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EVALUATING THE INTRODUCTION OF A QUASI-MARKET IN COMMUNITY CARE: ASSESSMENT OF A MALMQUIST INDEX APPROACH

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Abstract
It is often the case that only routinely collected, highly aggregate administrative data are available for the evaluation of major public policy initiatives. Such data clearly fall far short of the information advocated by statisticians for policy evaluation. This paper examines the extent to which methodologies developed in the productivity literature can nevertheless extract useful evaluative information from administrative data. A non-parametric Malmquist Index approach is used which seeks to decompose changes in efficiency into technical efficiency changes, scale effects and technological change. We apply the methods to the system of "community care" introduced in 1993 for people affected by problems associated with ageing, mental illness, learning disability or physical disability. Non-parametric methods are used to estimate productivity changes amongst 39 English county councils over a four year period from 1992 to 1995. The results suggest a steady annual increase in productivity of about 1.4% per annum over the period under investigation, but it is not possible to determine the extent to which this progress can be attributed to the introduction of community care. Our conclusion is that the methods deployed can exploit readily available data sets at low costs, and are a valuable form of exploratory data analysis, if interpreted with discretion.

Keywords: Productivity, Malmquist Index, Non-parametric, Public Sector.

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1. Introduction

It is often the case that only the most rudimentary, highly aggregate administrative data are available to analysts wishing to evaluate important policy changes. Such observational data clearly fall far short of the information usually advocated for the purposes of policy evaluation, which are likely to be highly disaggregate and experimental. Recent developments in productivity research nevertheless offer methodologies for using crude observational data to gain insights into productivity changes over time (Färe and Grosskopf, 1996), and several research teams have used these methods to assess the impact of an important policy change on various aspects of productivity. The purpose of this paper is to assess whether such productivity models offer meaningful evaluative insights.

The example used to illustrate the methods comes from English social services. In recent years a series of reforms in the management of personal social services has taken place in England, with the aim of introducing greater competition between providers, and thereby securing improved efficiency and effectiveness. These reforms have sought to create a "quasi-market" in social care, in which a mixed economy of providers (from the statutory, voluntary and private sectors) compete to provide the services required by local governments, who act as purchasers. They reflect similar models introduced in many areas of the UK public sector, most notably school education and health care (Bartlett, et al., 1994, Bartlett, et al., 1998, Le Grand and Bartlett, 1993). One of the key objectives of quasi-markets is to secure improvements in various aspects of efficiency in the provision of public services. Yet, notwithstanding the numerous theoretical arguments advanced in favour of such quasi-markets, there has been relatively research that seeks to evaluate these developments empirically, not least because of the difficulties of securing data which are useful for such purposes.

We first describe the productivity models we shall use in this paper, and briefly outline the community care reforms. We then present some empirical results, and conclude with a discussion of the general usefulness of the techniques employed.

2. Models of Productivity

The three indices used most frequently to measure changes of productivity are the Törnqvist Index, Fisher's Ideal Index (the geometric mean of the Laspeyres and Paasche indices) and the Malmquist Productivity Index (Caves, et al., 1982, Färe and Grosskopf, 1996). The first two require the calculation of both the amounts and the prices of all inputs and outputs. In contrast, the Malmquist Index has the advantage that no information is needed on the prices of inputs and outputs. Furthermore, calculation of the Malmquist Index requires no restrictive assumptions regarding whether the units under analysis object are benefit maximizers or cost minimizers. As Coelli (1998) indicates, these two characteristics make the Malmquist Index a particularly suitable tool for the analysis of productivity change in the public sector, where output prices are not in general available. A further advantage of the Malmquist approach is that it decomposes productivity into two parts that capture changes in the level of technical efficiency, and changes due to technical progress. For these reasons we have chosen to use the Malmquist Index as the basis for examining productivity change in social services. To this end, we deploy the methodology proposed by Färe *et al* (1994), that makes operational the principles of the Malmquist Index.

