Productivity analysis of the private general dental sector in Australia, 1983 to 1998

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Abbreviations	Description
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ADA	Australian Dental Association
Adel	Adelaide
ANOVA	Analysis of Variance
FE	Fixed Effects
LSPDA	Longitudinal Study of Dentists' Practice Activity
Melb	Melbourne
NSW	New South Wales
NT	Northern Territory
OLS	Ordinary Least Squares
O/S	overseas
QLD	Queensland
RE	Random effects
ref.	reference category
'real'	deflated estimate
RVU	Relative value unit
SA	South Australia
Syd	Sydney
Tas	Tasmania
Vic	Victoria
WA	Western Australia
$GB	Gross billings
χ^2	chi-square

Abstract

The need for investigation of health economic issues continues to grow. Despite the tremendous gains potentially available to the dental sector, this area has until presently been a void within research in Australia. Economic analysis should become a stronger aspect of informing policy. At the core of economic analysis lies productivity, underpinned by the relationship between demand and supply. Currently there is a reported labour force shortage in the dental sector resulting from a trend of declining capacity to supply dental visits by the dental labour force (Spencer et al, 2003) coupled with increasing demand for dental visits of the dentate population (AIHW DSRU, 2003) observed over the last several decades.

The currently reported labour force shortage in the dental sector has led to the need to investigate productivity, which has been approached in this study by using econometric production function modelling. The study used data from the Longitudinal Study of Dentists' Practice Activity (LSPDA), collected by mailed questionnaire which provided four representative cross-sectional surveys conducted at five-yearly intervals spanning the period from 1983/84 to 1998/99. The cross-sectional and longitudinal components of the LSPDA provided a unique opportunity to specify econometric production functions for each survey year cross-sectionally and across time (1983-1998) using panel longitudinal data. Until presently, production functions had been specified predominantly as cross-sectional snapshots in time. The methodology implemented in this study enabled testing of which input factors, grouped into capital (utilisation of surgeries and x-ray units) and labour inputs (dentist chairside hours, intra- and extra-oral auxiliaries), dentist characteristics (sex, experience, university of graduation, country of birth) and practice characteristics (configuration, size, state location, perceived busyness, length of wait for an appointment) were significant in each survey year production function and across a range of productivity measures including; patients-, services-, relative value units (RVUs)- and gross billings ($GB) per day. A longitudinal panel production function was then specified for each productivity measure to investigate productivity time trends across the 1983 to1998 period.

The overall productivity time trend observed across the 1983 to 1998 period was a decline in patients (20.8%) and services (11.1%) per day, at a reasonably stable level of work effort (RVUs per day) increasing by only 3.3%, and very high monetary rewards in the form of greatly increased $GB per day (126%) for private general dentists.

Overall, the most consistent and significant input factors were related to labour inputs consisting of dentist chairside hours per day and number of extra-oral auxiliaries per dentist. Inputs that did not show a significant association with productivity included sex, the number of intra-oral auxiliaries per dentist and practice characteristics such as configuration and size. The non-significance of the practice characteristics may be attributable to the way in which the LSPDA questions were worded; possibly resulting in inconsistency in the interpretation from participants, while intra-oral auxiliaries do not feature strongly as they are few in number and are more complementary rather than substitutional in terms of dental provision as compared with the dentist.

The production functions synthesised were OLS regression models which exhibited reasonably good fit and explained the variation in productivity within the range of 36 to 42% for patients per day, 22 to 30% for services per day, 15 to 41% for RVUs per day and 18 to 31% for $GB per day. Overall, the production functions with the greatest number of significant explanatory input factors and best fit were those estimated with patients per day as the dependent variable, while the production functions estimated with $GB per day as the dependent variable achieved the least number of significant variables and least 'best fit'.

The productivity time trends and relationship between the different productivity measures could have serious implications within private dental practice in the face of an already under-supplied labour force which could lead to increasing fees, decreased access to dental care and longer waiting times for routine dental care. The consequences are further complicated by the fact that coupled with an under-resourced public dental system and maldistribution of private dentists this leaves the highest risk groups most vulnerable to unaffordable dental care, decreased access to care and compromised treatment options when care is sourced. Implications of this kind warrant public intervention.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text of the thesis.

I give my consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Suzanna Mihailidis

April 2005

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And lastly, thank you to my wonderful husband Manuv for sharing another one of life's little journeys with me with the same kindness, support, patience and love as always!

1 Introduction

The need for investigation of input factors considered to be influential to private general dental practice productivity in Australia has never been greater. Over the last several decades there has been a trend of a declining capacity to supply dental visits by the dental labour force (Spencer & Lewis, 1986) coupled with increasing demand of the dentate population (AIHW DSRU, 2003). The combination of increased demand and decreased supply has led to an alarming shortage of some 120 dentists per annum (Spencer et al., 2003). In the face of an already burdened public dental system, this may be placing even greater pressure on the private dental sector. At the same time this shortage has developed there has been an observed escalation of dental fees, rising some 50.5% over the 1994-2003 period compared to health prices in general, which increased only 29.7% in comparison (AIHW, 2004).

In this chapter, background information on the economics of dentistry in Australia is provided, with a summary of the specific problem to be investigated. A rationale for the investigation, an outline of the framework and the specific objectives are given.

1.1 Dental health economics in theory

Dental health economics can be conceptualised as the application of basic economic theory in relation to dental health care. Models of dental care demand, supply and output will be presented and have been included as a means of providing introductory background information to concepts referred to regularly in the thesis.

Demand for dental care

Demand for dental care may be defined as the quantity demanded for a particular dental service at a particular price in a given period of time. Strictly speaking, demand is distinct from need, or utilisation and access in that 'demand' results only when need is converted into action; however, demand may or may not result in utilisation which is dependent on factors affecting access to care. The *Law of Demand* states that 'other things being equal, the higher the price of a good, the lower is the quantity demanded' (McTaggart, 1998). Not only does the price of the dental service

affect the quantity demanded, but so do the price of competing services, the patient's income, the size of the population and lifestyle trends. Figure 1.1 illustrates the market demand for dental services, in this particular hypothetical example a dental scale and clean. Consider the demand curve for a scale and clean to be D_1. As the price of a scale and clean increases from P_1 ($50) to P_2 ($75) the quantity demanded by the dental market decreases from Q_1 (2/year) to Q_2 (1/year). A change in price results in a shift along the demand schedule which assumes all other influencing factors are held constant. If the price of a scale and clean remains constant at P_1 ($50) but there is a change in any of the other influencing factors, then there is a shift in the demand curve from D_1 to D_2. In this example, if there is an increase in population or a general lifestyle shift toward increased preventive services, then this will result in an upward shift in the demand curve from D_1 to D_2 and an increase in output from Q_1 (2/year) to Q_3 (3/year) at the constant price of P_1 ($50).

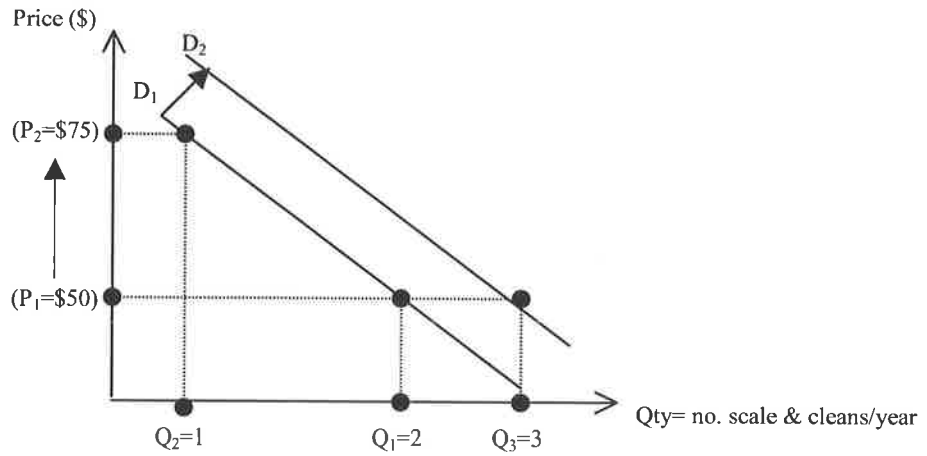


Figure 1.1: Demand curve for a single dental service

Figure 1.2 illustrates individual market demand curves for three different dental services. $Demand_A$ represents the demand curve for a luxury dental service such as an implant, $Demand_B$ represents the demand curve for a general dental service such a partial denture to replace a single missing posterior tooth and $Demand_C$ represents an emergency dental service such as an extraction to relieve acute toothache. You will note that each demand curve has a different slope which relates to their differing elasticity. Elasticity is defined as the sensitivity of quantity demanded of a particular dental service in response to a change in price. For example, if there is a nominal

price increase of P_1 to P_2 the greatest decrease in quantity demanded out of the three categories of dental services is for the luxury dental service (implant), decreasing from Q_{A1} to Q_{A2}, which we would agree is the most sensitive or 'elastic' to a price change. In contrast, the same price increase will result in a relatively smaller decrease in quantity demanded for the emergency dental service (extraction), decreasing from Q_{C1} to Q_{C2}, which we can see is the least sensitive or is relatively 'inelastic' to a price change. In the middle of the two is the example of a demand curve for a general dental service, where the same price increase results in a decrease in the quantity demanded from Q_{B1} to Q_{B2}. The steeper the demand curve for a particular service, the more inelastic or insensitive it is to a price change. The flatter the demand curve for a particular service, the more elastic or sensitive it is to a price change. Recognising that different categories of dental services respond differently to price changes enables a better understanding of how the dental market operates.

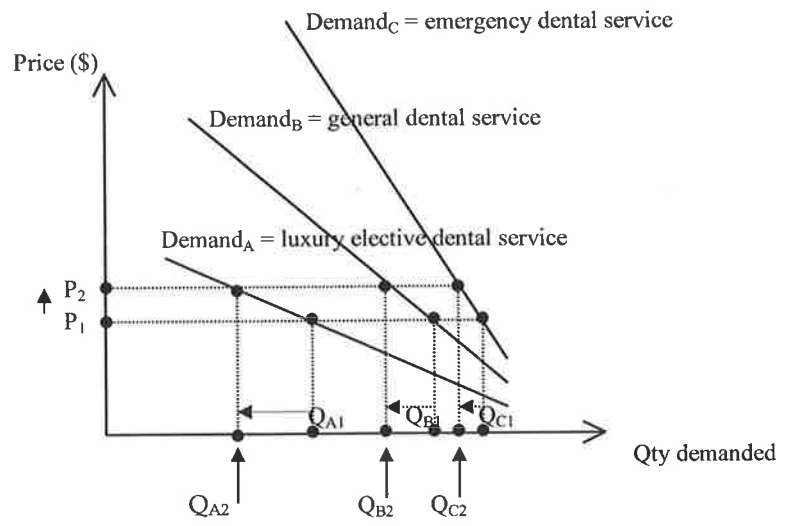


Figure 1.2: Demand curves for three dental services each with different elasticity

Supply of dental care

Supply of dental care may be defined as the quantity dentists plan to deliver of a particular dental service at a particular price in a given period of time. The *Law of Supply* states that 'other things being equal, the higher the price of a good, the greater is the quantity supplied' (McTaggart, 1998). Not only does the price of the dental service affect the quantity supplied, but so do the price of substitute and

complementary services, the price of factors of production and the number of suppliers in the market delivering dental services. Figure 1.3 illustrates the market supply for dental services, in this particular example, a fixed bridge. Consider the supply curve S_1 for a fixed bridge. As the price of a fixed bridge decreases from P_1 ($2500) to P_2 ($2000), the quantity supplied by all dental firms decreases from Q_1 (15/year) to Q_2 (10/year). A change in price results in a shift along the supply schedule assuming all other influencing factors are held constant. If the price of a fixed bridge remains constant at P_1 ($2500) but there is a change in any of the other influencing factors, then there is a shift in the supply curve from S_1 to S_2. In this example, if there is an introduction of new technology that results in a reduction in the cost of making a fixed bridge, then this will result in an upward shift in the supply curve from S_1 to S_2 and an increase in output from Q_1 (15/year) to Q_2 (20/year) at the constant price of P_1 ($2500).

