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Supplier Induced Demand Reconsidered

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ABSTRACT

This paper reconsiders the evidence and argument supporting the theory of Supplier Induced Demand (SID) in the light of recent criticisms and particularly those presented at the 1997 Health Economists Conference by Doessel (1997).

The paper commences by documenting the major facts of the health sector which any satisfactory theory – SID or orthodox – must address. A theory of SID is outlined which differs in some importance respects from the theory presented in most text books of health economics. Criticisms of the use of cross-sectional data are evaluated and the model used by Richardson (1981) and by Doessel (1997) are re-estimated with cross-sectional data from 187 statistical sub-divisions. The rates at which procedures are given to hospital patients following an emergency admission for acute myocardial infarction are then presented as a discriminating test of the relative importance of patients and doctors in decision-making.

It is concluded that SID provides a coherent explanation of the major facts in the health sector in a way that orthodox theory does not. It is suggested that the continued debate in the economic literature is attributable to the application of different criteria for the acceptance and rejection of new theories. A distinction is drawn between pragmatic and orthodox theorists and the criteria each is likely to apply for the revision of theory in the face of discordant observations.

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Galileo: There are stellar motions for which the Ptolemaic system has no explanation … if you gentlemen are agreeable we shall begin with the inspection of the satellites of Jupiter and the Medicean stars.

The Philosopher: I am afraid it will not be so simple … can such planets exist … are such stars necessary? Aristetelis define universum.

Galileo: Would you care to observe these impossible and unnecessary stars through the telescope?

The Mathematician: If your tube shows something that cannot exist it must be a rather unreliable tube.

Bertolt Brecht, *Life of Galileo*, Scene 4

1 Introduction

The proposition that most of the important decisions with respect to the demand for medical care are made by doctors would appear, to most doctors and patients, to be a direct observation. Orthodox economists, however, have resisted belief in the validity of the observation because it does not correspond with the implications of established theory. Abdication of patient decision-making conflicts with the assumptions — axioms — of rationality and independent preferences. The failure of doctors to shift demand to the technical limit (thereby reinstating a well-defined demand curve) conflicts with the assumption of income maximization unless there is a source of disutility associated with rising SID (Auster & Oaxaca 1981). To defend orthodoxy, a variety of often ingenious defences has been proposed to explain offending observations or to discredit the evidence and methods used to support a theory of supplier induced demand.[1] Some of the more important arguments have been summarized by Doessel (1998), who also presents GP data to support the contention that there is no unorthodox relationship or, more surprisingly, no relationship between the supply of GPs and the demand for their services.[2] The objective of the present paper is to reconsider these arguments and evidence and to present additional Australian data that are relevant to the debate.

[1] Analogously, to defend the geocentric view of the universe, opponents of the 'Copernican heresy' showed — correctly — that many of the apparent irregularities in the observed movement of the planets could be explained by assuming that they moved in a series of epicycles and — in some formulations — epicycles within epicycles as they circled the earth.

[2] In Doessel's Equation F and Figure 4, there is no association between 'medical practitioners' per thousand population and per capita use of their services. This is itself a surprising result as such a relationship is predicted by the conventional economic model if there is variation in autonomous supply. Such variation does exist as the doctor supply is known to vary with, inter alia, the desirability of the residential and professional location.

The most persuasive support for the theory of SID has always been, and remains, that SID provides the most satisfactory explanation of the major facts of the medical market. These facts are summarized in Section 2 below. The implications of SID for patient and doctor behaviour have been discussed at length in the literature. In Section 3, it is argued that the most common explanations of SID are, in important respects, unconvincing and that an alternative, and — from the view point of a non-economist — simpler explanation is more consistent with empirical evidence. The critique of the methodology of cross-sectional studies is discussed briefly in Section 4 and Australian cross-section data are re-analyzed in Section 5. Results differ significantly from Doessel's, suggesting that the base data used in the two studies have been defined differently. Policy implications and the reason why resolution of the SID debate has been so difficult are both discussed briefly in the concluding section.

2 Empirical Problems

A major purpose of a theory of demand is that, in combination with supply, it should provide an explanation of the pattern of service use, both cross-sectionally and through time. Six sets of cross-sectional or time series data are presented below, which indicate the 'empirical problem' that must be solved and the patterns that must be explained by our theory. The final choice between SID and orthodox theory should be based very largely upon the explanatory power for all of these patterns.

Prima facie, data in Table 1 are strikingly consistent with the orthodox model of supply and demand. As the supply of GPs per thousand population decreases (as it does systematically from capital cities to remote areas), prices rise and the use of services per person falls. Three aspects of this pattern are, however, noteworthy. First, and comparing remote areas and capital cities, the apparent elasticity of demand is much greater than has been established in other studies (Richardson 1991). A 9.0 percentage point fall in price is associated with a 51 per cent increase in use. Second, despite an increasing demand per medical practice and an increasing cost (both monetary and psychic) associated with remote locations, there is an astonishing consistency in the estimates of full-time equivalent medical income in all locations, which is more consistent with target income behaviour than with the outcome of rising supply and demand. Third, with increasing demand (or at least need), doctors work significantly longer hours for the same income.

Table 1: GP Practice Characteristics by Location

	Capital Cities	Other Major Urban	Rural Major	Rural Minor	Remote
Fees/Rebate	1.075	1.073	1.122	1.113	1.195
Consultations/Patient [1]	6.8	6.4	5.4	5.6	4.5
Income 1 (fte) ($000)	173	178	180	175	177
Income 2 (fte) ($000)	129	133	134	131	132
Hours/Week	46.9	51.0	50.7	54.4	58.5

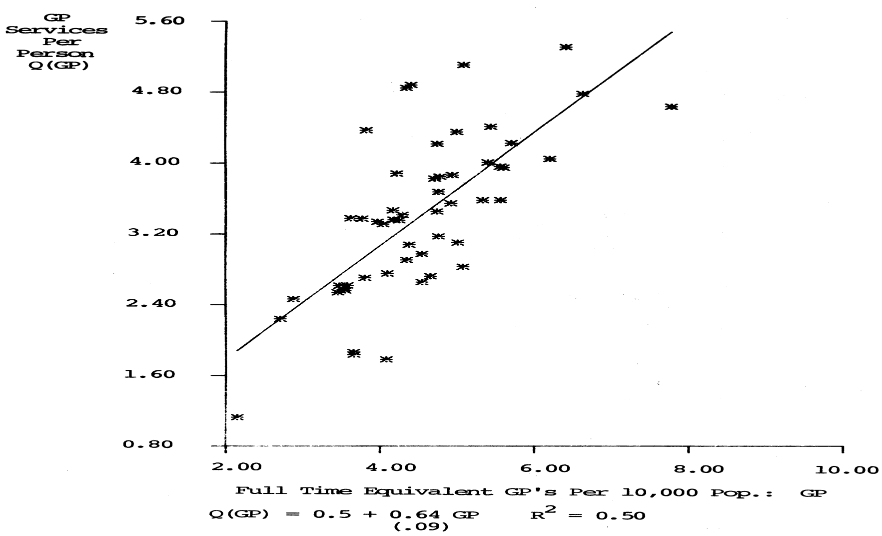
Source AMWAC (1996).

Note: 1 Consultation's are services accepted by the HIC for payment as consultations They are described in the schedule of fees.

These three factors do not invalidate the conventional model, but they leave unresolved questions about medical behaviour. They suggest the unsurprising likelihood that, for professional reasons, doctors exert greater effort when there is a need to do so. However, the professional element of medical supply is entirely omitted from conventional models[3] and it is perhaps unsurprising that a fully satisfactory theory of behaviour cannot be based upon a set of assumptions which omits a major motivating factor.

