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The "Supply Hypothesis" and Medical Practice Variation in Primary Care:

Testing economic and clinical models of inter-practitioner variation

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Short Title: "Supply Hypothesis" in Primary Care

Word Count: 8,042

Abstract

Medical practice variation (MPV) is marked, apparently ubiquitous across the health sector, well documented, and continues to be a focus of professional and policy interest. MPV have stimulated two paths of investigation, one economic in emphasis and the other more clinical in orientation; while health economists have stressed the potential role of income incentives in medical decision-making, health services research has tended to emphasise clinical ambiguity as a factor in practitioner decisions. Both sets of explanations converge in an implicit "supply hypothesis" that posits contextual practitioner and practice attributes as influential in clinical decisions.

Data on inter-practitioner variation are taken from a large and representative regional survey of general practitioners in New Zealand, a country in which unsubsidised fee-for-service is the predominant mode of remuneration in primary care. The paper assesses the impact on three important areas of clinical decision-making - prescribing, test ordering, request for follow-up - of three key conceptual dimensions - income incentives, physician agency, and clinical ambiguity (operationalised as local doctor density, practitioner encounter initiation, and diagnostic uncertainty respectively). Predictions are made about inter-practitioner variations in the rate of clinical activity in the three areas.

The results of the analysis using multi-level statistical techniques are:
(1) The extent of competition - local doctor density - seems to have *no effect* on the pattern of clinical decision-making.
(2) Doctor-initiated visits are, if anything, associated with *lower* rates of intervention.
(3) Diagnostic uncertainty is associated with *higher* rates of investigations and follow-up, both of which have clinical plausibility.
(4) There is no significant interaction effect between density and uncertainty.

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It is concluded that, for the clinical activities studied and for the practitioner attributes as operationalised in this investigation, a clinical, rather than an economic, model of practitioner decision-making provides a more plausible interpretation of inter-practitioner variation in rates of clinical activity in general practice. The "supply hypothesis" requires further analytical refinement and empirical assessment before it can be applied as a generic explanatory framework for MPV.

Introduction

Background

Medical practice variation (MPV) in rates of hospitalisation and medical and surgical intervention is well established (Folland and Stano, 1990; Paul-Shaheen *et al.*, 1987). Such patterns have been documented for well over a decade at different levels of geographic aggregation (McPherson et al., 1982) and for an ever-broadening range of conditions and procedures (Chassin *et al.*, 1986). There remain a number of important gaps in the literature, however. Firstly, much earlier MPV research remained at the level of descriptive report rather than explanatory and policy hypothesis (McPherson, 1994). Secondly, the bulk of research to date has focused on the secondary and tertiary sectors of care, with less work carried out on MPV in primary care (Parchman, 1995). Thirdly, despite the increasing sophistication of MPV research, there remain a number of methodological problems (Birch, Eyles and Newbold, 1993; Vollin *et al.*, 1994).

This paper seeks to address each one of these deficiencies in the current literature. In the first place a more or less explicit and consistent explanatory framework - the "supply hypothesis" - is developed for MPV research, and specific propositions are tested. Secondly, the study explores in greater detail the explanation of MPV in primary care. Finally, this research addresses at least some of the methodological deficiencies identified in that it is able to incorporate ecological, contextual and individual effects using multilevel statistical techniques.

The "Supply Hypothesis"

Central to what has been termed here the "supply hypothesis" is the observation that features of supply in medical care markets appear to play a powerful role in shaping

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patterns of utilisation. This insight has been fuelled by the well-documented evidence on MPV. The research response to MPV has been informed by two analytical traditions in particular - one drawing predominantly on economic models (Scott and Shiell, 1997), and the other deriving more from the clinical practice and health services literature (McPherson, 1994).