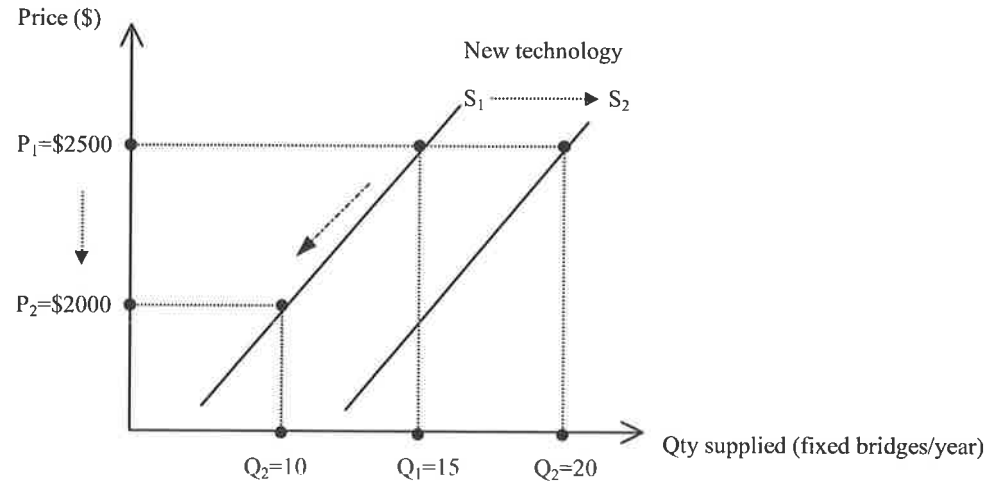


Figure 1.3: Supply curve for a single dental service

Dental output

The point at which demand and supply for a particular dental service are equalised (E) is referred to as the equilibrium output and price level and is presented in Figure 1.4. In reality, because the dental market is dynamic (as are many economic markets) the market is always moving *toward* a point of equilibrium rather than remaining in a static phase of equilibrium. An example of this is the undersupply of dental providers as currently observed in today's dental market in Australia. In

theory the shortage will in the short term increase dental fees which will in the medium term induce an increase in suppliers entering the market (or an increase in workforce participation of existing suppliers already in the market). In the long term the increase size of the dental labour force will stabilise fees and bring the market closer to equilibrium.

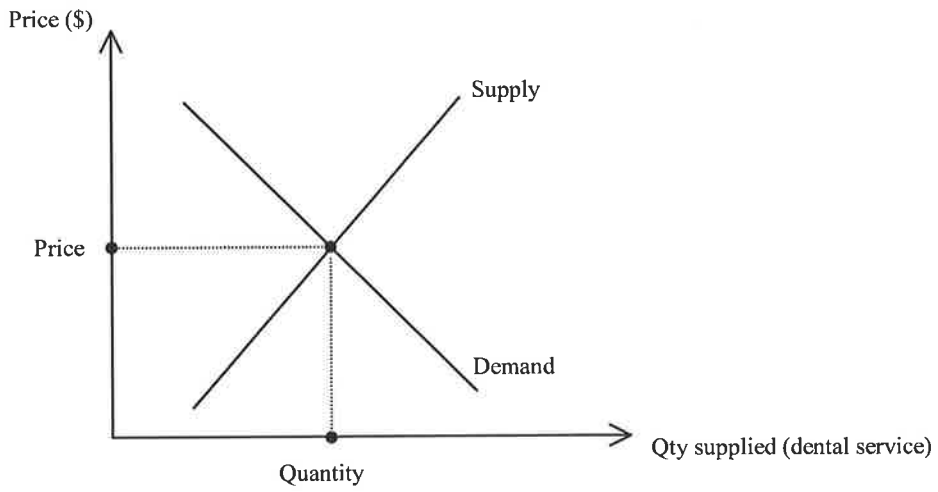


Figure 1.4: Equilibrium of dental demand and supply

Dental production function and marginal productivity

The dental production function (Figure 1.5) describes how the maximum attainable output varies as the quantity of the input varies (McTaggart, 1998). The marginal product is the change in total output that results from a unit increase from the quantity of input employed, assuming all other inputs and technology are held constant. The example below considers labour (dentist hours per day) as the input. The relationship between the total output curve and the marginal product is such that the steeper the slope of the total output curve, the higher is the level of the marginal productivity. As an example, one dentist hour per day results in two patients per day (point A), two dentist hours per day results in five patients per day (point B), ten dentist hours per day results in nineteen patients per day (point C) and eleven dentist hours per day results in some twenty patients per day (point D). When dentist hours per day increase from one to two, total output increases from two to five patients per day which is a marginal product of three patients per day. When dentist hours per day, increase from ten to eleven, total output increases from

nineteen to twenty patients per day, which is a marginal product of only one patient per day. We observe that the shape of the total output curve results in higher marginal productivity at lower levels of output and lower marginal productivity at higher levels of output. This phenomenon is known as *diminishing marginal productivity*.

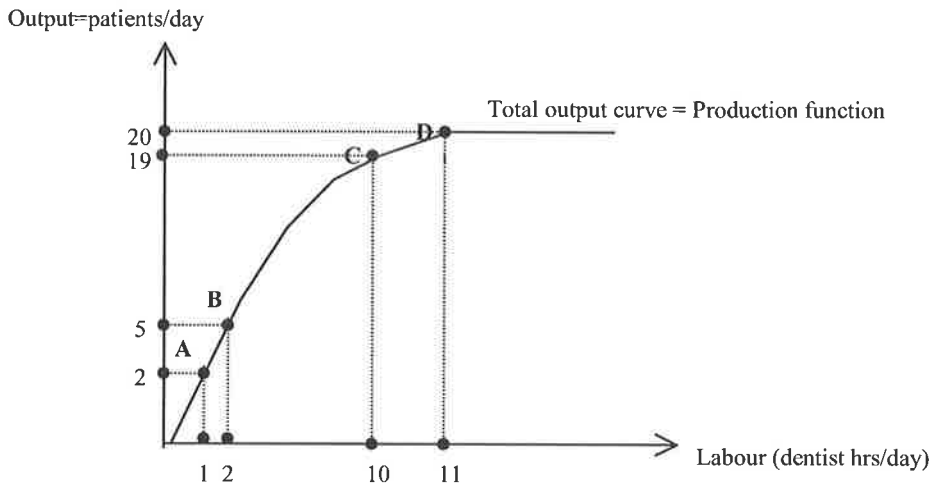


Figure 1.5: Production function and marginal productivity

Target Income Hypothesis

Figure 1.6 describes the labour supply of an individual dentist in terms of the price of their leisure time. The x-axis represents the supply of the dentist's labour which is measured by the number of dentist chairside hours worked per day, while the y-axis represents the price of the dentist's leisure time, measured in dollars. Consider point A. At 'A', the dentist is supplying a low level of labour at x_1 (2 hours per day) and is paying a high price for their remaining leisure time ($\$P_1$). At 'A', the opportunity cost of leisure time is very high and at this point, the dentist would most likely prefer to work more hours per day to increase their output to greater than x_1. Consider point B. At 'B', the dentist is supplying a higher level of labour at x_2 (8 hours per day) and is paying a low price for their leisure time ($\$P_2$). At 'B', the opportunity cost of leisure time is very low and at this point, the dentist would most likely prefer to work less hours per day and decrease their output to less than x_2 in order to have more leisure time which is relatively cheap to buy in exchange for their labour. It is hypothesised that dentists work toward a particular 'x' amount of labour input,

which incidentally, could be measured as hours per day as in the example but also, services or patients per day, which in turn serve as proxies for net financial return. The hypothesised target income will vary between dentists and across time, since the target bundle of goods and services also varies between dentists and across time as material preferences between dentists is different, and lifestyle trends emerge.

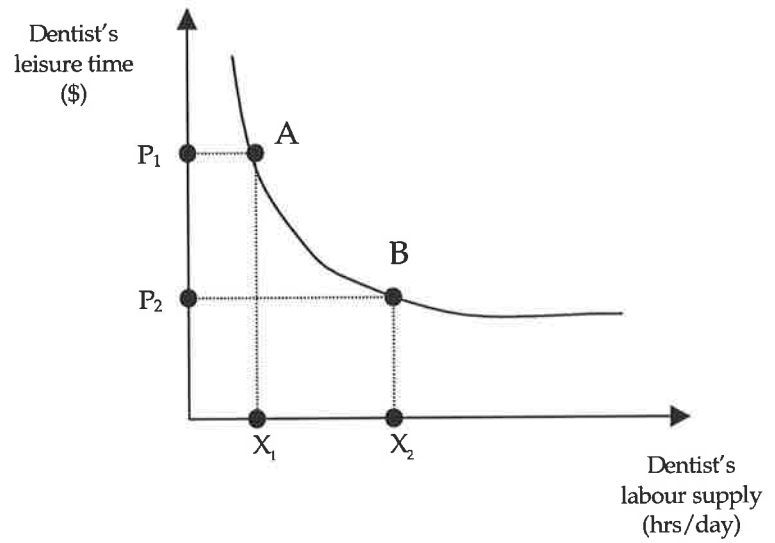


Figure 1.6: Dentist's supply of labour – target income hypothesis

1.2 Background: oral health expenditure

Before discussing the specific problem this thesis addresses, it is useful to highlight the link between dental productivity and affordability issues, hence justifying the need to study an important but overlooked area of dental health economics.

> 'Dental diseases and disorders rank amongst the most costly of health problems' (Mathers et al., 1998)
>
> and yet remain the least subsidised of all health services.

Historically, oral health has struggled to gain priority in the allocation of government subsidies devoted toward health care. This scenario is not unique to Australia and has been observed in comparable countries such as Canada (Baldota and Leake,

2004) where public share for expenditures on dental health care services declined between 1990 and 1999. In Australia, from the 1970s through to the late 1990s the only major direct subsidy for expenditure on dental services was tax concessional expenditure, rebate rate and total rebate for dental services for selected years between 1972/73 and 1983/84 (Spencer, 2000). Of the $72.7 billion spent on health expenditure in 2002/03, the proportion related to dental services was 6.4%. While some 68% of health care is publicly funded, dental care is primarily (68%) funded by individual out-of-pocket spending, (AIHW, 2004). This sizeable variation clearly emphasises the underestimated importance of dental care within a national health scheme.

Regrettably, the financial burden of receiving adequate dental care rests upon individuals, of whom a sizeable proportion reported hardship in purchasing dental care (Carter & Stewart, 2003). This situation has prevailed irrespective of the apparent shortcomings of the public dental system, reported to have waiting lists as high as 48.7 months for restorative dental treatment (AHMAC, 2001).