We first assume constant returns to scale (CRS). In order to define the productivity index, we assume the production technology, S^t, for every period of time, t, (t = 1....,T) can be represented as:

$$\boldsymbol{S}^{\boldsymbol{t}}=\{(\boldsymbol{X}^{\boldsymbol{t}},\boldsymbol{Y}^{\boldsymbol{t}}):\boldsymbol{X}^{\boldsymbol{t}}\text{ can produce }\boldsymbol{Y}^{\boldsymbol{t}}\} \tag{1}$$

where X^t and Y^t represent vectors of inputs outputs respectively. It is assumed that the production technology satisfies certain axioms that allow one to define the distance function (expressed in terms of output) for observation 0 in period t as:

$$\boldsymbol{D}_{\boldsymbol{o}}^{\boldsymbol{t}}(\boldsymbol{X}^{\boldsymbol{t}},\boldsymbol{Y}^{\boldsymbol{t}})=\inf\{\boldsymbol{q}:(\boldsymbol{X}^{\boldsymbol{t}},\boldsymbol{Y}^{\boldsymbol{t}}/\boldsymbol{q})\in\boldsymbol{S}^{\boldsymbol{t}}\} \tag{2}$$

This function allows a complete characterization of the production technology, satisfying certain properties, amongst which being that that it is a homogenous function of degree 1, Note that $(X^t,Y^t)\ 0\ S^t$ if and only if $D^t_o(X^t,Y^t)\ \#\ 1$.

It is now necessary to relate the vector of inputs-outputs of time period t, (X^t,Y^t) to the production technology for the following period, S^{t+1} (Caves, et al., 1982) making it possible to define:

$$\boldsymbol{D_o^{t+1}(X^t,Y^t)=\inf\{q:(X^t,Y^t/q)\in S^{t+1}\}} \quad (3)$$

In a similar fashion, D^t_0 can be defined over (X^{t+1},Y^{t+1}). In this case, the vector of inputs-outputs of the period t+1 is compared with the technology of production of the previous period. Clearly, in the presence of technical progress $(X^{t+1}, Y^{t+1}) \notin S_t$ and $D^t_0(X^{t+1},Y^{t+1}) > 1$ for an observation (X^{t+1}, Y^{t+1}) on the frontier in year t+1.

From the previous concepts, Färe *et al* (1994) define the following Malmquist productivity index:

$$M_o^{t+1}(X^{t+1},Y^{t+1},X^t,Y^t)=\left[\frac{D_o^t(X^{t+1},Y^{t+1})}{D_o^t(X^t,Y^t)}\frac{D_o^{t+1}(X^{t+1},Y^{t+1})}{D_o^{t+1}(X^t,Y^t)}\right]^{1/2} \quad (4)$$

This index of productivity is the geometric mean of two Malmquist productivity indices. The first takes as reference technology that corresponding to year t, whereas the second uses the reference technology corresponding to year t+1. This approach makes it unnecessary to adopt an arbitrary selection of one or another technology as the reference base.

This index can be rewritten as[1]:

$$M_o^{t+1}(X^{t+1},Y^{t+1},X^t,Y^t)=\frac{D_o^{t+1}(X^{t+1},Y^{t+1})}{D_o^t(X^t,Y^t)}\left[\frac{D_o^t(X^{t+1},Y^{t+1})}{D_o^{t+1}(X^{t+1},Y^{t+1})}\frac{D_o^t(X^t,Y^t)}{D_o^{t+1}(X^t,Y^t)}\right]^{1/2}$$

$$\text{or } M = E \times T \quad (5)$$

where E represents the change in the efficiency levels:

[1] Alternative decompositions of the Malmquist index can be found in Ray and Desli (1997), Simar and Wilson (1998) and Zofio and Lovell (1998).

$$E=\frac{D_o^{t+1}(X^{t+1},Y^{t+1})}{D_o^{t}(X^{t},Y^{t})} \tag{6}$$

and T reflects the changes in productivity levels due to technical progress:

$$T=\left[\frac{D_o^{t}(X^{t+1},Y^{t+1})}{D_o^{t+1}(X^{t+1},Y^{t+1})}\frac{D_o^{t}(X^{t},Y^{t})}{D_o^{t+1}(X^{t},Y^{t})}\right]^{1/2} \tag{7}$$

