Competition, prices, and quality: an analysis of the behavior of Australian GPs

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Abstract
General Practitioners (GPs) in Australia are free to set prices for consultations. Under the national tax funded Medicare insurance scheme patients pay the difference between the price set by the GP and a fixed reimbursement. In 79% of consultations, GPs ‘bulk bill’ the patient ie the patient makes no out of pocket payment and the GP is paid the fixed Medicare reimbursement. We construct a Vickrey-Salop model of GP third degree price and quality discrimination with bulk billing. We test its predictions using a dataset with individual GP-level data on prices, the proportion of patients who are bulk billed, average consultation length, and characteristics of the GPs, their practices and patients. We use area fixed effects to control for endogeneity of GP location decisions. We find that within areas, GPs with more distant competitors charge higher quality adjusted average prices, mainly by reducing the proportion of patients who are bulk billed, rather than increasing the price for patients who are not bulk billed.

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1 Introduction

Market structure and the degree of competition in health care markets can have important effects on health care costs, quality of care and access to health care. The aim of this paper is to examine the effect of competition on prices and quality in the market for GP consultations, using a rich Australian data set. Patients in Australia pay a fee for each GP consultation. The fees that GPs charge are not regulated and they are also free to price discriminate between patients, subject only to the constraints imposed by their market conditions. The national, tax financed, Medicare insurance scheme provides a subsidy for the cost of a consultation (the Medicare rebate). The patient pays the excess of the GP fee over the Medicare rebate and these out of pocket co-payments by patients cannot be covered by insurance. The fact that prices for consultations are unregulated, plus the availability of good GP level data make this

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a good market in which to examine the effects of competition on prices and quality. Our study has lessons for policy in other health care systems with unregulated prices for physicians. These includes France and the US, where the practice of charging fees above the price reimbursed by the insurer is known as balance billing (Glazer and McGuire, 1993).

The majority of studies examine the effect of competition in hospital or insurance markets, with few studies on the effects of competition in the market for physician services (Gaynor and Town, 2011). The literature on the influence of competition on prices charged and a range of other physician behaviours has been reviewed by Dranove and Satterthwaite (2000) and more recently by Gaynor and Town (2011). Prior to 2000, studies on competition and prices for physicians were conducted in the context of supplier-induced demand and had major identification problems. Of the more recent studies, Schneider et al (2008) find that physician market concentration in California, measured by the Herfindahl Hirschman Index (HHI) is associated with higher prices, though they did not allow for the endogeneity of HHI unlike similar studies of the hospital sector. Bradford and Martin (2000) find that higher physician density is associated with less profit sharing amongst physicians in group practices and lower prices. Gunning and Sickles (2012) estimate a structural model of the US physician market and find it is consistent with an Cournot oligopoly. Their approach follows Bresnahan (1989) and uses estimates of physician cost functions, and observed prices to estimate the degree of competition in the market

We add to this literature in several ways. First, we develop a formal model of GP first degree price and quality discrimination under bulk billing with free entry into GP markets. We use it to generate predictions about the effects of competition as guide to our empirical analysis.[1] Second, previous literature has relied on area level competition measures and so is potentially vulnerable to endogeneity bias if unobserved factors that influence entry and exit into areas are also correlated with prices and qualities. We use a physician-level measure of competition (distance to nearby other GP practices) that allows us to use area fixed effects that control for all area-level variables that are unobserved and may influence prices, including the characteristics of areas that influence exit and entry into those areas. Identification therefore relies on within-area variation in distance to other GPs. Previous studies have also used areas as the unit of analysis. This can lead to bias and to incorrect inferences being made about individual behaviour (Robinson, 1950). Our use of physician-level data overcomes this problem (Scott and Shiell, 1997).

Third, previous studies of the Australian market have relied on administrative data that does not include detailed information on the influence of doctor or practice characteristics (McRae

[1] Glazer and McGuire (1993) use a Hotelling model to examine how prices, bulk billing and quality vary with patient location. Brekke et al (2010) have a Vickrey-Salop circular city model with an exogenous number of doctors and all patients facing the same price and quality. There is no patient insurance and so no possibility of bulk billing. They show that the effects of an increase in the number of doctors on price and quality depend on assumptions about patient utility and doctor cost functions. Gravelle (2000) also studies price and quality in a Vickrey-Salop model and allows for entry by doctors but does not consider bulk billing or for prices and quality to vary across patient types.

2009, Richardson et al 2006, Savage and Jones 2004). This is exacerbated by using small area data which takes averages of GP and practice characteristics across areas and therefore masks heterogeneity. Use of administrative data ignores the effects of sources of heterogeneity that influence pricing decisions, in addition to the effect of competition. For example, depending on the structure of a partnership, each GP in a practice may: i) have full discretion to charge their own prices; ii) have discretion of whether to bulk-bill some patients but not others; iii) may have to charge the price agreed by the owners of the practice, or iv) may opt to bulk-bill all patients. These are decisions influenced by practice characteristics and by patient characteristics, both of which may be correlated with the degree and nature of competition. If these factors are not accounted for then the estimate of the effect of competition may be biased.

Our theoretical model of the market for GP services generates testable hypotheses about the relationship between price and quality variables, and a measure of competition: the distance between GP practices. We find results consistent with the predictions from our theoretical model. GPs whose rivals are further away charge higher quality adjusted prices. This result is robust to alternative estimation strategies, including area fixed-effects estimations. Although distance to rivals tends to increase average price and reduce quality the effects are not statistically significant. The main reason for higher quality adjusted average prices for GPs with less competition is that they bulk bill a smaller proportion of their patient. We also find that these effects of competition are stronger in areas with greater socio-economic advantage.

2 Institutional setting

General practitioners in Australia are paid by fee-for-service for consultations. They are free to charge what the market will bear. Their patients are subsidised by Medicare, a national tax-financed insurance scheme. Patients can claim back a fixed rebate from Medicare as set out in the Medicare Benefits Schedule (Australian Government, 2008). Co-payments by patients (the difference between the rebate and the price charged) cannot be covered by insurance. GPs can choose to 'bulk-bill' a patient, so that the patient pays nothing to the GP who claims the rebate direct from Medicare as full payment. Some GP practices choose to bulk-bill all patients, whilst GPs in other practice bulk bill none or only a proportion of their patients.

