

How can we improve waiting time for elective surgery in Australian public hospitals?

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Abstract

This paper presents preliminary results from a study on waiting time for elective care in Australian public hospitals. It uses available data published in Australia to test the hypotheses that public beds and hospital staffing (specialist surgeons and enrolled nurses) influence waiting time for elective surgery in Australian public hospitals. We extracted data from the National Elective Surgery Waiting Times Data Collection (NESWTDC) and analyse waiting times for 8 specialty surgeries in Australian public hospitals. Hospital beds, nurses and specialist surgeons are used as proxies for the endogeneity of waiting times in a multiple regression analysis.

Our results show that available hospital beds negatively influence waiting times ($b_2 = -0.0041$ in Model 1). Interestingly, the number of nurses ($b_1 = 0.0024$ in Model 1) and specialist surgeons ($b_1 = 0.07884$ in Model 2) positively influence waiting times. We conclude that physical resources such as available hospital beds are significant; to improve waiting times, hospitals should be adequately funded.

JEL classification: I11

Keywords: waiting time, elective surgery, hospital beds, nurses, surgeons, Australia.

1. Introduction

The Australian health care system is in desperate need of change. It was reported that in 2008, a total of 9052 elective surgeries were postponed owing to ‘hospital-related’ matters, and a 2-week ban on elective surgery was called in Queensland because of ‘chronic shortages of public hospital beds in Queensland’s health system’ (Miles and Michael 2008). More than half of these cancellations were due to lack of surgeons, nurses, anaesthetists, operating theatres and equipment. And despite an improved median waiting time compared to previous years, there is a rising groundswell of community opinion that demands decisive action to improve access. In October 2008, Health Minister Daniel Andrews blamed the hospital crisis of elective care on insufficient resources to cope with demand (Best and Ede 2008). The most commonly suggested solution is opening more beds but many see this as a flawed response and point to the lack of medical staff (Johnstone, Miles and Lion 2008)

The purpose of this paper is to determine the extent limited hospital capacity could influence the waiting time for elective surgery in Australian public hospitals; and we consider three variables: (1) available public hospital beds (2) nurses enrolled and (3) specialist surgeons. However, this paper does not look into waiting lists for elective care². We focus on waiting time as it is considered to be a reliable measure to gauge improvements of access to elective care under the zero user-charge public system of Australia (Australian Institute of Health and Welfare 2008b).

² Annual data on the number of admissions from waiting lists, as well as additions and removals from these lists, are available from the Australian Institute of Health and Welfare per State and per indicator procedure. Each waiting list is managed by the reporting hospital and methods of collecting data may differ across jurisdictions Australian Institute of Health and Welfare (2007). Australian hospital statistics 2005-06. Canberra, AIHW. **AIHW cat. no. HSE 50.**

We will firstly present a review of the relevant literature from which we have developed our models for analysis. Next in the method section, we will explain the variables used in the analysis (e.g. measures of waiting time and proxies for hospital resources). This is followed by the results, and lastly our discussion and conclusion.

