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The influence of economic incentives on treatment patterns in a third-party funded dental service

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Objective: To investigate the response of dental practitioners to administration and remuneration adjustments to the Dental Treatment Services Scheme (DTSS) in the Republic of Ireland. ***Design:*** Following the introduction of a series of administration and fee adjustments by a third party payments system in December 1999 the pattern of extractions and restorations are examined to determine whether the adjustments had influenced provider behaviour, in particular whether a substitution effect from extractions to restorations would result from a relative fee increase of 62% for amalgam fillings. ***Data and Methods:*** Data on patient and provider characteristics from June 1996 to April 2005, collected by the Health Service Executive (HSE) National Shared Services Primary Care Reimbursement Service to facilitate remuneration to dentists providing services in the DTSS, was used in this analysis. A graphical analysis of the data revealed a structural break in the time-series and an apparent substitution to amalgam fillings following the introduction of the fee increases. To test the statistical significance of this break, the ratio of amalgams to restorations was regressed on the trend, growth and level dummy variables, using Ordinary Least Squares (OLS) regression. The diagnostics of the model were assessed using the Jarque-Bera normality test and the LM to test for serial correlation. ***Results:*** The initial results showed no evidence of a structural break. However on further investigation, when a pulse dummy was included to account for the immediate impact of the fee adjustment the results suggest a unit root process with a structural break in December 1999. This implies that the amalgam fee increase of December 1999 influenced the behaviour patterns of providers. ***Conclusions:*** System changes can be used to change the emphasis from a scheme that was principally exodontia/emergency based to a scheme that is more conservative and based on restoration/prevention.

Key words: Economic incentives, 3rd party payments system, restoration/prevention, substitution effect, structural break.

Introduction

An important part of health care funding relates to the method of payment of physicians and dentists. Different payments systems have different financial incentives which in turn have different implications for the cost and quality of care provided (Grytten 2005). This paper focuses on the Dental Treatment Services Scheme (DTSS) operated by the Department of Health and Children in the Republic of Ireland. It is a publicly funded insurance scheme where dentists are remunerated fee-per-item through a third party payments system, namely, the Health Service Executive (HSE) National Shared Services Primary Care Reimbursement Service. Services are provided at zero cost to low-income medical cardholders, aged 16 and over. Eligibility is based largely on income but since 2005 all those aged 70 and over are also entitled to services.

With a third party bearing the costs of care, dentists have few incentives to moderate the amount of care they supply (Grytten 2005). Donaldson and Gerard, (2005) state that provider moral hazard is most often associated with systems of payments where dentists are remunerated based on fee-for-service as it rewards dentists according to the amount of work carried out. This can result in the overuse of services. In fee-for-service systems, problems of how much care is provided only arise if fees actually depart from true competitive prices. Donaldson and Gerard, (2005) argue that if fees are greater than the true competitive price, there will be an incentive to over-provide, whilst with fees below the true competitive price, the incentive will be to under-provide. Chalkley and Tilley (2006) also found that payment methods and patients' market opportunities affect the level of services. With the DTSS the schedules of fees[1] are negotiated between the Irish Dental Association (IDA) and the Department of Health and Children. For much of 1999, the IDA and the Department were in dispute about the inequity between the fees remunerated for services provided in the DTSS and those available for private patients, with DTSS fees on average 35% lower. The dispute was further complicated in that dentists required the prior approval of the HSE Principal Dental Surgeon to carry out all services on DTSS patients, except for emergency treatments, resulting in different criteria being applied in different Health Boards. The Department claimed

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[1]DTSS treatments are divided into above-the-line, and below-the-line treatment items. Above–the-line treatments include oral examinations, prophylaxis, amalgam and composite restorations, exodontics, surgical extractions and miscellaneous items. Below-the-line treatments include endodontics on anterior teeth, protracted periodontal treatment, radiographs and acrylic dentures.

that open access was not possible as accountability for Health Board expenditure was a key issue for them. This dispute led to a suspension in participation in routine and denture schedules, from July to December 1999, but they continued to provide emergency treatments.