Where variable returns to scale (VRS) exist, it is possible to decompose further the change in efficiency levels into two elements: that due to pure technical efficiency change, and that due to scale efficiency change. This is made operational by expressing equation (6) as follows:

$$E=\frac{D_o^{t+1}(X^{t+1},Y^{t+1})}{D_o^{t}(X^{t},Y^{t})}=\frac{D_{VRS}^{t+1}(X^{t+1},Y^{t+1})}{D_{VRS}^{t}(X^{t},Y^{t})}\frac{\dfrac{D_{CRS}^{t+1}(X^{t+1},Y^{t+1})}{D_{VRS}^{t+1}(X^{++1},Y^{t+1})}}{\dfrac{D_{CRS}^{t}(X^{t},Y^{t})}{D_{VRS}^{t}(X^{t},Y^{t})}}$$

$$\text{or } E = P \times S \tag{8}$$

where the first expression reflects the change in efficiency relative to the “true” VRS frontier, and the second reflects the extent to which the distance from the scale efficient point on the VRS frontier (relative to the notional CRS frontier) has changed.

In order to calculate equation (5) it is necessary to consider its four constituent distance functions. This can be achieved using parametric or non-parametric approaches. In our view, the non-parametric approach offers distinct advantages for analyzing public sector units. It requires less restrictive assumptions tan parametric methods regarding the functional form of the production technology; it can readily handle multiple inputs and outputs; it can yield useful results with small numbers of observations; and it is less vulnerable than parametric methods to statistical biases, such as endogeneity and omitted variables. We therefore consider the distance to the production frontier by means of the linear programming method developed by Farrell (1957) to examine the technical efficiency of decision-making units (DMUs). This technique has since been generalized by Charnes,Cooper and Rhodes (1978) under the title data envelopment

analysis (DEA), and has spawned a burgeoning theoretical and applied literature. For an accessible introduction to DEA see Coelli (1998).

The application of DEA to the Malmquist index requires the solution of four linear programming problems for each of the n units under investigation, corresponding to the four required distance functions. Thus, if we assume constant returns to scale, the function $D^t_o(X^t,Y^t)$ for DMU 0 can be considered solving for N the problem:

$$\left[\boldsymbol{D}_o^t(\boldsymbol{X}_t,\boldsymbol{Y}_t)\right]^{-1}=\max_{f\,l} f$$

$$\text{subject to} \quad \begin{aligned} -f\,\boldsymbol{y}_{0t}+\boldsymbol{Y}_t\,l &\geq 0 \\ \boldsymbol{x}_{0t}-\boldsymbol{X}_t\,l &\geq 0 \\ l &\geq 0 \end{aligned} \tag{9.1}$$

where x_{0t} and y_{0t} are the vectors of inputs and outputs associated with DMU 0 and λ is a flexible vector of weights to be applied to the matrices X^t and Y^t. The parameter N indicates the maximum proportion by which all outputs of DMU 0 can be expanded such that $(x_{0t},y_{0t}/N)$ remains feasible, as indicated by the performance of other DMUs (X^t,Y^t).

The three remaining linear programming programmes are variations of (9.1):

$$\left[\boldsymbol{D}_o^{t+1}(\boldsymbol{X}_{t+1},\boldsymbol{Y}_{t+1})\right]^{-1}=\max_{f\,l} f$$

$$\text{subject to} \quad \begin{aligned} -f\,\boldsymbol{y}_{0(t+1)}+\boldsymbol{Y}_{t+1}\,l &\geq 0 \\ \boldsymbol{x}_{0(t+1)}-\boldsymbol{X}_{t+1}\,l &\geq 0 \\ l &\geq 0 \end{aligned} \tag{9.2}$$

