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# Migration, Risk-Adjusted Mortality, Varieties of Congestion and Patient Satisfaction in Turkish Provincial General Hospitals

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# Migration, Risk-Adjusted Mortality, Varieties of Congestion and Patient Satisfaction in Turkish Provincial General Hospitals [1]

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**Abstract**: We analyze the operational performance of 330 Turkish provincial general hospitals. To help improve performance on both input and output space, we adopt a directional distance approach. We treat a mortality based variable as bad output. Congested hospitals are those for whom the switch from strong to weak disposability of mortality is costly. Thus we are able to address the "quality or adequacy of care" issue. We identify congested hospitals using 3 different direction vectors and derive the associated congestion inefficiency scores. For each case, we show these scores are negatively related to patient satisfaction. We separate congested hospitals into two groups: (i) efficient ones requiring *uniform* sacrifice of good outputs and/or extra inputs in order to reduce mortality, and (ii) inefficient hospitals that do not. The latter ones free up some inputs in addition to requiring extra amounts of other inputs and/or produce more of some outputs but less of others as the price of reducing mortality. The first group can be said to operate at "capacity" whereas the latter can be said to display "negative marginal productivity". Patient dissatisfaction is demonstrably higher in the latter group of hospitals, whereas mortality reduction is positively related to patient satisfaction in "capacity constrained" hospitals. The efficient group is more likely to be located in *emigrating* whereas the inefficient one in *immigrating* regions.

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**I) Introduction**: After Mexico, Turkey is the second poorest OECD member. Not surprisingly compared with other OECD countries, it has a poor health care system. It ranks last or among the worst in many important public health indicators: life expectancy, infant mortality, health care expenditure (both in nominal terms and share of GDP). Among OECD members, the country ranks last in physicians' density with only 1.6 practicing physicians per 1000 population. On the other hand, number of physicians is constantly increasing and this figure may converge to the OECD average in a few decades. On balance to compare Turkey to other middle income countries like Brazil, Iran or Mexico would allow a fairer and more informative assessment. Thus OECD (2008) concludes Turkey's health care performance is comparable with other middle- income countries in terms of basic public health indicators like life expectancy and child mortality.

A most salient demographic fact about Turkey is the ongoing rural to urban migration process. Since it has a bearing on the relevance of the main findings of this paper, it should be stressed this is a characteristic shared by comparable countries like Brazil, Iran or even China. Urban Turkish population constituted around 44% of the total in 1980; it had gone up to 76% in 2010.[2] Concomitantly, the contraction in the agricultural sector is paralleled by an expansion in urban based manufacturing and service sectors. This affects the composition of demand faced by the health system and the distribution of its resources.

The country has 6760 primary care facilities and 1205 hospitals. Although their main function is providing secondary and tertiary care, the public is known for ignoring the referral chain and going directly to a hospital. Perceived low quality at the primary care level and lack of financial incentives to follow the referral chain contributes to this problem. This results in routine cases being treated in more expensive specialty and teaching hospitals, causing wasted resources and inefficiency, For instance prior to 2003, only 40% of the consultations were made in primary care facilities while the remaining 60% were performed in hospitals, (OECD 2008, p84 and p113).

In 2003 the Turkish Ministry of Health started a wide ranging Health Transformation Program (HTP). The HTP includes the implementation of Universal Health Insurance (UHI) by consolidating the three public health insurance schemes[3] under one roof and improving access to and effectiveness of primary care services by introducing family medicine, (Mo H, 2003). HTP is conceived as a ten year reform program. It is designed to address long standing shortcomings in the health sector including a) lagging health outcomes compared to other OECD countries, b) inequities in access to health care, c) fragmentation in financing and delivery in health care leading to inefficiencies and d) poor quality of care (OECD, 2008). To ensure the program's success, *inter alia*, a performance based pay system coupled with periodic assessments of care adequacy and patient satisfaction was instituted.

Sahin et al (2011) provide a comprehensive summary of the HTP. They track the year to year performance of 352 general hospitals over 2005-8, using Malmquist analysis. We adopt a narrower focus and concentrate on efficiency and quality of care issues in one segment of the health sector, namely provincial hospitals during 2009. We choose to focus on such hospitals for two reasons. First, as pointed out by OECD (2008, p 11-12) prior to 2003 "there were regional and urban-rural disparities in utilization of health care services, and accessing health services in rural areas was significantly harder and more expensive". Lack of personnel was an important problem whereby "12% rural health centers and did not have doctors and two-

[2] Turkstat (2012). Currently total population is around 74 million.
[3] One for wage earners, one for the self-employed and another for civil servants

thirds of rural health posts did not have midwives" (OECD, 2008 p37). The HTP, via increasing the number of health personnel by 100,000 and enforcing the requirement for newly trained doctors to serve in rural areas, has brought about considerable improvements in the distribution of both physicians and nurses. Nevertheless, significant disparities remain (OECD, 2008, p74). Therefore wringing out inefficiencies in small town and rural settings is more urgent compared to large urban centers.

Second, restricting the analysis to provincial hospitals allows lessening the heterogeneity of the external environment. Since nondiscretionary factors influencing health outcomes, like hygiene awareness, nutritional practices or income levels, are likely to be more varied in urban and metropolitan settings, by focusing on rural and small town hospitals we reduce the influence of nondiscretionary or contextual factors on efficiency estimates, thereby enhancing their precision. As World Bank (2003, Ch 2) reports, knowledge of health related issues and income disparities have an important impact on health outcomes. It follows research strategies reducing the role of such contextual factors are desirable.

The rest of this paper is organized as follows. The next section reviews the literature and discusses modeling issues. Section III presents our directional distance models. Our data overview-including a discussion of our patient satisfaction index- and inefficiency estimates are in Sections IV and V respectively. Section VI contains a careful statistical analysis of our congestion scores and the final section offers a summary.

**II) Literature Review**: It seems likely the first application of DEA to health issues is unpublished work dating from 1979 dealing with family planning centers in Costa Rica and Guatemala, (Ray 2004, p. xi). Nunamaker and Lewin (1983) is the first published work applying Data Envelopment Analysis to health care, whereas Sherman (1984) was the first author to use DEA to evaluate overall hospital efficiency. By now there is a very extensive literature surveyed by O'Neill et al (2008), Ozcan (2008) and Hollingsworth (2008). The first paper emphasizes national differences in hospital efficiency research. The second monograph has a broader scope: it encompasses every aspect of health care delivery, as well as providing an overview of existing techniques. The last author classifies 317 published papers into various subcategories and offers comments as to their practical usefulness.

In addition to the already cited Sahin et al (2011), the works dealing with the Turkish health care system comprise Ersoy et al (1997), Sahin and Ozcan (2000) and Sahin (2009). This last paper contains useful institutional information about the Turkish health care system and its evolution over time.