According to the first tradition health practitioners are in a position to take advantage of their role as the patient's agent to influence the demand for their services, particularly in circumstances where such decisions are likely to affect their income (Wolf, 1989). In its strongest interpretation this is the theory of supplier-induced demand (SID), a theory that requires evidence not only of income enhancement through induced demand but also of consequentially "inappropriate" service use (Scott and Shiell, 1997). Even on a weaker interpretation of SID - called here the income incentives model - MPV can at least in part be explained by the influence doctors are able to exert over patterns of patient demand, especially in response to income incentives. SID, in both strong and weaker versions, has been tested - with varying empirical results - in a number of fields, including dentistry (for example, Grembowski et al., 1997; Grytten, 1992; Grytten et al., 1992), mental health (Hendryx and Rohland, 1994), surgery (Domenighetti et al., 1993; Rutkow, 1987), physiotherapy (Van Doorslaer and Geurts, 1987), obstetrics and gynaecology (Tussing and Wojtowycz, 1993; Vallgarda, 1989), and general practice (Scott and Shiell, 1997; Kristiansen and Holtedahl, 1993; Tussing and Wojtowycz, 1986).

An alternative, but closely related, research tradition is one that gives primacy to the pervasiveness of clinical ambiguity in medical care. According to this model, uncertainty - not necessarily manipulation of demand - is the key factor. It is argued that physicians are required to make decisions in circumstances of considerable

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clinical ambiguity, and that it is the exercise of clinical judgement under conditions of uncertainty that produces MPV (Wennberg et al., 1982). The model goes further in arguing that, in resolving this uncertainty, doctors develop distinctive styles of practice which shape their use of medical resources (Wennberg, 1984). A number of studies have been carried out documenting both the extent of uncertainty (McKinlay et al., 1998; Anderson et al., 1995; Biehn, 1982) and the existence of physician practice style (Bertakis et al., 1998; Bensing, van den Brink-Muined and de Bakker, 1993; Conroy, Pace and Main, 1991; Bowman, 1990), with some application to MPV (Calman, Hyman and Licht, 1992; Stano, 1986).

Central to the "supply hypothesis" in both traditions of research is the conceptual importance of physician agency. This is the notion that it is the doctor's role as agent acting on behalf of the patient that is particularly distinctive of medical decision making. Agency is linked to income incentives because physicians are seen as being in a position to use their decision-making authority to influence the pattern of patient demand. Similarly with the uncertainty model; although clinical ambiguity - rather than income concerns - is seen as the key mechanism, it is again the physician as agent who is making these clinical decisions on behalf of the patient (Wolf, 1989).

These three conceptual features - income incentives, physician agency, and clinical ambiguity - are quite central not only to the overarching "supply hypothesis" but also to two influential research traditions within that framework. All three dimensions will be incorporated in the analysis that follows.

MPV in Primary Care

Although most research on MPV has focused on the secondary and tertiary sectors

of care, substantial inter-practitioner variation in patterns of primary care activity has been established for a range of individual items of clinical activity. Much of this literature reporting MPV in primary care has been simply descriptive. However, a growing number of reviews with an explanatory focus have been carried out, for example, for investigations (Epstein and McNeil, 1987), prescribing (Bradley, 1991), and referrals (Wilkin and Smith, 1987). There have also been some more generic reviews of resource use (for example, Weiner et al., 1996). It is convenient to group these explanations into those with a focus, respectively, on the practitioner, the patient, and the practice context.

Taking the practitioner first, attributes that have been emphasised in accounting for MPV in primary care are: demographic characteristics such as age and gender (Haikio, Linden and Kvist, 1995; Davidson et al., 1994); personality (Epstein, Begg and McNeill, 1984); risk attitudes (Holtgrave, Lawler and Spann, 1991); beliefs (Hartley et al., 1987); and training (Vehvilainen et al., 1996; Epstein and McNeil, 1985; Epstein, Begg and McNeil, 1984).

The impact of patient attributes has generally been incorporated as an important control or confounding factor. In particular, investigators have been interested in determining the relative importance of health-related indicators - such as severity and age - and other, broader socio-demographic and attitudinal attributes, like socio-economic status (Epstein and McNeil, 1985; Hartley et al., 1984), demographic characteristics (Pharoah and Melzer, 1995; Forster and Frost, 1991), and expectations (Britten and Ukuomunne, 1997; Langely et al., 1992)

The analysis of the influence of practice context has incorporated a range of factors, including: characteristics of the practice such as size (Hawkey et al., 1997; McCarthy

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et al., 1992) and busyness (Haikio, Linden and Kvist, 1995; Healey, Yule and Reid, 1994; Davidson et al., 1994); delivery system measures such as fundholding status (Wilson et al., 1996) and local facilities (Langley, Minkin and Till, 1997; Christensen, Sorensen and Mabeck, 1989); broader system factors like cost (Hart et al., 1997; Weiss et al., 1996); and contextual influences such as social deprivation (Hawkey et al., 1997) and rural/urban location (Langley, Minkin and Till, 1997; Holm and Olesen, 1988).