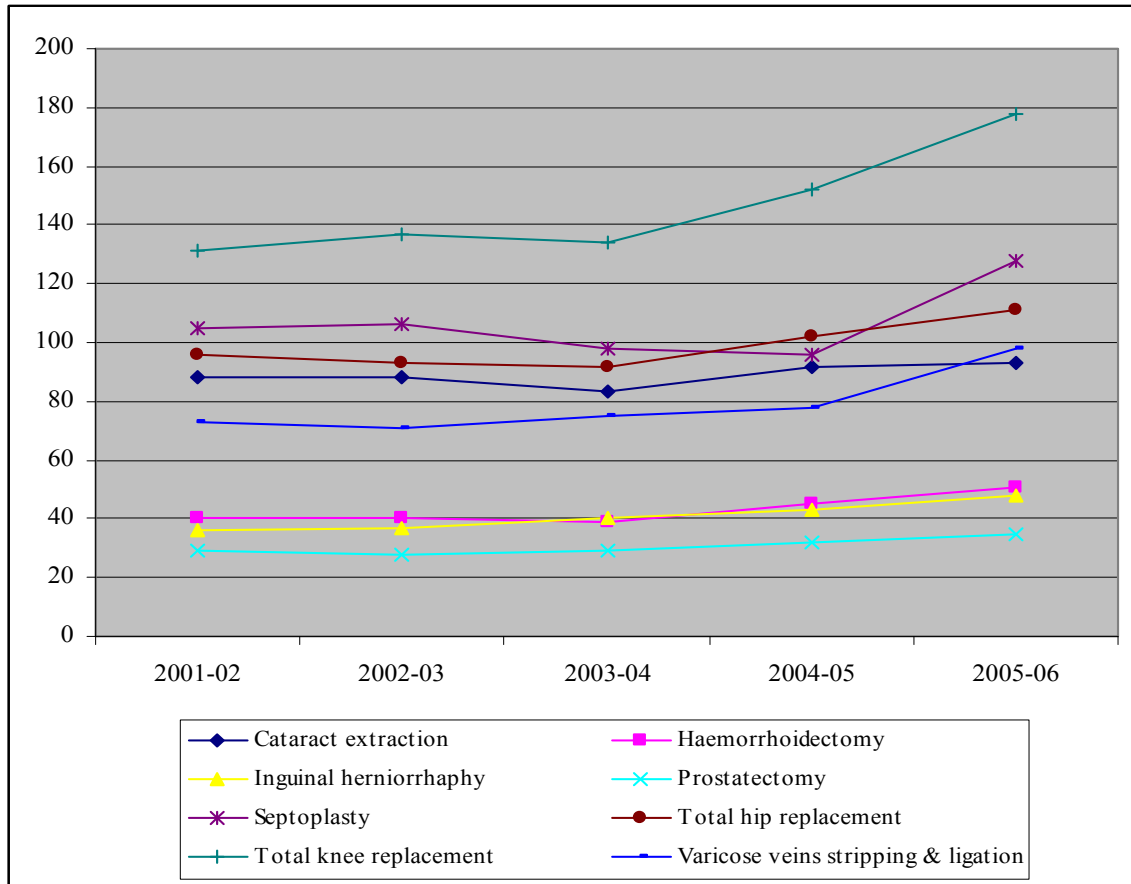
2. Literature review

Waiting time for elective care is defined as the time that elapses between firstly the physician's decision to admit a patient for elective surgery following clinical assessment and secondly the date of hospital admission (Martin and Smith 1995; Australian Institute of Health and Welfare 2002b; Siciliani and Hurst 2004; Australian Institute of Health and Welfare 2006a). In social insurance health care systems such as Medicare in Australia and the National Health Services in the UK, health care services are free of charge at point of demand in public hospitals. Owing to the nature of medical care, the demand for services is mostly driven by the need and the *capacity to benefit* from receiving care.

However, to control excessive demand for free medical services in public facilities, waiting time is used as a rationing device to deal with the high demand for a limited resource in the context of multiple priority levels (Patrick and Puterman 2007). Studies have shown that waiting times vary according to two factors: (1) the patient's covariates such as residence, demographic characteristics and health status (Siciliani *et al.* 2004) and (2) the indicator procedure³ (see Figure 1) which is implicitly related to the hospital location, its resources and the demand volume for such services (Gillett and Katauskas 1993).

³ These include total knee and hip replacement, cataract extraction, varicose veins.

Figure 1 - Days waited at 50th percentile by patients admitted from waiting list for elective surgery in Australia, 2001-06



Sources: Australian Institute of Health and Welfare (2002a; 2002b; 2003a; 2004a; 2005a; 2006a; 2007)

For instance, Gillett *et al.* (1993) found that Victoria and South Australia have higher mean waiting times for general surgery, orthopaedic surgery and ear, nose and throat surgery, but plastic surgery was in high demand in Victoria only, and therefore longer waiting time occurred there. Further discussions on the comparison of the velocity of delivery between urgent and non-urgent surgery can be found in Carroll, Soderfeldt and Malmberg (1995), Gravelle, Smith and Xavier (2000) and Hurst and Siciliani (2003).