Figures 1 and 2 indicate that there has been and remains a very close relationship between the geographic availability of GPs and the use of their services. As there is significant border crossing, especially between statistical sub-divisions (the unit of analysis in Figure 2), the relationship is not a necessary one. In principle, local supply could be unrelated to local demand, with border crossing and variable work loads accounting for the discrepancy. The two figures do not, of course, demonstrate a causal relationship between GP supply and the demand for their services for at least two reasons. First, increased border crossing would be associated with increased time costs. Consequently, poorly supplied regions would have lower demand because of these costs. However, from the perspective of a government interested in the creation of equal access or in the allocation of a health budget, the distinction between SID, as envisaged by academic economists, and a supplier induced variation in time costs which explains demand, is of very little interest. The close correlation suggests that SID could be accepted by government economists as an instrumental theory; that is, as a theory which is useful for prediction and policy if not for the description of individual behaviour and welfare. Importantly, border crossing was not a significant determinant of demand in Richardson's 1981 and present study.

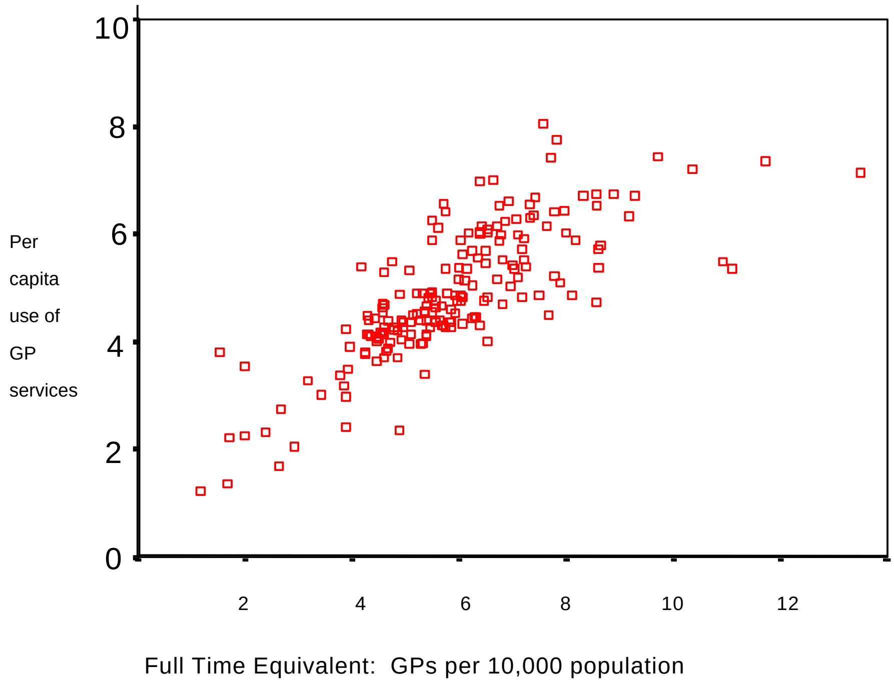
Figure 1: GP Supply vs Use by Statistical Division, Australia, 1976



Source: Richardson & Deeble (1982)

3 More generally, economic theory almost totally disregards intrinsic motivation and focuses upon the extrinsic motivations necessary to offset the disutility associated with marginal behaviours, despite the common observation that it is the intrinsic and not the extrinsic motivation that is dominant in the day-to-day behaviour of many people.

Figure 2: GP supply vs Use, by Statistical Sub-Division, Australia, 1996/97



Source: Department of Health and Family Services.

The real significance of these two figures is twofold. First, they demonstrate the possibility of Supplier Induced Demand: such a correlation is an almost necessary, if not a sufficient condition for the existence of SID.[4]

Secondly, it is possible that GPs locate their practices in areas of high autonomous demand. It is for this reason that a serious statistical analysis of cross-sectional data must attempt to take account of reverse causation and endogenise the GP supply. The importance of reverse causation could, however, be overstated. Age/sex standardization does not reduce the variation in either the 1976 or 1996 data significantly. Price, income and socio-economic variation are also insufficient to explain a significant part of the variation.

Correlational evidence is weak when the direction of the causation is in doubt and when one or more other variables contaminate the correlation because they are also correlated with the variables. However, correlational evidence is far more powerful when, as in the present case, reverse causation is improbable (eg. the capacity of Australian medical schools has been autonomously determined by a series of state, local and university decisions which in turn reflect idiosyncratic vested interests and power structures), and when other variables cannot be identified which confound the interpretation of the correlation. Indeed, such a correlation may represent the most convincing form of evidence as there is a quantitatively significant 'problem' to

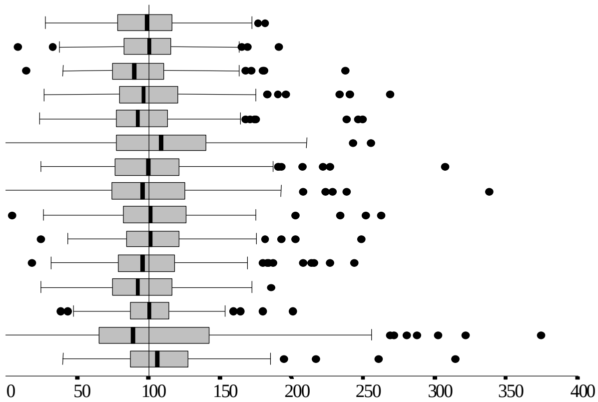
[4] It is possible to envisage areas of normal supply and low endogenous demand in which SID raised demand to the average level and thereby created a random association between supply and demand.

be resolved *vis* the increase in the use of services. There is no other variable which has changed to such an extent that it is capable of effecting such a large change in the use of GP services, which have remained relatively homogeneous despite the technological advances in specialist services.

Figure 3 illustrates one of the most important facts of the health system, namely, that there is an immense variation in the use of well-defined procedures between small areas, which cannot be attributed to age and sex. Nor can it be attributed to random variation. When the actual variation shown in Figure 3 is divided by the variation predicted by the ages/sex composition of each area[5] the actual variation exceeds its predicted value by a minimum of 110 per cent in the case of total hip replacement, and by an astonishing 2,000 per cent in the case of colonoscopy. The inescapable conclusion appears to be that the dominant factor in allocating these services is the clinical judgement of doctors. It is simply not credible that, with the removal of significant income and price barriers, such variation could arise from differences in individual patient preferences.

Figure 3: Standardized Rate Ratios for Various Operations in the Statistical Local Areas in Victoria, compared with the Rate Ratios for all Victoria

Procedure	Variance / Ex(Variance)
Coronary Angiography	13.4
Cor Revasc Procedure	5.4
Cataract Extraction	15.4
Tonsils & Adenoids	7.5
Myringotomy	11.7
Carpal Tunnel Release	8.4
Vertabral discetomy	2.1
Decomp laminectomy	1.9
Total Hip Replacement	3.8
Hysterectomy	6.4
Prostatectomy	3.9
Colonoscopy	45.3
Cholecystectomy	5.3
Explorat Laparotomy	1.7
Appendectomy	5.9



Note: Median, range, 25th and 75th centiles for statistical local areas, standardised to Victorian state ratio = 100. Extreme values greater than three times 50th – 75th and 25th – 50th centile intervals are recorded as separate points

Source: Richardson (1998)

The most persuasive data, however, are those presented in Figures 4a and 4b. They reinforce the conclusions of Richardson (1991) that over time there has been a nearly perfect correlation between the growth of general practitioners and the use of their services. Unless it is postulated that there has been a permanent excess demand for GP services, then causation must run from supply to demand. In Australia, doctor supply has been determined autonomously and erratically by the independent creation of capacity in medical schools and, more recently, by government policy. The apparent impact of supply upon demand is most strikingly illustrated following the

[5] Assuming a Poisson distribution for the use of health services in each age cohort.

cessation of the growth in the GP supply in 1995 and the corresponding cessation in the growth of service use.

During the time period shown in Figures 4a and 4b and the periods studied by Richardson (1991), neither the change in net prices nor the increase in per capita income can explain these correlations. The remaining demand side variable, time costs, may have contributed to the correlation. But reliance upon an unobserved variable, either formally or casually, to explain a major change in service use is not particularly persuasive and, as noted above, government planners could justifiably accept SID as an instrumentalist theory for the prediction of cost and for workforce planning.

