses in medicaments, reagents and hospital materials" as operational expense, as well as three output categories – "admissions" for case-mix unadjusted discharges, "consultations" for outpatient visits and "quantity of completed dissertations and theses" for teaching. Second, according to Ozcan (2008, p. 105), at the present stage of applied research on health-related productive units, while conceptualization of service production using comparable input and output categories is very important for robust DEA modeling, it is equally important to operationalize the variables with realistic and available measurements directly from the field via existing databases. Third, in comparison to established literature (Hollingsworth *et al.*, 1999; Worthington, 2004), the exclusion of "capital investment" as an input is fully consistent with the short run scope of the model as well as with the lack of significance of investment expenses at IPEC during the period. Fourth, the inclusion of "scientific output" and "cohort – quantity of patients" as outputs tries to capture the shared use of inputs in IPEC research activities, while the inclusion of "reference – quantity of searches in medical files" refers to research education and training of graduate students and the inclusion of "exams" indicates outpatient activities not included in outpatient visits. Last but not least, a little number of DMUs hinders the discrimination among them according to relative efficiency, specially if a great number of variables is considered, so that in the present model full advantage is taken from data flexibility in the DEA approach in order to:

- aggregate some expense variables measured in value and relating to input purchases; and
- use some variables measured in quantities.

In this paper the following variables were considered as inputs:

- Hour – doctor: time dedicated by medical professionals to each program.
- Medicament – year: expenses with medicines in each program.
- Reagent – year: annual expenses with kits and reagents for several exams as distributed per program.
- Hospital materials – annual expenses with hospital materials by program.

Also, the following variables have been considered as the outputs of the eight PAIs:

(1) Exams – quantity of exams carried out by program.
(2) Consultations – the quantity of consultations provided in each program.
(3) Admissions – number of annual admissions.
(4) PAI – a dummy variable indicating the annual evolution of program reputation.
(5) Scientific output – the quantity of scientific papers published by program.
(6) Cohort – quantity of patients included in each program for research purposes.
(7) Education – quantity of dissertations and theses completed/defended in each program.
(8) Reference – indicates the quantity of searches in medical files by students under the supervision of any researchers in each program.

Today it may be said that DEA is actually an approach encompassing a collection of models (Cooper *et al.*, 1999). Among many options of models to be experimented with and/or computed, the efficiency analysis developed in this paper employs a nine-variables version called output-oriented with variable returns on scale (briefly, DEA-BCC-O). There are at least two reasons for that choice. First, the institute's annual budget is pre-established so that any efficiency search must envisage aggregate input use as fixed whereas looking for output maximization; hence the output-oriented approach seems to be preferable to an input-oriented version. Second, since learning effects stemming from service experience acquired from patient care result in scale economies in (service) production, the short time period covered in the present analysis leads to discarding the assumption of constant returns, a typically long run hypothesis.

For mathematical convenience and the conceptual reasons pointed out in the analytical foundation section, the reputation dummy was excluded and three input variables have been aggregated into "current expenses except personnel": medicaments, reagents and hospital materials.

5. Findings

In agreement to a comprehensive growth trend in overall organizational activities during 2002-2006, Table III indicates that the eight selected programs altogether have shown a sustained increase in physical output. From the input expenditure viewpoint, Table IV indicates a significant increase in the quantity of resources mobilized for the selected PAIs during the period.

Having solved the optimization problem defined by the model DEA-BCC-O by means of the package Frontier Analyst®, the relative technical efficiency scores are obtained for each program-year, as presented in Table V. Figures show that program efficiency varied throughout period of analysis.

In fact, since the yearly average score represents relative technical efficiency for the whole set of PAIs at the corresponding year, the computed scores for 2002-2004 indeed confirm the conclusion that no efficiency losses occurred along that period (Jorge *et al.*, 2006), whereas the decrease for the next biennium indicates that although the production volume has increased, previous efficiency gains disappeared and have even turned down.

Output variables	2002	2003	2004	2005	2006
Exams (number)	197.055	242.655	252.466	228.652	243.730
Consultations (number)	10.270	11.253	12.294	19.024	13.381
Admissions (number)	5.892	6.586	3.955	7.399	4.374
Scientific output (in UPPs)	83	72	78	98	83
Cohort inclusions (number)	563	641	690	745	745
Oriented search (number)	14	7	5	5	8
Education (in UPPs)	24	96	112	24	68

Table III. Evolution of physical output of PAI programs: 2002-2006

Inputs	2002	2003	2004	2005	2006
Hours-doctors (number)	42.051	42.008	85.657	103.558	115.438
Current expenses (in R$) (excludes personnel)	591,610.63	1,105,818.53	1,248,530.38	1,611,745.79	2,030,150.03

Table IV. Input utilization: 2002-2006

Given the complexity of the PAIs as organizational structures, a question immediately stirred up by that interruption in efficiency growth relates to verifying the extent to which there were any management barriers binding the efficiency path suggested in the beginning of the period and, for that matter, implying the presence of scale diseconomies (Arrow, 1964).

There are two aspects to be explored. First, do the productive activities of PAIs present variable RTS? If yes, are there increasing or decreasing returns? The answer to these questions is important to the extent that decreasing returns would just mean that growth initiatives might be harmful along the period.

To answer those questions a model DEA-BCC-I was computed with the Frontier Analyst® and new efficiency scores obtained as presented in Table VI. In comparison to the figures in Table V, corresponding to DEA-BCC-O, note that the new benchmark frontier – and different efficiency scores, as is required – indicates the presence of variable RTS (Coelli *et al.*, 1998).