A further complication is the increase in demand for dental care. Factors that have contributed toward increased demand include economic indicators such as increased income per capita (ABS, 2003) and various demographic changes: an increased but ageing population (ABS, 2005) with decreased rates of edentulism (Dooland, 1992). The trend toward declining loss of teeth over time has resulted in a greater pool of teeth at risk for more complex service requirements (AIHW, 1996). An added complication, documented in Canada but potentially applicable in Australia, is the issue of 'older adults coping with diminishing resources as a consequence of retirement including those previously accustomed to accessing oral health services with dental insurance' (Manski et al., 2004). Between 1979 and 1995, the dentate per capita demand in Australia increased by 50% from 1 to 1.5 visits per capita per annum (AIHW DSRU, 2003). Furthermore, while demand has increased over time, there has concurrently been a shift in demand for service mix from medium level intervention/medium cost services, i.e. restorative, toward a combination of low level intervention/low cost services, i.e. preventive, diagnostic and high level intervention/high cost services, i.e. endodontic, fixed prosthodontic (Brennan & Spencer, 2002). Due to an increase in the number of more complex and time-

consuming dental services within a visit, the average length of a visit has increased from 23.7 minutes in 1961 (Barnard, 1977) to 33.6 minutes in 2001 (Barnard, 2003), even though practice activity trends indicate the hours worked per year by the private general dental sector have remained constant (Brennan & Spencer, 2002). Therefore, the overall effect is a decline in the number of visits per year, or declining capacity to supply visits by the private general dental sector - at a time of increasing demand for dental care. Basic economic theory dictates a price increase will occur within the competitive market model when there is excess demand over supply (McTaggart, 1998). This is precisely what has been observed and was highlighted at the start of this section in terms of the change in dental inflation as compared with general health inflation or the economy at large over that period. An important issue is that 'larger proportions of the population may not be able to afford dental care if prices continue to increase faster than individual budgets' (Furino and Douglass, 1990).

In summary, the background to dental productivity in Australia involves a shortage at a time of increased demand for dental care within the private dental sector. Pressure placed on the private sector has been exacerbated by substantial waiting lists within the public dental sector, where cardholders have been forced to seek care privately. Consequently, this may have contributed to an upward pressure on dental prices, further hindering access to, and affordability of, dental care.

1.3 Problem to be investigated

Having looked at the background of why it is important to study dental productivity, this section focuses specifically on the problem to be investigated.

Econometric studies in dental productivity have largely been the domain of health economists in North America and Norway. Historically, productivity has been formally modelled using multivariate analyses and quantified using a range of measures varying from numbers of services or visits in a given period of time, to value weighted measures such as data on gross billings. Many studies have shown that labour and capital inputs influence productivity to varying degrees, and that the type of influence of inputs on productivity may vary depending on how productivity

is quantified. For example, while Grytten (2000) found there was no statistical significance of dental hygienists and dental assistants on productivity, Wang (1994) found the marginal productivity of dentists' time was slightly higher when working with a hygienist. Change in the direction of influence may be uncovered when using more than one measure to quantify productivity. For example, Shuman and Davidson (1994) investigated how variation in service mix received by different patient age groups affects productivity. They found that while seeing older patients (70+ years) was a negative influence on time-based productivity, this was offset by the positive monetary gains observed in this age group's consumption of higher priced services.

In Australia, factors influencing the provision of dental services in private dental practice have been identified (Brennan et al., 2000) as well as tracking workforce participation rates in terms of the capacity of dentists to supply patient visits per year, and service provision trends (Brennan & Spencer, 2003). However, there are limitations to both of these approaches in answering questions specifically related to productivity.

The operational meaning of 'productivity' within the dental healthcare model has not been properly defined. From an economics perspective, productivity is concisely defined as an increase in output from a given set of inputs; it is a relative definition describing the change in the output rate *over time*, i.e. when the same factors of production can produce more output (Dornbusch et.al., 2002). Given the pace of technological advances in dentistry it is difficult to hold a 'set of inputs' constant across time when running time-series analyses. Approaching productivity from an oral health perspective also poses some challenges. As proposed by Reinhardt (1972), '...if it were practically feasible to specify the health production process accurately and to predict patients' future health status in the absence of intervention by a physician, then an outcome-based measure of physician output would certainly be compatible...' The limitations in predicting patients' future health status are obvious and render this definition virtually impossible to use in a scientific setting.

In spite of the challenges faced in just interpreting the meaning of 'productivity' in dental care, the literature has provided a sound framework for understanding the

factors that may influence productivity and how trends may change depending on how productivity is measured. Factors influencing productivity may include labour inputs such as participation of the dentist, auxiliary (hygienist and therapist), technician and administrative staff; dentist characteristics such as age, sex and experience; capital input usage such as the dental surgery, x-ray unit, drill, laser unit and Cerec machine; and practice characteristics such as configuration, size, location, level of busyness, dentist-to-population ratio and fluoridation status of the area. Productivity may be described using absolute measures of patients or services delivered in a period of time, or value weighted measures designed to capture variation in service mix and time efficiency, such as billings and relative production units.

In summary, there are a number of studies in the dental literature that have established factors that influence productivity. In some of these studies, multiple productivity measures have been used in an attempt to build a more comprehensive conceptual framework. The specific focus of this thesis involves the study of factors influencing productivity, where productivity is indexed using a range of measures, and compared at different points in time.

1.4 Rationale for studying the problem

The rationale for studying this research problem may be broadly classified into two main arguments. The first is related to the scientific merit associated with the methodology of the project. The research builds upon a major longitudinal study initiated in 1983 and continued at five-yearly intervals through to 1998 looking at dentists' practice activity. Each of the four data sets is rich in the range of independent input factors that can be analysed against a range of productivity measures. No published work on dental productivity could be identified that compares a range of productivity estimates across multiple points in time using multiple measures of productivity. There is some research that has been done on production function modelling for dental productivity in Australia (Spencer & Lewis, 1986); however, this considers only one point in time (1983). Generally, while there have been preliminary investigations into aspects of productivity in Australian dental practice, they have been limited in both number and scope, focusing more on

workforce participation rather than productivity. In addition, although used widely in other parts of the world, econometric production function regression modelling is a void within dental economic research in Australia. There is tremendous potential gain for dentistry where economic analysis becomes a stronger aspect of informing policy. A major strength of the research approach is its clear interdisciplinary focus. The second argument within the rationale for studying the problem is associated with the current situation in Australia of a labour force shortage and escalation of dental fees. The scope of the research included a wide set of input factors and a number of productivity measures to build a framework of the factors influencing productivity and investigate how the influence of these factors has changed over time. 'Accurate estimates of changes in dentist productivity are important in evaluating the adequacy of the number of dentists to meet the demand for dental services' (Beazoglou et al., 2002) and 'dental workforce strategies should strive for short-term responsiveness while avoiding long-term inflexibility (Brown, 2001). This implies that continual monitoring of productivity and the workforce is necessary in strategic planning for both the short and longer term. Acquiring productivity information is the first step toward enhancing productivity and reducing the shortage which in theory leads to stabilisation of dental fees. Hence, this research project provides a timely opportunity to advance the state of knowledge in this field.

In summary, the rationale for this research project was related to the longitudinal nature of the data which provides an excellent opportunity to carry out original analyses involving production function modelling, and build knowledge in an area of research that is underdeveloped but urgently required currently in Australia.

1.5 Research framework

The approach of this thesis was to apply production function modelling to the cross-sectional and longitudinal data. The production function model is the mathematical equation summarising the relationship between input factors (independent variables) and a range of productivity measures (dependent variables). It describes the process under which the inputs into a production process are transformed into output, as presented below in Figure 1.7.

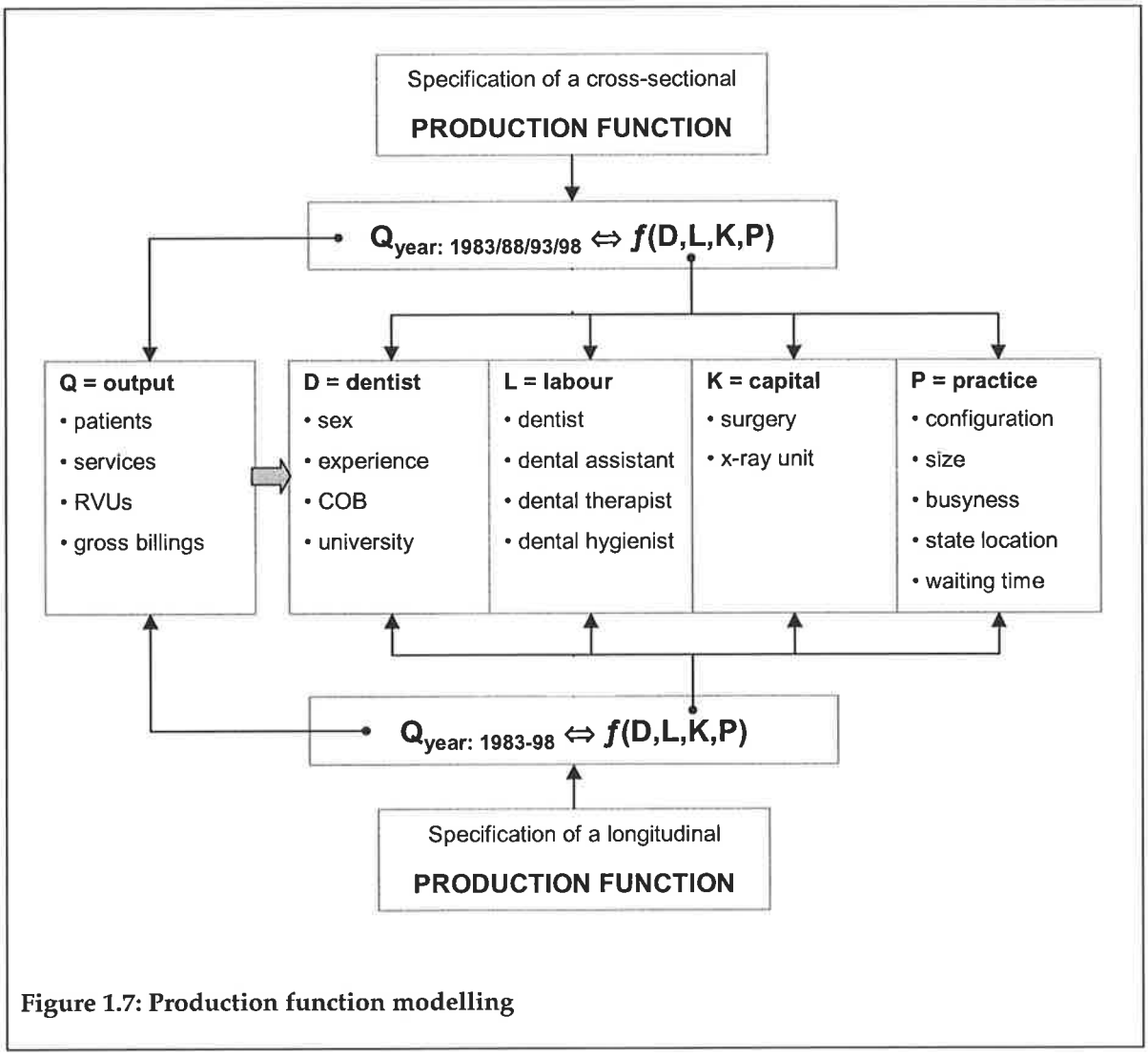


Figure 1.7: Production function modelling

The four selected productivity measures that serve as the dependent variable in the production function model are: patients per day, services per day, relative value units (RVUs) per day and gross billings ($GB) per day. The input factors have been broadly characterised into dentist characteristics including: sex, experience, country of birth and university of graduation; labour inputs relating to the dentist, clinical auxiliary (intra- and extra-oral) staff and administrative staff; capital inputs relating to the number of surgeries utilised by the dentist and the number of x-ray units in total at the practice; and practice characteristics relating to location, size, configuration, busyness and length of wait for an appointment.

The research problem hypothesises that factors related to dentist and practice characteristics, and labour and capital inputs, influence productivity, and that the influence on productivity will vary depending on the type of productivity measure used. It is also hypothesised that there will be variation in the trend of productivity observed when the four cross-sectional production functions for each of the four productivity measures (patients, visits, RVUs, $GB) are compared against each other across time over the period of 1983 to 1998.