A search of the *Medline* database between 1998 and 2006 has generated 1098 citations for waiting time, 268 citations for hospital beds, 34,466 for nurses and 22,074 for surgeons. The relationship between waiting time and the aforesaid hospital resources has been less closely studied generating only a total of 84 citations (one citation for waiting time and hospital beds, 41 for waiting time and nurses and 42 with surgeons). Of the 84 citations, some focused on improved access to care and others looked at patient's satisfaction in health care delivery.

In the literature, we found three key arguments that support the significant relationship between the availability of physical resources and the production of elective surgeries in public hospitals. Firstly, Beecham (1996) found the NHS hospitals that were unable to cope with rising demand for elective care were those with shortage of beds. A study from Martin and Smith (1999) also found that the provision of NHS beds was significant in the supply of admissions for elective surgery. Secondly, it was also found that the limited resources of the NHS were allocated to emergency admissions or were absorbed by elderly or mentally ill people; and this 'bed-blockers' phenomenon also occurred in Sweden (Styrborn and Thorslund 1993). Thirdly, physical resource constraints were an issue in policy initiatives to reduce waiting time. Such initiatives in many European countries include giving patients the freedom of hospital choice which is meant to improve simultaneously the utilisation of existing capacity and the velocity of delivered care (Goddard 1995; Garcia-Lacalle 2008).

Another factor that could influence velocity of delivered elective care in public hospitals is human resources. In a study of waiting times for cataract surgery in Manitoba, De Coster (2005) looked at non-clinical factors that could significantly affect waiting times.

She found that provider characteristics are as important as the patient (e.g. socio-economic status, age, health status) and system characteristics (e.g. competition, rate of surgery). Most importantly, she found that ‘the single most important factor in determining the length of waiting time for Manitoba cataract surgery patients was the surgeon’ (DeCoster 1999: s54). However, Mojon-Azzi and Mojon (2007) do not support this argument. Looking at waiting times for cataract surgery in ten European countries, they failed to find a significant relationship between human resources and waiting time. However, the authors do not completely exclude the possibility that density of cataract surgeons might have an influence on waiting times. The lack of available data on density of surgeons in all ten countries had prevented them from reaching such conclusions.

The literature on hospital labour force and waiting time for elective care is, as mentioned above, rather limited but growing. However, there has been more research conducted on labour force and the production of elective surgeries in the context of waiting lists than waiting times. A related paper is by Pope (1992) who found that an increase in resources may simply lead to more patients on the waiting lists and longer average waiting times, thus supporting the supplier-induced-demand (SID henceforth) hypothesis⁴. In an attempt to explain the SID hypothesis, Auster and Oaxaca (1981) have stated that in the case of an excess in the demand for health care,

Physicians or hospitals may shift the demand for health services in such a way to increase the demand for their own services (Auster *et al.* 1981: 328).

⁴ Hypothesis that providers or any other input supply induces increasing demand for health services
Auster, R., Oaxaca, R. (1981). "Identification of supplier induced demand in the health sector." Journal of Human Resources **16**(3): 327-42.

Empirical estimation of this hypothesis is not a trivial undertaking. The proper specification of an adequate model is challenging and there have been many attempts.

Yet, many writers believe that this hypothesis is true of the health sector:

Since utilization rates are higher where there are more health-care resources, increases in the supply of hospital beds and number of physicians may lead to increases in the amount of health care sought (Congressional Budget Office 1977)⁵.

While the issues of waiting lists and supplier induced demand are very interesting, they are outside the scope of this paper. While we do not exclude the possibility of spill-over effects of SID we are not explicitly looking at the physician's incentive to encourage demand for elective care which would lengthen the waiting list.

3. Method

Based on the above arguments and following the works of Mojon-Azzi and Mojon⁶ (2007), we have constructed four models to test the hypotheses that public beds and hospital staffing (specialist surgeons and enrolled nurses) influence the waiting time for hospital admissions to publicly-funded elective surgery. In the following section, we will describe the datasets and our proxies for hospital resources.

Main database

Our main database is the National Elective Surgery Waiting Times Data Collection⁷ (NESWTDC) for the period 1998-2006 inclusive. These data are published annually in

⁵ Cited in Auster et al. (1981: 327).