As stressed by Jacobs et al (2006), efficiency analysis should be based on *outcomes* of care. However researchers are often constrained to examine efficiency on the basis of *measured* activities like patients treated or surgeries performed. When there is room to suspect the effectiveness of such measured activities differs between institutions, it is imperative to augment activity counts with indicators of quality of outcome. Roos and Lundstrom (1998), Roos (2002) and Fare et al (2008a) have done pioneering methodological work in this area. Although the direct measures of health gain they develop are best, due to data requirements, such studies are definitely the exception. Most published work ignores the problem and the few analysts addressing the issue are typically forced to use proxies like mortality, e.g. Dismuke and Sena (2001) or readmission rates, e.g. Arocena and Prado (2007). For instance of the 317 studies surveyed by Hollingsworth (2008) only 9% use *outcome* measures like change in health status, mortality or quality of care.

In this study we use 'risk adjusted mortality' figures of each hospital as an inadequate quality indicator. Clearly, mortality is a 'bad 'or 'undesirable' output. The efficiency literature, e.g. Scheel (2001), classifies approaches to deal with it, into direct and indirect ones. Indirect approaches involve some data transformation – like inverting or subtracting the bad output from a large number to convert it to a good one. Ideally one wants the results obtained with such transformed data to coincide with those to be obtained by using the untransformed or true data. However this is rarely the case. Such approaches yield different results since in each case the units defining the efficient frontier are different. In other words the production possibility frontier constructed with transformed data does not- in general - coincide with the true one. When the transformation is linear additive, in some cases, invariance is possible. Pastor (1996) as well as Seiford and Zhu (2002) show that converting the bad into a good output by subtraction from a large number, leaves the optimal solution unchanged under input oriented BCC. Similarly output oriented BCC model's solution is invariant to input translation. This is due to the convexity condition helping eliminate the additive constant from the input (output) equations under output (input) orientation. Ray (2004, p109) contains a neat exposition and Pastor (1996) an extensive discussion. Note that the CCR model –both orientations- is not translation invariant. Inverting the bad output into a good one is a non-linear transformation. As such it demolishes the convexity condition which is the key to translation invariance, Hua and Bian (2007, p109). As a result taking the reciprocal of the bad output to obtain a good output is not classification invariant. Finally a recent paper by Fare and Grosskopf (2013) investigates the relationship between data transformation and DEA versus directional distance score invariance.

Direct approaches avoid transformation and use data as they stand. Therefore the true production possibility frontier prevails. Most recent studies, carefully surveyed by Thanassoulis et al (2008) follow this route. Liu et al (2010) present a systematic investigation of undesirable input and output models used in the DEA literature. They argue in favor of avoiding data transformation. They point out under strong disposability of bad outputs; data transformation is not needed in the first place. Giving the example of a service sector firm where serving customers is the good output and received complaints is the bad one, they argue *strong disposability* would be the appropriate modeling strategy for a monopolistic and *weak disposability* for a competitive environment. The intuition being a public or private monopoly *can* but a competitive firm *cannot* afford to ignore complaints.

From this perspective we can say the adoption of the HTP by the Turkish Health Ministry and the concomitant emphasis on quality of care requires adopting weak disposability as a modeling strategy. In the next section we show the difference between the efficiency scores obtained under the two approaches also gives an estimate of the price paid for reducing mortality.

**III) Directional Distance Function**: The model we use has its origins in the environmental efficiency literature, Fare et al (1989), Chung et al (1997), Fare and Grosskopf (2004), where undesirable by products like sulfur emissions are of interest. The directional distance approach allows output expansion and input contraction simultaneously. Thus data transformation which distorts the production possibility frontier is avoided.

O'Neill et al (2008) point out the hospital efficiency literature prefers the input orientation since in most countries, but particularly the US, cost containment has been and is the order of the day. Even in the US though, the debates and controversies surrounding President Obama's health care reform legislation show meaningful access to such care eludes and is desired by a substantial portion of the electorate. Thus as stressed by Hollingsworth and Spinks (2009) the public wants *both* good health outcomes *and* cost containment. In the Turkish case, OECD (2008) finds its bed occupancy rate of 69% *below* the OECD average of 75% and calls for its increase. This implies output expansion, since to increase the occupancy rate via input contraction would be tantamount to saying there are too many hospital beds in Turkey. In reality that is not the case. According to OECD (2009), Turkey has 2.7 acute hospital beds per 1000 population, substantially less than the OECD average of 3.8. However since prior studies find considerable 'input waste' we adopt the directional distance approach which enables improvement of both input as well as output amounts.

As the foregoing discussion suggests, choice of orientation involves value judgments. The issue is surveyed in Fare et al (2008b). They suggest 6 different direction vectors:

a) An exclusive input orientation – i.e. $gr_x$=x, $gr_y$=0, presumably preferred by cost cutters- or an exclusive output orientation – i.e. $gr_x$=0, $gr_y$=y when preserving jobs is the main focus[4].
b) One obtained from a policy directive or social welfare function.
c) Optimize to get a vector that minimizes distance to the technology frontier.
d) The direction implied by each DMU's data usage (i.e. $gr_x$=x , $gr_y$=y)
e) Use "average" DMU's data usage as the direction vector (i.e. $gr_x=\bar{x}$ , $gr_y=\bar{y}$.
f) The unit direction vector (i.e. $gr_x$=1, $gr_y$=1).

Essentially the choice of a direction vector calls for a judgment or reflects one's preferences. We chose the last 3 direction vectors. As noted by Fare et al (2008b) option (d) evaluates each DMU in a different direction based on its own input-output mix. Whereas options (e) and (f) appraise all observations in the same direction and in a sense they are "egalitarian".

The CRS version of the directional distance model under option (d) consists of

$$\text{Max} \quad \{\beta, \lambda\} \qquad \beta$$

$$\text{ST:} \quad \sum_{j=1}^{N} \lambda_j g_{mj} \geq g_{mo} + \beta_o g_{mo}, m = 1 \text{ to M} \quad \text{(Good outputs)}$$

$$\sum_{j=1}^{N} \lambda_j b_{kj} \geq b_{ko} - \beta_o b_{ko}, k = 1 \text{ to K} \quad \text{(Bad outputs)}$$

$$\sum_{j=1}^{N} \lambda_j x_{ij} \leq x_{io} - \beta_o x_{io}, i = 1 \text{ to I} \quad \text{(Inputs)}$$

Where 'm' indexes the 'M' good outputs, 'k' indexes the 'K' bad outputs and 'i' indexes the 'I' inputs. The choice variables {β, λ} represent the radial expansion-contraction factor and the intensity variables respectively. The "≥ or GTE" inequality for the bad outputs imposes strong disposability. It means the undesired output(s), such as risk adjusted mortality, which is jointly produced together with good outputs can be disposed of freely. In a hospital context "free disposal" must be thought of as neglecting adequacy of care issues in an *ex ante* sense. This is not a case of throwing away "dead bodies"*ex post* the way one pollutes rivers by dumping waste[5] in the absence of regulation. This means, the institutional environment in some sense tolerates the undesired output(s). In such a setting reducing mortality does not