Figure 4A: GP Supply and Use 1983-97

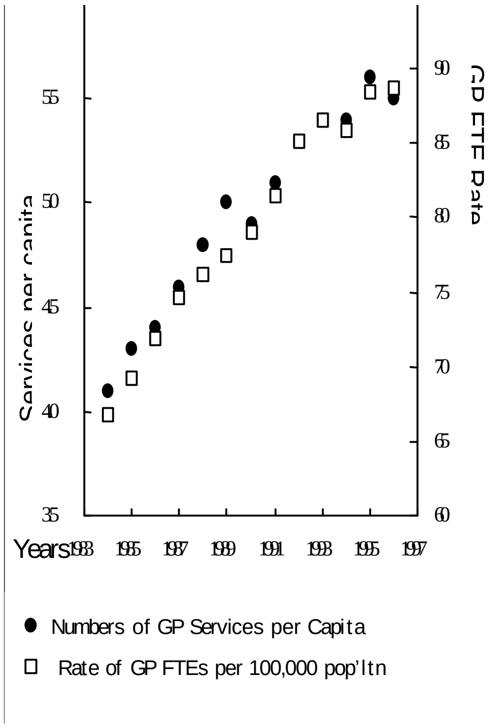
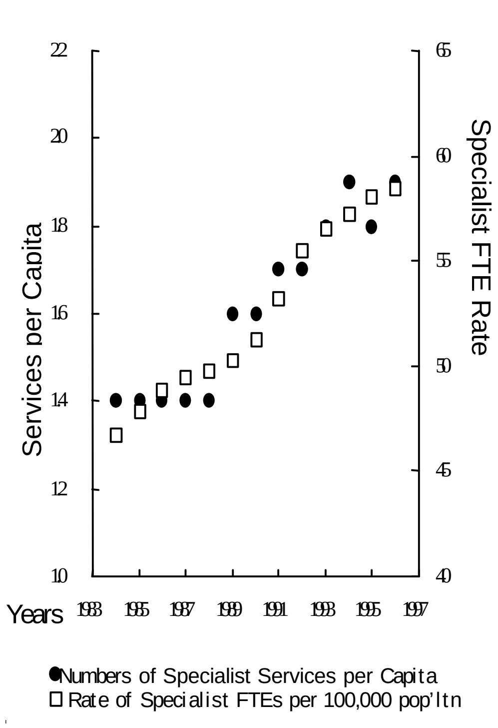


Figure 4B: Specialist Supply and Use 1983-87



Note: Excluding Pathology and Radiology.
Source: Commonwealth Department of Health and Family Services, Data file.

3 The Theory of SID

In the author's view, the understanding of SID has been seriously impeded by the almost universal but entirely unwarranted assumption that there is a medically necessary and ethically correct level of servicing. This is reflected in Doessel's (1998) discussion of the 'unbiased agent' whose treatment does not reflect SID. Dranove (1988, p 281) argues that under certain conditions the physician will have an incentive 'to recommend treatments whose costs outweigh their medical benefits'. These socially inefficient treatments correspond to the notion of "physician induced demand"'. It is for this reason that SID is equated with undesirable behaviour and widely associated with unethical behaviour.

By contrast with the economist's vision of a well-defined demand curve based upon well-defined need, expected benefits and the patient's valuation of these expected benefits, actual medical decision-making is characterized by pervasive uncertainty — as distinct from risk.[6] As noted by Wennberg (1988, p 100), there is 'intellectual confusion at the heartland of scientific medicine'. He argues that 'long held assumptions about the efficacy, the ethical sufficiency, and the legal basis of the physician's role in making vicarious utility assessments for patients as well as the validity of the many specific theories physicians hold on appropriate practices, are now recognised as problematic' (p 101) moreover 'professional uncertainty rather than consensus about the scientific basis of clinical practice is emerging as the dominating reality' (p 101).

In part, uncertainty is a function of the small number of services that have been evaluated even for clinical efficacy. One OECD study suggests that only 20 per cent of procedures in common use have been evaluated (Oxley & MacFarlan 1994). Practising physicians are often unaware of the studies that do exist and many reject the conclusions of control trials as being inapplicable to the real-world environment in which they work. Rather than reflecting an established set of responses to well-defined indicators, practice patterns appear to vary with the myriad variables that influence clinical decision-making: training, peer behaviour, conference attendance, personal temperament, personal experience, financial rewards, and, most importantly here, time and infrastructural capacity to undertake more or less intensive investigative and therapeutic work.

Not only is this the description of medical decision-making commonly given by practitioners, but there appears to be no other explanation for the dramatic variation in the patterns of care noted in Figure 4 and in similar studies elsewhere. Wennberg (1988, p 100) notes that 'it is no longer reasonable or feasible to base health policy on rational agency theory. The evidence from small area analysis, from the critical appraisal of strengths and weaknesses of the scientific basis of medicine and the failure of expert panels to reach consensus on appropriate practice build a consistent and strong case against the rational agency hypothesis and the associated assumptions about the nature of demand in medical markets'.

This perspective on medical decision-making significantly refocusses the analysis of behaviour and motivation. First, from the patient perspective, the problem faced is not simply the asymmetry of information between themselves and the qualified practitioner, a problem which

[6] 'Risk' applies to a situation in which there are known probabilities of different outcomes. 'Uncertainty' describes the situation in which there is insufficient information to assign such probabilities.

could, in principle, be overcome by training doctors to provide patients with all of the ‘relevant facts’. The real problem is that once facts have been established there is the critical — pivotal — step of making a medical *judgement*; that is, combining the facts according to some mental algorithm to reach a conclusion about the preferred course of treatment. Patients rightly recognize that there is an unbridgeable asymmetry in the capacity to make such *judgements*, and, in the light of medical uncertainty, judgements are inescapable.

While the capacity of patients to make decisions may be fatally impaired, there is still, in principle, a gold standard for a doctor’s behaviour, viz that the doctor should recommend for the patient what they would recommend for themselves. It is here that the simplistic notion of well-defined needs and benefits has the most damaging effect upon the understanding of SID. According to this simple notion, SID entails (and is sometimes defined as) the recommendation of services which exceed this gold standard. Consequently, as Hay and Leahy (1982) argued, physicians guilty of SID would demand fewer services for themselves and for their families than they provide for their patients.

This vision of medicine and the medical practitioner is absurd. To explain even a modest proportion of the increasing use of services in the post-war period, it would have to be assumed that virtually every doctor in the country had moved well beyond the ethical gold standard. But even the most casual observation of the medical profession by its fiercest critics would result in a rejection of this conclusion. Casual observation strongly suggests that doctors firmly believe in the efficacy of their own treatments and, indeed, it would require a remarkable personality to believe that the training and practice of a lifetime did not result in the creation of highly valued services, both on average and on the margin.

A more plausible assumption is that doctors do believe in the efficacy of their services and believe that more of them are better. In view of medical uncertainty, the increased use of diagnostic services may easily be rationalized. Similarly, and like most of the population, doctors have been socialized to believe that aggressive treatment is superior to a more conservative approach. From this perspective, SID is nothing more than the use of capacity to its limit; something doctors have been trained to do, expect to do and believe is ethically appropriate. Unsurprisingly, Hay and Leahy (1982) found that doctors and their families used the same number and not fewer medical services.

If inducement is not unethical, then there is the unexplained question of why doctors do not shift the demand curve — fuzzy and ill-defined though it may be — to its limit. Prima facie, any objective that the doctor seeks to achieve with unexploited demand shift can be achieved with greater profit when demand has been shifted to its limit.

This prima facie expectation is plausible primarily because of the extreme simplicity of the analytical framework. In this, the doctor is only permitted to derive utility from selfish objectives. As noted earlier, the entire role of intrinsic motivation has been ignored in this literature. Just as language can mould and shackle concepts, the axioms and framework of economic analysis discourage the exploration of altruism, professionalism and satisfying.