$$\left[\boldsymbol{D}_o^{t}(\boldsymbol{X}_{t+1},\boldsymbol{Y}_{t+1})\right]^{-1}=\max_{f\,l} f$$

$$\text{subject to} \quad \begin{aligned} -f\,\boldsymbol{y}_{0(t+1)}+\boldsymbol{Y}_{t}\,l &\geq 0 \\ \boldsymbol{x}_{0(t+1)}-\boldsymbol{X}_{t}\,l &\geq 0 \\ l &\geq 0 \end{aligned} \tag{9.3}$$

$$\left[\boldsymbol{D}_{o}^{t+1}(\boldsymbol{X}_{t},\boldsymbol{Y}_{t})\right]^{-1}=\max_{f\,l} f$$

$$\text{subject to} \qquad \begin{aligned} -f\,\boldsymbol{y}_{0t}+\boldsymbol{Y}_{t+1}\,\boldsymbol{l}&\geq 0\\ \boldsymbol{x}_{0t}-\boldsymbol{X}_{t+1}\,\boldsymbol{l}&\geq 0\\ \boldsymbol{l}&\geq 0 \end{aligned} \tag{9.4}$$

In the problems (9.3) and (9.4), notional efficiency calculations are made for observations for one period, taking as a reference base the production frontier corresponding to the other period. In these cases the value of ϕ does not necessarily have to be greater than or equal to one, as must necessarily be the case when technical efficiency is calculated using cross-sectional data. Thus, in equation (9.3) an observation of period t+1 is being compared with the production frontier for the previous period. If technical progress has taken place, this observation can be located beyond the production frontier, leading to a value of ϕ of less than 1.

The above equations yield estimates of distance functions under the assumption of constant returns to scale. The equivalent variable returns to scale distance function estimates required for equation (8) are secured by adding to (9.1) and (9.2) the constraint:

$$\sum_{n} \boldsymbol{l}_{n} = 1 \tag{10}$$

This analysis can be illustrated graphically by means of Figure 1, which seeks to explain the indices in more intuitive form. It shows a technology with one input x and one output y. The VRS technology in period t is represented by the frontier S^t_{VRS}, while the notional CRS technology is indicated by the line S^t_{CRS}. The unit of interest consumes input x^t and produces output y^t in year t. Then we can examine the Malmquist Index as comprising three elements, M = (P x S) x T.

