The Relative (in)Efficiency of South African Municipalities in Providing Public Health Care

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Abstract

Previous studies in South Africa have not dis-aggregated efficiency analysis across municipalities which are health system components of the broader national health system. The purpose of this paper is therefore to assess whether the relative efficiency of South African municipalities in primary health care and hospital care is different and whether South African municipalities can learn from each other to improve on their efficiency. The paper employs efficiency scores, estimated with Data Envelopment Analysis (DEA) using data from the District Health Barometer of the Health Systems Trust to rank South African municipalities across primary health care and hospital health care. The finding is that that the ranking of municipalities is not the same across both types of health care when efficiency scores and efficiency score growth are contemplated. These results imply that municipalities in South Africa are generally inefficient, but with the possibility of learning from each other's practice in order to increase their technical efficiency. The health system authority should monitor service-specific best practices among municipalities so that they can use them as practice guidelines for other municipalities.

JEL Codes: I 12

Key words: Municipalities, DEA, public, health care, technical efficiency, South Africa.

1 Introduction

South African territory is divided into municipalities, which are local political entities providing public services to the community. Municipalities in South Africa are sub-divisions of bigger political areas, these being the nine provinces. In 2011, South Africa had 44 district municipalities and 8 metropolitan municipalities (Monkam, 2014: 277). District municipalities provide services to the residents of rural settings and small towns, while metropolitan municipalities render services to the residents of major cities. Each district or metropolitan municipality is in turn subdivided into local municipalities such that in 2007 the country had a total of 226 local municipalities (Monkam, 2014:277). The analysis in this paper is limited to district and metropolitan municipalities.

Since the apartheid era, the organisation of municipal services has been inefficient either in terms of distribution of resources (Kirigia *et al.*, 2001: S2; Roux and Nyamukachi, 2005) or in actual delivery of services to the community (Buthelezi and Dollery, 2004). In 1994, following the fall of apartheid, a number of reforms were undertaken to address these inefficiencies (Roux and Nyamukachi, 2005). Among other reforms, municipalities were given some autonomy from the central government, such as autonomy in raising their own revenue and deciding on its use, as well as autonomy in making some decisions relevant to their circumstances (Nyalunga, 2006: 2). Moreover, to respond to the health care needs of the majority, a district health system in which primary health care takes priority over hospital health care was instituted (McLaren, 2008). In spite of these reforms, district municipalities continue to suffer recurrent public protests against poor service delivery (Dollery and Graves 2009:103; Bruce, 2014; Burger, 2009), suggesting the persistence of inefficiencies.

The concurrency of the above-mentioned autonomy with prevalent protests against poor service delivery by the public should have sparked research on the relative efficiency of municipalities. Surprisingly, however, only a few studies in this area have been conducted (VanderWesthuizen and Dollery, 2009; Financial and Fiscal Commission, 2011, Monkam, 2014; Mahabir, 2014). Using Data Envelopment Analysis (DEA) on a cross-sectional data set over the period 2006/2007, VanderWesthuizen and Dollery (2009) evaluated the productive efficiency of 231 local municipalities and 46 district municipalities, comparing average scores across provinces. They found that the average score ranged from 0.512 in the Eastern Cape to 0.667 in Gauteng. A study by Monkam (2014), using a second-stage Tobit regression on efficiency scores, assessed the technical efficiency of spending in 231 municipalities on services including water and electricity. The study found that some of these municipalities could have obtained the same level of services with about 80% fewer resources. Most recently, a study quantifying the inefficiency of such spending with free disposal hull (FDH) techniques in a sample of 129 local municipalities, found that most local municipalities can achieve the same level of output with 50% less resources (Mahabir, 2014). These studies are not enough for a problem as important as the inefficiency of municipalities in South Africa. The need for further studies is supported by the evidence that municipal fiscal management autonomy and the administrative skills of municipal managers influence the productive efficiency of municipalities in South Africa (Monkam, 2014:275), and by the fact that these management styles and skills cannot be expected to be the same.

In the health care sector, the inefficiency reported by studies in Africa (Kirigia, 2002; Kirigia *et al.*, 2004; Kirigia *et al.*, 2007; Masiye, 2007; Osei *et al.*, 2005) applies also to South Africa. For instance, in their study comparing technical efficiency among 155 public primary health care clinics in KwaZulu-Natal, Kirigia *et al.* (2001) found that only 30% were technically efficient. The study recommended more studies of this kind in other provinces in the country. A study by Kibambe and Koch analyzed the efficiency of public hospitals in Gauteng and found that they were inefficient (Kibambe and Koch, 2007). To our knowledge, the inefficiencies in the health sector have been reported only across facilities rather than across municipalities, which have been considered as health systems within a broader national health system (Balfour, 2004:4)

Whilst no research in South Africa has analysed the inefficiency of the health care system in the manner this study intends to do it, evaluations of inefficiency at the health system level have, in contrast, been prevalent elsewhere (see for example, Hitiris and Posnett, 1992; Babazono and Hilman, 1994; DeRosario, 1999; Thornton 2002). In particular , more recent times have seen an increase in such studies (Anton, 2013; Anton and Onofrei, 2012; Asiskovitch, 2010; Akazili *et al.*, 2008; Raguseo *et al.*, 2007; Grosskopf *et al.*, 2006), following the fact that the way the health system is organized is material to the overall output achieved in the health sector. Analyses of the inefficiency of health systems in other countries have, however, focused on cross-country comparisons of efficiency rather than on efficiency of health system components within the same country.