There is no enrolment of patients or list system. Patients can choose any GP practice each time they consult. GPs are gatekeepers to specialist and hospital services, though patients can access hospital services directly through emergency departments which can substitute for GP services. There are no restrictions on geographical location of practice, apart from doctors arriving from overseas who must first practice for a set period in under-doctored areas. GPs in designated geographical areas of workforce shortage are eligible for a range of payments to encourage them to locate to and remain in these areas.

There has been increasing concentration in the market for GP services. Between 2004/5 and 2009/10, although the number of GPs per capita grew slightly (by 0.04%), the number of practices fell by 4%. Both state and federal government policy have encouraged the formation of larger practices. There is also a trend for private companies to own chains of practices.

3 A model of price, quality, and bulk billing

3.1 Specification

We model GPs' decisions and the market equilibrium by extending the Vickrey-Salop model of monopolistically competitive firms (Vickrey, 1964; Salop, 1979) to include choice of quality as well as prices and for the possibility that GPs bulk bill for a proportion of their patients.

Under bulk billing, the total price per consultation received by a GP is $p + m$ where m is the price paid to the GP by Medicare. Patients pay p per consultation. Patients demand at most one consultation per period from their GP and the utility gain from a consultation at GP i is

$$u_i = r - p_i + \alpha q_i - td_i$$

where p_i is the price the patient pays at GP i, q_i is the quality of the consultation (measured say by its length), d_i is the distance to the GP, $\alpha \in [\alpha_0,\alpha_1]$ and t are taste parameters. We assume that r is large enough to ensure that the market is covered: all patients demand a consultation. All patients have the same marginal distance cost t. They differ in their marginal valuation of quality (α).

There are H patients in total, distributed uniformly around the circular market of length L, so that the density of patients at any point in the market is $h = H/L$. The probability distribution and density functions of patient types, $F(\alpha;\theta)$ and $f(\alpha;\theta)$, are independent of location within the market, so that at each point there are $hf(\alpha;\theta)$ patients of type α. θ shifts the patient type distribution. We assume that $F_\theta < 0$ so that markets with higher θ have a larger mean valuations of quality.

There are G GPs equally spaced around the market so that the distance between GPs is $\ell = L/G$. GPs observe patient types and can charge different prices and provide different quality to each type. The demand for GP i from type α patients depends on the price $p_i(\alpha)$ she charges them and the quality $q_i(\alpha)$ she provides, as well as the prices and qualities of her immediately neighbouring GPs:[2]

$$\begin{aligned} D_i = &\frac{hf(\alpha;\theta)}{2t}\{p_{i+1}(\alpha) - p_i(\alpha) + \alpha[q_i(\alpha) - q_{i+1}(\alpha)] + t\ell\} \\ &+ \frac{hf(\alpha;\theta)}{2t}\{p_{i-1}(\alpha) - p_i(\alpha) + \alpha[q_i(\alpha) - q_{i-1}(\alpha)] + t\ell\} \\ = &D_i(p_i(\alpha), q_i(\alpha); p_{i+1}(\alpha), q_{i+1}(\alpha), p_{i-1}(\alpha), q_{i-1}(\alpha), \alpha, \ell, h, \theta) \qquad (1) \end{aligned}$$

where the first term is demand from patients between GP i and GP $i + 1$ and the second is demand from patients between GP i and GP $i - 1$. The average variable cost of serving patients who get quality q is $\frac{1}{2}\delta q^2$.

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[2] See Gravelle (1999), Brekke et al (2010).

GP i profit is

$$\pi_i = \int_{\alpha_0}^{\alpha_1} \left[p_i(\alpha) + m - \tfrac{1}{2}\delta q_i(\alpha)^2 \right] D_i(p_i(\alpha), q_i(\alpha); \cdot) f(\alpha;\theta) d\alpha \tag{2}$$

The GP chooses $p_i(\alpha)$, and $q_i(\alpha)$ to maximise π_i, subject to the constraint that $p_i(\alpha) \geq 0$.[3] First order conditions are

$$\pi_{ip_i(\alpha)} = D_i(p_i(\alpha), q_i(\alpha); \cdot) - \left[p_i(\alpha) + m - \tfrac{1}{2}\delta q_i(\alpha)^2 \right] hf(\alpha;\theta) t^{-1} \leq 0,$$

$$p_i(\alpha) \geq 0, \quad p_i(\alpha)\pi_{ip_i(\alpha)} = 0 \tag{3}$$

$$\pi_{iq_i(\alpha)} = -\delta q_i(\alpha) D_i(p_i(\alpha), q_i(\alpha); \cdot) + \left[p_i(\alpha) + m - \tfrac{1}{2}\delta q_i(\alpha)^2 \right] \alpha hf(\alpha;\theta) t^{-1} = 0 \tag{4}$$

With identical GPs, the Nash equilibrium has all GPs choosing the same price and quality for each type of patient and we can now drop the GP specific subscript. At the equilibrium demand for each GP is $D(p(\alpha), q(\alpha); \cdot) = hf(\alpha;\theta)\ell$ and there are two solutions for the optimal patient price and quality, depending on the patient type:

$$p^b(\alpha;\ell,t,m,\delta) = 0, \quad q^b = q^b(\alpha;\ell,t,m,\delta) = \frac{\left[(\delta\ell t)^2 + 2\alpha^2\delta m\right]^{\frac{1}{2}} - \delta\ell t}{\alpha\delta}, \; \alpha \leq \alpha^b \tag{5}$$

$$p^{nb}(\alpha;\ell,t,m,\delta) = t\ell + \frac{\alpha^2}{2\delta} - m > 0, \quad q^{nb} = q^{nb}(\alpha;\ell,t,m,\delta) = \frac{\alpha}{\delta}, \qquad \alpha > \alpha^b \tag{6}$$

Patients are bulk billed ($p = 0$) if and only if their marginal valuation of quality is less than a threshold level α^b

$$\alpha \leq \alpha^b(\ell,t,m,\delta) \equiv \left[2\delta(m - t\ell)\right]^{\frac{1}{2}} \tag{7}$$

and the proportion of patients who are bulk billed is

$$F^b = \int_{\alpha_0}^{\alpha^b(\ell,t,m,\delta)} dF(\alpha;\theta) d\alpha = F\left(\alpha^b(\ell,t,m,\delta);\theta\right) \tag{8}$$

We see from (5) and (6) that, irrespective of whether they are bulk billed or not, patients with higher marginal valuations (α) of quality will receive higher quality because their demand is more responsive to quality.[4] The price charged to patients who co-pay and are not bulk billed increases with their marginal valuation of quality.