[4] Here "$gr_x$ , $gr_y$" stand for the x and y gradients of the distance function respectively.
[5] In a spirited defense of careful modeling Forsund (2009) makes this point forcefully.

compete with other useful hospital activities. Appending the convexity constraint yields the VRS-strong disposability model:

Max $\{\beta, \lambda\}$ $\beta$

ST: $\sum_{j=1}^{N} \lambda_j g_{mj} \geq g_{mo} + \beta_o g_{mo}, m = 1$ to M (Good outputs)

$\sum_{j=1}^{N} \lambda_j b_{kj} \geq b_{ko} - \beta_o b_{ko}, k = 1$ to K (Bad outputs)

$\sum_{j=1}^{N} \lambda_j x_{ij} \leq x_{io} - \beta_o x_{io}, i = 1$ to I (Inputs)

$\sum_{j=1}^{N} \lambda_j = 1.$

Weak disposability requires *replacing* the inequality of the bad outputs equation(s) with equality. This implies reducing 'bads' is costly; it may necessitate the reduction of good outputs. Here 'risk adjusted mortality' is the bad output, reducing it, means less tolerance for inadequacy. It follows the implementation of HTP, which emphasizes improved performance in providing healthcare, can be modeled by imposing weak disposability and recognizing the possibility of sacrificing some good outputs and/or requiring more inputs. Consequent to this modeling strategy, we will be able to pinpoint hospitals where such a trade-off occurs and will analyze the nature of this trade-off. Finally we also impose the null-jointness property by multiplying *both* output projections by $\delta$. This property indicates the joint production of good and bad outputs[6,7], So the VRS-weak version of the directional distance model becomes:

Max $\{\beta, \lambda, \delta\}$ $\beta$

ST: $\delta \sum_{j=1}^{N} \lambda_j g_{mj} \geq g_{mo} + \beta_o g_{mo}, m = 1$ to M (Good outputs)

$\delta \sum_{j=1}^{N} \lambda_j b_{kj} = b_{ko} - \beta_o b_{ko}, k = 1$ to K (Bad outputs),

$\sum_{j=1}^{N} \lambda_j x_{ij} \leq x_{io} - \beta_o x_{io}, i = 1$ to I (Inputs)

$\sum_{j=1}^{N} \lambda_j \leq 1 \;\; ; \;\; 0 \leq \delta \leq 1.$

Congestion is said to occur when VRS-strong score exceeds the VRS-weak score. The difference between the two scores measures its extent. Here we note if at the strong disposability optimum, the bad output constraint holds as an equality,- equivalently there is no

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[6] We thank a referee for clarifying this point. We note the above problem is non-linear. We solve it as an LP problem by performing a grid search for the value of $\delta$ over [0, 1]. See, Picazo-Tadeo and Prior (2005). In every case the optimum occurred at $\delta$=1.

[7] Picazo-Tadeo and Prior (2009) contains a very clear exposition of how weak and strong disposability relate in the presence of null jointness and VRS.

excess mortality i.e. no bad output slack -, then the imposition of weak disposability will not constrain organizational choices and therefore VRS-strong and VRS-weak scores will coincide leading to a zero congestion score. But when that constraint holds as an inequality, the aforementioned imposition will be binding, leading to a nonzero congestion score.

However, as suggested by Thanassoulis et al (2008), it is more fruitful to think of congestion in terms of the components of the (S – W) vector, where S and W stand for the strong and weak VRS *projections*. When the mortality component of that vector is positive, namely switching from strong to weak disposability reduces mortality, the other elements represent the cost – in terms of extra inputs and/or foregone outputs- of that decline. Here we would like to stress mortality reduction will occur in those cases where the mortality constraint does not bind i.e. holds as an inequality under strong disposability. There are two possibilities:

(a) For most cases the strong disposability optimum occurs on the Pareto efficient portion of the frontier. Then VRS-strong > VRS-weak and the congestion score will be nonzero.

(b) Those few cases where the strong disposability optimum happens to occur on the vertical (or horizontal) segment of the mortality axis. Then VRS-strong and VRS-weak scores will both equal zero leading to a zero congestion score. In other words for such cases taking the difference of the two scores will fail to signal the presence of congestion.

The careful reader will recognize our model simply adapts the "environmental performance indicator model"[8] to a hospital setting. It treats good and bad outputs as *joint products that are naturally produced together*. Another example would be flowers and allergenic pollens. The hallmark of this approach is its use of weak disposability of bads to capture the opportunity cost of their reduction. Forsund (2009, p16-23) mounts a forceful criticism of this approach *as a framework for modeling environmental performance*. He argues this approach "violates the materials-balance principle" and is not general enough to incorporate abatement options other than the reduction of good outputs. Instead Forsund (2009, pp 24-34) advocates explicit modeling of the technology that relates inputs to the production of bad and good outputs as well as *specific identification of offending inputs.* Thus other abatement options become conceivable e.g. in the context of producing electric power and smoke via fossil fuel, one can reduce the bad without reducing the good by switching to alternative sources of energy[9]. In addition to Forsund (2009), this viewpoint can also be found in Forsund (1998) and Murty and Russell (2010).

We believe in a hospital setting the joint product approach is more appropriate. First, health care involves uncertainties and improvisations which preclude the *ex ante* identification of an offending input. Since our bad output is mortality, it is obvious that a known offending input will never be used! Second, adopting the joint product approach, is akin to a 'let the data decide' strategy. It allows empirically determining the tradeoffs involved. In other words in a hospital context, letting the data decide could help determine *ex post* the technology that relates inputs to the production of bad and good outputs. We believe our findings discussed in conjunction with Figures 8a and 8b, attest to the fruitfulness of this strategy.

Thus far our exposition assumed improvement was sought in the direction implied by each DMU's data usage (i.e. $gr_x=x$, $gr_y=y$). When we seek improvement in the direction implied by the "average" DMU's data usage, namely option (e) we replace $\beta x$ by $\beta\bar{x}$ and $\beta y$ by $\beta\bar{y}$ - for

[8] According to Forsund (2009, p16), this term was first introduced by Fare et al (1996).
[9] We are grateful to Subhash Ray for these examples.

both good ( $g_{ro}$ ) and bad ( $b_{ko}$ ) outputs- on the RHS of all of the above inequalities. On the other hand adopting the unit direction vector – option (f) - involves replacing βx by β and βy by β –again for both output types - on the RHS, throughout the above inequalities. We note under (e) β represent the percentage of industry input (output) level by which performance can be improved. Under (f), β stands for the units of x and y by which performance can be ameliorated and need not have an upper limit of unity, Fare et al (2008).