At a more theoretical level, early concepts that have gone on to inform much of this clinical practice and health services literature have been practice organisation (Hlatky et al., 1983), professional norms (Luft, 1983), practice style (Wennberg, 1984), and professional uncertainty (Wennberg et al., 1982). This paper will concentrate on the role of practitioner and practice-related characteristics within the context of "the supply hypothesis" as already described, but with a focus on the theoretically strategic concepts of income incentives, physician agency, and clinical ambiguity.

Methodology and Empirical Predictions

One of the key deficiencies in the literature has been the reliance of MPV research on data drawn from small area variations (SAV) (Folland and Stano, 1990; Paul-Shaheen *et al.*, 1987). While SAV data provided the key initial insights into MPV, they are also clearly susceptible to the ecological fallacy. This has greatly hampered the drawing of any clear policy implications from MPV research (Stano, 1991).

As a correction to the unit of analysis problem (Divine et al., 1992), some investigators have instead concentrated on studies at the micro level into the

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decision-making processes of individual practitioners on a limited number of clinical problems using simulated, imaginary or real-life cases (for example, McKinlay et al., 1998; Poses et al., 1993). While generating important findings at the level of clinical decision-making, these studies have limited generalisability and, with some exceptions, do not necessarily incorporate contextual effects (Clark et al., 1991).

The growing acceptance of multilevel statistical techniques, together with the availability of patient-level data, has now made it possible to validly estimate parameters and attribute variation at different levels of aggregation with nested data. These techniques have been advocated for research in epidemiology (von Korff et al., 1992), health behaviour (Duncan, Jones and Moon, 1998), health services (Rice and Leyland, 1996), and health economics (Rice and Jones, 1997). These techniques are being applied in an increasing range of studies in primary care, including prescribing (Davis and Gribben, 1995), resource use (Scott and Shiell, 1997), patient consultation rates (Carr-Hill, Rice and Roland, 1996), immunisation rates (Jones et al., 1991), and patient satisfaction (Sixma, Spreeuwenberg, and van der Pasch, 1998). These techniques will be applied in this paper to a hierarchical data set of patient encounters with the three key conceptual dimensions as discussed above.

For each of these conceptual dimensions it is possible to develop hypothesised outcomes that encapsulate the economic and clinical models of inter-practitioner variation respectively (see Table 1). Thus in the health economics literature the link with local doctor density is important. Under conditions of enhanced doctor competition it might be hypothesised that rates of activity will increase - both as a main effect (especially for follow-up), but more particularly for encounters characterised by diagnostic uncertainty (Scott and Shiell, 1997). In other words, an

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interaction effect is posited. In the case of physician agency - doctor-initiated visits - an economic model might also predict income-maximising behaviour, although this is less clear-cut, while for clinical ambiguity - diagnostic uncertainty - the expected outcome under this model is not clear.

TABLE 1 ABOUT HERE

Under a putative clinical model, rates of activity would be expected to vary according to more clinically interpretable accounts. Hence, uncertainty should encourage investigative activity, while physician agency might be associated with patterns that are clinically plausible.

Methods

Study Details

The current study was carried out over the period September 1991 to August 1992 in the Waikato region of New Zealand. Centred on the provincial city of Hamilton, the region has an ethnically mixed, urban-rural population of 320,000. In demographic terms the Waikato region can be said to provide a representative cross-section, but not a replica, of the country as a whole. Data from the 1991 Census show that the region has an age structure slightly "younger" than the New Zealand norm, has a higher than average proportion of Maori - the indigenous people of New Zealand - but fewer Pacific Island Polynesians. It should be noted, however, that the Waikato has a higher than average proportion of its population living in rural, semi-rural and small town environments and has an economy that is heavily dependent on primary production (McAvoy *et al.*, 1994).