3.2 Model predictions

We do not observe prices and quality for individual patients but we do have data (see section 4.1) on summary measures of GP's decisions:

a) the proportion of each GP's patients who are bulk billed $F^b = F(\alpha^b, \theta)$;

b) the average price charged to patients who are not bulk billed ($\bar{p}^{nb}$);

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[3] It can never be optimal to set $p < 0$ (ie pay the patient in order to get the Medicare rebate m) since increasing p to zero, with quality constant, has no effect on demand (since patients pay nothing in both cases) and therefore no effect on costs, and increases revenue.

[4] $q_i(\alpha)$ is increasing and continuous in α (since $\text{Lim}_{\alpha^- \to \alpha^b} = \alpha^b / \delta$), though $\partial q_i(\alpha)/\partial\alpha$ is discontinuous at α^b.

c) the average quality of a GP ($\bar{q}$) (as measured by average consultation time for all her patients);
d) the average price charged to all patients ($\bar{p} = (F^b \times 0) + (1 - F^b)\bar{p}^{nb} = (1 - F^b)\bar{p}^{nb}$;
e) the average price to all patients adjusted by the average quality ($\bar{p} / \bar{q}$).

We use the model to derive predictions about how these variables respond to an increase in ℓ = L/G which we interpret as a decrease in competition in the market.

a) From (7) and (8), reductions in competition reduce the proportion of patients who are bulk billed

$$\partial F^b / \partial \ell = f(\alpha^b, \theta) \partial \alpha^b / \partial \ell < 0 \tag{9}$$

b) The effect of reduced competition on the average price charged to patients who are not bulk billed ($\bar{p}^{nb}$) is

$$\frac{\partial \bar{p}^{nb}}{\partial \ell} = \frac{\partial \mathrm{E}\left[p(\alpha; \ell, t, m, \delta) \middle| \alpha \geq \alpha^b \right]}{\partial \ell} = \frac{\partial}{\partial \ell} \left[\int_{\alpha^b}^{\alpha_1} p(\alpha; \ell, t, m, \delta) f(\alpha, \theta) d\alpha \frac{1}{1 - F(\alpha^b, \theta)} \right]$$

$$= \int_{\alpha^b}^{\alpha_1} \frac{\partial p(\alpha; \ell, t, m, \delta)}{\partial \ell} f(\alpha) d\alpha \frac{1}{1 - f(\alpha^b, \theta)} - \frac{p(\alpha^b; \ell, t, m, \delta)}{1 - F(\alpha^b, \theta)} \frac{\partial \alpha^b}{\partial \ell}$$

$$+ \int_{\alpha^b}^{\alpha_1} p(\alpha; \ell, t, m, \delta) f(\alpha) d\alpha \frac{1}{\left[1 - F(\alpha^b, \theta) \right]^2} \frac{\partial F^b}{\partial \alpha^b} \frac{\partial \alpha^b}{\partial \ell}$$

$$= \int_{\alpha^b}^{\alpha_1} \frac{\partial p_i(\alpha; \ell, t, m, \delta)}{\partial \ell} f(\alpha, \theta) d\alpha \frac{1}{1 - F(\alpha^b, \theta)}$$

$$+ \int_{\alpha^b}^{\alpha_1} p(\alpha; \ell, t, m, \delta) f(\alpha, \theta) d\alpha \frac{1}{\left[1 - F(\alpha^b, \theta) \right]^2} f(\alpha^b, \theta) \frac{\partial \alpha^b}{\partial \ell} \tag{10}$$

The first term in the last line is positive but the second is negative since α^b is decreasing in ℓ (less competition reduces the threshold type at which the GP sets a positive price)· Intuitively, reductions in competition increase the price for those already facing a positive price (the first term) but dilutes the average price to paying patients because of those patients who were previously not charged (ie were bulk billed) and who now pay but face a low price (the second term). If there are sufficient of these payers the average price for those not bulk billed will fall.

c) The effect of ℓ on average quality for all patients ($\bar{q}$) is, from (5) and (6),

$$\frac{\partial \bar{q}}{\partial \ell} = \int_{\alpha_0}^{\alpha^b} \left[\left((\delta \ell t)^2 + 2\alpha^2 \delta m \right)^{-\frac{1}{2}} \ell \left(\delta t \right)^2 - \delta t \right] f(\alpha, \theta) d\alpha$$

$$= \int_{\alpha_0}^{\alpha^b} \left((\delta \ell t)^2 + 2\alpha^2 \delta m \right)^{-\frac{1}{2}} \delta t \left[\delta \ell t - \left((\delta \ell t)^2 + 2\alpha^2 \delta m \right)^{\frac{1}{2}} \right] f(\alpha, \theta) d\alpha < 0 \tag{11}$$

where we use the fact that quality for bulk billed patients is positive so that the square bracketed term in the second line is negative from (5).

d) The average price paid across all patients ($\overline{p} = (1-F^b)\,\overline{p}^{nb}$ does however increase when competition is reduced since the price for all non bulk billed patients is increased:

$$\frac{\partial \overline{p}}{\partial \ell} = \frac{\partial \mathrm{E}\left[p(\alpha;\ell,t,m,\delta) \middle| \alpha \geq \alpha^b \right]\left[1-F(\alpha^b,\theta)\right]}{\partial \ell}$$

$$= \frac{\partial}{\partial \ell}\left[\int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha,\theta) d\alpha \frac{1}{1-F^b(\alpha^b,\theta)} \right]\left[1-F^b(\alpha^b,\theta)\right]$$

$$= \frac{\partial}{\partial \ell}\int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha,\theta) d\alpha = \int_{\alpha^b}^{\alpha_1} tf(\alpha,\theta) d\alpha - p(\alpha^b;\ell,t,m,\delta)\frac{\partial \alpha^b}{\partial \ell}$$

$$= \int_{\alpha^b}^{\alpha_1} tf(\alpha,\theta) d\alpha > 0 \qquad (12)$$

e) The previous results (11) and (12) imply that the average price for all patients adjusted by the average quality ($\overline{p}/\overline{q}$) increases with ℓ since $\overline{p}$ increases and $\overline{q}$ falls.