**IV) Data-Inputs and Outputs**: In Turkey there is 1205 hospitals, 42 military and 1163 civilian. The Ministry of Health is in charge of civilian hospitals. It directly owns and operates 769 hospitals and oversees the rest (394). Out of this total 332 are private, 56 are university hospitals and the remaining 6 are operated by municipalities. However since private hospitals are smaller, the share of the public/semi-public sector is larger than the ownership figures suggest. For instance the public sector accounts for 92% of overall bed capacity. The functional breakup of these 831 public/semi-public hospitals is as follows: 603 general, 117 specialized, 56 research and 55 teaching. The patient satisfaction survey was conducted in 551 Mo H hospitals –out of a 769 total. We provide detailed information about the survey subsequently, here we describe sample selection. We could not obtain complete input output information for 28 of the 551 surveyed hospitals. In order to achieve a homogenous sample we discarded specialty hospitals and general hospitals located in metropolitan centers, reducing our sample to 405. Since we use a mortality based “quality” measure, we had to remove 75 mostly small units where no deaths were registered. This left us with 330 general hospitals located in provincial areas.

These 330 hospitals represent about 30% of total (35% of public sector) bed capacity. Their share of outpatient visits and inpatient discharges within the hospital system are 40 and 26% respectively. According to the 2008 electronic population registry figures, roughly 35 % of the total population (about 47% of the urban public) lives in areas served by these hospitals.

| **Variable** | **Definition and explanation** |
|---|---|
| *Inputs: Year 2009* | |
| Beds | The total number of staffed beds in the hospitals |
| Doctors | The total number of specialists and general practitioners who are full time employees (FTEs) in the hospitals |
| Nurses | The total number of nurses who are full time employees in the hospitals, including midwives |
| Other Health Care Providers | The total number full time employees of all other supporting medical personnel (pharmacists, medical technologist, medical technicians, medical radiological technologists, dietitians etc.) |
| Clerical personnel | The total number full time non medical personnel (overwhelmingly administrative personnel, in a few cases includes technical personnel like engineers etc.) |
| Operating personnel | Data entry, maintenance, security and housekeeping and other personnel. |
| *Outputs: Year 2009* | |
| Outpatients | The total number of patients to outpatient departments and emergency rooms (unadjusted) |
| Inpatients | The total number of inpatients (unadjusted) |
| Chemotherapy | Total number of chemotherapy treatments |
| Radiotherapy | Total number of radiotherapy treatments |
| Dialysis | Total number of dialysis treatments |
| Else | Total number of other treatments (e.g. physical therapy) |
| A (e.g. kidney transplant or mitral valve reconstruction) | Mo H classifies surgeries in terms of difficulty, A: most serious to E: least serious |
| B | Total number of category B surgeries |
| C (e.g. muscular flab, rhynoplasty) | Total number of category C surgeries |
| D | Total number of category D surgeries |
| E (e.g. long leg plaster, circumcision) | Mo H classifies surgeries in terms of difficulty, A: most serious to E: least serious |
| Normal Births | Total number of normal deliveries |
| Surgical Births | Total number of surgical deliveries |
| Cesarean Births | Total number of cesarean deliveries |
| D/Inpatients Ratio | Number of deaths divided by total number of inpatients. |

**Table 1: Variable definitions and explanations**

| **Table 2a** | Beds | Doctors | Nurses | Other | Clerical | Operating | Patient Satisfaction |
|---|---|---|---|---|---|---|---|
| Min | 25 | 5 | 22 | 2 | 4 | 7 | 55 |
| Max | 978 | 245 | 2547 | 201 | 341 | 714 | 100 |
| Mean | 159 | 50 | 160 | 23 | 57 | 170 | 90 |
| St. Dev. | 164 | 46 | 195 | 24 | 58 | 562 | 8 |

**Table 2a: Summary input statistics of 330 provincial hospitals during 2009.**

| **Table 2b** | Inpat | Outpat | Chrmo. | Radio. | Dialys. | Else | A | B | C | D | E | Normal | Surgical | Cesar. | D/Inpat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | 32 | 28,309 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0002 |
| Max | 52,386 | 1,622,841 | 6,026 | 10,671 | 14,068 | 283,509 | 2,342 | 5,802 | 10,472 | 11,549 | 33,654 | 3,680 | 1,258 | 2,410 | 0.0938 |
| Mean | 7,558 | 339,098 | 98 | 44 | 1,530 | 5,285 | 141 | 769 | 1,392 | 1,319 | 2,010 | 403 | 41 | 308 | 7,558 |
| St. Dev. | 8,369 | 282,767 | 521 | 624 | 2,440 | 18,839 | 297 | 1,104 | 1,756 | 1,833 | 3,532 | 617 | 140 | 482 | 0.0102 |

**Table2b: Summary output statistics of 330 provincial hospitals during 2009.**

Table 1 lists our variables and their definitions. Tables 2a, 2b display the summary statistics. All of our data is from the Ministry of Health's website[10]. We use 6 inputs: beds, doctors, nurses, other health personnel, clerical workers and operating personnel. We have 1 bad output and 14 good outputs. The good ones are: inpatient discharges, outpatient visits; chemotherapy, radiotherapy, dialysis and else treatments provided; A, B, C, D, E category surgeries and normal, surgical and cesarean births. There is no diagnostic related groupings index in Turkey. Therefore outputs were not weighted on a DRG basis. We use deaths to inpatients ratio for each hospital as our "risk adjusted mortality" measure. This is also the "care adequacy" measure utilized by Sahin and Ozcan (2000) while evaluating the effectiveness of Turkish provincial hospitals.

| Size Class (beds) | # of Hospitals | Beds | Doctors | Nurses | Other Health | Clerical | Operating | Patient Satisfaction |
|---|---|---|---|---|---|---|---|---|
| <=50 | 100 | 37 | 15 | 54 | 8 | 17 | 32 | 0.917 |
| 51-100 | 80 | 72 | 26 | 83 | 14 | 28 | 67 | 0.903 |
| 101-200 | 56 | 144 | 50 | 143 | 22 | 52 | 134 | 0.895 |
| 201-300 | 40 | 248 | 78 | 242 | 37 | 93 | 216 | 0.881 |
| 301-400 | 22 | 340 | 106 | 292 | 47 | 139 | 321 | 0.851 |
| 401+ | 32 | 547 | 146 | 523 | 68 | 158 | 767 | 0.860 |

**Table 3a: Input and Satisfaction averages by hospital size**

| Size Class (beds) | Inpat | Outpat | Chemo. | Radio. | Dlys. | Else | A | B | C | D | E | Nrml | Srgcl | Cesar. | D/Inpat. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| <=50 | 1,409 | 115,253 | 30 | 0 | 440 | 1,372 | 5 | 64 | 157 | 194 | 385 | 108 | 18 | 38 | 0.0071 |
| 51-100 | 3,326 | 204,402 | 35 | 0 | 967 | 2,067 | 45 | 197 | 512 | 516 | 677 | 301 | 44 | 152 | 0.0061 |
| 101-200 | 7,576 | 355,848 | 9 | 0 | 1,958 | 8,445 | 91 | 639 | 1,382 | 1,305 | 2,041 | 485 | 82 | 363 | 0.0072 |
| 201-300 | 12,119 | 527,679 | 41 | 0 | 2,065 | 4,328 | 167 | 1,266 | 2,209 | 2,178 | 3,307 | 645 | 30 | 547 | 0.0135 |
| 301-400 | 16,712 | 679,252 | 402 | 485 | 2,742 | 10,390 | 381 | 1,942 | 3,239 | 2,612 | 4,728 | 852 | 42 | 677 | 0.0130 |
| 401+ | 25,328 | 876,454 | 486 | 120 | 4,098 | 17,720 | 694 | 3,203 | 5,173 | 4,907 | 6,882 | 827 | 41 | 887 | 0.0191 |