The general practitioner community in the Waikato is also reasonably representative (Gribben *et al.*, 1995). For example, a comparison with data from the Medical Council shows that the proportion of women, mean age of practitioners, years of practice and place of graduation are not out of line with national figures, although there are clear rural-urban differences within the region.   A further comparison with one rural and one urban region suggests that, on workload and on various practice characteristics, the Waikato presents something of an amalgam. Data for the years 1989/90 for general practitioner availability (population per full-time equivalent GP) and for levels of utilisation (consultations per capita) show the Waikato to be slightly above the national average on both counts (Malcolm, 1993).

As in the rest of New Zealand, general practitioner incomes in the Waikato are almost entirely determined by direct charges to patients on a fee-for-service basis - unless covered by private insurance - supplemented to a limited extent by public subsidy and by social insurance cover for medical treatment following personal injury by accident (Brown and Crampton, 1997).

The data for this study are drawn from the survey of general practice encounters that formed its central component. The encounter report form was modelled on that used in the National Ambulatory Medical Care Survey in the United States (USDHEW, 1974). Encounters were selected in a two-stage process designed to generate a one per cent sample of all general practice consultations in the Waikato region. All 210 general practitioners in the region were invited to administer the encounter report form for a representative sample of their patients. Each participating doctor was allocated a sampling interval set according to their estimated workload to produce a sample of 25 patients in each of four data collection weeks spread over a year. 80% of all practitioners took part in the first

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phase of data collection. A decline in compliance followed the first stage of data collection and, overall, data collections were successfully completed in 69% of all possible participating doctor/weeks. Data in this study will be presented for those 143 doctors completing at least 10 encounter forms; this amounted to 9,746 records, representing nearly 85% of all encounters collected in the survey.

Description of Variables

For each consultation, data was collected on patient demographics - these included age group, ethnicity, and gender - and on the diagnosis of any problems identified by the practitioner at the encounter. These constitute "case mix" variables that are potential confounders to be controlled, and are presented as binary items as follows:

diagnosis - practitioner-identified problems coded into seventeen ICPC chapters
(Lamberts and Woods, 1987).

patient demographics - age, ethnicity (pakeha (European), other), and gender (male
/ female);

In a prior survey practitioners were also asked to provide information on themselves and their practice, including age, workload, and practice size (McAvoy et al., 1994). These provide a broader set of binary "supply" variables in the form of the following practitioner and practice characteristics:

whether or not the doctor was in a group practice (defined as 3 or more doctors);

the age group of the doctor (whether or not the doctor was over 45 years old);

practitioner's workload (whether or not the doctor put on more than seven of a
possible ten consulting sessions per week).

The three clinical activity variables were constructed as binary outcomes:

prescribing - whether or not a script was issued at the conclusion of the encounter;

test ordering - whether or not an investigation was ordered;

follow-up - whether or not an arrangement was made for follow-up at a specified

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later date.

The three hypothesised determinants - income incentives, physician agency and clinical ambiguity - were operationalised and measured as follows:

income incentives: local doctor density - each practice was allocated to one of six strata according to the patient:practitioner ratio for the area;

physician agency: encounter initiation - the practitioner was asked to indicate on the encounter form who had initiated the visit (doctor, patient, other);

clinical ambiguity: diagnostic uncertainty - practitioners were asked to indicate on the encounter form the level of uncertainty associated with the main diagnosis for the visit (by ticking one of the categories "none", "low" or "high").

Descriptive statistics for all variables are reported in Table 2. It should be noted that the data are presented for encounters. Only the top five diagnosis groups are reported since these accounted for nearly 80 per cent of the total.

TABLE 2 ABOUT HERE

Further descriptive information on the rates of clinical activity are presented in Figure 1. For each intervention a frequency distribution of the number of doctors carrying out different rates of activity is outlined. As can be seen, there are three virtually non-overlapping distributions clustered around the overall rates reported in Table 2. These represent the raw material for the analysis of inter-practitioner variation reported in this paper.

FIGURE 1 ABOUT HERE

Statistical Techniques

Because the outcomes under investigation were binary, logistic regression was an

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obvious candidate for assessing inter-practitioner variation in rates of activity (Mason and Wong, 1984). Thus, the intercept term would represent an individual practitioner's clinical activity rate - for prescriptions, investigations or follow-up - and a measure of variation could be derived from the inter-practitioner variability in these intercept terms (Davis and Gribben, 1995). Confounders (age, gender, ethnicity and diagnosis) are controlled for by entering them into the model as fixed effects, and the significance of the three analytical variables (doctor density, doctor initiation and clinical uncertainty) is tested by examining their coefficients in the complete model.