In the empirical analysis we have a proxy for the market's overall preference for quality θ which shifts the distribution function of patient types. Increases in θ do not affect prices or quality for given types of patient but they do reduce the proportion who are bulk billed. Our assumption that an increase in θ gives a first order stochastic dominating distribution implies $F_\theta^b = F_\theta\left(\alpha^b(\ell,t,m,\delta);\theta\right) < 0$ so that the proportion who are bulk billed is lower. Moreover, first order stochastic dominance implies, since price is either constant or increasing in α and quality is increasing in α (see (5), (6)), that both $\overline{p}$ and $\overline{q}$ increase with θ.

The first five columns in Table 1 summarise the comparative static properties of the model when the number of GPs (and hence ℓ) is fixed. The table shows the ceteris paribus effects of changes in ℓ, *m, δ, t, h,* θ on the five variables we observe in our data.

We also investigate empirically whether our proxies for θ change the effect of competition on price, quality, and the bulk billed proportion. We can show (Appendix available from authors) that although the effect of θ on $\partial \overline{p}^{nb}/\partial \ell$, $\partial F^b/\partial \ell$, and $\partial(\overline{p}/\overline{q})/\partial \ell$ are ambiguous, increases in θ make $\partial \overline{q}/\partial \ell$ more negative and $\partial \overline{p}/\partial \ell$ more positive. Thus in markets with higher θ a reduction in competition will lead to greater reductions in average quality and greater increases in average price.

3.3 Endogeneity of competition

We test for the effects of reduced competition (increased ℓ) by estimating cross-section regression models of the prices and qualities chosen by GPs in different markets with differing amounts of competition. However, in the absence of restrictions on entry the number of GPs in a market and hence the distance between GPs (ℓ) is endogenous which raises the possibility that simple cross-section model will produce biased estimates of the effect of ℓ.

With free entry into different markets, in equilibrium all markets will yield the same profit. Denote GP fixed cost of operating in the market by K (which can be taken to be a financial cost minus the monetary equivalent of any utility from the amenities in the market. Substituting the optimal patient price and quality from (5) and (6) into (2), maximised GP profit is

$$\pi^* = h\ell\int_{\alpha_0}^{\alpha_1}\left[p(\alpha;\ell,t,m,\delta)+m-\tfrac{1}{2}\delta q_i(\alpha;\ell,t,m,\delta)^2\right]dF(\alpha;\theta) = \pi^*(\ell;\delta,t,m,h,\theta) \quad (13)$$

The equilibrium number of GPs and hence the distance between GPs is determined by the condition that GPs break even:

$$\pi^*(\ell;\delta,t,m,h,\theta) - K = 0 \quad (14)$$

so that in equilibrium the distance between GPs is

$$\ell = \ell(\delta,t,m,h,K,\theta) \quad (15)$$

Using the implicit function rule on (14) the effects of δ, t etc on the equilibrium ℓ are $\partial\ell/\partial\delta$ = $-\pi^*_\delta / \pi^*_\ell$ etc and these are reported in the rightmost column of Table 1.

Endogeneity of ℓ will lead to biased estimates if the estimated model omits variables which determine prices or qualities and are correlated with ℓ. For example, the true model for the bulk billing proportion is F^b = $F(\alpha^b(\ell,t,m,\delta);\theta)$ = $F^b(\ell(m,\delta,\theta,h,K),t,m,\delta,\theta)$. If the regression fails to include variables like θ which affect both F^b and ℓ positively, the estimated effect of ℓ will be positively biased. Omission of variables like t which only affect F^b and are not correlated with ℓ will not bias the estimated effect of ℓ, though it will lead a loss of efficiency. Finally, variables like K which only affect F^b though their effect on ℓ should be omitted from the regression, though they can act as instruments for ℓ. We discuss how we implement the estimation of the regression models in more detail in section 4.2 after describing the data.

4 Methods

4.1 Data

We use data from the first wave of the MABEL survey, a prospective cohort/panel study of workforce participation, labour supply and its determinants among Australian doctors. The sampling frame is the Australian Medical Publishing Company's (AMPCo) Medical Directory, a national database of all Australian doctors, managed by the Australian Medical Association (AMA). Data was collected from June to December 2008. The questionnaire covered topics such as job satisfaction and attitudes to work; characteristics of work setting (public/private hospital, private practice); workload (hours worked, on-call); finances (income, income sources); geographic location; demographics; and family circumstances (partner and children).

The number of GPs responding in the first round was 3906 (including 226 GP registrars (trainees)), a response rate of 19.36%. The respondents were nationally representative with respect to age, gender, geographic location and hours worked (Joyce *et al.* 2010). We restrict the study sample to GPs located in the five major conurbations. The areas outside these conurbations are sparsely populated and GPs in them face different financial incentives and regulations to those in our study sample. After excluding rural GPs, GP registrars, and those with incomplete data we had a study sample of 1798 GPs.

4.1.1 Prices

The survey asks two questions about consultation fees. The first is *"Approximately what percentage of patients do you bulk bill/charge no co-payment?"* We use this measure the proportion of patients who are bulk billed (F^b). Patients who are bulk-billed are charged no copayment and the GP is paid the Medicare rebate (m).

The second question is *"What is your current fee for a standard (level B) consultation? (Include Medicare rebate and patient co-payment. Please write amount in dollars; write 0 if you bulk bill 100% of your patients)"* which we use as a measure of the average price charged to patients who are not bulk billed. Different types of consultation (defined in terms of complexity and length) have different Medicare rebates and may have different copayments set by GPs.[5] However, level B consultations constitute the bulk of consultations and we believe the answer to this question will be a good measure of a GP's price setting behaviour for non-bulk billed patients relative to other GPs facing different market conditions.