Therefore, this paper contributes to the literature on South Africa by comparing inefficiency at a municipal level, and contributes also to the international literature by comparing inefficiency across the components of the health system within a single country, in this case, South Africa. Specifically, the study sets out to compare the relative efficiency of municipalities across primary health care and hospital health care services. This approach to the analysis of efficiency is motivated by the prevalence of some management autonomy among municipalities in allocating resources to these types of health care services and the need to determine whether municipalities can learn from each other's practice related to these types of health care. The approach is also motivated by a different emphasis placed on these two types of health care by national policy makers in South Africa. The study compares further the relative efficiency and relative efficiency growth among municipalities, an approach motivated by the evidence of very low efficiency coupled with some autonomous decision making at a municipal level, which make plausible the assumption that there will be potential fluctuations of efficiency from one year to the next and across municipalities. Such an assumption implies that even municipalities that are relatively efficient in the mathematical sense of the term (efficiency score =1) at one point in time, may still have room to improve on their relative efficiency in the conceptual sense of the term. These analyses are conducted by using Data Envelopment Analysis (DEA).

2 Materials and methods

2.1 *Data envelopment analysis*

DEA is a non-parametric technique, developed by Charnes *et al.* (1978) and extended by Banker *et al.* (1984), which has been applied extensively to analyze the technical efficiency of decision-making units (DMUs). DEA has been used in a variety of sectors. See for instance its use by, Taylor and Harris (2004) Cullinane and Wang (2010), and by Wanke (2012). While the DEA methodology has been upgraded with recent applications including different approaches to measuring efficiency such as bootstrapping estimates to allow sophisticated testing (see Wanke, 2012, for example), the DEA methodology still continues to be used in its original format (see Wang *et al,* 2013, for an example of the most recent use).This paper did not intend to make a methodological contribution and therefore used the original DEA specification.

DEA analyses technical efficiency by comparing the ratio of weighted outputs (virtual output) to weighted inputs (virtual input) for each of the DMUs, to the ratios of homogeneous DMUs on the "best practice" frontier. DEA does a relative comparison of technical efficiency by assigning an efficiency score of 1 to DMUs with the highest ratios, that is, on the frontier; and a related score (less than 1) to each DMU not on the frontier. A DMU is judged efficient if it obtains a score of 1 and inefficient if it obtains a score of less than 1. The extent to which a score of a DMU is less than 1 reflects how long is the radial distance of that DMU to an estimated production frontier (Farrell, 1957). In assigning the weights to inputs and outputs of a DMU, DEA maximizes the ratio of outputs to inputs for that DMU provided that the score attributed to that ratio, in relation to the scores of other DMUs, does not exceed 1. To determine the highest score for n DMUs, the relative technical efficiency is estimated, for each test DMU with i inputs and r outputs, by solving the problem in Model 1, as suggested by Charnes et al. (1978).

Model 1. DEA ratio model

$$Max\ ho = \frac{\sum_{r=1}^{s} u_r y_{rjo}}{\sum_{i=1}^{m} v_i x_{ijo}} \tag{1}$$

Subject to

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} <= 1 \tag{2}$$

$$u_r >= 0, r = 1, \ldots, svi >= 0, i = 1, \ldots, m \tag{3}$$

Where:

ho is the efficiency score of the test DMU jo,

j is a given DMU ranging from $1, 2, \ldots jo, \ldots$to $.n$

y_{rj} is the amount of output r produced by DMU j

x_{ij} is the amount of input i used by DMUj

u_r is the weight given to output r, this weight must be greater than 0

$v_i =$ is the weight given to input i, this weight must be greater than 0

DEA solves the problem by finding the highest score of each DMU given the weights assigned to inputs and outputs. To solve the fractional problem in Model 1 with linear programming methods, it needs to be transformed into a linear programming problem as in Model 2 below.

Model 2: DEA linear model

$$Max\ ho = \sum_{r=1}^{s} u_r y_{rjo} \tag{4}$$

$$Subject\ to \sum_{i=1}^{m} v_i x_{ijo} = 1 \tag{5}$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i}^{m} v_i x_{ij<} <= 0, j = 1, \dots m \tag{6}$$

$$u_r, v_i >= 0$$

The technology embedded in the problem in Model 1, as formulated by Charnes *et al.* (1978), is a constant returns-to-scale (CRS) technology. In 1984, the problem in Model 1 was extended by Banker *et al.*, (1984) to take account of both CRS and variable return-to-scale (VRS) technology. The linear formulation of the problem suggested by Banker *et al.* (1984) is written in Model 3.

Model 3. DEA linear model with constant and variable returns-to-scale technology

$$Max\ ho = \sum_{r=1}^{s} u_r y_{rjo} + z \tag{7}$$

$$Subject\ to \sum_{i=1}^{m} v_i x_{ijo} + z_{jo} = 1 \tag{8}$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i}^{m} v_i x_{ij<} + z_{jo} <= 0, j = 1, \dots m \tag{9}$$

$$u_r, v_i >= 0$$

Where:

Z_{jo} is a term reflecting VRS technology. Z_{jo} can take a zero, positive or negative value depending on whether inputs and output data reflect CRS, increasing returns-to-scale (IRS) or decreasing returns-to-scale (DRS) technology. The model can be used to control inputs (input oriented analysis) or output (output oriented analysis) to increase efficiency. The problem in Model 3 is run n times in identifying the relative efficiency score of all DMUs.

Model 3 has been mainly used to analyse the cross-sectional efficiency of DMUs, that is, efficiency of DMUs observed at one point in time (Wei, 2006: 317). Sometimes, however, an inefficient DMU in current time may be efficient in the future when the excessive use of inputs currently aims to increase future output. In such cases, efficiency estimation needs to cover longer periods. To do this estimation in DEA, the problem in Model 3 has been solved using the window approach described in the literature (see Cullinane and Wang, 2010, for example). This approach consists of comparing efficiency scores of DMUs in each of the successive sub-periods (windows) of the whole period of observation. These sub-periods are determined by taking into consideration the period required for DMUs to implement technological changes. This comparison entails considering each DMU as a different DMU at each time point in the window, such that the technical efficiency of a given DMU is estimated in relation to all observations at different time points in that window.