The phenomenon of increasing reimbursement rates for some services and decreasing the rates of others was examined by Rice (1983) in the US, who found that changes in practices and fees were consistent with doctors adjusting patient use. In contrast, Parkin and Yule (1988) found that reductions in dental charges in Scotland had little effect on demand. Donaldson and Gerard, (2005) stated that the ability of physicians to manipulate demand could be controlled by the heavy intervention of governments and policy-makers in fee setting. This seems to have been the option pursued by the Department of Health and Children in December 1999, when the Department agreed to administration and fee increases with the IDA. From January 2000, prior approval was no longer required for routine treatments. Parity of fees between the DTSS and the DTBS (Dental Treatment Benefit Scheme) was introduced with full retrospection. A special increase from €20.83 to €33.72 (62%) was agreed for amalgam fillings.

Aims

Despite the importance and well established nature of dental charges, evidence about their effects on patients' and dentists' behaviour is limited (Parkin and Yule, 1988). Grytten (2005) examined the various models for financing dental services, and described the effects that the different models can have on patients' and dentists' behaviour. Whilst studies such as Muller and Monheit (1988) and Sintonen and Maljanen (1995a) have investigated the impact of prices on patient behaviour this paper investigates whether the introduction of a series of economic incentives in the operation of the DTSS in December 1999 had influenced the pattern of provider behaviour in what was up to then a largely exodontia/emergency based scheme. More specifically, whether the removal of the requirement of prior approval for above-the-line treatments had altered patterns of service provision or whether the 62% increase in fees for amalgam fillings led to a substitution from extractions to amalgam fillings.

Data

Dental service data has been previously used to inform research and policy (Whelton *et al*., 2005). The data for this investigation was collected by the HSE National Shared Services Primary Care Reimbursement Service to facilitate remuneration to dentists providing services in the DTSS. This database holds a record of dental data, dating back to 1994, on the patient's medical card number, age and gender of patient, treatment type provided, the tooth number, date and cost of treatment, and the dentist's registration number. The analysis was confined to the same 722 dentists who operated the scheme both before and after the December 1999 adjustments and on the treatment patterns of the 16 to 34 age-group as this group were eligible for all dental services for the period June 1996 to April 2005.

Methods

There are very few studies on the demand for dental care based on time-series data (Sintonen and Linnosmaa, 2000). The exception is Parkin and Yule (1988) who regressed measures of demand for dental care on price and income, and dummy variables to capture changes over time in the dental care charging system in Scotland. The Ordinary Least Squares (OLS) estimation of the linear time-series model used in this analysis contributes to the dental literature and provides a guide for future researchers who wish to explore trends in time-series data.

A graphical time-series of the ratio of amalgams to extractions was constructed as in Figure 1. To empirically