⁶ Using data from the SHARE survey, Mojon-Azzi *et al.* (2007) use multiple linear regressions to assess the influence of four health indicators, including acute bed density, on waiting times in ten European countries. Their study shows that waiting times for cataract surgery is not influenced by acute bed density.

⁷ This database is a collection of patients' records on elective surgery waiting list and removals from waiting lists. Data are solely collected from public acute care hospitals.

the Australian hospital statistics report by the Australian Institute of Health and Welfare. On average, 194 public hospitals reported annual data on waiting times for elective surgery.

The annual report contains information about:

- The public hospitals⁸: main groups are the Principal referral and Specialist women's and children's hospitals and the small acute hospitals.
- Health of admitted patients: principal diagnosis, age, gender, status, area of residence and place of birth.
- Non-admitted patient care
- Waiting times for elective surgery in public hospitals⁹: methods of collecting data, comparison between states, distribution of waiting times according to specialty of surgeon and indicator procedure, and additions and removals from waiting lists.

While all this information is valuable, it does not provide any detailed information on the medical labour force (e.g. number of surgeons per state and/or per specialty). To overcome the data deficiencies of the annual report on labour force we used a supplementary database.

Supplementary database

Thus, we used data published by the Royal Australasian College of Surgeons which contains, among other data, the number of specialist surgeons per state; the Labour Force report which is published annually by the Australian Institute of Health and Welfare; and reports of the Australian Medical Workforce Advisory Committee

⁸ In the year 2005-06, there were 755 public hospitals with 736 being acute public hospitals. Information on expenditure, revenue, available beds, casemix data and separations are provided.

⁹ On average, 194 hospitals reported data on elective surgery waiting times for the period 2001-05.

(AMWAC henceforth). For comparison purposes, data were collected for the period 1998-2006 inclusive.

Variables used in the Models

Three indicators of waiting times are used in this study:

- *The number of waiting days of patients admitted, who were at the 50th position on the waiting lists* provides ‘the number of days within which 50% of patients were admitted’;
- *The number of waiting days of patients admitted, who were at the 90th position on the waiting lists* represents ‘the number of days within which 90% of patients were admitted’ (Australian Institute of Health and Welfare 2002b: 2); and
- *The proportion of patients admitted, who had waited more than 365 days on the waiting lists.*

Table 1 **Variables analyzed in this study**

<i>Variables</i>	<i>Description</i>
T	Waiting time
BEDS_PUB	Number of beds available in public hospitals
NURSES	Total nurses enrolled
T1	Waiting time at 50 th percentile
T2	Waiting time at 90 th percentile
T3	Proportion of admitted patients who waited more than 365 days
SURGEON	Number of speciality surgeons
NSW	Dummy variable =1 for NSW
VIC	Dummy variable =1 for VIC
QLD	Dummy variable =1 for QLD
WA	Dummy variable=1 for WA

Proxies for physical and human resources are used as instruments for the endogeneity of waiting times (Table 1).

- *The number of available public beds* is a key data item as it is a useful practical indicator of the effective capacity of public hospitals. It is expected that an increase in the number of available inpatient beds will facilitate health care utilization. Data for this indicator is released annually by the Australian Institute of Health and Welfare for each state. According to the Department of Health and Ageing, the number of available beds in the public sector has continuously fallen since the early 1990s, while the demand for care in the public sector has risen. Therefore, we expect this variable to be highly significant in our modelling.

- *The total number of employed medical or surgical clinical nurses* is published in the annual report of Australian hospitals statistics. The total value includes registered nurses and enrolled nurses per state. It is likely that employing more medical or surgical clinical nurses would reduce waiting time for elective surgery in public hospitals.
- *The number of specialist surgeons* is also a critical factor and is expected to hold a negative relationship with waiting time for elective surgery. This labour force indicator is published annually by the AIHW and the Royal Australasian College of Surgeons (Australian Institute of Health and Welfare 2000a; 2003b; 2003c; 2004b; Australian Medical Workforce Advisory Committee 2005; 2006b; Royal Australasian College of Surgeons 2007a; 2007b; 2008).