Formally, let T be a period with sub-periods t1, t2 . . . to tn. Let a window w be defined as a period of three sub-periods. Then, the relative efficiency of a given DMU is estimated in moving windows: t=t1 to t=t3, t=t2 to t=t4, t= t3 to t5, . . . tn-2 to tn. The relative efficiency of a DMU at a sub-period starting a window is estimated in relation to all DMUs in that window because at each sub-period, each DMU is considered as a different one. The efficiency scores at successive sub-periods of T can then be used to estimate the average efficiency scores or average efficiency scores growth rate in period T (For more on window analysis in DEA, see Yang and Chang , 2009; Pjevèeviæ,*et al.* 2010; Al-Eraqi *et al.*, 2008, among many others).

2.2 *Data collection and analysis*

The data used were extracted from the District Health Barometer (DHB), published by Health System Trust (n.d) in South Africa. The reporting format of DHB data has been improving over time and as a result, most of the input and output variables were not measured similarly over time. Although DEA methodology is expected to standardize different units of measurements of inputs and outputs in the comparison process (Cherikh *et al.,* 2004), the acknowledgment of confounding factors required a prior standardization of measures of input and output, before using them in comparison. The process entailed using measures such as proportions, percentages and rates, to take into account different sizes of municipalities in terms of population or burden of diseases and other factors specific to municipalities, such as socio-economic conditions. The standardization also involved the exclusion of output measures such as mortality and bed occupancy rates which might be not fully under the control of municipality management and are therefore likely to confound efficiency estimates. Since these output measures depend on the burden of diseases and are most likely to be influenced by socio-economic and environmental conditions specific to municipalities, they were not used as measures of output in the interest of standardization.

The chosen inputs and outputs were as typical as possible of the inputs and outputs used in primary health care and hospital health care. As a matter of fact, each type of health care uses both administration inputs and medical inputs. So, the input used in each type of health care reflected a proportion of medical expenditure on each type of health care and a proportion of management expenditure on that type of health to reflect the use of administration and medical resources. Similarly, the choice of output indicator variables were guided by their representation of typical output in each type of health care, and hence, since the bulk of primary health care services go to the general population, including services to women and children, the study used primary health care utilization rates, antenatal services utilization rates, and immunization rates as output variables to represent these services. Furthermore, general hospitalization services were represented by usable bed rates, the lengths of stay, while typical hospital services such as surgery were represented by Caesarean section completion rate. It is worth noting that the variables used are typical of variables used in other literature analyzing efficiency of health care systems (Benneyan et al., 2007, 254; Anton and Onofrei, 2012, for example). Since the lower the average length of stay (output variable in hospital) the greater efficiency, the study used the inverse of the original data of average length of stay so that it relates positively to inputs, as has been the practice in the literature (see Anton 2013: 32, for example). The inputs and outputs variables used are summarized in Table 1.

Even though, currently, the country counts 44 districts and 8 metropolitan municipalities (Monkam, 2014), this study covers 45 municipalities, that is, 40 district municipalities and 5 metropolitan municipalities. Seven municipalities were excluded due to either missing data records for the whole period of analysis or to inconsistent naming throughout the period as a result of changes in the naming of municipalities, due in turn to changes in the geographical demarcation of these municipalities (Monkam, 2014). Municipalities excluded on these grounds were: Dr K Kaunda, Buffalo City, NM Molema, Mangaung, RS Mompati (DC), JT Gaetsewe, and Joe Gqabi.

To compare relative technical efficiency across primary health care and hospital health care, efficiency scores of municipalities for both types of health care were calculated by solving the problem in Model 3. We adopted an input-orientated model because the social aspect of health services implies that municipalities should strive to control inputs to maximise outputs. The efficiency scores for the period 2005-2012, expressed out of 100, were estimated using average values of annual indicators of inputs and outputs in that period, which were standardized before being used in the comparison. Then these efficiency scores were used to rank municipalities in primary health care and hospital health care.

To compare the technical efficiency of municipalities across perspectives of efficiency, notably efficiency and efficiency growth, the annual efficiency scores of each municipality were estimated over the period 2005-2012 in each type of health care, using a window of three years and solving the problem in Model 3. The window of three years was based on the fact that municipalities can significantly change their spending plans in three years, to line up with the medium-term expenditure framework (MTEF), which are three-year rolling plans of spending and revenue for national and local governments (Robinson, 2002). Annual efficiency scores over the period were used to calculate the average efficiency scores and average efficiency score growth rates. These analyses were conducted using MaxDEA software.

The ranking was done as follows: for each type of health care, efficiency scores of municipalities were used to create intervals of efficiency. Likewise, for each type of efficiency perspective (efficiency and efficiency growth), average efficiency scores and average efficiency score growth rates were used to create intervals of efficiency. Ranked in descending order of efficiency scores, these intervals are Interval 1, Interval 2, Interval 3 and Interval 4 (see Table 2). The ranking of municipalities is compared within a given interval across both types of health care and across both perspectives of efficiency. We used interval ranking rather than individual ranking to facilitate the interpretation of change in inefficiency of municipalities across primary health care and hospital health care and over time. The ranking of a municipality in the same interval of efficiency across types of health care means no change in efficiency while the opposite is considered to be a change in efficiency.

3 Results

The same technical efficiency ranking of municipalities across primary health care and hospital health care implies that the ranking of the municipalities for combined health care (primary health care and hospital health care) is the same as the ranking for each type of health care. So, a preliminary step for gaining insight into how the technical efficiency of municipalities compares across primary health care and hospital health care, was to analyze whether there is change in the efficiency ranking of municipalities when combined health care is compared with each type of health care.

Table 3 shows the technical efficiency ranking of municipalities based on combined health care. As can be seen, 17 municipalities are in the top interval of efficiency scores (Interval 1) while 5 municipalities are in the bottom interval of efficiency (Interval 4). Furthermore, municipalities occupy different ranks within created intervals. Top ranked municipalities (Interval 1) have an efficiency score ranging from 100 to 92.1 while bottom ranked municipalities have efficiency scores ranging from 84.2 to 72.0.