Because of the hierarchical nature of the data structure, with patients being sampled from practitioners' weekly workloads, cluster effects are likely (Divine et al., 1992). Furthermore, the patient sub-samples varied in size from 12 to 120 between doctors. It was therefore convenient to use pooled data in instances where these practitioner sub-samples were small and potentially unstable. Multilevel or hierarchical modelling addresses all three issues - random effects, hierarchical data structures, and efficient parameter estimates across sub-samples of varying sizes - and it is this technique that forms the basis of the analysis that follows (Goldstein, 1995).

The model to be fitted can be described as follows. Let $\eth_{ij}$ denote the probability that the outcome of interest - say, that a script will be written - will occur at the ith encounter by the jth doctor. Our logistic model for $\eth_{ij}$ takes the form:

where:
b_{0j} is an intercept specific to the jth doctor;
A_{ij}, G_{ij}, and E_{ij} are variables for Age, Gender (1="male"), and Ethnicity (1="European"), and $icpca_{ij}$ ... $icpcy_{ij}$ are dummy variables representing each of the

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16 chapters of the ICPC diagnostic system classifying the problem (or problems) of the patient at the ith encounter with the jth doctor;

"numgps", "docage" and "fulltime" are variables for the number of doctors in the practice (1=3 or more doctors), the doctors age group (1=over 45) and doctor workload (1=more then 7/10) for the jth doctor;

and the last four terms in the model are dummy variables representing the analytical variables "dens" (doctor density), "init" (doctor initiated), "uncert" (clinical uncertainty), with "dens x uncert" a product term to measure the "doctor density" by "clinical uncertainty" interaction, all at the ith encounter with the jth doctor.

The coefficients $\hat{a}_1 \ldots \hat{a}_{27}$ are fixed constants common to all doctors. We assume that the intercepts, $\hat{a}_{0j}$, are normally distributed over the population of doctors, with mean $\hat{a}_0$ and variance $\tilde{u}_0 = [\acute{o}_0{}^2]$, which represents the inter-practitioner (or level-2) variation.

By specifying that only the intercept in the model is random, we have assumed that the effect of each of the variables in the model is the same for each doctor. The model may be visualised as a series of parallel regression lines, one for each doctor, crossing the y-axis at different points (see Jones, Moon and Clegg, 1991).

The MLn software package was used (Rasbash and Woodhouse, 1995; Woodhouse, 1995), together with a set of supplied macros for performing logistic regression within the multilevel framework (Yang et al., 1996). Models were fitted using second-order predictive quasilikelihoods, since these are more accurate (although computationally less stable) than a simpler first order approximation or a second order marginal quasilikelihood (Goldstein, 1995).

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Results

In Table 3 the statistical model as described in the previous section is applied to the hypotheses that were outlined in Table 1. The top section of the table presents the parameter estimates for each of the confounding variables. In all cases two values are reported for each parameter. The first value is the estimate of the mean of the parameter and the second value is the estimate of its standard error. The ratio of each estimate to its standard error is distributed approximately normally, and the reported significance tests are calculated on this assumption.

Taking the first row of the table, it should be noted that the significant intercept results are of no particular interest, as an estimate of zero is merely a rate of 50% on the logit scale. A significant result thus means only that an underlying clinical activity rate (when all other variables in the model are zero) is different from 50%. The importance of controlling for diagnosis in the analysis is well illustrated by the significant effect of most diagnosis categories on clinical activities. The patient and practitioner variables have a limited independent effect on clinical activity rates; thus, although there is a residual age effect for investigations, for example, there is no significant result for prescribing and follow-up since much of the effect is already accounted for in the diagnosis variables. Even after all controls, however, it appears that older GPs are less likely to suggest a follow-up visit and solo GPs are less likely to write a script.

TABLE 3 ABOUT HERE

The bottom section reports the results for the three analytical variables, together with a test for interaction between doctor density and clinical uncertainty. In each case

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the estimated parameter reflects the incremental increase (or decrease) in practitioner rates of the clinical activity between the two values of the analytical dimension in question. These estimates are calculated after controlling for all other variables - that is, diagnosis, patient, and practice and practitioner attributes.