4. Econometric modelling and analysis of hospital resources and waiting time

For this study we created two different balanced panels of data. The first dataset comprises data collected from 5 states (e.g. NSW, VIC, QLD, WA and SA) over 8 years from 1998-99 to 2006-07. The second panel comprises 40 cross-sections (eight specialty surgeries across 5 States) over 8 years from 1999-00 to 2006-07. The eight specialty surgeries include cardio-thoracic, ear nose & throat surgery (ENT), general surgery, neurosurgery, orthopaedic surgery, plastic surgery, urology and vascular surgery. The choice of specialty surgeries was determined by data accuracy and consistency over time and across States to allow for comparisons.

Assumptions

A total of four models were constructed to test our hypotheses: one model was derived using the first dataset and three models from the second dataset. In these models, we assume the error term has the following properties (Greene 2003):

$$A.1 \ E(\varepsilon_{it}) = 0$$

$$A.2 \ E(\varepsilon_{it}^2) = \sigma_i^2$$

$$A.3 \ E(\varepsilon_{it}\varepsilon_{jt}) = \sigma_{ij} \quad \text{for } i \neq j$$

$$A.4 \ \varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + u_{it}$$

$$A.5 \ E(u_{it}) = 0$$

$$A.6 \ E(u_{it}^2) = \phi_{it}$$

$$A.7 \ E(u_{it}u_{jt}) = \phi_{ij} \quad \text{for } i \neq j$$

$$A.8 \ E(u_{it}u_{js}) = 0 \quad \text{for } t \neq s$$

$$A.9 \ E(\varepsilon_{i,t-1}u_{jt}) = 0 \quad \text{for all } i, j$$

Modelling

We computed the Hausman's specification to test the appropriateness of each model using the following hypotheses (Verbeek 2004: 352):

$$H_0 : E(x_{kit}u_i) = 0$$

$$H_1 : \text{not } H_0$$

Using the p-value approach, we reject H_0 if the probability value of the Hausman test is less than the chosen significance level of 5%, and conclude that the assumption of a random effects model does not hold. Thus the appropriate model is a fixed effects model. Conversely, if we fail to reject H_0 then the assumption of a random effects

model holds. This is the model we choose to make inferences concerning the population. Using the first dataset (sample size of 45 observations over the 1998-2006 period), we developed Model 1 below.

Model 1 – Random effects model for nurses and public beds

$$T_{it} = \beta_0 + \beta_1 BEDS_PUB_{it} + \beta_2 NURSES_{it} \quad (1)$$

Using the second panel of data (sample size of 320 observations over the 1999-2006 period), we develop **Models 2-4** relating the measures of waiting times with the supply level of surgeons in public hospitals.

Model 2 - Random effects model for T1 and number of surgeons

$$T1_{it} = \beta_0 + \beta_1 SURGEON_{it} + \beta_2 NSW_{it} + \beta_3 VIC_{it} + \beta_4 QLD_{it} + \beta_5 WA_{it} \quad (2)$$

Model 3 - Random effects model for T2 and number of surgeons

$$T2_{it} = \beta_0 + \beta_1 SURGEON_{it} + \beta_2 NSW_{it} + \beta_3 VIC_{it} + \beta_4 QLD_{it} + \beta_5 WA_{it} \quad (3)$$

Model 4 - Random effects model for T3 and number of surgeons

$$T3_{it} = \beta_0 + \beta_1 SURGEON_{it} + \beta_2 NSW_{it} + \beta_3 VIC_{it} + \beta_4 QLD_{it} + \beta_5 WA_{it} \quad (4)$$

5. Results

Each model aims at identifying a potential relationship between hospital resources and an indicator of waiting time for elective care. Estimation results for the four models are presented in Table 2.

