

XIV. EFFICIENCY

1. WHR 2000

This section provides a commentary on the methodology used to measure health-system efficiency in the WHR 2000 statistical analysis, and on the changes proposed for the future. The methods used in WHR 2000 are outlined in World Health Organization (2000), pages 40-44, and the results given in Annex Table 10. Further details of the methods used are provided in Evans et al. (2000) and Tandon et al. (2000). The methodology was subsequently discussed at a WHO meeting of experts (World Health Organization 2001), and the analysis of efficiency with respect to healthy life expectancy has been reported in Evans et al. (2001).

To measure efficiency WHR 2000 used a frontier production function approach, an established technique employed to assess the efficiency of agricultural or industrial production, but which has been extended to the areas of education, local government, and health. This technique estimates the relationship between output and inputs to production, and the highest possible output that could have been produced for each combination of inputs. The ratio of the observed output to the maximum that could have been produced is defined as the efficiency score.

WHO modified this technique to allow for the fact that health outcomes in the absence of a functioning system would still be positive, not zero. So a minimum output level corresponding to the absence of health-system inputs was also estimated, using the relationship observed between literacy and health outcomes in the early 1900s. The inputs used to estimate efficiency in WHR 2000 were health expenditure per capita and average years of schooling of the adult population. Efficiency was estimated for the overall attainment index as well as for health attainment (HALE) separately.

The term "efficiency" is used throughout to denote the level of attainment secured by the health system in relation to spending and environmental inputs (external influences on attainment). In WHR 2000 this concept was referred to as "performance", but on the basis of the regional consultations WHO has decided to denote it as "efficiency".

2. Main commentaries and criticisms

The approach to efficiency measurement used in WHR 2000 is based on the parametric frontier estimation methods traditionally used in productivity

analysis. These are analogous to usual statistical regression analyses, except that the 'error' term for any observation may be decomposed into two elements – the conventional two-sided random error, and a one-sided error attributable to inefficiency. Such productivity models have reached an advanced stage of econometric development, and have been applied in a number of different areas. The expert group assembled by WHO included some of the leading exponents of productivity modelling. It broadly endorsed the statistical approach used in WHR 2000, but it should be noted that there are those who contest the entire edifice on which modern productivity modelling is based (Newhouse 1994; Stone forthcoming).

Criticisms of the WHO methods can be considered under four headings: philosophical concerns, the theoretical production model, measurement issues, and estimation. As well as the published commentaries listed in the references below (e.g., Häkkinen 2000; Jamison and Sandbu 2001; McKee 2001; Navarro 2002; Oswaldo Cruz Foundation 2000; Gravelle et al. 2002; Grignon 2001; Richardson et al. 2002; Hollingsworth and Wildman 2002; etc.), we have also seen a number of as yet unpublished papers that we are unable to cite. We are grateful to these authors for the privileged access to their material. The concerns are listed without an attempt to judge their validity. SPRG comments and recommendations follow under heading 4 below.

Philosophical concerns

- The econometric methods used to estimate efficiency are both complex and relatively new. This makes understanding and interpretation difficult, especially for nations seeking to improve their health-system performance (Almeida et al. 2001).
- The use of the concept of efficiency may send a confused message when set alongside the objective of improving health outcomes. A country might have low absolute levels of health attainment but still be deemed technically efficient because it spends very little on its health system. The concept of efficiency makes no judgement about how much should be spent on health, but health outcomes can evidently be improved by higher expenditure.
- The determinants of health-system performance are too complex to be reducible to a tractable statistical model, particularly in view of the poor quality of the data, the relatively small number of observations, and the lack of reliable time-series information.
- Parametric statistical models traditionally focus on estimating the relationship between a stimulus (inputs) and a response (in this case, attainment) but not on the residual for an individual observation. In contrast, productivity models concentrate on these residuals, and therefore require much greater attention to be placed on model specification.

- In particular, it can be argued that – in an application as complex as the WHO endeavour – it is inevitable that there is significant measurement error and that the model specification is incomplete. In these circumstances, little confidence can attach to the estimated measure of inefficiency.
- The uncertainty analysis used by WHO is incomplete, as it does not fully consider modelling errors that are potentially important sources of uncertainty (see also Section XI).
- Despite the progress made, there are numerous unresolved issues surrounding the methodology of productivity analysis. It may be premature to base definitive rankings of health systems on such developmental methodology.

The model of production

- The technical consultation on 'Measurement of Efficiency of Health Systems' seemed to be comfortable with the use of a single production function (on the grounds that all countries have access to the same medical technologies). However, several commentators have argued that the health production function may not be identical between nations, suggesting that there is disagreement about whether the use of a single model is appropriate (Richardson et al. 2002; Häkkinen 2000; Nord 2002).
- More generally, there is no consensus that the WHO approach uses an appropriate theoretical model of the production process it seeks to capture (Pedersen 2002; Grignon 2001). For example, many of the outcome indicators in WHR 2000 are influenced strongly by factors other than the health system (e.g., war or diet), and these are inadequately captured in the WHO model of production. The treatment of income has generated particular debate. It is also argued that some of the outcome indicators – e.g., health inequality – are affected not just by the average level of inputs (e.g., education, income) but also by the distribution of inputs (inequalities in education, income) (Ammar and Awar 2001).
- Although the proposed work on functions of the health system may help in the future, the methods used in WHR 2000 do not adequately model the 'reasons' why a given level of efficiency is observed (Grignon 2001; Pedersen 2002).
- The chosen model does not recognize the important time lags that exist in producing health outcomes (Grignon 2001).
- The need to calculate a "minimum" level of health attainment in the absence of a health system is contested (Gravelle et al. 2002; Häkkinen 2000).