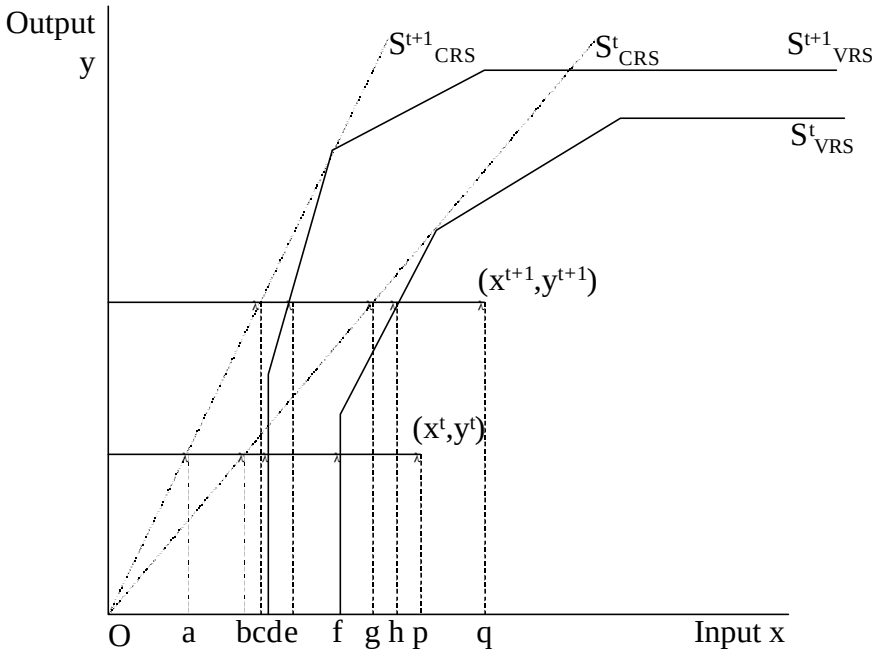

Figure 1: Illustration of productivity change with one input, one output

The pure efficiency change P between years is given by the ratio

$$\boldsymbol{P} = \frac{(Oe/Oq)}{(Od/Op)}$$

while the change in scale efficiency S is given by

$$S = \frac{\dfrac{(Oc/Oq)}{(Oe/Oq)}}{\dfrac{(Ob/Op)}{(Of/Op)}}$$

Finally, the change in the (scale efficient) technology is indicated by

$$\boldsymbol{T} = \sqrt{\left[\frac{(Og/Oq)}{(Oc/Oq)} \cdot \frac{(Ob/Op)}{(Oa/Op)}\right]}$$

(In this simple example the two components of T are identical, but this will not in general be the case.) This yields the Malmquist Index:

$$\boldsymbol{M} = \frac{(Oe/Oq)}{(Od/Op)} \cdot \left[\frac{\dfrac{(Oc/Oq)}{(Oe/Oq)}}{\dfrac{(Ob/Op)}{(Of/Op)}}\right] \cdot \sqrt{\left[\frac{(Og/Oq)}{(Oc/Oq)} \cdot \frac{(Ob/Op)}{(Oa/Op)}\right]}$$

An early application of these methods, as applied to productivity changes in Swedish pharmacies, was reported by (Färe, et al., 1992). Since then a modest number of applications in the health care sector has emerged, including an evaluation of the health care reforms in the Scottish National Health Service (Maniadakis, et al., 1999) in Finland (Linna, 1998) and in Sweden (Tambour, 1997), an assessment of productivity changes in the administration of primary health care (Giuffrida, 1999), and an assessment of reformed payment system for diagnostic tests in Portuguese hospitals (Dismuke and Sena, 1999). Other less directly relevant applications include: dairy farms (Tauer, 1998); airports (Murillo Melchor, 1999); banking (Berg, et al., 1992); and financial services (Worthington, 1999).

3. The reform of personal social services in England

From the mid 1980s, various studies (Audit Commission, 1986) highlighted important problems relating to the financing and delivery of personal social services. The severe criticisms made of the operation of these services, in particular of their systems of incentives, internal organization and poor use of resources, led the government to commission a report from Sir Roy Griffiths (Griffiths, 1988). This Report not only confirmed the conclusions of previous studies but, in addition, proposed a series of fundamental reforms.

These proposals formed the basis for the 1989 White Paper "Caring for People", which proposed the separation of the provider function from the purchaser function for large areas of social care, most notably for services for older people (Department of Health, 1989). The intention was

- to enable people to live as normal a life as possible in their own homes or in a homely environment in the local community;
- to provide the right amount of care and support to help people achieve maximum possible independence and … help them achieve their full potential;
- to give people a greater individual say in how they live their lives and the services they need to help them do so.

These aims reflect a concern with the economist's notion of *allocative* efficiency. However, there is also a clear concern in the reforms with *technical* efficiency, for

example in the concern expressed in the White Paper with securing better value for taxpayer's money (Hoyes, et al., 1994).

The proposals of the White Paper were soon enacted in the National Health Service and Community Care Act (UK Government, 1990). However, the reforms were not fully implemented until April 1993, when they became known as "community care". This timing is important for this paper as – although we use data straddling the formal introduction of the reforms – local governments may to some extent have anticipated the introduction of the quasi-market in preceding years.

In outline, we can characterize the community care reforms as follows:

- the services covered comprised services for adults in need of support, such as those with learning difficulties, those with physical disabilities, and older people (by far the largest group);
- although in receipt of transitional grants from central government, local governments became responsible for financing the services;
- local governments became responsible for assessing clients' needs, for designing a package of care, for organizing and purchasing the appropriate care, and for collecting any charges they chose to levy on clients;
- care was to be provided by a local "mixed economy" of private, voluntary and public sector providers, who compete for business from the local government.