A second limitation of the conventional analysis is that it relies upon the methodology of comparative statics. In combination with well-defined functional relationships, good information and a relentless quest by the doctor for the maximization of selfish objectives, it seems to be an inescapable conclusion that the demand curve will be shifted to its technical limit. If the first of these assumptions is relaxed then the dynamics of a simple supply demand model may reverse this conclusion. The hypothesized behaviour is based upon four weak assumptions, viz:

1 that prices are ‘sticky’ in the sense that doctors are reluctant to significantly change them in the short-run;

2 that *individual* doctors face relatively elastic demand curves;

3 that Doctors have limited knowledge of overall industry conditions;

4 that there is a target number of working hours which the doctor, for personal and professional reasons, seeks to achieve.

This last assumption could be replaced by the weaker assumption that market clearing is carried out in the short-run primarily by the adjustment of quantity and not by price.

With these assumptions, SID is a consequence of the dynamics of the health market following an increase in the supply of doctors. It is illustrated in the following figures.

In the initial equilibrium in Figure 5ia, the medical industry faces a relatively inelastic demand curve and a completely inelastic supply curve set by the number of doctors and their target working week. With either a competitive or monopolistic model the equilibrium, profit maximizing price P_1 will clear the market (Figure 5ia). The individual firm/doctor faces a much more price elastic demand curve (Figure 5ib) and is also in equilibrium at P_1. Following an increase in supply from S_1 to S_2, Figure 5ii shows the final equilibrium in a market with no demand shift. Industry supply and demand result in market clearing at price P_2.

For the individual firm, the increase in supply results in a reduction in demand from d_1 to d_2 (Figure 5iib). However this second equilibrium is never reached. Figure 5iii illustrates the dynamics of the adjustment process. In the short-run ‘sticky prices’ fall only to P_3 (Figure 5iiia) and at this price there is excess supply. The individual doctor will experience a significant reduction in demand from q_1 to q_2 (Figure 5iiib). In response to this the doctor can shift demand from d_2 to d_3 (Figure 5iv) at which point both industry and doctor are in a new equilibrium.

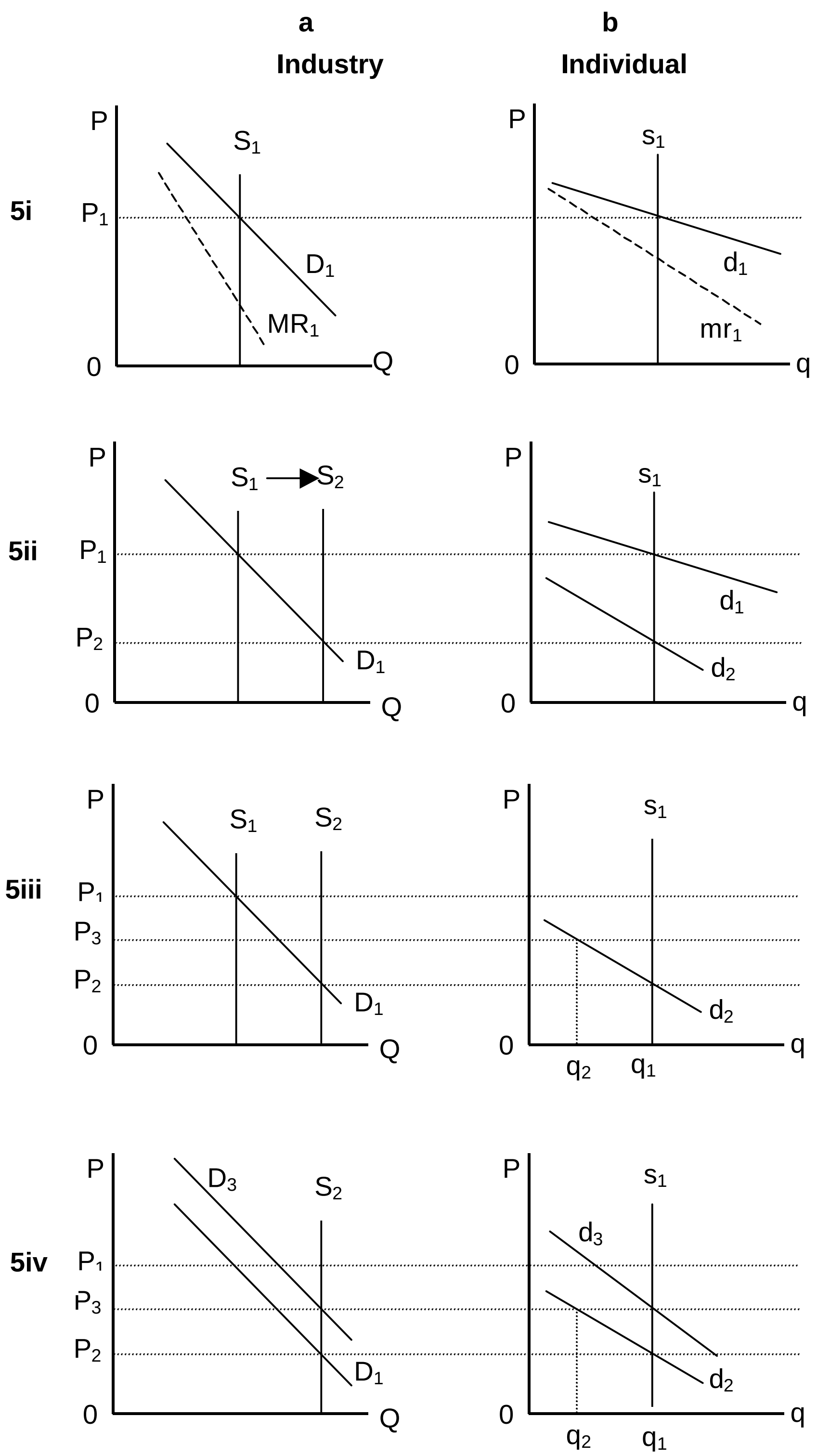


Figure 5: Adjustment to a Change in the Supply of Medical Services

Limited demand shift has occurred and the doctor is at a new profit maximizing equilibrium consistent with the target working week. Additional demand shift at this price would encounter the leisure constraint. (There could, of course, be some trade-off against leisure on the margin without the argument being substantially altered.) If the doctor were to experimentally increase price, demand would fall significantly. Unlike the previous decrease in demand the doctor could attribute this directly to their own pricing decision which would appear to be unprofitable. Because of poor market information, this would induce the doctor to accept P_3 as a final equilibrium.

The behaviour postulated here would be less likely to occur if the doctor's only motivation was the maximization of profit. With this objective they could be expected to engage in constant experimentation with different pricing and marketing strategies and the conscious decision to increase inducement specifically to offset the effect of a raised price. This might well appear to represent unethical behaviour to the doctor. The postulate here is that the majority but not, of course, all doctors have interest, but only limited interest, in pricing on the margin and in short-run profit maximization, but a major concern with the achievement of professional objectives through the provision of what is perceived to be valued and needed medical services.[7]

The behaviour described in Figure 5 is consistent with weak profit maximization and demand shift. However it is only one possible outcome from the exploration of the market dynamics. Demand shift with rising prices could similarly be explained if falling demand per doctor resulted in an increased price to maintain income, and demand shift to achieve the target working week. The general point is that there are multiple explanations for doctor behaviour that are consistent with demand shift if the dynamics of the market are combined with the assumption of weak profit maximization, belief in the efficacy of the services provided, and a professional commitment to ethical behaviour. These possibilities have been neglected because of the intellectual limitations placed upon analysis by the adoption of excessively simple and conventional assumptions of behaviour and motivation in a static analytic framework.

[7] In principle doctors could alter marginal behaviour — price and SID effort — and increase revenue and output with a fixed working week. This, however, would imply an implausible bifurcation of the doctor's self image as an ethical 'professional' citizen most of the working week and a self interested maximiser on the margin. As in the supply of blood, the motivation that drives marginal behaviour may 'spill back' and adversely affect intrinsic motivation and self image. As noted, economists have almost totally ignored the role of intrinsic motivation and focused on the extrinsic motivation on the margins of behaviour where marginal effort is a source of disutility requiring compensation.