The key results from the perspective of the economic account of inter-practitioner variation are identified in the first and fourth rows of the bottom panel of the table. Neither the main or the interaction effects for doctor density achieved significance for any of the clinical activities - including, most crucially, follow-up. Indeed, the only statistically significant effect for follow-up arose in the case of diagnostic uncertainty - for which there is an equally plausible clinical interpretation.

In the case of doctor initiation, rates of prescribing and investigations (though not quite to significance) are actually lower - a result which may be more consistent with a clinical interpretation of these visits being principally for the purpose of monitoring, check-ups and follow-up consequent on earlier visits. For diagnostic uncertainty, rates of investigations and follow-up are higher - a result that again may be more consistent with a clinical account.

The last line of Table 3 reports results for the estimate of the variance of the intercept in all three models. In each case significant variation in the intercept remained unexplained after including all confounding and analytical variables.

Discussion

The concept of the "supply hypothesis" has been coined in this paper as a shorthand reference to a set of assumptions underpinning much of the medical variations

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literature, the fundamental premise of which is that practitioner and practice attributes, together with other "supply-side" factors such as the distribution and availability of services, are a significant, if not predominant, influence in shaping patterns of clinical activity (Folland and Stano, 1990).

The focus of the current paper has been on clearly specifying the analytical and methodological requirements of the "supply hypothesis", applying these to the special case of general practice (Parchman, 1995), and generating testable hypotheses that are applicable to the primary care setting. A further distinctive feature of the analytical approach in this paper has been a concentration on activity rates calculated from encounter data at the practitioner level, thus avoiding any reliance on ecological data (with the associated potential analytical and methodological pitfalls).

The results reported in this paper bear upon the "supply hypothesis" in two respects: the applicability of this overarching hypothesis to primary care, and the relative importance of economic and clinical interpretations of its significance. In the first instance, therefore, the data sustain an extension of the "supply hypothesis" to the general practice setting, in the sense that two of the three key putative attributes of practitioner decision-making - physician agency and clinical ambiguity - have been shown to have significant effects in accounting for inter-practitioner variation in clinical activity. Nevertheless, it has also to be pointed out that these by no means absorb the full extent of inter-practitioner variation; significant residual variation remains.

Secondly, the results tend to support a clinical rather than an economic interpretation of MPV. The crucial measure in this context is request for follow-up.

While follow-up clearly has a strong clinical rationale, in a fee-for-service system and under conditions of local competition the extent of follow-up visits can obviously influence the practitioner's income (Scott and Shiell, 1997). However, higher rates of follow-up were not detected under those circumstances most conducive to the economic – that is, income incentives - model in Table 3; the single significant result was one that had a strong clinical rationale (and then disappeared when conditioned on doctor density). Furthermore, the remaining significant results in Table 3 all had clinical plausibility. Thus, greater uncertainty was associated with higher rates of investigations and follow-up, which could be indicative of practitioner intent to clarify a situation of some clinical ambiguity. Similarly, doctor initiation was associated with lower rates of prescribing and investigations (though not to full significance), which suggested that these visits were more likely for administrative, monitoring and assessment purposes.

There are a number of methodological shortcomings to the current investigation that need to be taken into account in evaluating these results. In the first place, there is the regional character of the study - together with its less than resounding response rate - which potentially limits the generalisability of its findings. Although the population and practitioner community are reasonably representative of the New Zealand norm (Gribben *et al.*, 1995), the region may not have included a sufficiently large and diverse demographic and health service base to provide an adequate range of variation to test the "supply hypothesis". The lack of ecological data also largely removes potential explanations for clinical variation that are external to the practice setting.

Secondly, the operationalisation of the key variables in the model may be imperfect. Among the many potential measures of clinical activity in general practice that could

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have been used in an analysis of this kind, only three are reported here. However, these three items - test orders, prescribing and request for follow-up - represent a substantial commitment of resources in general practice (apart, that is, from the practitioner's own time). A fourth possible candidate for inclusion - referral - could not be used in this analysis because of the highly skewed nature of its distribution.