1.6 Specific objectives

The specific objectives of the present study were to investigate the factors influencing productivity and how productivity trends are changing over time. The input factors examined were:

1. dentist characteristics: sex, experience, country of birth, university of graduation;

2. labour inputs: hours worked per day chairside by the dentist, number of clinical intra- and extra-oral auxiliary staff and administrative staff per dentist;

3. capital inputs: number of surgeries utilised by the dentist, number of x-ray units at the practice;

4. practice characteristics: configuration, location, size, busyness, length of wait for an appointment.

The study involved an investigation of the univariate distributions of input factors and productivity measures, bivariate associations of productivity (as indexed by a range of dependent output variables) with each of the independent input factors, and the formulation of a multivariate production function model of productivity by the set of independent input factors for each survey year (cross-sectional) and overall (longitudinal) using a pooled panel data set. This study represents the first and only of its kind in longitudinal production function modelling using four points in time.

2 Literature review

While there is extensive literature on productivity within the medical sector, the same cannot be said for the dental sector. The majority of studies in this area have been the domain of North American economists originating in the 1960s and early 70s, where data from the American Dental Association's Dental Practice Survey was used to study productivity and economies of scale in dentistry (Maurizi, 1969; Boulier, 1974). Many studies on dental production function modelling since that time have used comparative methodology from these earlier studies and also incorporated Reinhardt's approach to specification of the production function from his earlier work on physician productivity (Reinhardt, 1972).

In Australia, productivity studies have been used in labour force planning and hence, have focused more on workforce participation and capacity to supply dental visits (Brennan and Spencer, 2003), in contrast to econometric modelling of the technical relationship between inputs and output, as specified in the production function model used in this project.

The review will focus on the notable aspects that arise in the literature. These are: the range of variables included as input factors and related findings, the choice of variables with which productivity is measured and their associated strengths and limitations, analytical approaches to production function modelling and issues related to efficiency, practice configuration and returns to scale. The first section presents an overview of the dental market.

2.1 The dental market

Ambiguity exists as to whether the dental market is competitive or monopolistic or lies within the spectrum of these two extremes. Results related to dental market classification have oscillated in their findings from competitive (House, 1981; Kushman et al., 1978; Boulier, 1974) to monopolistic (Kushman & Scheffler, 1978). '*Perceived*' competition in private dental practice by individual dental practitioners was found by Tuominen and Palmujoki (2000), while in Israel dental laboratories the

private sector was found to be more competitive and efficient compared to their public sector counterparts. Other results reveal inconclusive results in either direction (Kushman, 1981) or that while dental markets may be imperfectly competitive, it is unclear whether prices exceed competitive levels (Grembowski et al., 1988). For a market to be defined as competitive, *a priori* theory indicates that there should be many firms, each selling an identical product, with no restrictions on entry into the market, and that firms (*practices*) and buyers (*patients*) are completely informed about the prices of the products (*dental services*) of each firm (*practice*) in the industry (*private dental sector*) (McTaggart, 1998). Corresponding to this last criterion, it is thought that patients do possess adequate knowledge to make informed decisions in relation to treatment options for dental care (Grossman, 1972). Grossman believed 'consumers regarded health as an investment type of purchase, in that, input of time and money earlier on such as preventive maintenance care would give a return of better oral health in the long term compared to others who had not made similar investments'. However, contrary to the second and third criteria, dentistry tends to operate as a multi-service industry, with regulated qualification requirements for entry into practice. It appears to be a significant challenge to quantify scientifically the non-competitive aspects of the dental market. If the market is in fact a monopoly, the outcome is decreased consumer welfare in the form of increased pricing and decreased output compared to a competitive price and output level (McTaggart, 1998). Such an outcome would support a strong case for removing elements of the market structure that facilitate monopolistic behaviour and encourage free market economies (Feldstein, 1974). This may come in the form of an increase in the supply of substitutional providers, an alternative to the existing labour force structure where the majority of non-dentist providers of dental services operate in a complementary fashion to the dentist. Research, although rather dated, has confirmed the potential efficiency gains of dentist substitution by auxiliary personnel without a reduction in the output and quality of dental services (Lipscomb & Scheffler, 1975; Feldstein, 1974; Kilpatrick, 1972). We would expect only an increase in efficiency gains over time due to improved quality in education and training of auxiliaries.

The next two aspects discussed in relation to dental market structure are demand and supply. Demand is determined by not only the price of the product demanded

but also the prices of complementary and substitute goods of the product demanded. Income, population trends and consumer preferences will also influence demand. In contrast to this theory, Waldman (2002) found that even when the economy was weak the dental sector was still strong, and similarly but in the opposite direction, Chattopadhyay et al. (2003) found that a booming US economy did not raise dental charges significantly and did not increase utilisation of dental care services. These two examples suggest there may be no consistent relationship between national aggregate income and the dental market. Demand is different from the 'utilisation' of services that we observe in the dental sector and often use as a proxy for demand. For example, overwhelming evidence supports the substantial burden of oral disease and dysfunction among older adults, especially the oldest old and those who are socioeconomically disadvantaged (Slade et al., 1996). However, statistics reported from the AIHW Dental Statistics and Research Unit's National Dental Telephone Interview Survey 1999 show that in the Australian community, while some 33.5% of adults are eligible for public dental care (Carter & Stewart, 2002), of those eligible only 38.0% accessed treatment in the public dental system (Carter & Stewart, 2002). Access to preventive and diagnostic services is particularly inequitable (AHMAC, 2001); hence there may be some under-reporting of demand per se. In Australia, those with the greatest demand for dental care are least able to utilise services due to economic barriers to access. Maurizi (1969) highlights factors other than price affecting demand, such as oral health and exposure to fluoride. Once again, these factors tend to be less favourable in lower socioeconomic groups where demand for dental care is greatest.

Supply in economic theory is linked to the price of capital, labour, services and introduction of cost-saving technology. An increase in any of these factors positively influences supply. In the competitive model, price achieves the function of regulating output such that demand equals supply. In the health sector, an atypical situation exists where the health provider is not only the supplier of services but also the main agent through which information about health services is made available to the patient. '... the patient more or less surrenders his/her decision-making sovereignty' (Tuominen, 1994). This suggests there is an avenue whereby the supplier may have some influence on demand, commonly described as 'supplier-induced demand'. Within the dental sector, controversial findings suggest evidence

of target-oriented behaviour demonstrated in the association between the price of services in a practice and the number of dentists per capita (Newhouse, 1981; Scheffler & Kushman, 1977) or between large busy practices with high fees and rates of service provision (Grembowski et al., 1990). Similarly, studies in Canada reject the no-inducement hypothesis (Schaafsma, 1994) and even in the presence of a regulated fee schedule, evidence of supplier inducement was found in Norway (Grytten et.al., 1990; Grytten, 1991a; Grytten 1991b; Grytten 1992). Conversely, more recent studies showed there was evidence against the supplier-inducement hypothesis (Grytten and Sorensen, 2003) with reported estimates of 'dentists per 100 000' shown to have a negative coefficient (Boulier, 1974), building evidence that demand to the individual practitioner is negatively associated with dentists per capita. The findings are inconclusive, especially considering that increased productivity and higher dentist-to-population ratios may be explained by either supplier-induced demand or, just as plausibly, by more efficient scheduling of patients in response to increased competition.

Productivity may be approached from either a supply or demand side, which under competitive model assumptions, both result in the same output and price level. The approach taken in this project is to study productivity from the supply side, with consideration of what inputs affect supply and how supply should best be measured.

The next section deals with how the first of these research questions, *factors influencing supply*, has been approached in the literature.

2.2 Input factors influencing productivity

In economics, input factors of productivity are broadly classified under labour, capital and raw materials. In relation to dentistry, the majority of productivity studies have categorised variables under labour, capital and characteristics related to the dentist and practice. To a lesser extent other types of representative groupings of input variables have been used, such as indirect and direct demand and supply (Howley, 1980) and design, structure and process (Wang et al., 1994). There has been a trend toward the inclusion of more inputs, especially exogenous inputs related to the community in which the dental practice is located and characteristics describing

the patient base such as age, sex, service mix demanded and insurance status. For example, Hay et al. (1982) found that the net price elasticity (*the sensitivity to a change in the price of a service*) was quite low for individuals with high dental insurance coverage.

The inputs described in this review will be discussed under the conventional headings most frequently used in the literature: labour, capital, dentist characteristics and practice characteristics. There is also some discussion on other variables that appear less frequently in the literature highlighting the wide and varied attempts to capture variation in the output variable and correctly specify the productivity model.

2.2.1 Labour

Labour inputs relate to the contribution made by dentists and auxiliary staff (therapists, hygienists, dental assistants, administrative staff, dental technicians) toward productivity. The majority of productivity studies have included the dentist and one or more auxiliaries as part of the labour component of input factors. Clearly, the dentist input most often exhibits the greatest change in the proportion of variation explained in the dependent variable and is consistently significant in the estimated production function regression models.

Dentist involvement tends to be measured on a work effort per unit time basis in most studies, while auxiliary input is presented either as an absolute number of auxiliaries (Grytten and Rongen, 2000; Kushman et al., 1978), or on a work effort per unit time basis (Lipscomb and Douglas, 1986; Gray, 1982). The difference in recording alters the interpretation of regression coefficients, i.e. whether marginal productivity is the change in productivity resulting from increasing the number of auxiliaries or the number of hours worked by an auxiliary.

Considerable focus has been placed on the potential productivity gains from employing auxiliaries. Studies by Feldstein and Maurizi have reported substantial productivity gains and have consequently advocated increased use of assistants, while other studies have reported that dentists on average hire approximately the optimal number of aides for maximising their hypothesised utility function, which equalled 1.5 aides per dentist (Boulier, 1974). There is some agreement that

auxiliaries will exhibit a diminishing marginal return beyond a particular level of input. Lipscomb and Scheffler (1975) found that a solo dentist could double their net revenue by hiring one Expanded Duties Dental Assistant (EDDA) but could not increase their productivity further by hiring additional EDDAs. Thus, beyond the input of one EDDA there was decreased marginal productivity in additional hiring of auxiliaries. Mitry found similar findings in his 1975 study. Independent practice by dental hygienists was found to: provide access to dental hygiene care and encourage visits to the dentist (Perry et al., 1997) , not increase the risk to the health and safety of the public (Freed et al., 1997) and result in economic benefit when a two-chair system was used, i.e. a hygienist working two chairs with an assistant (Williams, 1993). In Australia, Baltutis et al. (2000) have discussed the potential productivity gains associated with dental hygienist utilisation in schools, institutions, nursing homes, hospital and residential facilities and recommended increasing their utilisation in the public sector. These findings are skewed toward hygienists working independently, which is slightly different from those referred to in our study who work under the supervision of the dentist.

Having established that there are gains (up to a certain level of input) from hiring additional auxiliaries, the next question is: which auxiliaries give the highest marginal return to productivity? This depends on how productivity is measured and the scope of services an auxiliary is able to provide. Clearly, the larger the scope of services deliverable by the auxiliary the more substitutional in nature an auxiliary can be and therefore there exists the potential for higher productivity gains. A study by Scheffler and Kushman (1977) demonstrates this point. The marginal productivity (measured in visits per week) was highest for hygienists (16.1 visits per week) followed by a marginal productivity rate of 7.7 visits per week for dental assistants but lowest for clericals at 6.2 visits per week. The marginal return for technicians was a negative value of -3.9 visits per week, which as discussed earlier is most likely related to the more time-consuming case-mix in practices where technicians are employed.

This leads to the question, why do dentists not take advantage of the potential gains of hiring additional clinical auxiliaries?

Economic theory says that a firm, in our case a dentist, will increase the use of an input (an auxiliary) until the marginal benefit received is equal to the marginal cost of its implementation. When the marginal cost is greater than the marginal benefit, there is an incentive to decrease use of auxiliaries to a suboptimal level. Scheffler and Kushman (1977) offer the following explanation: 'professionals may prefer not to hire aides because of the administrative time and loss of independence involved. In that case the dentist will employ aides where their marginal products are increasing so long as the psychic costs of additional aides are sufficiently high and increasing'.