4.1.2 Quality

The GPs are asked *"How long does an average consultation last? (Please write number of minutes)"* . Since consultation length is positively correlated with measures of the quality of care including preventative care, lower levels of prescribing and some elements of patient satisfaction (Wilson and Childs 2002), we use this variable as a measure of the average quality of consultations ($\bar{q}$).

We also measure average quality as the number of patients seen per hour. This is constructed from two questions, the first of which asks about the number of patients seen in a usual week, and the second asks about hours of work in the last usual week spent in face-to-face clinical contact. This variable is equivalent to consultation length, but is less subject to heaping around multiples of 5 minutes.

4.1.3 Competition measure

There is a large literature on measuring competition in healthcare markets (Gaynor and Town, 2011). Studies on markets for hospital care often calculate Herfindahl-Herschmann indices (HHIs) based on market share information. Recent studies have used the approach of

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[5] The Medicare Benefits Schedule has four categories of consultation (Australian Government, 2008). Level A are simple consultations with limited examination, for example a consultation for a tetanus immunisation. Level B are more complex than Level A and include history taking, advice giving, ordering tests, formulation and implementation of a management plan. Level C are more complex than level B and must last at least 20 minutes. Level D consultations are yet more complex and must last at least 40 minutes.

Kessler and McClellen (2000) and Gowrisankaran and Town (2003), to avoid the obvious endogeneity problem that market share depends on a prices and qualities, by calculating the HHI from regression estimates of demand which include distance but not price or quality. Studies in physician markets generally have not been able to take this approach (with the exception of Schneider et al, 2008) because of the absence of data on patients' residential location. Instead, most physician market studies have used a measure of physician density (Bradford and Martin 2000, Richardson et al 2006) in an area. This has the disadvantage that all providers in an area are assumed to face the same competitive pressure.

We construct an individual-level variable measuring competition, the distance between a GP's practice and her rival practices. This approach follows directly from the model in section 3 where we use distance between GPs ℓ as a measure of competition. Several papers in the hospital competition literature have also used competition measures which are purely geographically defined (Propper et al, 2008). Drawing on Bresnahan and Reiss (1991), we consider various specifications of ℓ using the distance to the 3rd and 5th nearest GP.

We construct the competition measures using data from the Australian Medical Publishing Company (AMPCo) which covers the whole population of Australian GPs, not only those who responded to the MABEL survey. We calculated the road distances between GPs' street addresses. For each MABEL respondent we calculated the distance to the nearest, third nearest, and fifth nearest other GP practice in the AMPCo data (whether or not they were MABEL respondents).

4.1.4 GP and GP practice covariates

We control for a number of individual GP and GP practice characteristics to allow for differences in costs or preferences across practices which may influence pricing decisions. First, we control for GP gender and whether they have a spouse or dependent children. Second, we control for professional characteristics of the GP: whether they went to an Australian medical school, their level of experience (in ten year bands), and whether they are a partner or associate in a practice. Being a partner or associate indicates a direct financial (ownership) relationship with the practice which may give incentives to charge higher prices. Partner or associate status also indicates seniority of the GP within the practice. Third, we control for characteristics of the practice itself. These include practice size (number of GPs) and whether the practice is taxed as a company or not. Practice size may influence pricing decisions either via economies of scale or via its incentive effects (Gaynor and Pauly, 1990).

4.1.5 Local area characteristics

The 1798 study sample GPs are located in 380 Statistical Local Areas (SLAs) with an average population of 15,400. We use data on SLA characteristics to capture factors which may affect demand and cost conditions for GPs. We have Census data on the SLA age distribution, ethnicity, and self reported disability. The Index of Relative Socio-Economic Advantage and Disadvantage (IRSEAD) is constructed by the Australian Bureau of Statistics from 22 variables measuring education, income, occupational structure, employment status, and family structure. Higher values correspond to greater advantage and we expect SLAs with a higher IRSAD score to have greater valuation of quality and thus to have GPs who set higher prices and provide higher quality. We include a measure of median house prices since SLAs with higher house prices are likely to have higher premise costs for GPs and to have richer populations who may place a higher valuation on quality. In a small proportion of study SLAs there are additional incentives for bulk billing. We therefore include a dummy variable for such SLAs.

Our data set has three measures of the prices and quality decisions of each GP: the proportion of patients who are bulk-billed (F^b), the average price in excess of the Medicare reimbursement rate which is charged to patients who are not bulk billed ($\overline{p}^{nb}$), and the average quality (consultation length) for all consultations ($\overline{q}$). In addition, from these we construct two derived variables: the average price for all patients ($\overline{p} = (0\times F^b) + (1-F^b)\,\overline{p}^{nb} = (1-F^b)\,\overline{p}^{nb}$) and the average price for all patients standardised by the average consultation length ($\overline{p}/\overline{q}$).

4.2 Estimation

Our basic estimating equation is an empirical implementation of the theory model of section 3. We estimate models of the form

$$y_{ij} = \beta_0 + \beta_1 GPdist_{ij} + \beta_2 GPchars_{ij} + \beta_3 Areachars_j + \varepsilon_{ij} \qquad (16)$$

where y_{ij} is one of the five variables of interest for GP i in area j. There are three types of explanatories: *GPdist* is a GP specific measure of the distance between a GP and her rivals corresponding to ℓ in the theory model, *GPchars* are the characteristics of the GP and the GP's patients; and *Areachars* are characteristics of the SLA in which the GP is located.

The coefficient of particular interest is β_1, the effect of differences in competition faced by the GPs on the prices they charge. With OLS we hope to identify this effect through variation in prices and competition across GPs i and areas j. The key identification problem with this approach is related to GPs' ability to choose their practice location. As we noted in section 3.4, if there are unobserved factors which affect GPs choice of location and are correlated with both y_{ij} and $GPdist_{ij}$ then the error term ε_{ij} will not be conditionally uncorrelated with $GPdist_{ij}$ thereby biasing the OLS estimate of β_1.