Table 2 Estimation results for Models 1-4 (standard errors in parentheses)

<i>Variable</i>	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>
Nurses	0.0024* (0.0008)			
Public beds	-0.0041* (0.0013)			
Surgeon		0.0788* (0.0268)	0.2769* (0.1186)	0.0040 (0.0047)
NSW		-10.1769 (7.8494)	-25.1253 (48.6168)	-0.4641 (1.6225)
VIC		-11.0405 (7.4170)	4.9316 (43.8068)	0.5361 (1.4616)
QLD		-15.0189* (6.4200)	-59.9802** (34.7986)	-1.0873 (1.1809)
WA		1.3583 (9.4890)	25.4282 (51.8945)	1.0742 (1.7352)
DW	1.1291	0.09995	0.16142	0.2549

* Statistically significant at 5%

** Statistically significant at 10%

Model 1 – Random effects model for nurses and public beds

$$T_{it} = \beta_0 + \beta_1 BEDS_PUB_{it} + \beta_2 NURSES_{it} \quad (1)$$

In Model 1, the coefficients are statistically significant. The number of enrolled nurses and public beds significantly influence waiting time for elective care. Interestingly, the coefficients show that employing more nurses would increase waiting time for elective care in public hospitals while increasing the supply of public beds would reduce median waiting times. The errors in this model are serially correlated as $DW=1.1291 < d_L$.

Model 2 - Random effects model for T1 and number of surgeons

$$T1_{it} = \beta_0 + \beta_1 SURGEON_{it} + \beta_2 NSW_{it} + \beta_3 VIC_{it} + \beta_4 QLD_{it} + \beta_5 WA_{it} \quad (2)$$

In Model 2, the explanatory variable SURGEON holds a significant relationship with median waiting time for elective care at 5% significance. While the value of β_1 is much smaller, it still implies a positive relation where more surgeons would result in longer waiting times. Again, we would reject $H_0: \rho = 0$ and conclude that the errors are serially correlated.

Model 3 - Random effects model for T2 and number of surgeons

$$T2_{it} = \beta_0 + \beta_1 SURGEON_{it} + \beta_2 NSW_{it} + \beta_3 VIC_{it} + \beta_4 QLD_{it} + \beta_5 WA_{it} \quad (3)$$

In Model 3, there is a positive relationship between the labour supply and the waiting time at 90th percentile at 5% level of significance. Again this shows that employing more specialty surgeons would lengthen waiting periods. Like the previous models, the errors are serially correlated.

Model 4 - Random effects model for T3 and number of surgeons

$$T3_{it} = \beta_0 + \beta_1 SURGEON_{it} + \beta_2 NSW_{it} + \beta_3 VIC_{it} + \beta_4 QLD_{it} + \beta_5 WA_{it} \quad (4)$$

T3 represents the proportion of patients admitted who waited more than a year. Unlike the previous models, the surgery workforce does not seem to significantly affect the dependent variable. The errors are still serially correlated.

6. Discussion and conclusion

Our modelling and econometric analysis have yielded interesting results after we addressed the question of whether increasing hospital physical resources (more beds) and human resources (more surgeons and nurses) would improve access to elective care

in Australia. At this point, we should stressed that we have relied only on the available published data that were collected from reporting hospitals across Australia, and we note that secondary data has several limitations.

Limitations of the data used

Firstly, the available secondary data showed inconsistency and variation so that comparison was difficult across the states and territories. It was only in June 2008, that the Australian Institute of Health and Welfare announced that they would introduce new measures of waiting time for elective surgery (Australian Institute of Health and Welfare 2008b) in an attempt to improve the reliability and consistency of these data in the future. Secondly, while the dataset for the models was carefully built and balanced, the median waiting times for the year 1998-99 are significantly different from the other years and could potentially be outliers. Thirdly, we only studied five States in Australia because we think that for the present this is the best possible representative sample for the Australian population. Owing to unavailable data, it was not possible to include more States (e.g. more cross-sections) to increase the panel of data; TAS (for Tasmania) and the ACT had many missing data. Longer time series would have been ideal but disparities among the variables and the lack of consistent procedures for data collection have prevented the extension of our analysis to earlier years. As a result, the timeframe was restricted to 1998-2006.

We are planning to collect primary data in different locations across QLD and NSW to overcome these limitations and data deficiency and to derive other variables that can potentially influence waiting time for elective care in Australian hospitals.