A more severe problem of operationalisation arises in the case of the explanatory variables. Professional uncertainty has been widely invoked to account for medical variation, yet its measurement remains a matter of controversy (Folland and Stano, 1990). The approach adopted here has been to accept the practitioner's own assessment of the diagnostic uncertainty of a patient's problem. Clearly this may not tap the degree of agreement about different medical conditions existing in the wider professional community.

The agency role of the physician in medical decision-making has also been seen as an important potential source of inter-practitioner variability in clinical activity. The clinical discretion implicit in the concept has usually been invoked in a post hoc fashion to make sense of medical variation (Davis *et al.*, 1994), but has rarely been measured explicitly. Whether or not an encounter is initiated by the doctor rather than the patient - the measure used in this study - may not in itself adequately capture the discretionary element in medical decision-making that is implicit in the agency concept. Clearly the doctor acts as the patient's agent in a wide range of encounters, exercising discretion in some more than others.

Fundamental to the demand inducement model is the assumption that practitioners can manage demand in such a way as to influence (enhance or maintain) their eventual income. This is the concept of supplier-induced demand (SID) (Wennberg

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et al., 1982). Again, operationalisation is controversial. According to one recent review an adequate empirical assessment of this mechanism has yet to be achieved in the literature (Folland and Stano, 1990). The approach adopted in the current study has been to identify a contextual factor - the density of practitioners in the vicinity - deemed likely to encourage competitive and income-maximising behaviour by doctors working in a fee-for-service payment system. While this does not measure the mechanism of SID directly, it does address one of the key assumptions of the approach - namely, that in particular circumstances doctors may respond to non-clinical, particularly economic, incentives in their decision-making behaviour. To this extent, the results of this investigation do little to sustain the concept of demand inducement - at least as operationalised here.

Finally, the model fitted - around variation in the intercept - assumed that variation between practitioners was restricted to variations in the underlying rate of the measured clinical activity. A more sophisticated model   - permitting variation in slopes - would allow for the possibility that practitioners varied in their response to the presence of one or more confounding variables. These models are computationally considerably more complex and difficult to fit than the model fitted in this paper. A number of more complicated models were unsuccessfully explored, due to problems with convergence and the stability of the obtained estimates.

Conclusion

The term "supply hypothesis" has been coined to characterise a set of assumptions that have become increasingly influential in research on the widely-documented phenomenon of MPV. These assumptions share in common a primacy attributed to

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the impact of practice and practitioner attributes on utilisation and patterns of clinical activity. Two models are particularly influential, one emphasising the role of demand inducement, the other the ubiquitous nature of clinical ambiguity in medical practice; both models also attribute great importance to the agency role of the physician. The first of these interpretations has particular intuitive appeal. As Reinhardt (1999) has argued in a recent editorial in the Journal of the American Medical Association: "(W)hatever physicians may think of the economist's hard-headed model of physician behavior, attitudes in the real world of health policy have come to be powerfully influenced by that model." The results from this paper, by contrast, suggest that a clinical interpretation of inter-practitioner variation in decision-making may have more plausibility. To this extent our findings are consistent with Reinhardt's conclusions in the same editorial: "Although with their simple model of physician behavior economists have been influential beyond anyone's wildest imagination, the power of the model at the empirical level has been limited. .. Thus, despite its evident intuitive appeal among policymakers, economic theory has left a wide field of inquiry for sociologists and other students of professional behavior, including, of course, research-oriented physicians themselves."

Acknowledgements

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Table 1

Hypothesised outcomes for clinical decision-making measures:

Predicted rates of activity for economic and clinical models

ANALYTICAL DIMENSION	MODEL	PREDICTED OUTCOME
Income Incentives	Economic	Higher rates, particularly follow-up
(Doctor Density)	Clinical	No effect
Physician Agency	Economic	Possibly higher, especially follow-up
(Doctor Initiation)	Clinical	Clinically plausible effects
Clinical Ambiguity	Economic	No special effect expected
(Diagnostic Uncertainty)	Clinical	Higher investigations and follow-up
Ambiguity by Incentives	Economic	Higher rates, especially follow-up
(Interaction Effect)		