**Table 3b: Output averages by hospital size**

Tables 3a, 3b present the break-up of these 330 hospitals according to bed capacity and their average input-output levels. As can be seen average input and average output levels rise uniformly with hospital size, except for chemo and radiotherapy, surgical births and Deaths/Inpatients Ratio where the upward trend is less clear cut. On the other hand, patient satisfaction falls as hospitals get larger.

Our patient satisfaction figures result from the Inpatient Services Evaluation Survey for 2009. As part of the HTP, which ties pay to performance[11], this survey is conducted yearly. In every province, the local Performance and Quality Coordination office is responsible for the conduct and analysis of the Inpatient Services Evaluation Survey. Specially trained staff of

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[10] http:/www.saglik.gov.tr.

[11] In addition to this survey 3 other metrics measure the performance of a hospital. Access to Examination, Service Quality Standards , Efficiency Indicators . They try to assess service attributes like visibility of road signs directing traffic towards a hospital, existence of a personal office for each doctor etc.

Quality Coordination offices survey inpatients. In each hospital, size of the surveyed sample, which does not include psychiatric and terminal patients, is at least the number of beds in that particular hospital. Surveys are conducted either face to face, via telephone or mail.
The survey consists of a total of 39 questions, including 8 demographic questions that have no bearing on the score. The 31 questions regarding patient satisfaction are in multiple choice format and arranged into 8 categories: Admission, facilities, physicians, nurses, medical care, discharge, general evaluation and other. Every possible answer to a question has a predetermined point and evaluation score for each survey is obtained by adding them. The questionnaire, answers and points corresponding to answers are determined by the MoH. They reflect what policy makers consider is most important for patient satisfaction. Table 4 summarizes the number of questions and maximum number of obtainable points in each category. Medical care is considered the most important with 6 questions with a total of 21 points while discharge is the least important with only 2 questions and 6 points. The highest score a hospital can garner in a survey is 100.

| **Dimension of Patient Satisfaction** | **Number of Questions** | **Total points** |
|---|---|---|
| Admission | 3 | 8 |
| Facilities | 5 | 16 |
| Physicians | 3 | 8 |
| Nurses | 4 | 11 |
| Medical Care | 6 | 21 |
| Discharge | 2 | 6 |
| General Evaluation | 4 | 18 |
| Other Issues | 4 | 12 |
| Total | 31 | 100 |

**Table 4: Breakdown of questions in the survey**

There are notable differences between questions; some have only 2 possible answers while others have as many as 5. Similarly maximum number of points for a question varies between 2 and 6. Some questions try to measure patient satisfaction (e.g. "Did you find the heating and air-conditioning system adequate?") while others are asked to determine whether or not some policy guideline is being implemented (e.g. "Have you been informed about the patient rights unit?") Table 5 contains 6 of the 31 questions in the survey to illustrate these differences.

The MoH takes great pride in its human centered management and pays significant attention to Inpatient Services Evaluation Survey. Since it has financial consequences, hospital staff would be inclined to work in a way that increases survey scores. We think survey scores are a valid measure of the quality of healthcare provided in public hospitals.

| Question Number | Category | Question | Answers | Points |
|---|---|---|---|---|
| 10 | Admission | Have you been sufficiently informed about hospital rules and policies (visitation hours, smoking prohibition, etc.) before you were admitted? | Yes, completely<br>Yes, partially<br>No | 2<br>1<br>0 |
| 14 | Facilities | Did you find the heating and air-conditioning system adequate? | Yes<br>Partially<br>No | 3<br>2<br>0 |
| 17 | Physicians | Were your questions answered by the physicians in a manner you can understand? | Yes, always<br>Yes, sometimes<br>No | 3<br>2<br>0 |
| 31 | Discharge | Were you given a phone number to contact the clinic you were treated? | Yes<br>No | 3<br>0 |
| 34 | General Evaluation | In general, how would you rate the treatment you received? | Perfect<br>Very good<br>Good<br>Average<br>Poor | 5<br>4<br>2<br>1<br>0 |
| 36 | Other Issues | Have you been informed about the patient rights unit? | Yes<br>No | 2<br>0 |

**Table5: Some of the Questions in the Survey**

**V) Inefficiency Estimates**: We computed CRS, VRS- strong and weak-, Scale and Congestion inefficiencies using our directional distance model. The CRS and VRS-strong figures are obtained directly, assuming strong disposability. Subtracting the VRS estimate from the CRS one, yields the scale inefficiency estimate. The difference between the VRS estimates obtained under strong vs. weak disposability respectively, gives the congestion inefficiency estimate. Tables 6a, b, and c display the average inefficiencies using our 3 different direction vectors by hospital size as well as their overall means and standard deviations.

| Size Class (beds) | **# of Hospitals** | CRS | VRS-strong | VRS-weak | Scale | Congestion | $\sum_{j=1}^{N}\lambda_j = 1$ |
|---|---|---|---|---|---|---|---|
| # efficient | | 136 | 200 | 222 | 136 | 263 | |
| <=50 | 100 | 0.092 | 0.025 | 0.013 | 0.066 | 0.0123 | 0.649 |
| 51-100 | 80 | 0.071 | 0.051 | 0.042 | 0.020 | 0.0092 | 0.805 |
| 101-200 | 56 | 0.044 | 0.037 | 0.034 | 0.006 | 0.0037 | 1.029 |
| 201-300 | 40 | 0.045 | 0.033 | 0.031 | 0.012 | 0.0016 | 1.342 |
| 301-400 | 22 | 0.050 | 0.033 | 0.028 | 0.017 | 0.0054 | 1.560 |
| 401+ | 32 | 0.038 | 0.015 | 0.012 | 0.023 | 0.0026 | 1.743 |
| Overall Average | | 0.065 | 0.034 | 0.027 | 0.031 | 0.007 | 1.002 |
| Overall SD | | 0.084 | 0.061 | 0.057 | 0.055 | 0.022 | 0.578 |