This description corresponds closely to the characteristics of a quasi-market (Le Grand, 1991), although – in contrast to other sectors, where providers remain governmental organizations – profit-making providers may compete in the market for social care. The reforms in principle offer a client a custom-built voucher (from the local government) with which they may purchase an approved package of community care from approved providers. In practice, clients do not always have a great say in the choice of provider (Audit Commission, 1997, Mannion and Smith, 1997), and in many areas clients with adequate means have been subject to charges to defray some or all of the costs of provision (Baldwin and Lunt, 1996).

Clearly the community care reforms are predicated on the economic theory which - in certain very restrictive circumstances - demonstrates that markets can secure efficiency and effectiveness (Lunt, et al., 1996). Of course the extent to which the

unusual service of social care conforms to the neoclassical ideal is an open question, which we do not intend to debate. Rather, we seek to determine whether, using rudimentary models of productivity and the most basic administrative data, it is possible to detect any evidence of efficiency associated with the reforms. In spite of the academic and policy interest which the managerial instrument of the quasi-market has stimulated, there have been very few attempts to assess quantitatively the strategic impact of such reforms. Instead, the interest has been in seeking out qualitative impacts at a micro level (Gostick, et al., 1997, Means and Smith, 1997, Wistow, et al., 1996).

4. Empirical Analysis

We take as units of analysis the 39 English shire counties over the four year period 1992/93 to 1995/96. Formally community care was introduced at the end of the second of these fiscal periods. However, there is likely to have been both anticipation of the reforms in previous years, and conversely some delay before the full impact of the quasi-market took effect in subsequent years. The data used are the Social Services Actual Expenditure statistics published annually by the Chartered Institute of Public Finance and Accountancy (various years).

The variables we were able to use was severely constrained by the nature of the information available for each of the five years studied. As the single input we used the gross cost of all services for elderly people (X1). Outputs comprised: the number of people who receive residential care (Y1); the number of people who receive care at day centres (Y2); the number of hours of domiciliary care delivered (Y3); the number of meals delivered to people at home (Y4); and the magnitude of the user charges raised from those in care (Y5). The first four outputs reflect the major activities that make up the services known as community care for elderly people. The income received in the form of user charges is an indicator of the extent to which the social services department is successful in recovering its costs from clients. The monetary variables (X1 and Y5) have been calculated using constant pounds deflated to the year 1992 on the basis of a social services cost index. A further adjustment is made to these variables in a small number of counties in south east England to reflect the higher costs of providing services in those areas, using the government's area cost adjustment.

The most obvious omission from these data is any indication of the *quality* of care delivered. The absence of such indicators bedevils most evaluation, and is a limitation to which we return in the conclusions. Also, the ease with which a social services department is able to create the chosen outputs (for a given input) is highly dependent on local environmental circumstances. In principle, therefore, we should include additional contextual variables in the model, which capture differences in local circumstances which might affect output levels. For example, the ability to raise user charges is clearly influenced by local income levels. However, because the core of the analysis is in effect an incremental model, and these contextual variables change only slowly, we do not believe that the exclusion of such environmental variables is likely to be a material influence on results.

The Malmquist productivity index for each county is presented in Table 1, alongside the various components of the index described earlier: the change in the level of pure technical efficiency, scale efficiency, and technological change.

On average, across all the counties, there has been a moderate increase in productivity of 1.4% per annum. There has been no detectable trend in levels of scale efficiency. Pure efficiency has declined by an average of 1.5% per annum, reflecting a growing divergence in efficiency between the efficient and inefficient counties. This may indicate, for example, that areas with efficient management already in place may have found it easier to reap any benefits (or avoid adverse consequences) associated with the community care reforms. The index of technological progress is 3.5% per annum, and is greater than one in thirty of the thirty and nine counties.