The issue of labour input should be an important focus since it is reported to be the major component of incurred expenses within the dental industry (ABS, 1999) and also is the most important input in explaining productivity in the production function regression model.

2.2.2 Capital

Capital input factors are included in the production function modelling to account for changes in productivity attributable to tangible assets. Generally, the main variables used to measure capital input relate to the number of dental chairs (Maurizi, 1969; Scheffler and Kushman, 1977) and more recently, the number of hygienist chairs (Shuman and Davidson, 1994), number of x-ray units (Howley, 1980) and the presence of an OPG machine in the practice (Grytten and Dalen, 1997). In Reinhardt's modelling of physician productivity, capital input was approximated by the sum of the physician's annual depreciation on furniture and equipment and the annual cost of renting/owning office space. As an alternative to measuring the absolute number of chairs or x-ray units, the age of the dental chair has been recorded in an attempt to capture the quality rather than the quantity of the input (Wang, 1994; Grytten and Dalen, 1997). Other infrequently used measures of capital have included: supply of materials (Wang, 1994) and whether a computer is used for accounting (Grytten and Dalen, 1997).

There are two issues in relation to capital that are noteworthy to discuss. The first issue is related to the technology aspect of capital and the second is related to the 'lumpy' style of recording capital usage. In reference to the first point, qualitative improvements over time in the form of improved technology are a major

impediment to comparing production functions across time since technology is assumed to be constant. Technology will vary across time and will also vary between dentists. Since most production functions in the literature are cross-sectional, a related problem is finding ways to measure technology differences between dentists, or practices at one point in time. Technology is typically embedded in capital and so we observe a range of capital-related variables that have been used in the literature to capture variation in the state of technology between practices. These have included: the age of dental chair and x-ray units (Gray, 1982), the presence of a computer used for accounting (Grytten and Dalen, 1997) and time spent working four-handed dentistry (Gray, 1982).

The second point is that capital tends to be increased in lumpy units, as it is not freely divisible. This means that dental chairs or x-ray units can only be increased in whole units and therefore there may be periods of under- or over-utilisation of capital within the practice. Increasing capital is quite different from increasing labour since hours worked can be easily adjusted by the provider in response to fluctuations in patient demand. This justifies the need for inclusion of more qualitative measurements of capital inputs such as the age of a dental chair which describes vintage and hence productive capacity as opposed to the number of dental chairs utilised which due to their 'lumpy' style may not be truly representative of their productive capacity.

2.2.3 Dentist characteristics

Inclusion of variables that describe the characteristics of the dentist aim to capture the innate qualities of the dentist that are thought to influence productivity. Dentist characteristics may be considered an indirect measure for a direct input. For example, dentist attributes such as entrepreneurial or superior managerial abilities will positively enhance productivity but are not easily measurable traits. Through the inclusion of indirect measures such as experience or sex, the influence of these hard-to-measure innate dentist factors may be expressed through easy-to-collect proxy measures. This is based on various assumptions, for example, that managerial ability is assumed to improve with increased years of experience.

It is evident in the literature that only a limited number of dentist characteristics are

included in production function modelling. Generally sex, age or experience are the main variables used to describe dentist characteristics. Some studies have included age only (Shuman & Davidson, 1994; Howley, 1980) while others have included both the age and square of the age to correct for technical change over time (Kushman et al., 1978; Scheffler & Kushman, 1977; Boulier, 1974). 'Dentists educated after World War II will be more apt to have trained in four-handed dentistry, while younger dentists will be more apt to use new equipment such as high-speed drills' (Scheffler & Kushman, 1977). The relatively lower productivity of dentists in the younger and older age groups compared to middle-aged dentists results in an inverse U-shaped association between age and productivity.

There is scope for inclusion of a number of other dentist characteristics which could influence productivity but are perhaps not so obvious. These include the: number of dependents of the dentist, level of continuing education, degree of work satisfaction and general health status. To date, however, it does not appear that these more lateral types of variables have been included in any of the dental production function models.

2.2.4 Practice characteristics

Some emphasis has been given to collecting information on characteristics of the dental practice that may influence productivity. The most notable of these is related to size and configuration, with a significant number of studies focusing on the potential productivity gains of group versus solo practice. Size is associated with the number of dentists in a practice, while configuration describes the revenue- and/or sharing arrangements between dentists in a practice. Data related to size and configuration are collected as separate variables since they are quite distinctly defined and have been found to influence productivity differently (Kushman et al., 1978). For example, productivity studies for a group style configuration, within a non-revenue sharing environment such as the public dental system in Norway, yielded no significant difference in productivity to solo dental practice (Grytten & Rongen, 2000). Conversely, significant differences were found between solo and group practice within a private dental practice setting where there was revenue sharing (Grytten and Rongen, 2000; Kushman et al., 1978).

There is some disagreement in the literature as to how variables have been classified under the various categories of practice input factors. The implication of this is related to how the researcher has hypothesised the influence of that input on productivity. An illustration of this point is dentist non-chairside time, which may include both work time not at the chair and free time at the office. As a labour input, we could hypothesise that dentists with decreased chairside time (or dentists with a higher proportion of their work time spent non-chairside compared to other dentists) reflects idle time in response to inadequate demand for that particular dentist's services and is therefore directly related to the dentist, and hence, should be classified as a dentist characteristic. This would result in a negative regression coefficient for this variable. Scheffler and Kushman (1977) found that both work time not at the chair and free time at the office had negative regression coefficients, exhibiting a marginal productivity value of -0.26 and -0.74 visits per week respectively. However, dentist work time away from the chair may be indicative of the dentist substituting auxiliary personnel for their time. The result would be a positive marginal productivity and 'may capture firm-specific differences in technical efficiency, the unobserved management input' (Scheffler & Kushman, 1977). Hence, dentist non-chairside time should be classified as a practice characteristic. Thus, to a degree, the sign of the regression coefficients may reflect whether the factor is dentist or practice-specific. The inference here is that interpretation of regression coefficients stemming from the initial hypotheses will determine at what level changes should be implemented, that is, at a dentist or practice level.

Alternative groupings for practice-related inputs have categorised factors under direct supply and direct demand (Howley, 1980). Practice configuration and number of other dentists in the practice were classified as variables related to direct supply, while waiting time for an appointment, seeking personnel, perceived level of busyness and whether another dentist was required were classified as variables related to direct demand. Wang (1987) included dental clinic size and location under the category of structure, while provider payment mix was grouped in the category of design.

The inclusion of practice-related characteristics is an important part of productivity

analysis, especially the issue of size and configuration of the practice. This is justified by the fact that the majority of dental care in Australia is delivered by solo, private general dentists (Teusner & Spencer, 2003) which may represent a configuration that is not necessarily in line with the most efficient and productive work configuration available.

2.2.5 Other input factors

There is value in drawing attention to some less mainstream input factors that have been used in dental productivity studies. This is to highlight the spectrum of influences researchers have hypothesised to have an effect on productivity.

In the technology matrix devised by Lipscomb and Douglas (1986), a variable relating to legal restrictions on task delegation for auxiliaries was included. Presumably, this was included to account for lost productivity due to the limited scope of services provided by auxiliaries.

Supplementary to describing characteristics of the practice are characteristics specific to the geographical location of the practice such as population of the town, dentist-to-population ratios and fluoridation status (Howley, 1980). As mentioned previously, dentist-to-population ratios serve as a proxy for demand and may also be used to support the hypothesis of supplier-induced demand when the regression coefficient is found to be positive. Due to variation in the results, the findings associated with supplier-induced demand are inconclusive.

Grytten and Rongen (2000) used local tax revenue as an indicator of whether productivity is lower in counties where revenue is higher because more dentists can be employed. Incidentally, this was found to be not significant.

Variables related to patient and service mix have most frequently been used to formulate weighted output productivity measures and less frequently input factors. However, their use as an input is validated since variation in patient and service mix between practices could certainly influence productivity. Patient factors have included: oral health status such as number of decayed teeth and number of elderly or otherwise handicapped patients (Grytten and Rongen, 2000); however, the

regression coefficients were found to be small, indicating priority is given to treating children (0-18) independent of demand for dental care among other groups. Patient income was found to be an important determinant of dental utilisation in Greece, influencing both the percentage and frequency of dental utilisation (Zavras et al., 2004). The regression coefficients were found to be small, indicating priority is given to treating children (0-18) independent of demand for dental care among other groups. Shuman and Davidson (1994) included patient age groups (1-60, 61-69, 70+ years) and service mix; proportion of visits for hygiene; operative, removable and fixed prosthodontics. Service mix variables have also been included by Gray (1982).

Table 2.1 presents a summary of the main inputs found to be significant ($p<0.05$) in the studies discussed. It is not a conclusive list and reports only on what is understood to be the main regression model presented in each study. Where there is more than one main regression model presented, as with Howley (1980) the one pertaining most closely to this study, the linear additive model with the dependent variable being number of patients per week seen by the dentist, has been reported. Similarly, the underlying production function for which Grytten and Dalen's cost function is based upon has been reported (Grytten & Dalen, 1997).

Table 2.1: Summary of significant input factors

	Labour	Capital	Dentist	Practice	Other input factors
Maurizi (1969)	Dentist hrs/yr	No. chairs No. drills			
Boulier (1974)	Dentist, aux hrs/yr	No. chairs	Dentist age		
Mitry et al. (1976)	No. dentists No. EDDAs	No. chairs			
Scheffler& Kushman (1977)	Dentist, aux, tech.: hrs/yr	No. chairs	Dentist age	Dent:popn	
Kushman et al (1978)	Dentist, aux hrs/wk	No. chairs	Dentist age, sex	Dent:popn, size, revenue sharing	Patient age
Roehrig & Feldstein (1979)	Dentist, aux hrs/wk		Dentist age		
Howley (1980)	Dentist, aux hrs/wk	No. chairs	Dentist age, sex	Dent:popn, wait time, busyness	
Gray (1982)	Dentist hrs/wk	No. chairs	Dentist age		Crown & bridge, ortho service mix
Spencer & Lewis (1986)	Dentist hrs/day	No. chairs, no. xray units	Dentist age, experience, sex	Size, wait, busyness, recruit needs	Dent:popn, fluoride exp.
Lipscomb & Douglass (1986)	No. dentists	No. chairs No. xray units	Dentist age	Cost-sharing	Patient age, race, legal restrictions
Wang (1994)	Dentist, aux hrs/yr				
Shuman & Davidson (1994)	Dentist, aux hrs/day	No. chairs	Dentist age		Patient age, service mix (VWS), year
Grytten & Dalen (1997)	No. person-labour yrs of dentists	No. chairs		Dent:popn	No. decayed teeth, patient disabilities

2.3 Productivity measures

The notion of measuring the productivity of a health professional raises some interesting ethical and practical issues. Ethically, there is a responsibility placed on the health professional to have had an impact on the patient's oral health (Reinhardt, 1972). On a similar note, Scheffler and Kushman (1977) have argued 'health services should be evaluated in accordance with their impact on the patients' health'. Hence there appears to be some consensus that a measure of dentist productivity should at least attempt to capture the magnitude of the dentist's impact on oral health. Such a measure would have to 'account not only for actual, positive changes in patients' dental health, but also for the largely unobservable prevention of potential disease and disorder' (Reinhardt, 1972).

However, in reality, productivity is more easily measured in a quantitative rather than a qualitative manner. Since the quantitative approach has been used routinely for dental productivity studies, it would appear there exists an underlying assumption that a quantitative measure such as a dental visit does in fact have a positive impact on the patient, and that this impact is constant between patients and between dentists themselves. Otherwise the concept of measuring productivity quantitatively would have little meaning. It could be just as easily counter-argued that these assumptions are difficult to uphold and that quantitative measures do not necessarily give an accurate representation of the extent to which the dentist has had an impact on the individual's oral health or that the impact is not constant between dentists and/or patients. On a practical note, quantitative measures such as the number of dental visits or services have the advantage of computational simplicity and are easily collected data items. This may explain why these variables have been used widely to measure productivity.