**Table 6a: Inefficiency estimates, direction vector: (x, y)**

| Size Class (beds) | # of Hospitals | CRS | VRS-strong | VRS-weak | Scale | Congestion | $\sum_{j=1}^{N}\lambda_j = 1$ |
|---|---|---|---|---|---|---|---|
| # efficient | | 136 | 200 | 222 | 136 | 264 | |
| <=50 | 100 | 0.017 | 0.006 | 0.003 | 0.012 | 0.0028 | 0.657 |
| 51-100 | 80 | 0.025 | 0.019 | 0.015 | 0.006 | 0.0039 | 0.801 |
| 101-200 | 56 | 0.031 | 0.027 | 0.024 | 0.004 | 0.0031 | 1.023 |
| 201-300 | 40 | 0.061 | 0.041 | 0.038 | 0.020 | 0.0022 | 1.336 |
| 301-400 | 22 | 0.099 | 0.061 | 0.049 | 0.038 | 0.012 | 1.588 |
| 401+ | 32 | 0.102 | 0.035 | 0.028 | 0.067 | 0.007 | 1.741 |
| Overall Average | | 0.041 | 0.023 | 0.019 | 0.017 | 0.004 | 1.004 |
| Overall SD | | 0.071 | 0.052 | 0.049 | 0.040 | 0.018 | 0.574 |

**Table 6b: Inefficiency estimates, direction vector: ($\bar{x}$ ,$\bar{y}$)**

| Size Class (beds) | # of Hospitals | CRS | VRS-strong | VRS-weak | Scale | Congestion | $\sum_{j=1}^{N}\lambda_j = 1$ |
|---|---|---|---|---|---|---|---|
| # efficient | | 121 | 190 | 213 | 119 | 191 | |
| <=50 | 100 | 1.810 | 0.656 | 0.001 | 1.153 | 0.655 | 0.556 |
| 51-100 | 80 | 2.524 | 1.904 | 0.003 | 0.620 | 1.901 | 0.757 |
| 101-200 | 56 | 2.690 | 2.319 | 0.003 | 0.371 | 2.316 | 1.010 |
| 201-300 | 40 | 5.384 | 4.381 | 0.006 | 1.003 | 4.375 | 1.263 |
| 301-400 | 22 | 8.494 | 5.795 | 0.003 | 2.699 | 5.792 | 1.517 |
| 401+ | 32 | 7.987 | 3.224 | 0.003 | 4.763 | 3.221 | 1.747 |
| Overall Average | | 3.610 | 2.284 | 0.003 | 1.326 | 2.281 | 0.947 |
| Overall SD | | 6.019 | 4.845 | 0.006 | 2.946 | 4.842 | 0.604 |

**Table 6c: Inefficiency estimates, unit direction vector**

We note the magnitude of these estimates is not comparable across tables. For instance in Table 6a and 6b, the estimates are in percentage units whereas in 6c in actual units. Furthermore, for Table 6a the percentage inefficiency refers to every unit's own input-output usage whereas for 6b, it is in terms of the 'average unit's input-output usage. Thus for small hospitals, when improvement is sought in the 'average' direction - gradient ($\bar{x}$ , $\bar{y}$) - the resulting inefficiency score is smaller than when improvement is sought in 'own' direction – gradient (x,y). The opposite holds for large hospitals and inefficiency scores under ($\bar{x}$ , $\bar{y}$) exceed those obtained under (x, y).

A comparative analysis of results obtained under our 3 approaches reveal the following:

a) Hospitals found CRS, VRS and Scale efficient coincide under gradient (x, y) and ($\bar{x}$ , $\bar{y}$) .
b) The unit direction vector is more stringent. Around 15 hospitals 'lose' their CRS and Scale efficient status and about 10 their VRS efficient status. The rest of the efficient DMUs coincide. Namely DMUs found efficient under (1, 1) are also efficient with the other two direction vectors.

c) All 3 methods reveal a similar, U shaped, scale inefficiency pattern. In particular, all suggest the 101-200 bed range to be the most efficient scale.

d) Excepting scale, all other inefficiency scores fall when moving from the second largest to the largest, 401+, size class. Moreover, the largest hospitals tend to have rather low congestion scores. Since difficult cases are referred to this size class they are better equipped and less likely to suffer from resource mismatches. Therefore, to the extent that congestion is a "mix" problem, this is a sensible finding.

e) We note the "unit vector method", unlike the other two, ascribes almost the totality of VRS-S type inefficiency to congestion. Again if we think of inefficiency as a "mix" problem, the method which seeks improvement in natural units would be more likely to stress incompatibilities between the magnitudes comprising an input or output bundle.

The "environmental performance indicator model" model we adapted to a hospital setting, views congestion as a way of detecting and measuring the costs involved when switching from a strong to a weak disposability regime, in the presence of bad outputs. Thus, in an environmental management context, congestion measures the costs of pollution abatement. Congested units are the ones that have to expend further resources to reduce their pollution levels. Here we are dealing with hospitals and a mortality measure is our bad output to be reduced. Congested hospitals are the ones that have difficulty in adapting to the new, weak disposability[12] or better quality regime. Therefore one would expect such congested hospitals to have lower patient satisfaction scores. Based on Table 7, that certainly seems to be the case.

Table 7's Panel A displays, the simple as well as rank correlation coefficients between patient satisfaction and congestion scores for hospitals having non-zero congestion inefficiency estimates. All of our correlation coefficients are negative and most are significant at the usual levels.

| Panel A | # of Congested Hospitals | Simple Corr. | t-value | Rank Corr. | t-value |
|---|---|---|---|---|---|
| (x,y) | 67 | -0.24 | -1.95 | -0.19 | -1.58 |
| ($\bar{x}$, $\bar{y}$) | 66 | -0.22 | -1.81 | -0.33 | -2.76 |
| (1,1) | 139 | -0.24 | -2.89 | -0.21 | -2.53 |
| Panel B | | | | | |
| (x,y) | 73 | -0.23 | -2.02 | -0.17 | -1.43 |
| ($\bar{x}$, $\bar{y}$) | 70 | -0.23 | -1.92 | -0.25 | -2.14 |
| (1,1) | 145 | -0.24 | -3.01 | -0.21 | -2.55 |

**Table 7: Correlation coefficients between patient satisfaction and congestion scores**

Let us denote the strong and weak VRS *projections*, by S and W respectively. Weak disposability means equality is imposed on the bad output –mortality- constraint whereas the other inputs & outputs obey strong disposability. As pointed out by Thanassoulis et al (2008), we can think of the ensuing congestion in terms of the components of (S – W) vector. When the mortality component of that vector is positive, namely switching from strong to weak

[12] We reiterate, in a hospital context this means less tolerance for inadequate care or higher quality requirements.

disposability reduces mortality, the other elements represent the cost – in terms of extra inputs and/or foregone outputs- of that decline. Let us recall mortality reduction will occur in hospitals where bad output constraint does not bind under strong disposability, leading to nonzero mortality slack. As mentioned previously there is:

(a) The regular cases projected onto the Pareto efficient portion of the frontier, where VRS-strong > VRS-weak and thus a nonzero congestion score holds (see Panel A of Table 7) and

(b) The few cases where the strong disposability optimum occurs on the "horizontal" (or "vertical") portion of the mortality axis. Then the ensuing zero congestion score will fail to signal its presence.