The technical efficiency ranking of municipalities per type of care would be the same as the technical efficiency ranking of municipalities for combined health care, if each municipality is equally efficient across each type of care, that is, it occupies the same rank regardless of the type of health care. A ranking for each type of health care that differs from the ranking for combined health care would indicate a difference in technical efficiency across the types of health care.

The technical efficiency rankings of municipalities for each type of health care are shown in Table 4. Even though some municipalities in Interval 1 in primary health care (with code 0) were also in the same interval in combined health care (see Table 3 above), new municipalities occupy ranks in Interval 1. These municipalities are coded with a plus sign indicating that they moved up the rank in primary health care compared to their ranking in combined health care. For instance, Uthukela moved up the rank from Interval 4 in combined health care to Interval 1 in primary health care, that is three intervals up (hence the code+3). By the same token, new municipalities are in Interval 4 when the technical efficiency in primary health care is considered. For instance, a municipality such as Xhariep, which was in Interval 1 in combined health care, is now in Interval 4 in primary health care, a decrease in efficiency to the 4^{th} interval, that is a decrease in efficiency three intervals down (hence the code -3). Even in other intervals, many municipalities have a code different from zero, meaning that they have changed their efficiency ranking from combined health care to primary health care. These results apply to hospital health care. The fact that some municipalities change their technical efficiency ranking from combined health care to each type of health care, indicates that these municipalities are not equally efficient across each type of care.

The difference in the technical efficiency ranking of municipalities across primary health care and hospital health care is made clear when a comparison of ranking is made across types of health care. Table 4 shows that only a few municipalities occupy the same rank across primary health care and hospital health care (under the heading: *ranking is the same* in each interval). For example, only four municipalities: Lejweleputswa, uMgungundlovu, Umkhanyakude, and Uthungulu belong to Interval 1 in both primary health care and hospital health care, while the majority of municipalities in that interval are not the same across primary health care and hospital health care. It should be noted that this pattern is observed in other intervals of efficiency scores, confirming that, indeed, the technical efficiency ranking of municipalities is not the same across primary health care and hospital health care.

The most efficient municipalities may not necessarily be the municipalities with the most efficiency growth rates. To assess to what extent this is the case in South Africa, municipalities were ranked according to the average efficiency score and according to the average efficiency score growth for each type of health care. Table 5 shows such rankings for primary health care.

Table 5 also shows that only very few municipalities occupy the same interval ranking across both perspectives of efficiency (efficiency and efficiency growth). In Interval 1, for example, only two municipalities, Uthukela and Sedibeng, occupy the same interval ranking across both perspectives of efficiency. In Interval 4, only one municipality is ranked in the same interval across efficiency and efficiency growth perspectives. In contrast, most of the municipalities are ranked in different intervals of efficiency across the two perspectives.

Comparing the ranking of municipalities across efficiency and efficiency growth perspectives for hospital health care, the results look similar to the results for primary health care. Table 6 shows that very few municipalities are in the same interval of efficiency across the two perspectives. In Interval 1, four out of 12 municipalities ranked in that interval on the basis of efficiency growth, belong to the same interval when ranking is done on the basis of efficiency only. All other municipalities are in higher efficiency intervals when ranking is done on the basis of efficiency growth, than when it is done on the basis of efficiency only. Municipalities such as Zululand, Bojanala, Ugu and Sisonke on the lowest interval of efficiency (Interval 4) in the case of ranking by efficiency, belong now to the top interval of efficiency (Interval 1) in the case of ranking by growth in efficiency, therefore moving up three intervals of efficiency (code +3). This analysis applies to the ranking in Interval 4 for efficiency growth, in which municipalities decrease their ranking in relation to the ranking they occupied when efficiency was considered. Some of the municipalities, such as Central Karoo, decrease efficiency to Interval 4 in the efficiency growth perspective from Interval 1 in the efficiency perspective, therefore moving three intervals down. More generally, Table 6 shows that municipalities change their ranking from one perspective to another.

In line with the purpose of the paper, that is whether or not municipalities in South Africa should learn from the "best practice" of a set of the most efficient municipalities or from each other, the paper sought to synthesize the above results to this end in Table 7. As the table shows, very few municipalities emerge as a benchmark (in Interval 1) for other municipalities in each comparison, and very few or no municipalities emerge as the worst performing (Interval 4) in each comparison (See columns 2, 3, 4 of Table 7). Furthermore, no municipality emerges as the highest performing (in Interval 1) in all comparisons and no municipality emerges as the worst performing (Interval 4) in all comparisons (see column 5 of Table 7). These results suggest that municipalities are generally underperforming and can learn from each other's practice to improve their technical efficiency. The evidence suggests also that the efficiency of municipalities depends on the point of view of the type of efficiency under review.

4 Discussion of the results

Poor services delivery by municipalities in South Africa continues to be a cause of great concern as indicated by recurrent public protests. Therefore, the need to address these inefficiencies motivated this paper. Specifically, the paper sought to answer the question of whether or not the efficiency ranking of municipalities in South Africa was consistent across primary health care and hospital health care in the period of analysis. It was the expectation of the study that this answer would help determine whether municipalities can improve efficiency by learning from each other's practice or whether a set of municipalities would serve as a benchmark for "best practice" for others. The evidence from the literature that municipalities with more resources use their additional resources less efficiently than the less well-off municipalities (Mahabir, 2014) provided plausible grounds for the research.

The results obtained indicate that the ranking of each type of health care was different from the ranking for combined health care (primary health care and hospital health care). The fact that most municipalities changed their technical efficiency ranking for combined health care to each type of health care indicates that these municipalities are not equally efficient across each type of care. This evidence was supported by other evidence in the study that only very few municipalities remained in the same interval ranking across the two types of health care. These results suggested that the most efficient municipalities in primary health care are not necessarily the most efficient in hospital health care.