Generally, more than one type of quantitative measure has been used in most studies. These have included the number of services or visits, courses of dental care, billings and weighted estimates of productivity over a given period of time. The monetary measure of billings and the value weighted measures of relative production units are both designed to account for variation in service and patient

mix between dentists. A summary of productivity measures used by different researchers is presented in Table 2.2, followed by some discussion on each of the categories of quantitative measures.

Table 2.2: Summary of productivity measures

	Dentist visits	Dentist + hygienist visits	Course of care (COC)	Dental Services	Billings	Weighted output measures
Maurizi (1969)	Patients/ year				Gross income/ year	
Boulier (1974)	Visits/ year				Gross billings/ year	
Mitry et al. (1976)						RPU/day
Scheffler& Kushman (1977)	Patients/ week					
Kushman et al (1978)		Patients/ week				
Roehrig & Feldstein (1979)	Visits/ week					
Howley (1980)	Patients/ week	Patients/ week				
Gray (1982)					Gross fees/hour	
Spencer & Lewis (1986)	Patients/ day					
Lipscomb & Douglass (1986)	Patients/ week				Total revenue	
Wang (1994)			No.COC to 3-18yr-olds in 1yr			
Shuman & Davidson (1994)						1. RPU/day 2. VWS/day
Grytten & Dalen (1997)	No. consults/ year					
Grytten & Rongen (2000)			No.COC to 0-18yr-olds in 1yr			

2.3.1 Number of patient visits/services

Evidently, as Table 2.2 depicts, the most widely used measure for productivity in the literature has been the quantitative measure for number of visits within a given period of time. This is followed by monetary measures for gross billings in a given period of time. As previously pointed out, the popularity of number of visits is most likely related to the computational simplicity and ease of collection associated with this variable.

Some issues to consider in relation to the number of visits is how well these two measures describe actual productivity and whether they are good proxies for one another.

In response to whether the number of visits and services are good proxies for one another, the answer is generally no. An increase in the number of services provided doesn't necessarily equal an increase in the number of visits provided, just as a decrease in the number of services provided doesn't necessarily equal a decrease in the number of visits provided. The increase in the average length of a visit is attributable to a change in the service mix profile which could reflect a shift toward either: proportionately more but shorter, or proportionately less but longer duration services. The shift toward either shorter or longer duration services could be reflecting changes in factors other than actual changes in productivity: service mix shifts, change in patients' oral health needs, technology, personal attributes of the dentist and the dentist's time efficiency.

In terms of describing productivity, one major limitation of these two measures (visits and services) is that neither takes the provider's service mix into account. That is, productivity when measured by the number of services or visits will be invariably higher for a practitioner whose service mix consists of predominantly simpler and shorter duration services for each patient compared to a practitioner whose service mix consists of predominantly more complex and longer duration services per patient. The dominance of service mix observed will be shaped by not only the oral health needs of the patient base (influenced by age and socioeconomic status) but also by the abilities and preferences of the practitioner and technological advancement of the practice. The state of technological advancement of the practice

may be reflected in, for example, the proportion of composite resin versus amalgam restorations (which will vary between dentists of different age groups), the age of the dental chairs (which will affect the time efficiency of the dentist) and the presence of a laser or Cerec machine (which will alter the range of treatment options offered by the dentist to their patients). An additional limitation related to a difference in service mix between dentists is the change in service mix that occurs over time. Change in oral health status over time will affect the number of services/visits demanded. Therefore, an increase/decrease in productivity when measured in services/visits may reflect genuine changes in productivity across time, but may also reflect a change in the trend in demand for dental services/visits as a result of changed oral health needs.

There is variation in how researchers have chosen to measure the number of services/visits productivity rate by varying the window of time within which it is estimated. For example, the total number of services/visits has been reported as a productivity rate per dentists' work hour (Lipscomb & Douglass, 1986), week (Howley, 1980; Scheffler & Kushman, 1977; Roehrig & Feldstein, 1979; Reinhardt, 1972) and year (Grytten & Dalen, 1997; Nash & Wilson, 1979; Maurizi, 1969). The most common method is to express the number of services/visits on a per week basis. Logically, a per week basis is the most sensible since a per day basis may not be representative of all typical clinical days and does not capture treatments which require more than one visit for completion, e.g. fixed or removable prosthetic work, while a per year basis seems too long a period for readers to relate to when interpreting results of the study. Conversely, a per year basis could be described as the most accurate productivity rate since all types of treatment, clinic days, service mix and work participation rate of the dentist are represented.

Additionally, there has been some effort to account for dental visits to hygienists in addition to visits made to dentists (Howley, 1980; Kushman et al, 1978). The number of these is even greater than the notably small number of studies that use number of services as a productivity measure (Lipscomb & Scheffler, 1975). A reason that number of services has not been widely used may be related to the variation in service mix between dentists that will be left uncaptured when reporting number of services only.

2.3.2 Billings

As highlighted, measuring productivity by using an absolute measure for number of services or visits has the obvious limitation of equal weighting for simple and complex procedures that may have varying fees. Due to this limitation, attempts have been made to apply some monetary value to services/visits as a means of comparative weighting between different dental procedures. This method of measuring productivity was used in the earliest productivity studies (Maurizi, 1969; Reinhardt, 1972; Boulier, 1974; Lipscomb & Scheffler, 1975) and later by Gray (1982) and Lipscomb & Douglass (1986). More recently, monetary data have been used to formulate a translog cost function by Grytten and Dalen (1997) to study productivity.

There is some degree of variation in the types of monetary measures that have been collected to measure productivity, and often monetary measures have tended to be used supplementary to other measures such as patient visits. Generally, a 'gross' figure has been estimated which is the amount equal to total billings over a given period of time with no deductions made for laboratory, personnel or other overhead costs. Studies have reported gross billings on an hourly basis (Lipscomb & Douglass, 1986; Gray, 1982), on a per day basis (Shuman & Davidson, 1994) and on a per annum basis (Lipscomb & Douglass, 1986; Boulier, 1974; Maurizi, 1969). Shuman and Davidson (1994) formulated a Value Weighted Services (VWS) measure which applied a constant average fee for each dental procedure delivered over the period of one day. This method is a useful way of applying monetary weight to different services, thus accounting for variation in service mix between dentists. For accurate estimation, it does require, however, that the constant average fee applied to a particular service appropriately represents the comparative value of that service compared to another service, and also that the level of monetary value for a service is constant between dentists. These two requirements may be violated if the fee schedule between dentists varies (which is commonly observed) and also if comparative fee scheduling is different between dentists. Kabir and Mellor (2004) found that 'the most important factors affecting fee setting were clinical time, practice overheads and laboratory costs'. For example, a dentist may have a higher fee schedule for all services compared to another dentist. Alternatively, a dentist may set higher fees for some procedures that they place greater monetary value on

due to their skill, technology and time constraints compared to other dentists with different skill, technology and time constraints. As a hypothetical example, older dentists may charge more for composite resin restorations compared to younger dentists, who may charge more for amalgam restorations compared to older dentists. This suggests that a constant fee across all dentists for a particular procedure may be different from the actual fees charged. Mitry et al. (1976) points out that 'it is not uncommon for dentists to charge relatively less for time consuming procedures and relatively more for very simple procedures'. A range of monetary measures was used by Lipscomb & Scheffler (1975) which included total revenue, long-run total cost, long-run average cost per procedure and net revenue.

While monetary measures of dental productivity tend to exhibit a stronger relation than number of visits, data on billings and income are considered quite sensitive and tend to be more difficult to obtain, thus posing a significant barrier to data collection. Even by reporting estimates as gross billings figures per given period of time, it 'is difficult to extract overhead costs and lab fees from gross billings' (Gray, 1982). The proportion of overhead costs will vary between dentists and practices, depending on location, modernisation of the practice and number of personnel employed. The variation in fee schedules between dentists may also reflect some variation in the quality of service provided or materials used which will result in variation of gross billings between dentists for reasons other than variation in productivity levels.

The main disadvantages in reporting gross billings on a per day basis are that one day may not be a truly representative clinical day and there may be some bias in the dentists' choice of which day to report billings. Furthermore, there is no adjustment made for services which are provided over more than one visit on a single day e.g. fixed and removable prosthodontics. Gray (1982) suggests that 'gross fees may be a potentially reliable output measure in the General Dental System (*in the United Kingdom*) because they are set to be time equalised per item of work undertaken'. This is somewhat in contrast to the view taken by Tuominen and Tuominen (1994), who suggest that 'for evaluation of the value of output in the private sector, the use of prices is justified... however, when the productivity of non-profit dental offices is evaluated, a value system which is not based on market prices is needed'. Finally, some consideration should be given to the possibility of private dental subsidisation,

also referred to as *pro-bono publico* or charitable dental care. Private dental subsidisation refers to dental services provided by private dentists either free of charge or at a reduced fee to patients. There has been no estimation of the proportion of private dental subsidisation in Australia. Some examples include: discounts given to pensioners or students, multiple services provided in one visit charged at lower rates than the standard fee or charging the dental benefit only. The proportion of private dental fees subsidised by individual dentists most likely vary between dentists and hence further complicate gross billings estimates.

2.3.3 Value weighted measures

A challenge faced by researchers investigating dental productivity is formulating a measure which encompasses the multi-service or multi-product nature of dentistry. Weighted measures have been used in studies in an attempt to meet this challenge by taking into account the service-mix variation between dentists and patients and applying weights accordingly. The weights may be time, knowledge, skill and/or responsibility based.

There are four types of non-monetary weighted measures identified in the literature. Firstly, a Relative Production Unit (RPU) used by Shuman & Davidson (1994) is a standardised time-based measure of productivity. Points are assigned to each dental procedure based on the average time of the procedure. Its use produces optimal results for practitioners whose fees are based upon time rather than specific services. However, productivity will be misguidedly lower for practitioners who take longer to deliver services to patients due to the time taken to explain each step of the procedure and give oral hygiene advice. Also, the fact that best results are produced for practitioners whose fees are based upon time rather than specific services suggests that this measure is not suitable for practitioners who do not base their fees on time. There are many examples where the average fee of a more time-consuming procedure is not relatively higher compared to a less time-consuming procedure.

The second type of a non-monetary weighted measure is the Relative Productivity method (Mitry et al., 1976). This is an approach that permits the aggregation of dental products by constructing a measure that reflects the dentist's time to perform each of 161 different dental procedures. Mitry chose this measure from five others:

the number of patients treated, the number of patients whose treatment was completed, the number of patients visits and a weighted index of patient services. An example of Mitry's Relative Productivity method can be illustrated in a simple, one surface, class 1 amalgam which requires the following steps to be performed: anaesthesia, rubber dam, preparation, base, insert and carving. Average times taken to perform each of these steps are aggregated to formulate a productivity measure. The main downfall with the Relative Productivity method is that the data collection was carried out in a controlled lab setting at a government-sponsored dental clinic using eight dentists only.

The third example of a non-monetary weighted productivity measure was used by Dolkart (1978) who formulated a value of weighted services which assigned weights to tasks according to the amount of knowledge, skill, effort and responsibility involved. This is an interesting measure since it is unique in its approach and also assumes that the greater the knowledge, skill, effort and responsibility required to perform a dental procedure, the greater the productivity. Presumably, the dentist would seek appropriate reimbursement for the greater knowledge, skill, effort and responsibility exerted for a particular procedure, and this would be evident in the comparative fee scheduling between services of varying knowledge, skill, effort and responsibility, but akin to earlier discussion, this is not generally what we observe in fees for dental services.