Despite these deficiencies, we obtained the following important results:

[1] Increasing the number of available public beds can improve elective surgery waiting times ($b_2 = -0.0041$ in Model 1);

[2] Conversely, the number of nurses ($b_1 = 0.0024$ in Model 1) and specialist surgeons ($b_1 = 0.07884$ in Model 2) has a positive relationship with waiting time for elective surgery in public hospitals.

Physical resources: hospital beds as a proxy

The results of Model 1 show that available beds in public hospitals are a significant exogenous factor for elective surgery waiting times. Most of the overseas research on waiting times was conducted in the United Kingdom. Our results for Australia support that of Martin *et al.* (1999) who found that the provision of NHS beds is significant in the supply of admissions for elective surgery. They found that a long-run increase in public beds was necessary to cut long-run waiting time, given a constant level of demand; but a short run increase in public beds will not immediately improve waiting time.

By contrast, Cullis and Jones (2000) found no relationship between available public beds and the velocity of health care delivery arguing there was no simple relationship between resource provision and waiting times. While there is empirical evidence of a fall in waiting times when more resources are allocated, Yates (2001) argues that there is no multivariate analysis that currently supports this. However, he suggests that a more sophisticated analysis of surgeon provision and waiting times could enlighten the understanding of long waiting times.

Human resources

Drawing from the work conducted by Mojon-Azzi *et al.* (2007), we performed an analysis of the supply of surgeons in Australian public hospitals. Our econometric results show both nurses and surgeons are positively associated with waiting times.

Enrolled nurses: Our model estimates show that more nurses tend to lengthen waiting times for elective care but the effect is really small ($b_1 = 0.0024$, see Model 1). Our result is different from Benjamin's (2003) in a study of nurses staffing in Papua New Guinea. He found a negative relationship between the number of nurses and waiting times, implying that the low supply of nurses would explain the unreasonable waiting time in urban clinics.

Specialist surgeons: Our results relating to the supply of surgeons suggest that a rise in the number of surgeons is reflected in longer waiting times which perhaps may be interpreted as implying an effect of supplier-induced demand (SID). Indeed, Cullis *et al.* (2000) remind us that information asymmetry could give doctors the opportunity to stimulate demand. However, we think that a positive relationship between the supply of surgeons and longer waiting times does not necessarily imply a causal relationship. Even if we interpret our results on surgeon supply as seemingly pointing to SID, it would be unwise to recommend a policy to restrict the number of specialist surgeons because a certain specialty and/or region may be in shortage while another may be in surplus.

Concluding remarks

In order to reduce the waiting time of publicly funded elective surgery, many countries have adopted a variety of policy measures. These include using capacity in the private sector¹⁰ (Iversen 1997; Hurst *et al.* 2003), promoting day-surgery¹¹ (Hurst *et al.* 2003), increasing choices for patients¹² (Hurst *et al.* 2003; Siciliani 2005) and adopting maximum waiting-time guarantees (Hurst *et al.* 2003; Dawson, Gravelle, Jacobs, Martin and Smith 2005). Perhaps some of these policies may not be so effective. Their benefits may not be fully realised without complementary measures such as adjusting the funding level and allocation of resources according to the level of demand. Based on the results of this study, we conclude that a good policy option on public hospitals is to provide long run capital investment in the physical resources for elective surgery to improve waiting time in the long run.

¹⁰ There is a view that promoting private health insurance does not necessarily help in reducing waiting period. According to Iversen (1997), if the demand for medical care is elastic, waiting time for publicly funded elective surgery could increase further if a private sector develops.

¹¹ Advanced medical technologies have allowed for more effective and shorter surgeries. The National Health System in England introduced 'diagnostic and treatment centres' which would only treat day-cases in order to reduce elective surgery waiting times. Evidence on the impact of this policy initiative is yet to come. However, if proved to be successful, this could alleviate the public hospitals.

¹² It was found that waiting times and the degree of substitutability among hospitals are positively related. The more choices people have of where they obtain surgery, the longer the waiting times are. Studies show that if people go to a hospital which exhibits lower waiting time, this hospital will eventually result in more patients, which in turn would increase the waiting time for elective surgery. Hence, increased supply of medical services would eventually become saturated and therefore waiting time is just shifted from a hospital to another.

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