The other question of interest to the study was whether or not municipalities with the highest level of efficiency over the period of analysis have also a high level of efficiency in all sub-periods of the analysis, in other words, whether municipality ranking was the same when efficiency and efficiency growth were contemplated. This analysis would appear less relevant in the first place because it is obvious that the least efficient municipalities have room to grow their relative efficiency faster than the relatively efficient ones. However, in the case of South Africa where efficiencies of municipalities are not only low but are also likely to fluctuate very much because of variations in management decisions and priorities over time, this analysis was pertinent.

The evidence emerging from these analyses was that only very few municipalities occupied the same ranking when efficiency level and efficiency growth were considered (Table 5). The synthesis of these results (Table 7) showed that very few municipalities emerged as a benchmark (Interval 1) for other municipalities in each comparison and very few or no municipalities emerged as worst performing (Interval4). This evidence indicated that ranking of municipalities across efficiency and efficiency growth perspectives was not consistent.

These results have provided answers to the study's initial research question as to whether or not municipalities can learn from each other practices or a set of municipalities can serve as a benchmark for practices for others. The different ranking of municipalities, with no set of municipalities being ranked consistently across primary health care and hospital health care or across efficiency and efficiency growth, implies that municipalities can learn from each other's practice. Municipalities which do not perform well in primary health care can learn from municipalities which are doing well on hospital health care and vice versa, to improve their respective practices. Furthermore, the inconsistent ranking of municipalities on the basis of relative efficiency and relative efficiency growth implies that even municipalities that emerge as efficient, have something to learn from the practices of municipalities that are relatively less efficient but whose efficiency growth is faster in some sub-periods.

One would wonder why such a result is observed. Taking into account the reported very low level of efficiency, some autonomous decision making in resource allocations and the dynamic nature of this decision making among municipalities, can be thought of as factors underlying the observed evidence. The inconsistent ranking of municipalities across primary health care and hospital health care can be interpreted as resulting from the fact that municipal managers prioritize primary health care and hospital health care on a discretionary basis, leading to observed differences in ranking. While the inconsistent ranking across types of health care can arise from decision making based on different priorities, the different ranking across efficiency levels and efficiency growth is likely to be explained by the changes in these priorities or decisions over time. In fact, municipal management is expected to respond to criticism related to inefficiency and to public protest pressure to address municipality inefficiencies. As management responds, however, they introduce new forms of inefficiencies because their responses are based on strategies that are not carefully crafted due to skills deficiencies. As a result, the effectiveness of the strategies is random, hence the ups and downs in the efficiency with which the two types of health care are provided. These fluctuations are likely to aggravate the inefficiency and are therefore considered to be further evidence of inefficiency among South African municipalities.

The inefficiency among public institutions providing health care is not unique to South Africa. Previous studies analysing efficiency in health care in African countries, found that there was a great deal of inefficiency in the health sector. Analysing the technical efficiency of 89 public health centres in Ghana, a study found that 65% of the health centres were technically inefficient as they used more inputs than required (Akazili *et al.*, 2008: 1). In South Africa, similar results were reported in a study which analysed the technical efficiency of 155 primary health care clinics and found that 70% of these clinics were technically inefficient. While the study did not explore factors that might explain inefficiency, it was pointed out that it was important to explore such factors in future (Kirigia *et al.*, 2001:S2).Other studies in South Africa concluded that the facilities studied were inefficient (Zere *et al.*, 2001; Kibambe and Koch, 2007) and this has reinforced the existing evidence of inefficiency.

While this study's evidence is in line with the findings of previous studies, it is worthwhile to highlight its contribution to the literature. Thus far, most of the studies on the efficiency of the health sector in Africa (Kirigia *et al.*, 2001; Kirigia *et al.*, 2004) and South Africa (Zere *et al.*, 2001; Kibambe and Koch, 2007,) have been conducted at a facility level and not at a health system level. The analysis at the latter level has recently been considered very important because of the belief that a well organised health system is material to desirable health outcomes. Even those studies conducted at a health system level were not meant to yield policy implications of the same nature as the policy implications of this study. These studies conducted cross-country comparisons (Kirigia *et al.*, 2007; Verhoeven *et al.*, 2007; Mirmirani *et al.*, 2008; Grigoli, 2012; Borisov *et al.*, 2012; Häkkinen and Joumard, 2007) with policy implications not easily implementable, as the "best practice" health systems were outside of the control of the national health system authorities. To our knowledge, this is the first paper to analyse, within South Africa, the efficiency of health care provision at a health system level using broad health care sector indicators, such as proportions of expenditure, and primary health care utilization rates as input and outputs in the estimation of efficiency scores. Hence, in our view, this paper constitutes a significant contribution to the literature.

This contribution, and particularly the finding that municipalities can learn from each other's practice within the same health care system, that is the South African health system, is important for policy making and strategies. By showing that fluctuations of efficiency across primary health care, hospital health care and over time aggravates inefficiency, the paper can alert the national policy makers to policy avenues that can improve health system components, namely, the municipalities, over which the national policy makers have control. Indeed, the policy makers could survey the factors that resulted in desirable fluctuations (reduction of inefficiency) in these municipalities and use them to compile guidelines for the "best practice" for all municipalities

Finally, the results of this study need to be understood within the limitations of the study. One of the most important limitations of the study was that it used only representative inputs and outputs for each type of health care. It would have been better to include all input and output variables, but these were not reported in a standard manner in the District Health Barometer. Furthermore, some output measures, such as health-outcomes measures, are under contention (Kirigia al., 2007:3) and could not be used. Yet these health outcomes measures are expected to be the ultimate output of any health care sector. In more recent studies, the inefficiency is considered more as a random variable and parametric methods have proliferated to reflect this fact. While the results provided some evidence, further studies addressing the above-mentioned limitations are recommended.