We attempt to overcome this problem by taking advantage of the fact that the GP specific competition measure (distance to rival GPs) varies both between areas (over j) and within areas (over i). We estimate three types of models which incorporate area effects in different ways. The random effects specification is identical to (16) except that $\varepsilon_{ij} = \gamma_j + u_{ij}$ where γ_j is the area effect. The fixed effect model is

$$y_{ij} = \beta_0 + \beta_1 GPdist_{ij} + \beta_2 GPchars_{ij} + \gamma_j + u_{ij} \qquad (17)$$

where the area fixed effect now picks up the effect of the cross area variation in all the observed ($Areachars_j$) and unobserved area variables. The Mundlak (1978) specification is

$$y_{ij} = \beta_0 + \beta_1 GPdist_{ij} + \beta_2 GPchars_{ij} + \beta_3 Areachars_{ij} + \lambda_1 \overline{GPdist}_j + \lambda_2 \overline{GPchars}_j + u_{ij} \qquad (18)$$

where $\overline{GPdist}_j$, $\overline{GPchars}_j$ are the area means of $GPdist_{ij}$ and $GPchars_{ij}$.

The random effects specification will yield a consistent estimate of β_1 if the unobserved area effect γ_j is not correlated with $GPdist_{ij}$. The fixed effects estimation is consistent for β_1 if u_{ij} is uncorrelated with $GPdist_{ij}$ given γ_j and $GPchars_{ij}$. Consistency for the Mundlak estimation requires that u_{ij} is uncorrelated with $GPdist_{ij}$ given $GPchars_{ij}$ and $\overline{GPdist}_j$, $\overline{GPchars}_j$. This is more stringent than the requirement for fixed effects since it requires that the included area mean variables are correlated sufficiently with the area means of omitted variables to absorb their entire effects. The fixed effect estimator ensures that the across area effects of omitted variables are picked up by the area effect γ_j.

If unobservable factors correlated with the GP's location decision (and hence with $GPdist_{ij}$) operate at the level of the area, and do not vary within areas, the error term v_{ij} has a zero mean conditional on j and the fixed effect estimate of β_1 will be consistent. Using the Mundlak or fixed effects specification means that β_1 is identified only from *within-area* variation and we need sufficient variation in both y_{ij} and $GPdist_{ij}$ within areas to successfully identify β_1. The advantage of including area effects in the estimation is that it controls for characteristics of areas that would otherwise be unobserved, including demand side influences such as socio-economic status, age-gender composition of the population, and supply-side influences, such as the availability of other health services that may be substitutes for GP care (eg the number of pharmacies and emergency departments).

5 Results

Table 3 presents has detailed results for the regression for quality standardised average price ($\bar{p}/\bar{q}$) from the four estimation methods. All models allow for clustering at SLA level.[6] The first two rows of coefficients (and associated standard errors) are for our main competition measure *GPdist*, the log of the distance to the third-nearest GP practice and its interaction with the IRSEAD index of advantage. There are statistically significant positive coefficients for the distance to the third-nearest GP practices in all estimated models: the further the distance to nearby competitors, the higher the quality standardised average price charged by the GP. The effect is approximately 25% larger in the Mundlak and fixed effects models, which control for the correlation between unobserved area-level characteristics affecting quality standardised price, and for the within-area varying characteristics (including the distance competition measure). This suggests that on average, there are unobserved area level variables which tend to drive up price and also reduce the distance between GPs. For example, areas with greater amenities could attract richer or better educated populations willing to pay more for quality (higher θ in terms of the theory model) and also be more attractive to GPs (lower net real fixed location cost K).

[6] The 1798 GPs are located in 1296 practices. We also allowed for clustering at practice level but this made little difference to the results.

Whether the GP graduated from an Australian medical school, and whether they are a partner or associate in the practice, also predicts higher quality standardised price in all models. More experienced GPs, and those in larger practices, appear to have higher quality standardised prices in general, but this effect is not consistently statistically significant across the models. Family and personal characteristics, and whether the practice is taxed as a company, does not appear to affect quality standardised prices.

Table 4 has the coefficients on *GPdist* and its interaction with the socio-economic advantage from regression models for the four other measures of GP pricing and quality decisions (the proportion bulk billed F^b, average price to those not bulk billed $\overline{p}^{nb}$, the average price over all patients $\overline{p} = (1-F^b)\overline{p}^{nb}$, and average quality $\overline{q}$. The signs of the estimated coefficients are in line with the predictions of the theory model: greater distance to rival GPs is associated with a lower bulk billing rate, a higher average price, and lower quality. (The theory model implied that the effect of distance to other GPs on $\overline{p}^{nb}$ was ambiguous.) Only the association with the bulk billing rate is significant and the results suggest that the main effect of distance to nearby competitors on the standardised average price $\overline{p}/\overline{q} = (1-F^b)\overline{p}^{nb}/\overline{q}$ is through the bulk billing rate F^b. The models with bulk-billing rate as a dependent variable consistently show distance to the third-nearest GP practice reducing the bulk-billing rate F^b (therefore increasing average price $\overline{p} = (1-F^b)\overline{p}^{nb}$). In the fixed effects model bulk billing model the interaction with the index of local area advantage is significant and negative, suggesting that the effect of distance to local competitors on the bulk billing rate is larger (more strongly negative) in more advantaged areas. The coefficient on *GPdist* in the model for quality standardised price $\overline{p}/\overline{q}$ is much larger than on the unstandardised mean price because *GPdist* is associated with reductions in $\overline{q}$ as well as increases in $\overline{p}$.

Table 5 presents results using the quality standardised average price as the dependent variable with three alternative measure of competition: logs of distance to the nearest, third nearest, and fifth nearest GP practice. Using the distance to the 5^{th} nearest GP practice the estimated effect on quality standardised average price is slightly greater than in the baseline specification with distance to the third nearest GP practice. However, when we use distance to the nearest GP practice to measure competition, the effect is only significant in the random effects model. never significant in predicting prices charged. This may be because there is less variation in distance to the nearest GP practice compared with the other distance measures.

6 Conclusions

6.1 Discussion

Our results broadly support the hypotheses generated by the model in section 3 (given in Table 1). The baseline measure of *GPdist* (ℓ) as the log of distance to third-nearest GP practice, is significantly negatively associated with the proportion of patients who are bulk billed F^b and with the quality standardised average price $\overline{p}/\overline{q}$. A 1 standard deviation

(1.5km) increase in the distance to the third nearest GP is associated with a $1 increase in the quality standardised price. Shifting a GP from the lowest decile of the distribution of distance to third nearest GP (0.6km) to the top decile (2.9km) is associated with $2.21 (22%) increase in the quality standardised average price and a 8.7% reduction in the proportion of patients who are bulk billed (ie face zero copayment).