Measurement issues

- The description of the treatment of missing data is inadequate, as in the HSPA exercise as a whole (see Section XII). Estimates of missing data

- will be subject to considerable errors-in-variables, and hence will cause biases in parameter estimates and possibly in rankings (Almeida et al. 2001; Häkkinen 2000; Pedersen 2002).
- The components of the efficiency model refer to different definitions of the health system – for example, the output measure refers to a very broad definition of the health system, whilst the input (expenditure) measure relates predominantly to expenditure on health care (Nord 2002).
 - The composite measure of output is highly contested and embraces numerous assumptions and value judgements (see Section XI), which have consequential implications for the efficiency measure.
 - Relative prices of inputs differ between nations, and estimates of total expenditure do not reflect the cost advantages in producing different outputs.
 - The measures of cost rely on PPP-adjusted estimates of expenditure, which are subject to error (in the absence of health-specific PPP factors), causing bias in parameter estimates and possibly in country ranks (Grignon 2001).
 - Years of education is an inadequate proxy for external influences on health-system performance (Williams 2001; Jamison and Sandbu 2001; Häkkinen 2000; Grignon 2001).
 - The methodology and data used to measure the “minimum” are contested (Williams 2001; Pedersen 2002).

Econometric methodology

- The use of the fixed-effects panel data estimator is inappropriate, given the very low degree of variation from one year to the next in most observations (Gravelle et al. 2002).
- The models used presume a fixed level of efficiency across the entire four-year period examined, which may be unrealistic (Pedersen 2002; Gravelle et al. 2002).
- The methods do not adequately treat the important contribution of income to the production of health and therefore to health-system performance. The role of income needs to be properly modelled even if estimation turns out to be econometrically inconvenient (because income is highly correlated with both inputs and outputs) (Pedersen 2002).
- Formal model-selection techniques should be employed in choosing the preferred functional form for the model.
- More details are required on whether the chosen model passes the usual model misspecification statistical tests.
- There is evidence of a structural difference between developed and less-developed countries, implying the need for separate modelling (Richardson et al. 2002).
- Equally plausible alternative statistical model specifications can give rise to significantly different results (Gravelle et al. 2002; Hollingsworth and

Wildman 2002; Richardson et al. 2002; Grignon 2001; Jamison and Sandbu 2001).

3. WHO responses and proposals

The following detailed issues are highlighted in Section VI of the WHO Summary Document and in discussion documents prepared for SPRG, which include WHO proposals for further development of this work. WHO proposes to continue developing the concept of efficiency on the grounds that health resources are scarce in all Member States. The Secretariat believes it is important to determine if those resources contribute to the greatest extent possible to the outcomes that people value. This is an important complement to the goal of finding additional resources for health.

(i) Timing

There are lags between the timing of health-system inputs and health outcomes. In WHR 2000 the assumption was made that current expenditures are highly correlated with past expenditures, but it would be preferable to use a time series of expenditures in explaining health outcomes and measuring efficiency. Data limitations prevented this in WHR 2000.

(ii) The minimum

In the absence of a health system population health (e.g., life expectancy at birth) would still be positive, so WHO argues that it is important to identify the minimum level. The minimum for WHR 2000 was estimated from limited data around 1900 when the modern health system did not exist. Only literacy was found to be correlated with health outcomes, but it would be useful to determine if there are other ways of defining the minimum.

(iii) Difficulty

Variations in the difficulty of translating inputs into outcomes were not fully captured in the production function in WHR 2000. Some, however, were subsequently analysed in the second-stage analysis.

(iv) Determinants of output

There is ongoing debate about the correct specification of the production function, but the Secretariat argues that it is critical to separate clearly the inputs to production from the factors that influence the efficiency of the production process.

(v) Determinants of efficiency

The technical consultation on this topic had suggested that the determinants of efficiency were better estimated at the same time as the estimation of efficiency rather than at a second stage, which was the approach adopted by WHO.

Because of the complexity of the issues surrounding efficiency, WHO has proposed some new analysis including: (a) estimating the traditional production function as a one-step process for efficiency simultaneously with

the possible determinants; (b) a random-coefficients econometric specification of the production model. In terms of a new approach, WHO has proposed that the unobserved efficiency variable could be inferred from a multiple indicator model, which would use both the existing specification and additional models based on measures of process, such as coverage.

In light of this debate WHO proposes the following.