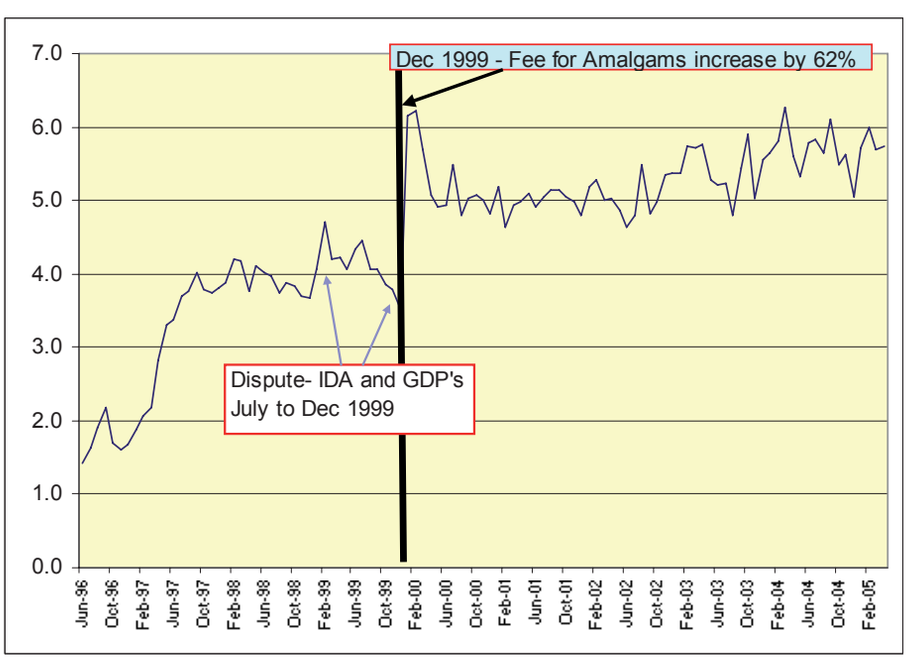

Figure 1. *Ratio of amalgam fillings to extractions June 1996 to April 2005, Age 16-34's*

test for a structural break in this time series, the ratio of amalgams to extractions was regressed on the trend, growth and level dummies. Assuming that the adjustment following the structural break is instantaneous, the following equation is estimated which allows for changes in both the level and growth of the ratio:

$$(1)\ Ratio_t = \beta_1 + \beta_2 Trend_t + \beta_3 Level_t + \beta_4 Growth_t + \varepsilon_t$$

where Ratio = ratio of amalgams to extractions and Trend = time trend. The variables Growth and Level are two dummy variables constructed as follows:

$Growth_t = 0$ if $t \leq T_b$ and $Growth_t = t$ for $t > T_b$
$Level_t = 0$ if $t \leq T_b$ and $Level_t = 1$ for $t > T_b$.

The time period T_b refers to the time of the structural break, which in this case is December 1999, the period of the amalgam fee increase. This model allows for a sudden change in the level followed by a different growth path. To empirically test for a structural break, the above equation is estimated using OLS and the significance of the dummy variables examined. If the dummy variables are found to be statistically significant, it would indicate that the amalgam fee increase did have an effect on the ratio of amalgams to extractions; specifically there was an increase in the number of amalgams relative to extractions after the fee increase. The following diagnostics are also checked to ensure that a congruent model is obtained. The null hypothesis that the residuals of the model are normally distributed is examined using the Bera and Jarque (1981) test for the joint significance of the skewness and kurtosis of the residuals. The hypothesis that the disturbances are serially uncorrelated is tested using the Lagrange multiplier (LM) statistic; specifically the LM statistic is computed for serial correlation of order 12.

Results

The graphical analysis in Figure 1 reveals a structural break in the time-series just after the December 1999 adjustments. For the two years prior to the adjustments the average ratio of amalgams to restorations was 4.0, whereas the ratio increased to 5.1 for the two years after, providing evidence of a substitution from extractions to amalgams. Furthermore, within twelve months of the adjustments the number of dentists providing DTSS services had increased from 722 to 854, an increase of 18%.

The estimates for equation (1) are presented in Tables 1 and 2.. A lag of the dependent variable ($Ratio_{t-1}$) is included in order to avoid serial correlation. Pulse is a dummy variable which takes the value of 1 in January 2000 and zero otherwise. The probable explanation of its inclusion relates to the amalgam fee increase of December 1999 and its immediate impact effect in January 2000. If the pulse dummy is not included the level and growth dummies are significant (Table 1). However these results must be treated with caution as the Jarque-Bera normality test (210.516 with a p-value of 0.000) indicates that the residuals of the model are not normally distributed.

The pulse variable is then included to deal with a non-normality problem. The diagnostic tests suggest that the model is well specified (Table 2). The adjusted R^2 suggests shows that the model explains 92% of the variation in the ratio of amalgams to extractions. The Jarque-Bera normality test and the serial correlation LM test both suggest that the error term is well behaved. It is clear from Table 2 that the Level and Growth dummies are individually statistically insignificant (p-values of 0.224 and 0.318 respectively). This implies that there was no structural break arising from the amalgam fee increase in December 1999.