Table 2 presents the annual averages for each one of the years in the period under analysis. In common with other authors, we find the methodology yields very large fluctuations in year-on-year technology changes. However, the Malmquist Index shows a steady increase, from 0.7% in year 2 to 2.3% in year 5.

Using a bootstrapping methodology, it is possible to compute 95% confidence intervals around the estimates reported in Table 2 (Atkinson and Wilson, 1995). These should be viewed with extreme caution, as the estimator is inconsistent whenever there is

random error (as well as technical inefficiency) associated with the production frontier (Löthgren, 2000). This situation is almost certain to obtain in our example.

5. Discussion

This paper has sought to take advantage of routinely collected longitudinal data of a highly aggregate nature to determine whether an important policy innovation has had an effect on productivity. The methods used are based on rigorous economic theory, and are easy to apply. However, they rely on very rudimentary data, and so the results must be viewed with considerable reservations.

The principal role of the quasi-market in the public sector is to introduce competition into the supply of a service, and thereby (it is hoped) improve both its efficiency and effectiveness. In practice, it will always be exceedingly difficult to evaluate whether the introduction of such an instrument secures its objectives (Hoyes, et al., 1994). Reasons include:

- the introduction of the quasi-market may to some extent have been anticipated before its formal implementation, implying the need for a relatively long time series of data before implementation;
- the impact of the quasi-market may take some time to take effect, implying the need for a relatively long time series of data after implementation;
- change would have occurred in any case, and it is difficult to disentangle the element of technological change attributable to the social policy under evaluation;
- relevant data over the required time period may be limited in scope, based on small numbers of observations, and collected only at a highly aggregate level;
- the data may be of questionable quality (and indeed data recording may have been influenced by the introduction of the quasi-market);
- the transformation process (the mechanism whereby inputs are converted into outputs) may be poorly understood;
- the technical methodology used to detect change (in this case DEA) is highly imperfect and vulnerable to bias.

In principle it would be desirable to assess the impact of such important innovations by examining the services received by identical individuals before and after

implementation, ideally using controlled experimentation, and adjusting for independent changes in technology that would have taken place even without the reforms. Such a counsel of perfection is usually unattainable because of data shortcomings and prohibitive research costs. Instead, evaluation must frequently be based on coarse macro analyses of the sort presented here. The advantage of such methods is that they are intellectually coherent, rely on readily available data, and are very inexpensive to conduct. Disadvantages include the difficulty of modelling the phenomenon of interest properly (and thereby isolating effects that are attributable to the intervention) and vulnerability to data errors and omissions.

Further caution related specifically to this example must be noted. The variables we have been forced to use are clearly highly imperfect, most notably because they fail to capture changes in the *quality* of the outputs. Higher volume might be secured merely by compromising on quality, a phenomenon we are unable to detect. There is independent evidence to indicate that community care has led to some quality improvements, suggesting that productivity gains may have been higher than those detected here (Audit Commission, 1997). A further consideration is that the economic model deployed in this paper focuses on technical efficiency issues, and ignores the important issue of allocative efficiency, which plays a central role in the rationale for this policy reform.

Within these constraints, we have detected a small but sustained improvement in the productivity of social care for elderly people over the period under investigation. We cannot say with any confidence whether community care has had any material influence on this trend. However, it is probably reasonable to infer that it has had no dramatic influence on productivity, either positive or negative. The increased average levels of technical inefficiency detected over the study period indicate a growing divergence between the best and worst performers, suggesting that the new arrangements may have contributed to some growth in inequity between populations of different areas.

In spite of these rather modest conclusions we believe that – if viewed in the light of these methodological and data limitations – intertemporal productivity models offer some valuable insights into the impact of public policy initiatives on productivity. They extract important information from readily available datasets that would otherwise lie

undetected, and can be readily applied at very low cost. They require careful interpretation, and should never be used as the sole source of policy guidance, or to pass definitive judgement on individual organizations. However, if viewed as an important but essentially exploratory forms of data analysis, we believe such “low-tech” methodologies have much to commend them in situations where the alternative would be a complete absence of evidence.