Summary

This paper applied the most widely used DEA, but it applied it to two different health "goods" across municipalities in South Africa. The paper finds that there are indeed inefficiencies, and that these inefficiencies are not similarly "ranked" across the two health "goods". We argue that this information provides a great opportunity for municipalities to learn from one another.

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Table 1: Inputs and output used in the analysis

Primary health care services	
Inputs	Outputs
- Proportion of district health expenditure on primary health care -Proportion of district health expenditure on management - Primary health expenditure per capita	- immunization rate - antenatal service usage rate - primary health care usage rate
Hospital services	
- Proportion of District health expenditures on hospital services - Proportion of district health expenditure on management	- Usable bed rate - Average length of stay - Caesar section

*__Source:__ Health System Trust. www.hst.org.za

Table 2: Interval of efficiencies used to rank municipalities in South Africa

Interval 1 Highest efficiency scores	Interval 2	Interval 3	Interval 4 Lowest efficiency scores
75th percentile efficiency score or above	*50th percentile of efficiency scores or above but less than75th percentile*	*25thpercentile of efficiency scores or above but less than 50th percentile*	*Below 25th percentile of efficiency scores*

*__Source__: authors

Table 3: Technical efficiency ranking of municipalities for combined care

Interval 1			**Interval 2**		
CPT	Cape Town	100	DC42	Sedibeng	90.3
DC10	Cacadu	100	DC44	A Nzo	90.3
DC1	West Coast	100	DC47	Greater Sekhukhume	89.1
DC12	Amathole	100	DC35	Capricorn	89.0
DC18	Lejweleputswa	100			
DC20	Fezile Dabi	100	**Interval 3**		
DC2	Cape Winelands	100	DC32	Ehlanzeni	88.9
DC22	UMgungundlovu	100	DC13	Chris Hani	87.2
DC24	Umzinyathi	100	DC48	West Rand	87.2
DC 25	Amajuba	100	DC19	Thabo Mofutsanyane	86.4
DC26	Zululand	100			
DC27	Umkhanyakude	100	**Interval 4**		
DC28	Uthungulu	100			
DC29	iLembe	100	DC43	Sisonke	84.2

DC30	Gert Sibande	100	DC23	Uthukela	83.0
DC3	Overberg	100	DC37	Bojanala platinum	79.4
DC33	Mopani	100	TSH	Tswane	72.5
DC34	Vhembe	100	DC15	O.R. Tambo	72.0
DC36	Waterberg	100			
DC4	Eden	100			
DC5	Central Karoo	100			
DC6	Namakwa	100			
DC7	Pixley Kaseme	100			
DC8	Siyanda	100			
DC9	France Baard	100			
ETH	eThekwini	100			
JHB	City of Johannesburg	100			
NMA	Nelson Mandela Bay	100			
EKU	Ekurhuleni	99.7			
DC21	Ugu	98.7			
DC16	Xhariep	95.9			
DC31	Nkangala	92.1			

*__Source__: Estimates based on data from the Health System trust.

Table 4: Service-specific change in efficiency ranking in relation to overall efficiency ranking: average efficiency scores 2005-2012

Primary health care

Interval 1	score	change
**Ranking is same*		
DC18 Lejweleputswa	100	0
DC21 Ugu	100	0
DC22 UMgungundlovu	100	0
DC27 Umkhanyakude	100	0
DC28 Uthungulu	100	0
**Ranking is different*		
DC10 Cacadu	100	0
DC23 Uthukela	100	+3
DC26 Zululand	100	0
DC29 iLembe	100	0
DC3 Overberg	100	0
DC34 Vhembe	100	0
DC35 Capricorn	100	+1
Dc4 Eden	100	0
DC42 Sedibeng	100	+1
DC44 A Nzo	100	+1
DC8 Siyanda	100	0
JHB City of Johannesburg	100	0
Interval 2		
**Ranking is the same*		
DC7 Pixley Kaseme	98.6	-1
DC1 West Coast	98.2	-1
DC5 Central Karoo	97.4	-1
**Ranking is different*		
DC24 Umzinyathi	98.7	-1
DC33 Sekhukhume	98.5	0
DC48 West Rand	97.9	+1

Interval 3		
**Ranking is same*		
DC19 Thabo Mofutsanyane	96.0	-1
**Ranking is different*		
CPT City of Cape Town	96.8	-2
DC43 Sisonke	96.8	+1
DC6 Namakwa	96.0	-2
DC9 France Baard	94.5	-2
NMA Nelson Mandela Bay	94.4	-2
DC15 O.R. Tambo	94.3	+1
DC20 Fezile Dabi	94.0	-2
ETH eThekwini	93.6	-2
Interval 4		
**Ranking is the same*		
DC37 Bojanala Platinum	90.8	0
DC47 Greater Sekhukhume	90.8	-2
DC32 Ehlanzeni	89.3	-1
DC36 Waterberg	87.6	-3
**Ranking is different*		
DC13 Chris Hani	92.9	-1
DC16 Xhariep	92.6	-3
EKU Ekurhuleni	91.6	-3
DC25 Amajuba	88.7	-3
TSH Tswane	88.3	0
DC30 Gert Sibande	85.3	-3
DC31 Nkangala	83.5	-3
DC12 Amathole	81.5	-3

Hospital care

Interval 1:		
** ranking is the same*		
DC18 Lejweleputswa	100	0
DC21 Ugu	100	0
DC22 UMgungundlovu	100	0
DC27 Umkhanyakude	100	0
Dc28 Uthungulu	100	0
**Ranking is different*		
CPT Cape Town	100	0
DC20 Fezile Dabi	100	0
DC2 Cape Winelands	100	0
DC31 Nkangala	100	0
DC6 Namakwa	100	0
DC9 Frances Baard	100	0
ETH: eThekwini	100	0
JHB City of Johannesburg	100	0
NMA Nelson Mandela Bay	100	0
Interval 2		
** Ranking is the same*		
DC7 Pixley Kaseme	93.4	-1
DC1 West Coast	99.1	-1
DC5 Central Karoo	97.2	-1
**Ranking is different*		
EKU Ekurhuleni	99.7	-1
DC29 iLembe	99.3	-1
DC8 Siyanda	99.3	-1
DC4 Eden	96.2	-1
DC16 Xhariep	93.2	-1
DC42 Sedibeng	90.3	0