After including such cases, our congested hospitals lists grow by the same 6 units under (x, y) and (1, 1); and by 4 under ($\bar{x}$ ,$\bar{y}$). Also these additional cases overlap. Namely the 4 additions to the ($\bar{x}$ ,$\bar{y}$) congested list are also congested under (x, y) and (1, 1). Table 7's Panel B lists the correlations between congestion and satisfaction scores when those few cases are added. The qualitative picture remains the same.

The next section provides an analysis of the nature of such congestion and its determinants.

**VI) Congestion and its determinants:** We begin by noting the switch from strong to weak disposability can be interpreted as follows. For those units where the bad output constraint holds as equality at the strong disposability optimum, the switch to weak disposability, namely imposing equality onto the bad output constraint will not matter. But for those hospitals where the same constraint holds as an inequality under the strong disposability optimum, the switch to weak disposability will matter. In such cases the obligation to decrease bad output i.e. 'risk adjusted mortality' levels which are no longer tolerated will require changes in input requirements and/or level of good outputs produced.

For such congested hospitals, namely those whose (S-W) vector's 'mortality' component is positive, at least one other element of the (S-W) vector will be nonzero. Since strong disposability offers more productive or organizational choices than weak disposability, normally one would expect ($S_{out} > W_{out}$ ) and ($W_{in} > S_{in}$ ). To highlight this expectation we construct, the input portion of this vector by ($W_{in} - S_{in}$ ) and its output portion by ($S_{out} - W_{out}$). One would expect each element of the thus constructed halves of the (S-W) vector to be positive[13]. Also the non-mortality components of the vector would represent the *sacrifice* or the *cost* incurred for reducing 'risk adjusted mortality'.

However when we look at our congested hospitals, with each one of our 3 methods, only 25 hospitals and always the same 25 hospitals turn out to have a *thoroughly non-negative* (S-W) vector. According to this evidence, these 25 hospitals must be operating at 'full capacity' under strong disposability. This means to achieve the 'mortality reduction' associated with weak disposability, they 'need' extra resources in the sense of *more* inputs or *less* workloads *than those indicated by Strong disposability projections*.

[13] Or zero, namely, one expects the (S-W) vector to be non negative.

| Nurses | Inpatients | Dialysis | Else | A | B | C | D | E | Normal Births | Surgical Births | Cesarean | D_Inp_Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 73 | 584 | 191 | 1 | 1 | 52 | 29 | 56 | 91 | 5 | 9 | 0.012 |

Çankırı Çerkeş hospital. All figures rounded to the nearest integer. Zero components, e.g. radiotherapy, deleted.
**Table 8a**

Table 8a lists the non-zero components of the (S-W) vector for one such hospital using (x, y) as the direction vector, - under ($\bar{x}$ , $\bar{y}$) and (1,1) Çerkeş hospital's needs remain comparable. Interpreted literally, according to our numbers, the Çerkeş hospital can reduce its 'mortality' rate by 0.012 below that of its Strong disposability projection, if it adjusts its working practices towards those consistent with Weak disposability. However to achieve this goal, it needs 1 more nurse; moreover its workload should be reduced by the indicated amounts, e.g. 73 fewer inpatients, 584 fewer dialysis treatments…etc. We note these 25 'capacity constrained' hospitals serve areas of emigration that lose population,-Table 9 will provide statistical evidence on this point. Since trained medical personnel are in short supply in Turkey, the Mo H prefers to employ them in areas where they can serve a greater number of patients. Thus, the Ministry errs on the side of caution when assigning personnel to population losing districts[14]. Our finding about these 25 hospitals being 'capacity constrained' is consistent with such a policy. Cooper et al (2011, p177) stress the importance of dealing with congestion in measuring the slippery concept of 'capacity'. Not surprisingly these 25 hospitals have VRS-W scores of zero and are weakly efficient. 22 of them occur on the Pareto efficient portion of the frontier and the rest are on the "horizontal or vertical" segment

All the others, namely the remaining 48 hospitals under (x, y) – 45 under ($\bar{x}$ , $\bar{y}$), 120 under (1, 1) - turn out to have at least one or more negative (S-W) component. When such a negative component is an input, i.e. ($W_{in} < S_{in}$ ), this suggests the switch from strong to weak disposability or mortality reduction frees up some of that input. In case the negative component is an output, i.e. ($S_{out} < W_{out}$), it implies regime change towards weak disposability would lead to a larger production level for that output[15]. Both eventualities point out to 'negative marginal productivity'. Thanassoulis et al (2008, pp305-6) contains a crisp discussion of this point. These hospitals display weak inefficiency because their VRS-W scores are greater than zero[16]. For further reference we note such hospitals are concentrated in regions of immigration where population growth is substantial.

| Beds | Dctrs | Nurse | SHP | SWC | SOP | Inp | Outp | Dlys | Else | A | B | C | D | E | NB | SB | Cesr. | Dinp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1 | -1 | -1 | -10 | 4 | 93 | 51,047 | -78 | 3,592 | 2 | 15 | 103 | 49 | 69 | -32 | -1 | 6 | 0.00033 |

**Table 8b**. Izmir Aliağa hospital. All figures rounded to the nearest integer. Zero components, e.g. radiotherapy, deleted

Table 8b displays the situation at Izmir Aliaga hospital. Again taken literally, these numbers mean 'risk adjusted mortality' can be decreased by 0.00033 from the level indicated by strong disposability projection. In this case the implied organizational change would require 2 more beds, 1 more doctor and 4 more service workers; also the workload served under the strong

[14] Live interview with the Minister of Health Recep Akdağ. On HABERTÜRK's Press Club program, 18/02/2012.
[15] In our hospital context, weak disposability of bad outputs, means 'more adequate or better quality care'.
[16] Excepting the same few cases - 3 under (x,y), (1,1) and 1 under ($\bar{x}$ , $\bar{y}$) - involving the "horizontal" segment of the frontier where VRS-W scores are zero.

disposability *projection*, would have to *decrease* by the amounts indicated by the *positive* components, i.e. 93 and 51,047 fewer in and out-patients, 3,592 fewer else treatments…etc. However and unlike in *capacity constrained* hospitals, the organizational changes implied by a switch to weak disposability, would free up inputs and produce more outputs for the *negative* components[17]. Thus 1 nurse, 1 health worker and 10 clerks would be released and 78 more dialysis treatments, 32 more natural and 1 more surgical delivery would be performed.