We also find that interaction between local area socio-economic status and distance to local competitors is statistically significant, and in areas with higher status an increase in the distance to rival GPs is associated with a larger increase in the quality standardised average price and a larger reduction in the proportion of patients who are bulk billed. Again this is consistent with the predictions of the theory model.

The results for the other dependent variables (average quality, average price, and average price for patients who are not bulk billed) are consistent with the predictions of the theory model but are not statistically significant.

We interpret the results from the fixed effect models as evidence of a causal effect of distance to nearby competitors on GP pricing decisions. We think it reasonable to assume that omitted variables correlated with the competition measure and pricing decisions operate mainly at SLA level. This requires either that factors affecting GP location operate across SLAs and not within them or that factors shifting demand or cost functions and thereby affecting price are fairly homogenous within SLAs and vary mainly across them.

The fact that we find bigger effects on quality standardised price in the models with area effects suggests that there are area level variables which are positively correlated with distance to nearby competitors, and negatively correlated with quality standardised price. An example might be if areas with poor amenities are unattractive both to GPs and to patients willing to pay more for consultations and our socio-economic index is not sensitive enough to capture this aspect of the population.

Our results suggest that the trends to increasing concentration in markets for physician services in the US and Australia where physicians can set prices as well quality may lead to higher prices and lower quality. The trend in Australia has arisen, not because of fewer physicians, but because of an increase in the number of physicians per practice so that the number of practices per head of population has fallen. This trend is in part due to government policy to encourage larger practices in the belief that there are benefits by way of cost reductions associated with economies of scale in larger practices. With data from a single cross-section we cannot tell if the overall welfare effects of larger firms are positive or negative but it does seem that patients of GPs facing less competition will, at any point in time, face higher quality adjusted average prices.

6.2 Extensions

The current draft is work in progress. In addition to various robustness checks with alternative functional forms (for example GLM models with log dependent variables or models with Box-Cox transforms of the *GPdist* variables), the alternative measure of consultation length, and sets of explanatories which may be better measures of demand side factors, we will apply instrumental variables methods. As we noted in the theory section, if we have variables like the fixed cost *K* which affect location decisions but do not affect price or quality decisions we can use these as instruments for the competition measure. One possibility is that MABEL provide information on whether the GP grew up in a rural area. It is plausible that this will affect their taste for location, for example making GPs who grew up in rural areas more likely to locate in less densely populated area and hence to have larger distances to competing GPs.

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Table 1. Comparative static properties

Increase in	Ceteris paribus effect on prices, bulk billing, quality					Effect on distance between GPs (ℓ)
	$\bar{p}^{nb}$	F^b	$\bar{q}$	$\bar{p}$	$\bar{p}/\bar{q}$	
ℓ	?	–	–	+	+	na
t	?	–	–	+	+	0
m	–	+	+	+	?	–
δ	–	+	–	–	?	+
θ	+	–	+	+	?	–
h	0	0	0	0	0	–
K	0	0	0	0	0	+

$\bar{p}^{nb}$: average price (excess over Medicare reimbursement m) paid by patients who are not bulk billed; F^b: proportion of patients who are bulk billed (pay nothing out of pocket); $\bar{p} = (1 - F^b)\,\bar{p}^{nb}$: average over all patients of price paid (in excess over Medicare fee m); $\bar{q}$: average quality (consultation length); ; $\bar{p}/\bar{q}$: average over all patients of price paid, adjusted by average quality; $\bar{p}^{nb}/\bar{q}$: average price paid by patients who are not bulk billed, adjusted by average quality; ℓ : distance between GPs; t: patient travel cost; m: Medicare reimbursement; δ: quality cost parameter; θ: shift parameter for distribution of patient marginal valuation of quality (higher θ implies higher average valuation); K: GP fixed costs net of value of local amenities.

Table 2. Summary statistics

Variable	Mean	S.D.	Min	Max
Standardised price ($) $\overline{p}/\overline{q}$	10.050	10.126	0	115.328
Bulk-billed (%) F^b	59.765	31.399	0	100.000
Average fee ($) $\overline{p}^{nb}$	17.884	13.000	0	142.200
Av consult time (mins) $\overline{q}$	16.877	7.628	5.000	204.000
Third closest GP practice (km) ℓ	1.495	1.544	0.003	17.448
ln(Third closest GP practice (km))	0.001	0.948	-5.954	2.859
Female GP	0.476			
Spouse	0.867			
Children	0.642			
Australian Medical School	0.821			
Experience 10-19 years	0.215			
Experience 20-29 years	0.387			
Experience 30-39 years	0.232			
Experience 40+ years	0.078			
Partner or associate	0.459			
Practice size: 2-3 GPs	0.170			
Practice size: 4-5 GPs	0.193			
Practice size: 6-9 GPs	0.325			
Practice size: 10+ GPs	0.171			
Taxed as a company	0.273			
Incentive area	0.233			
IRSEAD	0.000	1.000	-4.510	2.194
Median house price ($000,000)	6.921	3.739	2.000	30.225
Prop under 15	0.174	0.050	0.009	0.296
Prop 65+	0.130	0.041	0.032	0.279
Prop disabled	0.039	0.013	0.005	0.076
Prop NW Europe	0.080	0.039	0.011	0.269
Prop SE Europe	0.051	0.042	0.005	0.301
Prop SE Asia	0.044	0.052	0.000	0.332
Prop Other	0.102	0.084	0.002	0.496
Population/km^2	2128.616	1672.824	0.100	8757.000

IRSEAD: Index of Relative Socio-Economic Advantage and Disadvantage (higher values indicate greater advantage). Average price charged to all patients $\overline{p} = (1 - F^b)\overline{p}^{nb}$

Table 3: Full regression results for standardised average price ($\bar{p}/\bar{q}$)