- (i) The questions of timing and how best to estimate the minimum are complex and the opinions of relevant outside experts will be sought. At the same time, the multiple indicator model approach is promising and should be developed further. This requires that the proposed work on coverage, discussed in Section IV of the SPRG report, should continue (with the World Health Survey providing the relevant information).
- (ii) To address the question of timing, following discussion with SPRG two suggestions were made. The first was to estimate current HALE as a function of the series of past expenditures, or to use HALE at some time in the recent past, say five years ago, as a controlling variable. (The latter method has the drawback of lagged dependent variable models, while the former requires developing a historical time series of health expenditures.) The second proposal was to pursue the question of incidence-HALE – the HALE that is determined by this year's activities (Section V.A in the Summary Document). This has the advantage of being much more clearly determined by actions taken this year, but which will not produce an outcome until some time in the future. It would still be necessary to control for that part of incidence-HALE determined by actions taken in the past.

4. SPRG comments and recommendations

SPRG considers that there are strong arguments in favour of seeking to measure health-system efficiency. Consideration of efficiency should – in principle – permit valid comparison of systems operating with different health expenditures and in different external environments. It could therefore make a vital contribution to HSPA. The WHO initiative has launched interesting technical debates and a research agenda that has the potential to advance rapidly our state of knowledge of health-system performance. It has also stimulated the search for improved conceptual models and data sources, and has made some innovative technical contributions to productivity analysis.

However, there are some important objections in principle to the method used by WHO, the most important of which are: (a) that the health system is too complex to be captured by these simple statistical models; (b) the data available are currently inadequate to support such an endeavour; and (c) the

analysis is too demanding technically to be helpful to policy makers and other government officials.

In addition, it is possible to invoke numerous practical objections to the methods that have been applied, many of which are summarized above. Some of the most important are: (a) the treatment of missing data (applies to all of HSPA); (b) the treatment of influences on outcomes other than the health system; (c) the inadequate treatment of time lags; (d) the method of implementing some of the econometric techniques used; (e) the handling of uncertainty and sensitivity analysis.

We also believe that there should be complete 'transparency' of the research process relating to efficiency. As in much econometric work, the findings in WHR 2000 are the result of numerous technical judgements, and are not just the consequence of ineluctable scientific logic. Examples include the nature of the model of production, the concept of the "minimum", the treatment of missing data, and a series of econometric choices. We recognize that there may not always be consensus regarding the correct technical approach. However, it is in our view imperative that all technical judgements are capable of being understood, scrutinized and challenged by external observers. This requires preparation of a technical audit trail, publication of all methods used, and ready availability of data.

Recommendations

As the debate on WHR 2000 has demonstrated, any analysis of efficiency must be considered work-in-progress rather than a definitive judgement on health systems. On balance, we feel there is a case for continuing work in this area. However, we recommend that any continued WHO work on health-system efficiency should be presented as an ongoing research programme rather than a definitive judgement on health systems, and that progress should be reviewed at regular intervals.

The practice of publishing a league table of nations based on efficiency estimates has been highly contentious, but in the view of SPRG the decision to continue publishing league tables is a strategic and policy decision for WHO rather than a scientific one. Given the large number of technical problems that have still to be resolved, we recommend that this work should be developed further, and that any tables produced should be recognized as work-in-progress.

There are numerous possibilities for improving the data sources on which the efficiency rankings are based. These include improvement in the measurement metrics and the treatment of missing data (considered elsewhere in this report), and where possible the use of sub-national data sources. We recommend that WHO should make strenuous efforts to improve the quality and extent of data used in efficiency analysis (indeed in

all of HSPA), and to adopt a transparent and careful approach to the treatment of missing data.

Particular concern has been expressed in the literature at the comparison of all health systems within a single model of production. It is possible that systems in different environmental circumstances are confronted with different production possibilities. We recommend that WHO should carefully explore the implications of incorporating environmental factors into the analysis, or developing separate models for different types of health system.

A particular conceptual weakness of methods to date has been the treatment of time. Measures of health outcome reflect years of health-system endeavour, while measures of expenditure refer to the current period. Furthermore, health-outcome measures are likely to be affected by factors other than the health system. These weaknesses suggest that contemporary measures of future (predicted) outcomes, e.g. certain process measures, may be more satisfactory measures of system performance than health-outcome measures. For this reason, we recommend that WHO should explore the scope for incorporating coverage and other measures of process into the model of efficiency.

The econometric analyses presented in WHR 2000 and subsequent variants exhibit some scientific weaknesses. We recommend that WHO engages in an ongoing consultative process with relevant experts to address the technical issues raised by outside commentators.

The treatment of uncertainty in WHR 2000 needs to be expanded as does the sensitivity analysis that was presented. We recommend that the method of modelling and presenting uncertainty should be reformulated to include a much broader scope of alternative models and assumptions.

The issues surrounding the measurement of efficiency are undoubtedly complex and require extensive data. Because of this complexity, we feel that in this area – perhaps more than in others – the input of a wide range of experts from different backgrounds is desirable. We recommend that WHO should actively consult and engage outside experts in the further development of this area, and that its analyses should be fully documented to maintain transparency.

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