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Table 1: Breakdown of Malmquist Index (annual average, 1992-1996)

	technical efficiency	technology	pure efficiency	scale efficiency	Malmquist Index
Avon	0.905	0.981	0.927	0.977	0.888
Bedfordshire	0.958	1.078	0.962	0.996	1.033
Berkshire	0.969	1.013	0.969	1.000	0.982
Buckinghamshire	0.998	1.024	1.014	0.985	1.022
Cambridgeshire	1.067	0.988	1.062	1.005	1.055
Cheshire	0.945	0.980	0.964	0.980	0.926
Cleveland	0.905	1.042	0.912	0.992	0.942
Cornwall	0.942	1.144	0.943	0.999	1.077
Cumbria	0.957	1.127	0.944	1.014	1.079
Derbyshire	0.983	1.013	1.000	0.983	0.996
Devon	0.945	1.022	0.985	0.959	0.966
Dorset	1.025	1.057	1.022	1.003	1.083
Durham	0.975	1.053	0.977	0.997	1.026
East Sussex	1.022	1.037	0.998	1.024	1.060
Essex	0.930	1.019	0.975	0.954	0.948
Gloucestershire	0.969	0.919	0.957	1.013	0.890
Hampshire	0.900	1.018	0.953	0.944	0.916
Hereford	0.957	0.984	0.961	0.996	0.942
Hertfordshire	0.904	1.075	0.919	0.985	0.972
Humberside	0.932	1.056	0.948	0.982	0.984
Isle of Wight	1.017	1.044	1.000	1.017	1.062
Kent	1.048	1.071	1.033	1.014	1.122
Lancashire	1.021	1.065	1.000	1.021	1.086
Leicestershire	0.993	0.981	0.993	1.000	0.975
Lincolnshire	1.018	1.063	1.014	1.004	1.081
Norfolk	1.015	1.006	1.021	0.994	1.021
Northamptonshire	1.020	1.004	1.026	0.994	1.024
Northumberland	0.975	1.084	0.984	0.991	1.056
North Yorkshire	1.000	1.132	1.000	1.000	1.132
Nottinghamshire	1.000	0.976	1.000	1.000	0.976
Oxfordshire	1.000	1.090	1.000	1.000	1.090
Shropshire	1.000	1.056	1.000	1.000	1.056
Somerset	1.000	0.857	1.000	1.000	0.857
Staffordshire	1.000	1.058	1.000	1.000	1.058
Suftolk	0.975	1.052	0.976	0.999	1.026
Surrey	0.963	1.101	0.992	0.970	1.060
Warwickshire	0.999	1.046	1.009	0.990	1.044
West Sussex	0.977	0.997	0.978	0.999	0.974
Wiltshire	0.990	1.087	0.986	1.004	1.076
Mean	0.979	1.035	0.985	0.994	1.014

Table 2: Malmquist indices; summary of annual means and lower and upper 95% confidence intervals (C_L and C_U)

Year	technical efficiency	technology	pure efficiency	scale efficiency	Malmquist Index
1992-1993	**0.967**	**1.041**	**0.966**	**1.000**	**1.007**
C_L	0.955	1.028	0.942	0.987	0.976
C_U	0.971	1.052	0.969	1.011	1.010
1993-1994	**0.999**	**1.010**	**1.000**	**0.999**	**1.009**
C_L	0.984	1.000	0.996	0.993	0.991
C_U	1.002	1.016	1.010	1.005	1.018
1994-1995	**1.056**	**0.965**	**1.051**	**1.005**	**1.018**
C_L	1.038	0.937	1.046	0.998	0.988
C_U	1.123	0.971	1.054	1.011	1.035
1995-1996	**0.903**	**1.133**	**0.927**	**0.974**	**1.023**
C_L	0.898	1.095	0.918	0.954	0.998
C_U	0.912	1.136	0.931	0.982	1.037
Mean	**0.979**	**1.035**	**0.985**	**0.994**	**1.014**

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