Of which kind might those variable returns be? Two additional optimization problems have been computed, using the Excel Solver, to answer this question. According to Table VII, there is evidence of increasing RTS for program activities during the period: equal efficiency scores obtained by the DEA-CCR-I and DEA-NIRS-I models (Coelli *et al.*, 1998).

6. Conclusion

The application of efficiency analysis to understand the recent restructuration experienced by IPEC brought about a comprehensive result of interest: due to incomplete information on the part of managers concerning the productive activities

Table V.
Average efficiency scores (in percent): model DEA-BCC-O

PAI	2002	2003	2004	2005	2006
Chagas	84.93	85.70	86.26	98.63	81.65
DFA/dengue	87.98	100.00	98.29	100.00	100.00
HTLV	100.00	84.84	100.00	82.53	82.20
Leishmaniosis	100.00	100.00	100.00	97.25	100.00
Mycosis	100.00	100.00	100.00	100.00	100.00
Toxoplasmosis	100.00	100.00	100.00	100.00	90.92
Tuberculosis	100.00	100.00	100.00	100.00	95.67
HIV	100.00	100.00	100.00	100.00	100.00

Table VI.
Efficiency scores (in percent): BCC-I model

PAI	2002	2003	2004	2005	2006
Chagas	68.05	66.14	42.78	95.16	49.97
DFA/dengue	59.82	100.00	94.33	100.00	100.00
HTLV	100.00	71.40	100.00	40.09	46.55
Leishmaniosis	100.00	100.00	100.00	81.70	100.00
Mycosis	100.00	100.00	100.00	100.00	100.00
Toxoplasmosis	100.00	100.00	100.00	100.00	60.67
Tuberculosis	100.00	100.00	100.00	100.00	66.89
HIV	100.00	100.00	100.00	100.00	100.00
Average	90.98	92.19	92.14	89.62	78.01

of the complex organization where they belong and to the pre-established nature of their budgetary resources, the implicit hypothesis under which the PAIs operate yearly (i.e. “look at your peers and maximize output”) is consistent with DEA-BCC-O model so that its application is useful to explain how short-term operational plans have been chosen and managed during 2002-2004 (Jorge *et al.*, 2006). Due to cross learning among programs, it may be said that the improvement occurring in that period did not depend on any substantial increase in the resources available to the DMUs and that such improvement resulted by simply allowing the managers to adopt pro-efficiency strategies when choosing their short run operational plans.

The short period of time covered by the present analysis does not contemplate situations of long-term equilibrium such as those implicit in the hypothesis of constant RTS. That is why the decrease in the annual average score for the subsequent biennium may be interpreted as indicating that, despite the initial trend of growing gains, the increase in productive activity in fact took place in a context of inverted efficiency trend.

Summing up, the paper analyzed two main questions. First, it investigated whether managerial constraints occurring in a “growth-cum-diversification” setting may bring about scale inefficiencies that, in addition to depicting the output growth path, would be compatible with a pro-efficiency strategy manifested in the simultaneous production of healthcare reference services, scientific knowledge and human resources for clinical research on infectious diseases. Second, the paper examined which implications might result from scale inefficiencies (La Forgia and Couttolenc, 2008) in terms of impacting upon the short run operational choices opened up for both program and institutional managers at IPEC.

Regarding the first question, it was shown that DEA models CCR, BCC and NIRS may empirically explain the existence of distinct productive processes where maximum productivity varies in function of output scale. Those models allowed to contemplate, at one same time, DMUs with differing sizes as well as to establish the nature of corresponding scale inefficiencies, whenever present. In what the second question is concerned, the models computed here identified the presence of increasing RTS for the period 2005-2006, so that it may be concluded that efficiency gains will result if activity levels are increased and that PAIs as an organizational format and the ongoing growth strategy are corroborated.

It must be stressed that, as for its academic contribution, the paper acts as a demonstration effect, with views to the dissemination of the principles of efficiency analysis in the establishment of the analytical framework, in the modelling, and in the

PAI	2002	2003	2004	2005	2006
Chagas	68.07	64.38	37.38	69.54	55.63
DFA/dengue	55.17	58.79	42.55	52.26	45.00
HTLV	100.00	70.62	52.67	35.56	38.28
Leishmaniosis	100.00	100.00	100.00	56.23	79.68
Mycosis	100.00	100.00	95.77	62.71	58.61
Toxoplasmosis	100.00	100.00	100.00	100.00	100.00
Tuberculosis	100.00	100.00	58.25	59.34	42.05
HIV	100.00	100.00	28.12	62.62	64.43
Average	90.41	86.72	64.34	62.28	60.46

Table VII. Efficiency scores (in percent): NIRS-I and CCR-I models choice of the method for other studies on the behavior of multipurpose organizations in the short run, in presence of uncertainty, with problems of mutual adjustment and with no tradition in the maintenance of comparable databases on resources and results.

The IGs proposed and computed here may furthermore serve for routine follow-up of program performance by technical staff. The numerical nature of this tool allows for simulation and experimentation that may help developing new insights on organizational positioning and improvement. In other words, the analysis presented here is closely related to the production and use of organizational data that may help understand the multiple aspects of goal setting, policy implementation and feasibility constraints occurring in public organizations devoted to S&T activity (Jorge *et al.*, 2006).

Finally caution should be raised concerning robustness of findings. In fact, since the indicators have been computed with the help of deterministic models, their estimation is fully dependent on data availability and quality. To help cope with the structure and behaviour of errors along the modeling process, future research should then include some robust version of frontier estimation (Daraio and Simar, 2007).

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