4 SID and Cross-Section Data

Cross-section studies that have included doctor supply in the demand equation have been subject to two serious criticisms which are summarized in Doessel (1998). First, Ramsey and Wassow (1986) have reconstructed a number of the data sets which were used in these cross-section studies and shown that the reported demand equations do not pass one or more of the diagnostic tests that have recently been developed. From this they conclude that the original researchers probably could not reproduce their own results and, more seriously, that 'the anomalous empirical findings [viz those suggesting SID] are *statistical artefacts*' (emphasis added) (p 67).

The conclusions are unconvincing, and Ramsey and Wassow would obtain a very low score if their methods and conclusions were evaluated using the usual criteria for the judgement of an evaluation protocol. For a convincing evaluation the intervention group must be matched against a control group. Failing this, it is impossible to judge whether or not the intervention group has an atypical experience or an outcome that is indistinguishable from the experience of other subjects. More specifically, the diagnostic tests used were developed after the conduct of these cross-sectional SID studies. It is highly likely that studies in general would have failed these new tests and the author's conclusions would only be interesting if it could be shown that the failure rate amongst SID studies was significantly greater than amongst studies generally. It would be the common experience of virtually all researchers that a degree of experimentation is required before the correct functional form and combination of variables are identified which meet the available criteria for the good performance of econometric results. With the introduction of new diagnostic tests, further exploration would almost certainly lead to the final selection of a different set of results. This experimentation is, in part, a result of using imperfect and proxy variables and, in part, because theory seldom defines the precise functional form of the hypothesized relationships.

Equally importantly, the Ramsey/Wassow conclusion cited above, viz that the empirical findings are probably artefacts, is highly misleading. The magnitude of the coefficients would almost certainly change after further experimentation with variables and functional forms. In this way the precise numerical coefficients may be described as 'artefacts'. However, it is not possible to judge whether or not further experimentation would produce acceptable coefficients. It is certainly not possible to pass judgement upon the theory of SID on the basis of post-hoc diagnostic tests from one — and only one — of the methodologies used to support it.

But their methodological comments are of secondary importance as compared with the results of the re-examination of cross-sectional Australian data reported below. These indicate that demand equations *which do not include the doctor supply are mis-specified*. The error term from such equations is highly correlated with an omitted variable *vis* the doctor supply. The second and more widely cited criticism of the econometric testing of SID, attributable to Auster and Oaxaca (1981), is that with the usual specification of the equations, the SID effect cannot be econometrically identified. Following Folland, Goodman and Stano (1993), Doessel (1998) explains this problem with the following analysis of supply and demand functions (1), (2) and (3), where (1) represents demand without SID and (3) represents demand with SID.

$$Q_D = a_O - a_1 P + a_2 Y + e_1 \quad (1)$$

$$Q_S = b_O + b_1 P + b_2 X + b_3 MP + e_2 \quad (2)$$

$$Q_D^{SID} = a_O - a_1 P + a_2 Y + a_3 MP + e_3 \quad (3)$$

Where Q_D, Q_S = quantity demanded, supplied
Q_D^{SID} = demand incorporating SID
P = price
Y = income
MP = medical practitioners
X = price of inputs

Solving the conventional equation system (1) and (2) results in an equation of the form:

$$Q = g_O + g_1 X + g_2 Y + g_3 MP + e_4 \quad (4)$$

However, solving the SID equation system (1) and (3) results in an equilibrium with exactly the same structure as (4) which, Folland et al argue, indicates that the effect of SID cannot be disentangled from the effects of a conventional model.

It is useful to examine the coefficients in (4) in more detail. Holding X and Y constant, and substituting the initial SID model coefficients for the values of γ results in equation (5):

$$Q = K + \left(\frac{a_1}{a_1 + b_1}\right)\left\{b_3 MP + \frac{b_1 a_3}{a_1} MP\right\} \quad (5)$$

where *K* = a constant

This indicates that the effect of increasing doctors (*MP*) may be decomposed into two parts. The first is determined by the coefficient $a_1 b_3 / (a_1 + b_1)$. This reflects the effect of doctors upon supply (b_3) and the slope coefficients for the supply and demand equations. In Figure 6, this combined effect is to move the equilibrium from A to B. The second impact of the doctor supply is determined by the coefficient $b_1 a_3 / (a_1 + b_1)$. In addition to the slope of the curves, the impact now depends upon the demand shift coefficient a_3. The identification criticism is that these two movements cannot be separated and a demand curve that moves through the points A-C may be mis-specified.
However the argument presented by Folland et al (1993) is simply wrong, and the error lies in the sentence following Equation 4. In two-stage least squares regression the reduced form equation for each of the endogenous variables has the same exogenous variables. There is no reason why a change in the structural equations must necessarily change the reduced form equations. If

the argument presented by Folland et al was correct then economists would, not only be unable to identify SID, but also be unable to identify supply and demand equations. Their argument implies that for a generation this defect has not been noticed by economists and econometricians!.

By contrast, the point made by Auster and Oaxaca (1981) is correct; it is not, however, relevant to the problem here. If the supply of services is added to the demand equation, (their equation 4) then there will be an identification problem because of the identity $Q_D = Q_S$. There would also be a problem if Q_S was a non-stochastic variable which was a function of other variables. However, in the present model, and in the model employed by Fuchs and Kramer (1972), the variable introduced into the demand equation is stochastic and it depends, interalia, upon the doctor density which, in turn, depends upon a variety of variables including the desirability of the residential location. The general identification question is whether, given the reduced form, we can impose enough restrictions to be left with only one possible form of each structural equation. These conditions are fulfilled here and elsewhere[8].

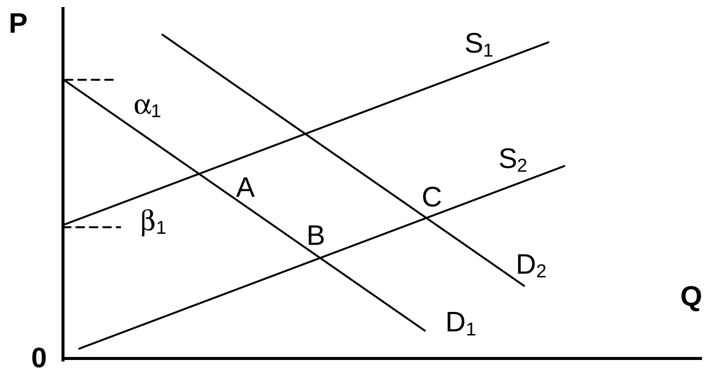
The wrong argument by Folland et al does, however, raise the important question of why so many economists have uncritically accepted the incorrect argument by Folland et al. It is suggested elsewhere that there are two standards for the acceptance of evidence and argument in economics; one for analyses that extend or defend orthodox theory and another for argument and evidence in conflict with orthodoxy (Richardson 1999). Supplier induced demand is unambiguously in this second category.

Even if there was a residual doubt about the specification of the equations, there is an additional empirical test of the plausibility of the results. This is because there is independent information about the likely magnitude of the price effect AB. This has probably been the most intensively researched issue in health economics (Richardson 1991) and, consequently, an independent assessment may be made of the likelihood that price and SID effects have been confounded. In Figure 6 a demand curve passing through points A and C would certainly imply a price elasticity far in excess of known price elasticities. Conversely, the failure to pick up any elasticity effect may or may not indicate that this has been wrongly attributed to the SID effect BC. In Richardson (1981) this was possible, but the range of observed prices was so small between statistical divisions that the bias would have been negligible.

There is, however, an identification problem illustrated in the following section orthodox equations which omit the doctor supply are unambiguously mis-specified: the residual is highly correlated with a missing variable, vis., the doctor supply.

[8] The author would like to thank Professor Max King, Head of the Department of Econometrics at Monash University for his examination of this issue and confirmation of the arguments presented here.

Figure 6: **Identification of SID**



5 Re-Examination of Australian Cross-Section Data

The model analyzed by Richardson (1981)[9] and summarized in Figure 7 below has been re-estimated using average data from statistical sub-divisions across Australia. Summary statistics, correlation coefficients and diagnostic tests are reported in the appendix.