The fourth and final example is the relative value method (RVU) which is a method applying relative loading to dental services in terms of time, skill and responsibility required to perform the services. The notion is to establish a scientific basis for determining fees (Clappison et al., 1965). The RVU has been used to formulate one of the productivity measures implemented in the analysis, with some changes made the original loadings specified by Clappison to reflect changes in technology and dental service mix trends that have occurred over the past 40 years.

In summary, the main types of dental productivity measures that can be found in the literature are quantitative in nature and although they do not specifically measure qualitative improvements in the patient's oral health we assume that the interaction between a patient and a dentist as measured by a visit, service, bill or time spent, is a

positive interaction in relation to the patient's oral health. The most widely used measure is the quantitative aggregation of the number of visits/patients/services/courses of care per dentist, or per dentist and hygienist, in a given period of time. Although these measures are practical for data collection purposes, their main limitation of these measures is that they do not capture variation in service-mix provision by dentists, or the variation in service-mix demanded by patients. Gross billings and value weighted measures endeavour to deal with this limitation by applying weight to services which vary in fees, time duration, skill and effort. While this helps in accounting for variation in service-mix, it does not allow for variation in: dentists' schedule of fees, time spent in delivering a particular service which varies not because the dentist is less productive but because they spend more time in explaining steps, or the individual dentist's skills and knowledge base. It is clear that there are both merits and caveats associated with the range of productivity measures in the literature, and for this reason, more than one type of productivity measure is used in most studies.

2.4 Method of analysis

Table 2.3 presents a summary of the functional forms of the production function models (and their associated R^2 values) which have been used in the literature, and listed below are the mathematical equations of each function.

1. **Multiplicative (Cobb-Douglas) model**:

$$Q = c \; . \; x_1^{a_1} . \; x_2^{a_2} \ldots x_3^{a_3} \; x_n^{a_n}$$

2. **Transcendental model:**

$$Q = c \; . \; x_1^{a_1} e^{b_1 x_1} . \; x_2^{a_2} e^{b_2 x_2} \ldots x_3^{a_3} e^{b_3 x_3} \; x_n^{a_n} e^{b_n x_n}$$

3. **Linear additive model:**

$$Q = c \; . \; a_1 x_1 + a_2 x_2 + a_3 x_3 + \; + a_n x_n$$

where

Q = productivity; c = intercept; a, b... = regression coefficients and x_i, i = 1, 2, 3...n are input factors. (Source: Howley, 1980)

The multiplicative model can be used when there is an assumption of constant elasticity; however, all inputs are required to have non-zero values to produce non-zero output. Given that the assumption of constant elasticity may not always hold, an alternative model is the transcendental form which can be used when all independent variables are input quantities measured in continuous volumes or when elasticity is assumed to vary at different levels of output. There are, however, limitations in its ease of understanding and the interpretation of coefficients. As both of these models have been heavily criticised in the literature, the linear additive model was used in the study and chosen based on goodness of fit and parsimony.

Table 2.3: Functional form of production function

	FUNCTIONAL FORM			
	Multiplicative (Cobb Douglas)	Transcendental	Additive	Other
Maurizi (1969)	R^2 = 0.31 - .053			
Boulier (1974)		R^2 = 0.34		
Mitry et al. (1976)		R^2 = 0.99		
Scheffler & Kushman (1977)		R^2 = 0.45		
Kushman et al (1978)		R^2 = 0.43		
Roehrig & Feldstein (1979)	R^2 = 0.49			
Howley (1980)	R^2 = 0.31	R^2 = 0.50	R^2 = 0.40	
Gray (1982)		R^2 = 0.16		
Spencer & Lewis (1986)		Mixed transcendental R^2 = 0.41		
Lipscomb & Douglass (1986)				Technology matrix
Wang (1994)	R^2 = 0.76 – 0.82			
Shuman & Davidson (1994)			R^2 = 0.40 – 0.54	
Grytten & Dalen (1997)				Translog cost function
Grytten & Rongen (2000)				Stochastic

2.5 Related issues

There are other issues related to dental productivity which although not making a strong appearance in the literature are worthy of some discussion. These issues include efficiency, returns to scale and productivity differences between group and solo practice.

2.5.1 Efficiency

There are two concepts of efficiency in economic theory: economic efficiency and technological efficiency. The production method is economically efficient when the cost of producing a given output is as low as possible, and is technologically efficient when it is not possible to increase output without increasing inputs (McTaggart, 1998). There are multiple technologically efficient methods available, each with different input configurations. For example, one method may be highly labour intensive while another may be highly capital intensive, but both methods can be technologically efficient. There will be one technologically efficient method that coincides with the economically efficient method and that usually is the production method that will prevail in a competitive market. A firm implementing any other method will not be operating competitively and will not last in the long term.

The first and only dental productivity study to estimate technical efficiency was by Grytten & Rongen (2000). When using a stochastic production frontier the findings showed the level of inefficiency to be fairly small. When a deterministic production frontier was used the level of inefficiency was larger due to the inclusion of random noise. Random noise results when the dental clinic is operating below its production frontier for reasons beyond its control - which should not count as inefficiency.

2.5.2 Economies of scale

Economies of scale are defined as 'reductions in the cost of producing a unit of a product that occur as the scale of output increases' (McTaggart, 1998). Constant returns to scale is the most efficient method of service delivery and indicative of competitive market forces, while increasing or decreasing returns suggest there is

scope to expand or contract output levels respectively. There are a number of dental productivity studies which have attempted to investigate this issue. However, the results are inconclusive in any one direction. Constant returns to scale have been documented (Mitry et al., 1976; Lipscomb & Scheffler, 1975; Kilpatrick et al., 1972) as have increasing returns to scale (Grytten & Rongen, 2000; Grytten & Dalen, 1997; Lipscomb & Douglass, 1986; Nash & Wilson, 1979; Maurizi, 1969) and decreasing returns to scale (Utrainen et al., 1993; Westerberg, 1987).

2.5.3 Group vs. Solo practice

Similar to the findings regarding returns to scale, there is ambiguity as to whether there are gains in group dental practice compared to solo practice. Kushman et al (1978) found there were increasing returns to size, up to at least five dentists, but at the cost of a reduction in output of 4% that accompanied revenue sharing. Lipscomb and Douglass (1986) also found cost efficiency increases with practice size over the range of one to four dentist practices. On the contrary, other studies have found either no difference between solo and group practice (Grytten & Rongen, 2000; Grytten & Dalen, 1997) or group practice to be less productive (Sintonen, 1986).

Related to efficiencies of group practice, if present, would be the investigation of whether these efficiencies are absorbed by the practice and passed onto the patient in the form of a lowered fee schedule, shorter waiting time for appointments, an increase in the proportion of privately subsidised services and/or capital investment.

3 Methodology

This chapter of the thesis provides background on the methodology implemented in the research project. The section first describes the data used in the study, which comprises the four waves of the Longitudinal Study of Dentists' Practice Activity (LSDPA). The data collection is described in terms of the questionnaire components and sampling techniques used. Next, data are discussed in terms of the weighting process applied, categorisation into groups of independent input variables (labour, capital, dentist and practice characteristics) and dependent output variables (patients, services, relative value units and gross billings) along with an outline of the statistical approach taken. The last section highlights limitations of the data set and problems associated with the statistical methodology of analysis.

3.1 Longitudinal Study of Dentists' Practice Activity (LSPDA)

The research is built upon the foundation of a unique, long-established and high-quality data set: the Longitudinal Study of Dentists' Practice Activity (LSDPA). The design of the study, which used a longitudinal component with a sample supplementation process at each wave, provides four representative cross-sectional surveys conducted at five-year intervals spanning the period 1983 to 1998. The core longitudinal component can be traced through all four points in time. Overall, the design of the LSPDA provides a rich source of data on dental practice inputs and outputs, the value of which is enhanced by the data having been collected at a national level from a comprehensive sampling frame (e.g. dental registers), achieving response rates in excess of 70% and particularly the longitudinal aspect of the design. Data from all four waves of the LSPDA was used in the research project.

The LSPDA was commenced in 1983/84 under a grant from the Commonwealth Department of Health, Health Services Research and Development Committee, and has been supported by competitive grants. It, in turn, has supported several higher degrees and some twenty research papers. Spencer and Lewis at the University of Melbourne, Department of Preventive and Community Dentistry were responsible

for developing the initial survey. The last three waves of the study have been administered by Spencer and Brennan.

3.2 Data collection and data items

3.2.1 Survey questionnaire

The most recent of the four survey questionnaires (1998) is presented in Appendix A. Some examples of differences between data items collected in the questionnaires (1983, 1988, 1993, 1998) are discussed later in this section. There were two consistent parts to the data collection, divided into sections A and B.

Section A comprised of data collection items which related to dentist characteristics including age, sex, country of birth, year and university of graduation; practice characteristics of the three main locations of work including type and configuration of practice, state location, size, perceived level of busyness and length of wait for an appointment; labour input data including dentist and auxiliary workforce participation estimates; and capital input data such as number of surgeries (in total/utilised/fully equipped) and number and type of x-ray units in the practice.

Section B comprised the service provision log where participants were asked to record services provided over generally one self-selected typical day of clinical practice. In 1993, the service log was compiled by participants over two self-selected typical days of clinical practice. Service provision was recorded by entering item numbers of services provided and the estimated time taken to provide each service. Item numbers were classified according to the Australian Dental Association's *Schedule of Dental Services* (Appendix E). Participants were asked to include item numbers of service provision whether or not the item number was charged to the patient. An example of a frequently provided but less routinely charged item of service is oral hygiene instruction, which may take up clinic time, but is not always billed to the patient. In the earlier waves of the survey, there were additional data items in Section A of the questionnaire related to whether the dentist consulted with management professionals, if a recall system was in place and if so what type, whether the patient base of the practice lived in a fluoridated area and if so the

estimated number of years of fluoridation, and the expected age of retirement of the dentist. Additional data items in Section B of the questionnaire (service provision log) in earlier survey waves included estimates of total chairside, non-chairside and free time of the dentist and dental assistant. There was also inclusion of a total revenue estimate for the day of service provision recorded in the log, but this was phased out after the 1988 survey wave, most likely due to a low response rate and sensitivity of the data.

Participants were consistently asked to record the average fee charged for each of five common service item numbers at the main location of practice. These five service item numbers were an examination, a scale and clean, a simple extraction, a two-surface amalgam and a set of full upper and lower dentures, and are the same item numbers that have been used by the Australian Bureau of Statistics (ABS) to compute the national dental fee index. Theoretically, the record of fees charged for the five item numbers could be used to compute a dental fee index for the period 1983 to 1998 and compared to the national dental fee index to check for comparability and representativeness of the two separate data sources.

Other data items included in Section B describe patient characteristics and include patient age, sex, insurance status, reason for visit and diagnosis by the dentist of the patient's main dental problem.

The LSPDA is a unique questionnaire of its kind in Australia due to the service log provided by dentists which is a supplement to the main questionnaire asking dentists questions on workforce participation and practice characteristics. Close examples include data collected through mailed questionnaire by the Australian Dental Association (ADA) which conducts an annual Dental Fees Survey involving private general dentists providing estimates on the average fees of services provided and there is also the Dental Practice Survey series.

3.2.2 Sampling

The population of dentists for each round of the LSPDA included all dentists listed on the eight dental registers of the states and territories of Australia who were resident within their state or territory of registration. The sample included the total

number of registered dentists, the only exclusions being overseas registered dentists, specialists where identified; dentists with interstate addresses were included if they were not registered in another state/territory. A random selection of 10% of male dentists and 40% of female dentists were drawn from the dental registers where a greater weighting was given to female dentists. This was to generate a large enough number of responses which could be useful in the precision of estimates in the analysis of the data collected from female dentists.