Comparing strong and weak disposability *projections*, according to our estimates a regime change to weak disposability would entail, inter alia, 6 less cesarean births and 32 more natural births (NB). Considering natural and cesarean births to be alternative methods of child delivery, involving partially overlapping input requirements, we offer the following explanation. Women's desire to avoid pain, coupled with the variable and unpredictable length of natural births lead to an overuse of the cesarean -to the detriment of natural- delivery method in order to prevent backlog formation waiting for resources used extensively for natural delivery. Presumably inputs thus busy performing cesareans are withheld from other useful health care activities possibly leading to 'excess mortality'. A similar interpretation can be attached to "Dialysis versus Else or A…"

This particular form of congestion involving overuse of cesarean occurs in 17 out of 48 (33%) hospitals displaying such 'negative marginal productivity' under the (x, y) direction vector. The figures for the other two methods are of comparable magnitude: 18 out of 45 (40%) for $(\bar{x}, \bar{y})$ and 39 out of 120 (33%) under (1, 1). Moreover, especially for the first two approaches, hospitals in question coincide to a large extent. Interestingly, according to OECD (2011), Turkey has one of the highest incidences of cesarean deliveries among OECD members. It was the first in 2009 with an incidence of 42.7%. Finally, Balakrishnan and Soderstrom (2000), in their study on "congestion" in the US health care system, present a comparable analysis regarding the overuse of cesarean methods.

We think the two types of "congestion" we just described, 'capacity constrained' versus 'negative productivity', have different causes. The first type occurs in population losing, the second in population gaining areas. Also they seem to be viewed differently by patients. Table 9 displays the population growth figures for our two 'congestion types'.

| **Direction vector (x, y)** | | | | **Direct. vector $(\bar{x}, \bar{y})$** | | | | **Direction vector (1, 1)** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *N* | *Mean Pop.* | *Var. Pop* | *Z value* | *n* | *Mean Pop.* | *Var. Pop* | *Z value* | *N* | *Mean Pop.* | *Var. Pop* | *Z value* |
| *25* | -0.01 | 0.02 | **2.53** | *25* | -0.01 | 0.02 | **2.69** | *25* | -0.01 | 0.02 | **4.11** |
| *48* | 0.06 | 0.02 | | *45* | 0.07 | 0.02 | | *120* | 0.08 | 0.02 | |

**Table 9:** Congestion types and Population loss versus gain during 2007-2010. N=25 are the 'capacity constrained', N=48 (45, 120) are the 'negative marginal productivity' hospitals. In each case the Z values refer to a test of equality between two means.

The information displayed in Table 9 shows, the 25 hospitals identified as 'capacity constrained' by all 3 methods, are located in regions whose average population has declined by about 1% , over 2007-2010. Whereas the hospitals identified as displaying 'negative

[17] For reasons discussed previously, we construct, the input portion of this vector by ($W_{in}$ - $S_{in}$ ) and its output portion by ($S_{out}$ - $W_{out}$).

marginal productivity' are in fast growing regions whose populations, on average, rose by 6%, 7% and 8% respectively. We think, the first type of congestion –in addition to the obvious overall scarcity of trained medical personnel and expensive equipment- is related to M o H's erring on the side of caution when allocating resources to regions of emigration. The latter type of congestion seems to be related to the difficulties of coping with the varying composition of demand under conditions of rapid population growth. Also since these are public hospitals, the rationing cum resource allocating role of the price system can be invoked only minimally.

Table 10 provides evidence which purports to demonstrate the public's differential reactions to the two types of congestion. Looking at the correlations between congestion and satisfaction scores – C(c,s)- for each of our 3 direction vectors, we see the coefficients are negative and significant for 'negative marginal productivity' hospitals. On the other hand, for the 25 'capacity constrained' hospitals, the same correlations are statistically insignificant. Therefore, it seems, patients do not react negatively to 'capacity constraint' rooted congestion, but register their displeasure when faced with the 'negative marginal productivity' variety.

| **Direction vector (x, y)** | | | | | **Direct. vector ($\bar{x}$ , $\bar{y}$)** | | | | | **Direction vector (1, 1)** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *n* | *C(c, s)* | *tvalue* | *C(m,s)* | *tvalue* | *n* | *C(c, s)* | *tvalue* | *C(m,s)* | *tvalue* | *n* | *C(c, s)* | *tvalue* | *C(m,s)* | *tvalue* |
| *25* | -0.03 | -0.16 | 0.40 | **2.10** | *25* | -0.14 | -0.69 | 0.38 | **1.97** | *25* | -0.30 | -1.52 | 0.49 | **2.67** |
| *48* | -0.34 | **-2.47** | -0.14 | -0.99 | *45* | -0.32 | **-2.23** | -0.18 | -1.18 | *120* | -0.24 | **-2.63** | -0.10 | -1.11 |

**Table 10.** C(c,s): correlation coefficient between congestion and satisfaction; C(m,s): correlation coefficient between mortality component of the (S-W) vector and satisfaction. N=25 are the 'capacity constrained', N=48 (45, 120) are the 'negative marginal productivity' hospitals.

One can think of the 'mortality reduction' component of (S-W), as capturing the efforts of hospital staff to provide the 'extra care' required by a switch from strong to weak disposability of risk adjusted mortality. In other words it would represent the proverbial "extra mile". As such one would expect it to be positively related to patient satisfaction. According to our results the correlations between 'mortality reduction' and patient satisfaction - C *(m,s)*- are consistently positive and significant for the 25 'capacity constrained' hospitals, but negative and insignificant for 'negative marginal productivity' ones. This suggests patients notice and appreciate health personnel's efforts in the first group but not in the second. Whether this is due to patients correctly perceiving and separating 'capacity constraint' rooted difficulties from other problem areas causing 'negative marginal productivity' remains to be investigated.

**VII) Summary and conclusions**: In this paper we analyze the operational performance of 330 Turkish provincial general hospitals during 2009. For that purpose we develop a model with 6 inputs 14 good outputs and 1 bad output. A mortality based variable is our bad output. Congested hospitals are those for whom the switch from strong to weak disposability of mortality is costly. Thus we are able to address "quality or at least adequacy of care" issues. To help improve performance on both input and output space, we adopt a directional distance approach and utilize 3 different direction vectors. We identify congested hospitals and derive the associated congestion inefficiency scores. For each of our 3 directions, we show these scores are negatively related to patient satisfaction. We separate congested hospitals into two groups: (i) those requiring *uniform* sacrifice of good outputs and/or extra inputs in order to reduce mortality, and (ii) those that do not. The latter ones free up some inputs in addition to requiring extra amounts of other inputs and/or produce more of some outputs but less of others as the price of reducing mortality. The first group, which consists of "weakly efficient congested" hospitals, can be said to operate at '*capacity*' whereas the latter, comprising the "weakly inefficient congested" units, can be said to display '*negative marginal productivity*'. Mortality reduction is strongly positively correlated with patient satisfaction for the first and efficient but not the second and inefficient group. On the other hand congestion scores are strongly negatively correlated with patient satisfaction for the latter group. The first '*capacity constrained'* group is more likely to be located in emigrating whereas the second '*negative marginal productivity*' one in immigrating regions. The congestion we were able to pinpoint seems to be caused- in addition to obvious resource shortages- by difficulties associated with handling the changing composition of demand triggered by migratory patterns.

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