Some important data issues need to be emphasised. First, and importantly, when these results are compared with those of Doessel (1998), definitions of the doctor supply differ. In this study, as previously, doctors have been defined as doctors providing services from within each statistical sub-division. Thus, if a doctor practiced in two or more locations, their supply would be apportioned pro rata between these two or more locations. Secondly, a very large number of doctors work part-time (doctors with family commitments; hospital doctors with limited private practice; semi-retired doctors and doctors with multiple practices). In this case an algorithm was used to convert to full-time equivalent (FTE) doctors. When standard fee income was above $100,000 for GPs or $150,000 for specialists, one full-time equivalent doctor was assigned to an SSD. Standard fee incomes below these levels were summed and divided by the average standard fee income of the corresponding type of doctor nationwide.

[9] Doessel's comment that 'Richardson 1981, 215, also acknowledges inter alia, the assistance of Professor Fuchs' (1998, p 21) is incorrect.

Figure 7: Supply and Demand for Medical Care with SID

$$Q_D = f\left(P_N, \text{INCOME}, \text{SES}, \text{DOC}\right) \quad (1)$$

$$DOC = g.(P_G, \text{RES}) \quad (2)$$

$$P_N = \left(\frac{P_G Q - REBATE}{P_G Q}\right) P_G \quad (3)$$

$$Q_S = DOC(Q / DOC) = Q_D \quad (4)$$

ENDOGENOUS VARIABLES	**EXOGENOUS VARIABLES**
P_N = Net Price after rebate.	INCOME = Median income
P_G = Gross price.	SES = Socio-economic indicators
Q = Quantity of services.	RES = Indicators of a desirable Residential location
DOC = GPs/10,000 population.	REBATE = Medicare rebate

Source Richardson (1981)

By contrast, utilisation data were derived from patient files and sorted according to the patient's residence. There were, therefore, no data problems associated with border crossing. A further qualification is that, reflecting Australia's health system, the data are a comprehensive record of private services provided in or out of hospital. They omit services provided by public hospitals and for this reason it is important that the model includes hospital capacity (a complementary product for specialist services) and outpatient capacity (a substitute for private out of hospital practice).

As discussed earlier, the demand equation in this model is identified and can therefore be estimated. The demand curve is identified because of the introduction of the DOC variable into the demand equation, where DOC is stochastic endogenous variable determined, in part, by a vector of exogenous variables relating to residential desirability. The presence of these exogenous variables, excluded from the demand equation, allows the demand curve to be identified (Maddala, 1988).

Econometric results are presented in Table 2 and the implications of the key coefficients summarised in Tables 3 and 4. All results are presented for models estimated using a linear functional form.

Table 2: GP Supply and Demand: Regression Results[1]

Equation	Supply	Demand			
Equation	**1 OLS**	**2 OLS**	**3 TSLS**	**4 OLS**	***5***
Dependent Variable	**GP/10,000**	**Q(GP)/Capita**	**Q(GP)/Capita**	**Q(GP)/Capita**	***e***
Net price		-0.28**	-0.42**	-0.34**	
Gross price	0.16*				
GP/10,000		0.39**	0.40**		0.28**
Pop density	6.82**				
Hosp/10,000	-0.31**				
Urban dummy	1.12**				
ACT	-1.52**				
NT	-2.53**				
VIC	-0.46**				
WA	-0.99**				
% ABOR		-4.29**	-4.01**	-8.45	
Constant	1.95	3.57	3.86	6.22	1.7
R^2	0.69	0.83		0.59	0.43

Note [1]Regression Coefficient (significance level). See appendix for further analysis.
* = $p<0.05$.
** = $p<0.01$.

Table 3: Magnitude of the Price Effect

	OLS	TSLS
Mean Net Price $(\overline{p})$	$2.70	$2.70
β	-0.28	-0.42
$\Delta Q((P=O) \rightarrow (P=\$2.70))$	0.76	1.13
MeanQ	5.0	5.0
ΔQ/Q	15.2%	22.6%

Note β = Regression coefficient for net price.

Δ Q = Change in demand when the price rises from zero to the mean

Table 4: Magnitude of Implied SID

	OLS	TSLS
Mean GP/10,000	6.0	6.0
GP/10,000 +50%	9.0	9.0
b	0.39	0.40
$\Delta Q(GP \rightarrow GP + 50\%)$	1.17	1.20
$\Delta Q/Q$	23.4%	24.0%

Notes β = Coefficient on GP/10,000

ΔQ = Change in Q arising from a 50% increase in GP/10,000 from the mean.

Different traditions exist with respect to the presentation of results. Some authors prefer to include all variables, significant or insignificant.[10] Others only include statistically significant results with the implied conclusion that the postulated relationships between other variables have been rejected. This latter tradition is adopted here.

Results are striking. Coefficients have the expected signs, the significance level of each of the included variables is extremely high and the overall goodness of fit statistics are almost suspiciously large. Despite vigorous attempts, it was not possible to find a reason for attributing these good results to artefactual errors.[11] Rather, it appears that the extension of the unit of analysis from the statistical division (Richardson 1981) to the statistical sub-division has resulted in a far greater range of observations which are successfully explained by the postulated variables. Most importantly, and as indicated in Tables 3 and 4, the magnitude of the price and SID effects are plausible. Price elasticities are possibly somewhat higher than would be expected (Richardson 1991) suggesting that if there is bias introduced because of the identification problem discussed earlier, then this bias has resulted in a reduction of the SID and increase in the price effects.

The demand equation estimated using two stage least squares (model 3) proved to be well specified when scrutinized using more formal diagnostic tests. The equation was first tested using a general test for misspecification in two stage least squares (Godfrey 1988). The test consists of a null hypothesis that the equation is correctly specified, and a general misspecification alternative hypothesis. The demand equation proved to be very well specified under this test (Test Statistic = 8.67, X^2_{200} (0.05) critical value = 233.99). Tests for heteroscedasticity in a single equation within a simultaneous equations model (Carr-Hill et al 1994) also indicated the model was well specified. GP Supply (Test Statistic = 3.37) and percent Aboriginal (Test Statistic = 8.04) both indicated heteroscedasticity was not present at the 1% level (X^2_2 (0.01) critical value = 9.21). Slight heteroscedasticity may have been present due to the

[10] The inclusion of insignificant variables can sometimes lead to misunderstanding as in the case of Doessel (1998, p 115) who writes that 'Richardson has admitted that his study, with respect to the own price elasticity variable, did not obtain plausible results … these results might suggest there is something amiss in the study'. The results referred to were statistically insignificant and, consequently, the perverse sign on the insignificant variable was of no particular interest.

[11] No attempt was made to test for a non-nested relationship between demand and SID as suggested by Doessel (1998). To the author's knowledge no one has ever suggested a non-nested relationship. Rather, demand, as generated by normal economic variables, is shifted. This does not imply a difference in the underlying theoretical structure which is as different as, for example, Monetarism and Keynsianism.

presence of the Net Price Variable (Test Statistic = 12.16), but this variable still passed the test at the 0.1% level (X^2_2 (0.001) critical value = 13.82). Any effects were therefore likely to be negligible.

Because of the specification problem discussed above, two additional equations were estimated and reported in Table 2. The first, Equation 4 re-estimates demand with the GP supply omitted. This ensures that the full explanatory power of the remaining variables will not be wrongly attributed to the GP supply, although the converse may occur, that is the effect of the GP supply may be attributed to one of the remaining variables. The error term, *e* from this equation was then used as the dependent variable in Equation 5, with the GP supply as the only independent variable. As price effects have been fully deleted from the dependent variable, its relationship with the doctor supply cannot be attributed to the relationship between the GP supply and net price. Results of Equation 5 suggest that the GP supply independently adds to the explanation of GP use. The impact is less than in Equation 2. But this is because the significance of the variable ABOR (a proxy for the socio-economic status of a region) increases due to its correlation with the GP supply (0.58). Clearly the omission of the doctor supply from the demand equation does not result in white noise as the error term correlates significantly with the omitted variable.