Interval 3		
**Ranking is the same*		
DC19 Thabo Mofutsanyane	85.6	-1
**Ranking is different*		
DC26 Zululand	89.8	-2
Dc24 Umzinyathi	87.2	-2
DC30 Gert Sibande	87.2	-2
DC34 Vhembe	86.4	-2
DC12 Amathole	85.2	-2
DC23 Uthukela	84.5	+1
DC48 West Rand	84.4	0
DC31 Nkangala	83.7	-2
DC21 Ugu	82.9	-2
DC33 Sekhukume	82.3	-1
Interval 4		
**Ranking is the same*		
DC37 Bojanala platinum	79.4	-0
DC47 Greater Sekhukhume	82	-2
DC32 Ehlanzeni	80.7	-1
DC36 Waterberg	74.5	-3
**Ranking is different*		
DC10 Cacadu	80.1	-3
DC35 Capricorn	80.1	-2
DC43 Sisonke	77.7	0
DC13 Chris Hani	77.3	-1
DC44 A Nzo	75.5	-2
TSH Tswane	73.5	0
DC15 OR Tambo	68.1	0

***Source:** Estimates based on data from the Health System Trust (publications from various years). Code 0 means no change from combined health care ranking to per type of health care ranking. Code number with minus sign mean that, in relation to combined health care, the municipality decreased in efficiency ranking by that number of intervals. The code number with a plus sign means that in relation to combined health care, the municipalities increased in efficiency ranking by that number of intervals.

Table 5: Change in technical efficiency ranking of municipalities based on perspective of efficiency (2005-2012): primary health care

Average efficiency scores

Interval 1		
**Ranking is the same*		
DC23	Uthukela	93.83
DC42	Sediberg	92.49
**Ranking is different*		
DC34	Vhembe	94.38
DC7	Pixley Kaseme	93.29
Eth	Ethekwini	93.01
Dc21	Ugu	92.84
DC5	Central Karoo	92.59
NMA	Nelson mandela Metro	92.28
DC9	France Baard	92.20
DC35	Capricorn	91.72
DC4	Eden	90.79
DC22	Umgungundlovu	90.45
Interval 2		
**Ranking is the same*		
DC24	Umzinyathi	89.78
DC33	Mopani	86.70
DC29	Ilembe	86.58
**Ranking is different*		
Dc3	Overberg	90.09
DC8	Siyanda	89.54
DC27	Umkhanyakude	89.40
DC18	Lejwebutsa	87.78
Dc28	Uthungulu	87.03
Dc48	West rand	86.78
JHB City	Johananesburg	86.66
DC44	Nzo	86.47

Interval 3		
**Ranking is the same*		
DC20	Fezile Dabi	86.07
DC1	west coast	86.03
DC10	Cacadu	84.73
Dc15	Or Tambo	84.37
DC30	Sibande	83.00
DC13	Chis Hani	83.77
**Ranking is different*		
DC47	Sekhukume	86.19
Dc43	Sisonke	85.03
CPT	Cape Town	84.92
DC19	Thabo Mofutsanyane	84.61
DC26	Zululand	83.48
Interval 4		
**Ranking is the same*		
DC16	Xhariep	81.98
**Ranking different*		
DC2	Cape Winelands	82.34
DC25	Amajuba	81.36
DC32	Ehlanzeni	80.46
TSH	Tswane	80.15
DC36	Waterberg	78.91
DC6	Namakwa	78.13
EKU	Ekurhuleni	78.11
DC12	Amathole	77.43
DC31	Nkangala	76.53
DC37	Bojanala	76.30

Average efficiency scores growth rates

Interval 1	GR	code
**Ranking same*		
DC23 Uthukela	6.59	0
DC42 Sedibeng	4.18	0
**Ranking different*		
DC48 West Rand	11.89	+1
DC28 uThungulu	4.13	+2
DC 18 Lejwebutsa	4.33	+1
JHB City of Johannesburg	6.57	+1
DC36 Waterberg	6.32	+3
EKU Ekurhuleni	6.04	+3
DC26 Zululand	6.04	+2
DC19 Thabo Mofutsanyane	4.70	+2
Dc27 Umkanyakude	4.64	+1
DC37 Bojanala Platinum	4.57	+3
Interval 2		
**Ranking is the same*		
DC24 Umzinyathi	2.68	0
DC33 Mopani	2.59	0
DC29 iLembe	2.67	0
**Ranking is different*		
DC6 Namakwa	4.05	+2
DC32 Ehlanzeni	2.60	+2
TSH Tswane	2.01	+2
DC43 Sisonke	1.31	+1
DC21 Ugu	1.12	-1
CPT Cape Town	1.02	+1
DC31 Nkangala	0.98	+2
DC25 Amajuba	0.88	+2

Interval 3	GR	code
Dc20 Fezile Dabi	-0.26	0
DC1 West Coast	-0.72	0
DC10 Cacadu	-1.22	0
DC15 OR Tambo	-2.02	0
DC30 Gert Sibande	-0.34	0
DC13 Chris Hani	-0.55	0
**Ranking different*		
DC9 France Baard	-1.90	-2
ETH Ethekwini	0.52	-2
DC12 Amathole	-0.27	+1
DC2 Cape Winelands	-1.02	+1
DC35 Capricorn	-1.59	-1
Interval 4		
**Ranking the same*		
DC16 Xhariep	-2.93	0
**Ranking different*		
DC33 Sekhukume	-4.34	-1
DC22 Umgungundlovu	-2.03	-3
DC7 Pixley Kaseme	-2.03	-3
DC10 Cacadu	-2.04	-1
DC34 Vhembe	-2.07	-3
NMA Nelson Mandel Bay	-2.56	-3
DC44 Nzo	-3.69	-2
DC4 Eden	-3.92	-3
DC8 Siyanda	-4.37	-2
DC5 Central Karoo	-4.62	-3
DC3 Overberg	-5.96	-2

***Source:** Estimates based on the Health System Trust (various years). Code 0: efficiency ranking of the municipality in terms of growth is the same as the efficiency ranking of the municipality in terms of average efficiency score. Code +, means the efficiency ranking according to growth increase efficiency is the number of intervals equal to the number preceded by the +sign. Code -, means the efficiency ranking according to growth decrease efficiency ranking is the number of intervals equal to the number preceded by the -sign. GR: growth rate.