Dependent variable: Standardised Average Price: $\bar{p}/\bar{q}$

	OLS		R.E.		Mundlak		F.E.	
Variable	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
ln(3rd closest GP pr)	0.716	0.311 **	0.781	0.301 ***	1.143	0.362 ***	1.115	0.364 ***
x IRSEAD	-0.246	0.298	-0.044	0.274	0.246	0.29	0.531	0.270 **
Female GP	0.820	0.516	0.889	0.517 *	0.900	0.551	0.920	0.562
Spouse	0.647	0.595	0.733	0.592	0.876	0.627	0.833	0.649
Children	0.051	0.494	0.184	0.475	0.390	0.485	0.736	0.495
Australian Medical School	2.935	0.537 ***	2.989	0.525 ***	3.042	0.589 ***	3.167	0.613 ***
Experience 10-19 years	1.919	0.836 **	1.730	0.822 **	1.400	0.893	1.318	0.922
Experience 20-29 years	1.078	0.801	0.838	0.785	0.646	0.867	0.478	0.898
Experience 30-39 years	0.998	0.913	0.914	0.901	0.848	0.997	0.836	1.039
Experience 40+ years	-0.535	1.004	-0.581	1.013	-0.342	1.117	-0.456	1.135
Partner or associate	1.496	0.534 ***	1.465	0.549 ***	1.167	0.595 **	1.225	0.621 **
Company	0.846	0.528	0.710	0.511	0.663	0.532	0.589	0.553
Practice size: 2-3 GPs	0.172	0.794	0.068	0.770	0.207	0.789	0.092	0.814
Practice size: 4-5 GPs	0.708	0.705	0.844	0.693	1.369	0.739 *	1.310	0.784 *
Practice size: 6-9 GPs	1.462	0.699 **	1.142	0.691 *	1.028	0.740	0.937	0.774
Practice size: 10+ GPs	1.389	0.774 *	1.175	0.774	0.820	0.849	0.609	0.882
IRSEAD	2.657	0.460 ***	2.637	0.456 ***	2.750	0.448 ***		
Incentive Area	1.196	0.809	1.307	0.842	1.162	0.861		
Median house price	0.243	0.076 ***	0.235	0.076 ***	0.226	0.076 ***		
Percentage U15	-6.699	7.889	-4.237	8.376	0.73	8.244		
Percentage 65+	20.589	7.916 ***	20.222	8.174 **	22.04	7.947 ***		
Percentage disabled	-29.816	34.013	-27.131	35.357	-21.21	34.52		
Percentage NW Europe	5.894	10.199	4.518	9.926	4.566	9.538		
Percentage SE Europe	-26.553	8.438 ***	-22.785	7.618 ***	-20.04	7.549 ***		
Percentage SE Asia	7.708	9.013	3.417	9.630	2.866	9.431		
Pop per km2	0.000	0.000 *	0.000	0.000	2E-04	2E-04		
Local area random effects	No		Yes		Yes		No	
Local area averages	No		No		Yes		No	
Local Area FE's	No		No		No		Yes	
Obs	1797		1797		1797		1797	
R^2								

IRSEAD: Index of Relative Socio-Economic Advantage and Disadvantage (higher values indicate greater advantage)

Table 4: Other measures of GP behaviour

Dependent variable	OLS			R.E.			Mundlak			F.E.		
Explanatory variables	Coeff.	S.E.		Coeff.	S.E.		Coeff.	S.E.		Coeff.	S.E.	
Dep var: $\overline{p}^{nb}$ *Fee ($)*												
ln(3rd closest GP pr)	0.569	0.464		0.569	0.464		1.104	0.628	*	0.972	0.646	
x IRSEAD	-0.424	0.458		0.424	0.458		0.027	0.582		0.414	0.56	
Dep var: B: Bulk-billed (%)												
ln(3rd closest GP pr)	-2.921	0.947	***	-3.06	0.909	***	-4.04	1.112	***	-4.214	1.133	***
x IRSEAD	0.265	0.867		-0.062	0.827		-0.888	0.961		-1.514	0.907	*
Dep var: $\overline{p}$ *: Average price*												
ln(3rd closest GP pr)	0.427	0.395		0.475	0.409		0.909	0.549	*	0.884	0.562	
x IRSEAD	-0.561	0.378		-0.471	0.391		-0.167	0.491		0.08	0.472	
Dep var: $\overline{q}$ *Consult time (mins)*												
ln(3rd closest GP pr)	-0.315	0.224		-0.315	0.224		-0.563	0.368		-0.559	0.358	
x IRSEAD	-0.345	0.276		-0.345	0.277		-0.702	0.465		-0.741	0.454	
Dep var: $\overline{p}/\overline{q}$ *: Stand. ave. price ($)*												
ln(3rd closest GP pr)	0.716	0.311	**	0.781	0.301	***	1.143	0.362	***	1.115	0.364	***
x IRSEAD	-0.246	0.298		-0.044	0.274		0.246	0.296		0.531	0.270	**

All models contain the same specification as the analogous model reported in Table 3. IRSEAD: Index of Relative Socio-Economic Advantage and Disadvantage (higher values indicate greater advantage)

Table 5: Sensitivity to competition measures

Dependent variable	OLS		R.E.		Mundlak		F.E.	
Explanatory variables	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Dep var: $\overline{p}/\overline{q}$ *: Stand. ave. price ($)*								
ln(closest GP pr)	0.169	0.159	0.144	0.158***	0.203	0.163	0.136	0.185
x IRSEAD	-0.123	0.145	-0.105	0.135	0.035	0.141	-0.252	0.140*
Dep var: $\overline{p}/\overline{q}$ *: Stand. ave. price ($)*								
ln(3rd closest GP pr)	0.716	0.311**	0.781	0.301***	1.143	0.362***	1.115	0.364***
x IRSEAD	-0.246	0.298	-0.044	0.274	0.246	0.296	0.531	0.270**
Dep var: $\overline{p}/\overline{q}$ *: Stand. ave. price ($)*								
ln(5th closest GP pr)	0.949	0.360***	1.003	0.346***	1.251	0.408***	1.194	0.456***
x IRSEAD	-0.099	0.141	0.072	0.128	0.000	0.134	-0.195	0.132

All models have the same specification as the analogous model reported in Table 3. IRSEAD: Index of Relative Socio-Economic Advantage and Disadvantage (higher values indicate greater advantage)