Exclusion of the GP supply variable from Model 3 was also tested using more formal diagnostic tests. Exclusion of the GP Supply variable from model 3 was found to be invalid using a test for linear restrictions under two stage least squares (Carr-Hill et al. 1994) (Test Statistic = 77.65, X^2_1 (0.05) critical value = 3.84). This supports the results of models 4 and 5. Model 3, excluding GP Supply, was also tested for general misspecification. Whilst the model passed this test (Test Statistic = 81.96, X^2_{200} (0.05) critical value = 233.99), the test statistic increased 10 fold from the exclusion of this variable. Again, this suggests potentially significant bias from the exclusion of GP Supply from the demand equation.

In addition to the results shown in Table 2, regressions were estimated using a double log model. The goodness of fit statistics were similar to those reported. The significant coefficients for net price and GPs per 10,000 population implied elasticities of -0.17 and 0.43 respectively.

The Supply equation (model 1) was also subjected to diagnostic testing. If the instrumental variables used in two stage least squares are poor predictors of the endogenous regressor, bias may be introduced into model results (Jones 1998). The supply equation was tested for misspecification by rerunning the regression with the squared predicted value of the dependent variable added as an extra regressor. This is a form of the RESET test (Horowitz 1994), which has proved a robust check for many forms of misspecification (Sutton and Godfrey 1995). The supply equation proved to be well specified (Test statistic = 3.65, $F_{(1,200)}$ (0.05) critical value = 3.89), indicating instrumental variable bias was not present.

6 A Natural Experiment

Australia provides an interesting and unique laboratory for the examination of the relative importance of price and SID effects on patient demand. The perverse and idiosyncratic financing of health services results in a public sector in which hospital patients are treated without cost and a private sector in which, in return for the purchase of private health insurance, the patient is left with significant out of pocket expenses. In a simple market equilibrium public demand per capita would be expected to exceed private demand per capita. However, incentives facing doctors also differ. In the public hospital there is no financial benefit from the treatment of additional patients. In the private sector a full fee is earned. There is therefore no incentive for doctors to increase demand in the public sector and a strong incentive to increase it in the private sector.

In a recent study Richardson et al (1998) examined the treatment of patients after an emergency admission with a heart attack (acute myocardial infarction [AMI]). Various treatments are possible for AMI. The most expensive and recent of these include the diagnostic test, angiography, and the procedures collectively known as 'revascularisation', that is coronary artery bypass surgery, balloon angioplasty and stenting. Each of these four procedures attracts a significant fee.
Differences in the rates of angiography and revascularisation for the Victorian population are shown in Table 5. In this, a percentage of patients receiving CARP (Coronary Artery Revascularisation Procedure) is shown in the first two columns and the likelihood of revascularisation in different hospital settings is shown in the subsequent columns in which the average likelihood of CARP for all AMI patients in Victoria is set equal to 100 in each year. Column entries show the likelihood of revascularisation in each setting after (indirect) age standardisation.[12] Thus, in 1996 the likelihood of a private patient in a private hospital receiving CARP was 5.99 and 7.23 times greater for men and women admitted to private hospitals than the state average. The likelihood of public patients receiving revascularisation was 0.57 and 0.48 times the state average; that is, men and women were 10.5 and 15.1 times more likely to receive CARP as a private patient in a private hospital than as a public patient. It would require remarkably agile footwork to avoid the conclusion that these patterns were driven by physician judgement rather than patient preference.

Three important caveats must be made. First, patients who do not receive revascularisation often receive thrombolytic drug therapy and only the quality of life is affected by the choice of therapy. Secondly, data do not indicate whether private or public practice is closer to best practice medicine. Third, data refer to the first eight weeks after AMI. Cardiologists shown these results have argued that, after twelve months, revascularisation rates for the two groups will be similar as the private sector permits the swifter use of procedures. This does not occur in WA and the hypothesis is currently being pursued in Victoria. The significant point, however, is that whether or not rates converge, there is clearly a different pattern of treatment in the two systems and, as it appears unlikely that patients will have a clear view of the appropriate time or pattern of treatment, then these patterns are driven by physicians. Patient-driven patterns determined by the

[12] The adjustment results in the likelihood of revascularisation if the particular hospital setting had the state-wide experience with respect to the age of patients.

usual economic variables would result in greater early service use in the 'free' public system or in significant queuing, and neither of these are observed for AMI.

Table 5: Age Standardised Likelihood of CARP in Different Hospital Settings

Percentage of AMI Patients Undergoing CARP			Private Patients in Private Hospitals		Private Patients in Public Hospitals		Public Patients in Public Hospitals	
	Men %	Women %	Men	Women	Men	Women	Men	Women
1991	2.5	1.6	381	374	121	211	93	83
1992	3.2	2.8	451	427	127	112	84	86
1993	8.1	4.0	693	719	59	88	63	60
1994	10.9	6.3	606	601	83	88	58	63
1995	16.8	10.4	667	633	71	64	51	55
1996	19.4	12.2	599	723	81	98	57	48

Note All private hospitals in Victoria did not contribute data to the Victorian Inpatient Minimum Dataset before 1993.
Source Richardson et al (1998).

7 Discussion

One conclusion drawn from this paper is that many of the criticisms of the theory of SID have not been even-handed; they have not applied the same criteria or rigour to the conventional model. Once the uncertainty of medical decision-making and the complexity of medical judgements are taken into account, SID is based upon a more plausible theory of patient and doctor behaviour than the conventional model, which abstracts from these fundamental characteristics of the medical market place. More importantly, SID provides a satisfactory explanation of the observed pattern and change in the demand for medical services. Variations in other observed variables are incapable of providing this explanation within the conventional model.

It might be expected that this difference in the explanatory power of the two theories would be accepted as the critical and distinguishing test by economists. The fact that it is not is itself a puzzle. A possible theory to explain the tenacity of the orthodox view is that economists may be influenced by personal ideology. Economic orthodoxy lends support to the belief that deregulation, privatization and small government may maximize social welfare — or, at least, when this is defined in terms of 'welfarism', the view that social welfare is a function of individual 'utilities' as defined by people's willingness to pay. There is little doubt that this normative view is attractive to many economists who may, as a consequence, be critical of arguments and evidence that do not support economic orthodoxy.

However, the relationship between SID and the desirability of intervention in the medical market place is more complex than suggested by this hypothesis. As shown in Table 6 the likelihood of intervention depends not simply upon the existence or otherwise of SID but, additionally, upon the effectiveness of medical treatments and upon social objectives. A common but unstated assumption in much of the literature is that SID corresponds with the delivery of medically worthless care (cell B) and that, conversely, the non-existence of SID corresponds with the delivery of medically useful care (cell C). It is certainly true that this cell corresponds to the scenario in which intervention is least likely. But even with this outcome intervention is possible if the society rejects simple welfarist objectives and seeks objectives that do not, fortuitously, flow from the unregulated medical market place. In other words, the non-existence of SID does not guarantee non-intervention. This is even clearer in cell D. Even with welfarist objectives it may be deemed appropriate to minimize the use of medically worthless services that occur because of mis-information, marketing and moral hazard. Conversely, the existence of SID does not necessarily imply the need to regulate the medical market. If doctors are inducing services that are health promoting — there is a model of responsible professional domination — it may be judged unnecessary to regulate the sector when there are either welfarist or extra-welfarist objectives. In sum, the debate between welfarism in cell C and extra-welfarism in cell B is a gross simplification of the three dimensional set of alternatives described in Table 6.

There is a second and possibly more plausible explanation for the tenacity of the orthodox theory. This is that economists may have, consciously or unconsciously, adopted different criteria for the assessment of theory. On the one hand there are 'theoretical pragmatists': those who regard the role of theory as being overwhelmingly to explain observations, and who are willing to accept that theory may be context specific. From this perspective, the criterion for accepting a theory is that it provides the best (empirical) explanation of the major facts. By contrast, there are 'orthodox theorists' who believe the role of theory is to extend the scope of theoretical orthodoxy and to rationalize observations within this framework. From this perspective, theory largely transcends any particular context and the criterion for accepting a new theory is far more stringent: orthodoxy is true until proven false. But as the empirical world is not characterized by conclusive evidence, this criterion can be made increasingly stringent until economic theory is inviolate and its core axioms become the basis of what Kuhn (1962) describes as 'normal science', and what Popper (1974) decries as the outcome of badly trained scientists.