Table 6: Change in technical efficiency ranking of municipalities based on perspective of efficiency (2005-2012): Hospital health care

Average efficiency score

Interval 1

**Ranking is the same*

Dc6	Namakwa	89.98
DC9	France Baard	95.39
DC23	Uthukela	96.28
EKU	Ekurluleni	95.45

**Ranking is different*

CPT	Cape Town	99.87
JHB	Johananesburg	99.78
NMA	Nelson mandela Metro	99.73
Eth	Ethekwini	98.00
DC2	Cape Winelands	96.28
DC20	Fezile Dabi	94.86
DC8	Siyanda	93.07
DC5	Central Karoo	92.19

Interval 2

**Ranking is the same*

DC34	Vhembe	82.07

**Ranking is different*

DC4	Eden	88.73
DC22	Umgungundlovu	88.54
Dc3	Overberg	87.36
DC27	Umkhanyakude	87.35
DC16	Xhariep	87.31
DC1	west coast	87.13
DC18	Lejwebutsa	87.09
DC42	Sediberg	85.83
DC7	Pixley Kaseme	84.19
TSw	Tswane	84.16

Interval 3

**Ranking is the same*

DC29	Ilembe	80.40
DC10	Cacadu	77.53

**Ranking is different*

DC30	Sibande	81.19
DC31	Nkangala	80.02
Dc28	Uthungulu	78.93
Dc48	West rand	77.65
DC12	Amathole	77.27
DC33	Mopani	76.73
DC19	Mofutsanyane	75.93
DC35	Capricorn	75.93
DC24	Umzinyathi	75.01

Interval 4

**Ranking is the same*

None

**Ranking is different*

DC47	Sekhukume	74.92
DC37	Bojanala	74.56
DC26	Zululand	74.21
DC32	Ehlanzeni	73.85
Dc43	Sisonke	73.72
DC13	Chis Hani	73.28
Dc21	Ugu	73.28
DC44	Nzo	70.43
DC36	Waterberg	69.48
DC25	Amajuba	67.16
Dc15	Or Tambo	64.35

Average efficiency score growth

Interval 1

**Ranking is the same*

DC6	Namakwa	1.89	0
DC9	France Baard	1.83	0
DC2	Uthukela	1.26	0
EKU	Ekurhuleni	1.25	0
DC28	Uthungulu	1.78	+2
DC27	Umkanyakude	5.93	+1

**Ranking is different*

DC26	Zululand	10.41	+3
DC37	Bojanala platinum	5.97	+3
DC21	Ugu	2.87	+3
DC43	Sisonke	2.53	+3
DC12	Amathole	1.63	+2
DC32	Ehlanzeni	1.23	+3

Interval 2

**Ranking is the same*

DC34	Vhembe	1.03	0

**Ranking is different*

DC35	Capricorn	0.70	+1
DC8	Siyanda	0.59	-1
DC47	Greater Sekhukhume	0.56	+2
DC15	OR Tambo	0.54	+2
ETH	Ethekwini	0.03	-1
JHB	City of Johannesburg	0.00	-1
NMA	Nelson Mandela Bay	0.00	-1
CPT	Cape Town	0.00	-1
DC2	Cape Winelands	-0.29	-1
DC32	Mopani	-0.42	+1

Interval 3

**Ranking is the same*

CPT	ILembe	-0.58	0
DC10	Cacadu	-0.99	0

**Ranking is different*

DC43	A Nzo	-0.60	+1
DC1	West Coast	-0.75	-1
DC20	Fezile Dabi	-0.94	-2
DC36	Waterberg	-1.04	+1
DC25	Amajuba	-1.11	+1
DC18	Lejwebutsa	-1.22	-1
DC42	Sedibeng	-1.51	-1
DC13	Chris Hani	-1.60	+1
DC 3	Overberg	-1.61	-1

Interval 4

**Ranking is the same*

None

**Ranking is different*

DC16	Mofutsanyane	-2.55	-1
DC48	West Rand	-2.60	-2
DC37	Eden	-2.77	-2
DC16	Xhariep	-2.78	- 2
DC32	Nkangala	-2.84	-1
DC22	Umgungundlovu	-2.99	-2
TSH	Tswane	-3.01	-2
DC30	Gert Sibande	-3.23	-1
DC31	Central Karoo	-4.02	-3
Dc12	Pixley Kaseme	-6.92	-3

***Source**: Estimates based on the Health System Trust (35) (various years). Meaning of codes is the same as in Table 5.

Table 7: Summary of the results

Intervals of efficiency	Primary health care versus hospital heath care	Primary health care: Efficiency versus efficiency growth	Hospital health care: Efficiency versus efficiency growth	All perspectives
Interval 1	Lejwebutswa Ugu UMgundlovu Umkanyakude Uthungulu	Uthukela Sedibeng	Namakwa France Baard Unthukela Ekurhuleni	None of the municipalities is in Interval 1 of all comparisons done
Interval 4	Bojanala Platinum Greater Sekhukume Ehlanzeni Waterberg	Xhariep	None of the municipalities is in Interval 4 of both efficacy and efficiency growth	None of the municipalities is in Interval 1 of all comparisons done

*Source: authors