Table 2

Description of the Data Set

VARIABLES	Percentage[a] (N=9,746)	
Diagnosis Groups[b]		
Respiratory	21.8%	
Muskuloskeletal	17.5%	
Skin	15.1%	
General	12.7%	
Cardiovascular	11.3%	
Patient Attributes		
Average Age		35.3 years
Male		42.2%
European		80.8%
Practitioner Variables		
Doctor aged over 40		44.3%
Doctor in full-time practice[c]		50.8%
Fewer then three doctors in practice		40.6%

Clinical Activity Rates

Prescribing   62.0%

Test ordering   12.4%

Follow up   78.1%

Analytical Variables

High Doctor Density   61.5%

Doctor-initiated Visit   12.9%

High Diagnostic Uncertainty   7.4%

[a] Except for patient age, percentage of encounters in which the stated attribute was present.

[b] The diagnosis groups are ICPC chapter headings for the top give groups reported.

[c] "Full-time" means working at least eight tenths.

Table 3

Multilevel Analysis of Clinical Activity:

(Standard errors in brackets. Bold figures are significantly different from 0 at p<.001)

	Prescribing (s.e.)		Investigations (s.e.)		Follow-Up (s.e.)	
Intercept	**-0.579**	(0.139)	**-2.741**	(0.197)	**0.825**	(0.181)**Diagnosis[a]**
ICPCA	0.098	(0.077)	**0.360**	(0.100)	-0.156	(0.081)
B	0.693	(0.257)	**1.603**	(0.246)	0.145	(0.291)
D	**1.079**	(0.101)	**0.363**	(0.118)	0.286	(0.108)
F	**1.383**	(0.154)	-0.416	(0.228)	0.243	(0.149)
H	**1.569**	(0.106)	**-0.820**	(0.185)	**0.352**	(0.102)
K	**1.556**	(0.095)	0.301	(0.016)	**1.017**	(0.112)
L	**0.247**	(0.074)	**-0.722**	(0.111)	**0.346**	(0.082)
N	**0.586**	(0.143)	-0.638	(0.232)	0.126	(0.161)
P	**0.771**	(0.119)	-0.135	(0.161)	**0.720**	(0.149)
R	**2.264**	(0.084)	**-0.536**	(0.105)	**0.397**	(0.076)
S	**1.119**	(0.078)	**-0.475**	(0.115)	**0.601**	(0.085)
T	**1.232**	(0.140)	**1.155**	(0.128)	**0.750**	(0.163)
U	**1.393**	(0.171)	**2.519**	(0.160)	0.096	(0.172)
W	-0.023	(0.094)	**0.677**	(0.114)	**0.831**	(0.112)
X	**0.977**	(0.118)	**1.142**	(0.122)	0.383	(0.131)
Y	**1.252**	(0.315)	**1.428**	(0.309)	0.572	(0.340)
					Patient	
Age	0.004	(0.003)	**0.026**	(0.004)	0.005	(0.003)
$(Age)^2$	**5.10E-05**	(2.89E-06)	**3.71E-04**	(3.95E-06)	-4.44E-06	(4.70E-05)
Ethnicity	-0.172	(0.064)	0.035	(0.091)	-0.080	(0.068)
Gender	-0.097	(0.050)	**-0.187**	(0.075)	-0.105	(0.054)
					Practice and Practitioner	

	Est.	(SE)	Est.	(SE)	Est.	(SE)
GP over 45	0.046	(0.083)	-0.020	(0.115)	-0.178	(0.124)
GP Full-time	-0.002	(0.082)	-0.126	(0.114)	-0.113	(0.123)
No. GPs	**0.249**	(0.085)	0.039	(0.118)	-0.095	(0.127)
					Analytical Variables	
UNCERT	0.091	(0.088)	**0.651**	(0.123)	**0.374**	(0.099)
DENSITY	-0.199	(0.101)	-0.154	(0.150)	-0.195	(0.143)
DOCINIT	**-1.246**	(0.074)	-0.258	(0.128)	0.192	(0.082)
DENS x UNC[b]	0.035	(0.107)	0.116	(0.150)	0.069	(0.119)**Inter-practitioner variation**
Variance (Int)[c]	**0.141**	(0.027)	**0.260**	(0.051)	**0.406**	(0.062)

[a] ICPC Chapter groupings.

[b] Density by Uncertainty interaction

[c] Variance of the intercept