Table 6: Should There be Intervention in the Medical Market Place?

SID	**Medical Benefits**		**Social Objective**
	Yes	**No**	
	A	**B**	
Yes	Maybe (if u = health)	Yes	Welfarist
	Maybe (less likely)	Yes	Extra -welfarist
	C	**D**	
No	Least likely to be beneficial	Maybe (if u = health)	Welfarist
	Maybe (less likely)	Maybe	Extra -welfarist

There is, of course, a spectrum of attitudes and 'meta' criteria between these two archetypes. Health economics has, to date, been characterized more by theoretical pragmatism than theoretical orthodoxy. It is not surprising, therefore, that the majority of its practitioners have, sometimes reluctantly, accepted the theory of Supplier Induced Demand (see Feldman & Morrisey 1990).

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APPENDIX

A1 SUPPLY OLS
Summary Statistics

	Mean	Std Deviation	N
GPs per 10,000 persons	5.9856	1.8444	187
Fees per GP service	25.5599	4.7191	187
Population density	3.494E-02	7.390E-02	187
Hospitals per 10,000 persons	0.991928	1.280485	187
Urban (excl NT)	0.30	0.46	187

Correlations

	GPs per 10,000 persons	Fees per GP service	Population density	Hospitals per 10,000 persons	Urban (excl NT)
Pearson Correlation					
GPs per 10,000 persons	1.000	.435	.617	-.371	.546
Fees per GP service	.435	1.000	.194	.099	-.038
Population density	.617	.194	1.000	-.298	.620
Hospitals per 10,000 persons	-.371	.099	-.298	1.000	-.442
Urban (excl NT)	.546	-.038	.620	-.442	1.00 0
ACT	.044	.055	.086	-.128	.275
Northern Territory	-.312	-.063	-.075	-.090	-.140
Victoria	.092	.004	.158	-.183	.081
Western Australia	-.215	.079	-.145	.274	-.089
Sig. (1-tailed)					
GPs per 10,000 persons	.000	.000	.000	.000	.000
Fees per GP service	.000	.000	.004	.089	.303
Population density	.000	.004	.000	.000	.000
Hospitals per 10,000 persons	.000	.089	.000	.000	.000
Urban (excl NT)	.000	.303	.000	.000	.000
ACT	.273	.226	.120	.041	.000
Northern Territory	.000	.197	.155	.111	.028
Victoria	.106	.478	.016	.006	.135
Western Australia	.002	.143	.024	.000	.112

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	442.455	8	55.307	51.738	.000[a]
	Residual	190.279	178	1.069		
	Total	632.735	186			

Notes a Predictors: (Constant), WA, ACT, NT, fees per GP service, population density, VIC, hospitals per 10,000 persons, urban (excl NT).
b Dependent variable: GPs per 10,000 persons.

Coefficients[a]

	Unstandardised Coefficients		Standardised Coefficients			Collinearity Statistics	
Model	B	Std Error	Beta	t	Sig.	Tolerance	VIF
1 (Constant)	1.915	.452		4.237	.000		
Fees per GP service	.164	.017	.420	9.645	.000	.890	1.123
Population density	6.822	1.396	.273	4.887	.000	.540	1.852
Hospitals per 10,000 persons	-.311	.070	-.216	-4.446	.000	.715	1.399
Urban (excl NT)	1.160	.240	.290	4.826	.000	.467	2.140
ACT	-1.518	.457	-.145	-3.319	.001	.880	1.137
Northern Territory	-2.528	.389	-.278	-6.490	.000	.920	1.087
Victoria	-.459	.184	-.110	-2.498	.013	.875	1.143
Western Australia	-.987	.239	-.183	-4.123	.000	.862	1.161

Note a Dependent variable: GPs per 10,000 persons.

Collinearity Diagnostics

Model	Dimen s'n	Eigen value	Condition Index	Variance Proportions (Con-stant)	Fees per GP service	Pop. density	Hospitals per 10,000 persons	Urban (excl NT)	ACT	NT	VIC	WA
1	1	3.610	1.000	.00	.00	.01	.01	.01	.00	.00	.02	.01
	2	1.543	1.530	.00	.00	.06	.08	.04	.05	.01	.01	.09
	3	1.033	1.870	.00	.00	.00	.00	.01	.21	.35	.08	.13
	4	1.008	1.892	.00	.00	.00	.00	.00	.27	.42	.12	.00
	5	.769	2.167	.00	.00	.10	.03	.03	.28	.04	.14	.23
	6	.508	2.667	.00	.00	.07	.21	.00	.04	.03	.39	.46
	7	.313	3.399	.01	.01	.50	.17	.17	.13	.05	.15	.07
	8	.202	4.228	.01	.02	.16	.50	.65	.01	.09	.09	.00
	9	1.461E-02	15.721	.97	.97	.09	.00	.08	.01	.01	.01	.00

A2 DEMAND OLS
Descriptive Statistics

	Mean	Std Deviation	N
Per capita use of GP services	4.9695	1.2450	187
Average price per service	2.6988	1.7694	187
GPs per 10,000 population	5.9856	1.8444	187
Proportion Aboriginal	3.91E-02	8.39E-02	187

Correlations

		Per capita use of GP services	Average price per service	GPs per 10,000 population	Proportion Aboriginal
Pearson Correlation	Per capita use of GP services	1.000	-.517	.790	-.596
	Average price per service	-.517	1.000	-.177	.055
	GPs per 10,000 population	.790	-.177	1.000	-.496
	Proportion Aboriginal	-.596	.055	-.496	1.000
Sig. (1-tailed)	Per capita use of GP services	.000	.000	.000	.000
	Average price per service	.000	.000	.008	.228
	GPs per 10,000 population	.000	.008	.000	.000
	Proportion Aboriginal	.000	.228	.000	.000

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	240.078	3	80.026	303.745	.000[a]
	Residual	48.214	183	0.263		
	Total	288.292	186			

Notes [a] Predictors: (Constant), proportion Aboriginal, average price per service, GPs per 10,000 population.
[b] Dependent variable: Per capita use of GP services.

Coefficients[a]

Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.	Collinearity Statistics	
		B	Std Error	Beta			Tolerance	VIF
1	(Constant)	3.568	.177		20.123	.000		
	Average price per service	-.281	.022	-.399	-12.972	.000	.967	1.034
	GPs per 10,000 population	.389	.024	-.576	16.289	.000	.732	1.367
	Proportion Aboriginal	-4.288	.517	-.289	-8.293	.000	.753	1.328

Note [a] Dependent variable: Per capita use of GP services.

Collinearity Diagnostics[a]

Model	Dimension	Eigen value	Condition Index	Variance Proportions			
				(Constant)	Average price per service	GPs per 10,000 population	Proportion Aboriginal
1	1	2.914	1.000	.01	.03	.01	.02
	2	.814	1.892	.00	.00	.01	.67
	3	.245	3.448	.01	.82	.06	.02
	4	2.661E-02	10.465	.98	.15	.93	.29

Note [a] Dependent variable: Per capital use of GP services.

A3 DEMAND TWO STAGE LEAST SQUARES

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	206.70627	68.902091
Residuals	183	59.19655	.323478

Note F = 213.00368 Signif F = .0000.

Coefficients[a]

Model		Unstandarised Coefficients		Standardised Coefficients		
		B	Std Error	Beta	t	Sig
3	(Constant)	3.858	.221		17.477	.000
	Average price per service	–.416	.031	–.591	– 13.608	.000
	GPs per 10,000 population	.400	.032	.592	12.495	.000
	Proportion Aboriginal	–4.01	.610	–.270	–6.585	.000

Note [a] Dependent variable. Per capita use of GP services