However the Pulse dummy is significant and warrants further investigation. Given that the coefficients on the Trend, Level and Growth are statistically insignificant, they are excluded from the model and the equation is re-estimated in Table 3. As in the previous case, all the diagnostic tests suggest that the model is well specified. All the variables are statistically significant. As the coefficient on the lagged ratio is close to unity, these results suggest a unit root process with a structural break in December 1999. To formally test for a unit root (that is, the coefficient on $Ratio_{t-1} = 1$), it is possible to use the standard t-statistic given by (0.926-1) / 0.027 = -2.67543

The appropriate Dickey-Fuller (1979) critical values (n=100) are -2.89 and -3.51 at the 5% and 1% significance levels, respectively. This means that the null hypothesis of a unit root cannot be rejected at conventional significance levels. This means that the above process is a unit root. Furthermore, as the pulse dummy is statistically significant (p-value = 0.000), this indicates a unit root process with a structural break. In a unit root process, a single pulse in the dummy indicates a permanent effect on the ratio of amalgams to extractions indicating that the amalgam fee increase of December 1999 did have an impact on the behaviour patterns of providers.

Discussion and Conclusions

Removing the requirement of prior approval and introducing a relative fee increase for amalgam fillings altered provider behaviour in two ways: Firstly, the changes to the scheme removed the operational inefficiency of the requirement of prior approval, and may have influenced the subsequent 18% increase in the number of service providers. The increase in the number of dentists providing service will improve the accessibility of the scheme. Secondly, the fee increase for amalgams has shifted the emphasis of the DTSS from a scheme that was mostly exodontia/emergency to a scheme that is more principled in restoration/prevention which is one the main goals of the Dental Health Action Plan (1994). Similarly, Grytten and Sørensen (2001) found that the type of contract influenced physician behaviour in Norway, and both Chalkley and Tilley (2006) and Dusheiko *et al*., (2006) found evidence in the British National Health Service that provider remuneration affects the level of services.

Whilst the agreement between the IDA and Department on changes to the DTSS in December 1999 was aimed principally at ending an industrial dispute and did not appear to be policy driven, the results suggest that economic incentives can be used to alter provider behaviour in a third party funded dental service.

Table 1. OLS Estimation of Equation 1 (Ratio of amalgam fillings to extractions July 1996 to April 2005, pulse variable not included)

	Coef.	*Std. Error*	*t-Ratio*	*P-value*
Constant	1.0142	0.196	5.162	0.000
Trend	0.020	0.007	2.892	0.005
Level	0.915	0.293	3.114	0.002
Growth	-0.016	0.007	-2.377	0.019
$Ratio_{t-1}$	0.584	0.078	7.468	0.000

$\overline{R}^2$=0.89

F(4, 101) = 213.683 [p-value = 0.000]

Serial Correlation (12): F(12, 89) = 0.892 [p-value = 0.558]

Normality: χ^2 (2) = 210.516 [p-value = 0.000]

Note: Dependent Variable is the ratio of amalgams to extractions ($Ratio_t$)

Table 2. OLS Estimation of Equation 1 (Ratio of amalgam fillings to extractions July 1996 to April 2005)

	Coef.	*Std. Error*	*t-Ratio*	*P-value*
Constant	0.747	0.167	4.464	0.000
Trend	0.011	0.006	1.930	0.056
Level	0.316	0.259	1.224	0.224
Growth	-0.006	0.006	-1.005	0.318
$Ratio_{t-1}$	0.720	0.068	10.633	0.000
Pulse	2.319	0.337	6.877	0.000

$\overline{R}^2$=0.92

F(5, 100) = 258.766 [p-value = 0.000]

Serial Correlation (12): F(12, 88) = 1.2413 [p-value = 0.269]

Normality: χ^2 (2) = 0.956 [p-value = 0.620]

Table 3. OLS Estimation of Equation 1 excluding Trend, Level and Growth variables (Ratio of amalgam fillings to extractions July 1996 to April 2005)

	Coef.	*Std. Error*	*t-Ratio*	*P-value*
Constant	0.354	0.129	2.735	0.007
$Ratio_{t-1}$	0.926	0.027	33.720	0.000
Pulse	2.553	0.331	7.709	0.000

$\overline{R}^2$=0.92

F(2, 103) = 579.815 [p-value = 0.000]

Serial Correlation (12): F(12, 91) = 1.167 [p-value = 0.318]

Normality: χ^2 (2) = 0.211 [p-value = 0.900]

Note: Dependent Variable is the ratio of amalgam fillings to extractions ($Ratio_t$)

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