A sample supplementation procedure was used in successive waves of the study following the first survey in 1983, to ensure representative cross-sectional samples for ensuing years (1988, 1993, 1998). The process involved sampling dentists new to the dental registers from the preceding survey in the same ratios (10% male; 40% female) as applied initially.

3.3 Statistical approach

Dental productivity, or output, was examined under four main categories of input factors: labour, capital, dentist characteristics and practice characteristics. These input variables represent the independent variables, while dental productivity represents the dependent variable. The process of examining productivity was repeated in four phases, each time using a different dependent variable to measure productivity. The four different dependent variables used to describe productivity were: patients per day, services per day, RVUs per day and $GB per day.

Some discussion of the weighting process is provided, followed by a summary of the dependent and independent variables (Table 3.1 and Table 3.2) and some discussion on the main groupings of variables. Lastly, the form of statistical analyses performed to pursue each of the study objectives is described.

3.3.1 Weighting process

Data were weighted to account for the over-representation of female dentists in the sampling procedure. The process involved calculating weights by using the estimated number of practising general private dentists (ADA, 1983; ADA, 1988) and age and sex distributions obtained from the most current population census

(AIH, 1981; AIH, 1986). This was applied in the first two waves of the survey, while in the last two waves of the survey age and sex distributions of practising general private dentists were obtained from national dental labour force data collections (AIHW DSRU, 1992; AIHW 1994). All results use weighted data with the exception of Table 4.1, which presents sample response rates.

3.3.2 Dependent variables

A summary of the dependent variables and their derivation is presented in Table 3.1 below.

Table 3.1: Dependent variables

Dependent variable	Estimation (*Source*)
1. Patients per day	Dentists' response to: 'How many patients per day, on average, do you treat?' (*LSPDA Section A*)
2. Services per day	Sum of the total number of service item numbers recorded by dentists in the service provision day log (*LSPDA Section B service log*)
3. RVUs per day	Product of the average time by responsibility loading per service item number summed across all services for 1 day in 1983, 1988 and 1998, or averaged across 2 days in 1993 (*LSPDA Section B service log; see Appendix B for average time per service and responsibility loadings*)
4. $GB per day	Fee estimate applied to each service item number summed across all services for 1 day, or averaged across 2 days in 1993 (*LSPDA Section B service log; see Appendix C for fee estimates per service item number*)

The patients and services per day productivity measures involved a relatively straightforward calculation of the reported number of patients per day and summing of services across all patients seen in the day service provision log respectively; thus do not require additional discussion to what is presented in Table 3.1. The process of developing the RVUs and $GB per day measures was more involved and therefore warrants more discussion.

The RVU productivity variable was estimated by multiplying the average time taken to provide a service item number by the responsibility loading assigned to that particular service item number (Clappison, et al., 1965). The average time was estimated by summing the total time taken to deliver that particular service as reported by dentists in the service provision log and then dividing by the number of times that the service item number appeared in the service provision log. The

responsibility loadings for each service item number were based on the 'knowledge, judgement, skill, and clinical and technical risk associated with the service item number' (Clappison, et al., 1965) and varied from 1.0 to 1.75, with the service item number 022 (single intra-oral film) having a loading of 1.0, and a cast post core (625) having a loading of 1.75. Some improvisations were made for item numbers which were not listed in the paper by Clappison et al. and also to account for changes in technology over time. The complete list of estimated average time per service item number and assigned responsibility loadings are listed in Appendix C.

The $GB per day productivity measure was estimated by applying an estimated fee to each individual service item number provided per patient, which was then summed across all services per patient, to arrive at a $GB estimate per patient. This was then summed across all patients that the dentist reported they provided services to on the clinical log day recorded in Section B of the LSPDA questionnaire to arrive at an estimate of the total $GB per dentist per day. The fee applied to each individual service item number was estimated using a number of sources, but in a systematic hierarchy of preference. Firstly, where possible, the average fee from the annual ADA Dental Fees Survey (corresponding to the year of the survey) was used. Where no average fee estimate was available from this source for a particular survey year, an inflation or deflation index based on the Dental Price Index reported in the Health Expenditure Bulletin was applied to estimate a fee so it corresponded with the year of the survey for which no fee estimate from the ADA Dental Fees Survey was available. Where both these options were not available, estimates from the Mutual Community, Medibank and Veterans Affairs fee schedules were used to approximate fees for item numbers that did not appear in the ADA Fees Survey in any one year and again an inflation or deflation process was applied to reflect real dollar value to the base year (1998). All gross billings estimates presented in the results chapter are given in constant 1998 dollars. A comprehensive list detailing fee estimates for each service item number and source is included in Appendix C. These estimates were given in current dollars for the year of survey; however, the 1983, 1988 and 1993 fee estimates were then inflated to constant 1998 dollars prior to the analyses.

3.3.3 Independent variables

A summary of the independent variables is presented in Table 3.2 below.

Table 3.2: Independent variables

Category	Data item
1. Labour	1.Dentist hours per day chairside 2.Number of extra-oral auxiliaries per dentist 3.Number of intra-oral auxiliaries per dentist
2. Capital	1.Number of surgeries utilised per dentist 2.Number of x-ray units in main practice
3. Dentist characteristics	1.Sex 2.Experience 3.University of graduation 4.Country of birth
4. Practice characteristics	1.Configuration 2.Size 3.State location of main practice 4.Perceived busyness level 5.Length of wait for an appointment

Labour

The independent variables used to describe labour involve mainly the input of the dentist and auxiliaries, where input has been measured as total chairside time per day (hours), and number per dentist, respectively. To measure dentist input, the data items of total time spent at the practice per day and free time at the practice were also options, but were disregarded since chairside time spent per day was thought to offer the most appropriate measure of dentist labour input for the particular dependent productivity variables chosen for this study. Free time spent by the dentist at the practice may be considered a useful variable influencing productivity in a positive way, if it is assumed that the free time is spent on entrepreneurial activities, management and administrative tasks. However, since there were no data collected in describing what activities are actually engaged in during dentists' free time at the clinic, the option of including this variable was disregarded.

Two new auxiliary variables were created and used in the analysis. These included the number of extra-oral auxiliaries and the number of intra-oral auxiliaries. The former was computed by summing the number of certified and non-certified dental

assistants, and the latter was a summation of dental hygienists and therapists. Additional auxiliary staff such as dental technicians and managers/bookkeepers were not included as there were too few in number and they did not appear in all years of the survey.

Capital

Capital input was measured using the variables of number of surgeries utilised by the dentist and number of x-ray units at the main location of practice. The number of surgeries utilised, as opposed to the number of surgeries in total or the number of surgeries that the dentist reported as fully equipped (which were additionally collected data items), was preferred since it captures the practice style of dentists who may use more than one surgery by moving between patients who were set up in separate surgeries. This was presumably a more time-efficient process.

Dentist characteristics

Data items describing characteristics of the dentist were sex, experience, university of graduation and country of birth. It is not these characteristics specifically which we expect will influence productivity, but rather the less easily collected data on behavioural qualities for which we assume they provide a proxy. For example, years of experience may serve as a proxy for technical ability, knowledge and greater credibility in the eyes of the patient; however, it could also be a proxy for out-of-date treatment philosophies and poor patient management skills.

Generally, these data items were included to investigate how productivity varied between male and female dentists and dentists with different experience levels.

Practice characteristics

Data items relating to perceived level of busyness, state location of main practice, length of wait for an appointment, size and configuration of practice described the main location of practice for the dentist and provided some proxy for practice inputs that may influence productivity.

Perceived level of busyness was categorised as: 'less busy/as busy/more busy than

would like', while length of appointment was recorded in days or weeks. Both of these data items could represent either characteristics of the dentist and/or the practice. If representative of the practice characteristics, it could be either an attribute unique to the practice or merely related to the dentist-to-population ratio in which the practice was located.

3.3.4 Statistical techniques

Generally, with the exception of two variables, missing cases were excluded. There was no technique employed, for example, where missing values were automatically replaced with arithmetic means. This technique may have been beneficial if there were only a few missing values, however, there was some degree of variation in the sample sizes used for analysing data from the first part of the questionnaire, covering general demographic and practice characteristics, and data from the log-entry component of the questionnaire. For example, the production function regression models which used patients per day (PPD) as the dependent variable resulted in larger sample sizes due to the variable PPD originating from the first part of the questionnaire where there were less missing cases. Conversely, production function regression models which used either services per day (SPD), relative value units per day (RVUs) or gross billings per day ($GB) as the dependent variable resulted in relatively smaller sample sizes due to these variables originating from the log-entry component of the questionnaire in which there was a relatively more missing cases and in which only responses from private, general dentists were included. All sample sizes, indicating the number of valid n and the number of missing cases, are presented at the base of each regression model table in the Results.

The two variables of concern, in which some imputation to missing values was carried out, were intra-oral auxiliaries and group practice size. Firstly, during the initial analytical stages, both intra- and extra-oral auxiliaries were grouped into one category to account for the small sample sizes, particularly for the category of intra-oral auxiliaries. In later analytical stages, it was considered desirable to differentiate auxiliaries into intra- and extra-, to account for productivity differences the two types of auxiliaries. For subjects who had answered all parts of the staffing component of the questionnaire but had left the responses to intra-oral auxiliaries

blank, a zero was inserted to account for these missing values. This allowed for an adequate sample size for the category of intra-oral auxiliaries. In relation to the second variable, group practice size, some imputation was required to accurately compute the associated categories (0, 1, 2, 3, 4+). For dentists who had responded to being solo dentists but had not responded to the question asking: 'number of other dentists in the practice', a zero was imputed to account for the number of other dentists in the practice.

Included in each regression table, per dependent variable and per year, is an indication of the number of missing cases. As previously discussed, the sample size available for regression modelling with patients per day specified as the dependent variable was greatest. This is due to the fact that the dependent variable 'patients per day' was taken from the first part of the questionnaire for which there was less missing data compared to the second part of the questionnaire where dentists were required to fill in a day log of service provision. For the regression models with either 'services per day' or 'gross billings per day' specified as the dependent variable, the number of missing cases was higher compared to the regression models with 'patients per day' as the dependent variable for a number of reasons. Dentists had to have completed both parts of the questionnaire which were relevant to the variables specified in the model and also had to qualify as being private general practising dentists. The samples sizes reported for regression models with either 'services' or 'gross billings per day' as the dependent variable were the same due to the reason that imputed fee estimates were applied to all cases were a service item number was specified. The regression models with 'relative value units' specified as the dependent variable are slightly smaller compared to the regression models with either services or gross billings per day specified as the dependent variable due to the requirement that since the relative value unit was a weighted variable comprising of a "time" and "responsibility" loading, dentists who did not allocate time taken for a particular service were excluded from the analysis. This was on the basis that if the dentist did not specify a time component to the service then either then the time component of the weighted value would have to be imputed to be either zero or a standard value, both of which were considered inappropriate for cases that had missing values for the time taken.

The statistical analysis carried out was approached in a systematic manner in relation to each of the specific objectives of the study. All data items included in the analysis were classified under their respective categories of input variables (labour, capital, dentist and practice characteristics) and then recoded into subcategories. As an example, the labour input of dentist hours worked per day chairside was coded into three categories (≤ 4 hrs, >4-8 hrs, 8+ hrs). The subcategories were consistent in all of the analyses. Table 3.3 presents the categories for each of the independent variables and which category was specified as the reference in the multivariate production function modelling.

Table 3.3: Transformation of independent variables into categories

Independent variables (input factors)	Categories of independent variables	Subcategories of independent variables	Reference group
1. Dentist	Sex	Male	Male
		Female	
	Experience (years)	≤ 5	25 +
		> 5 – 10	
		> 10 – 15	
		>15 – 25	
		25 +	
	Country of birth	Australia	Australia
		Not Australia	
	University of graduation	Overseas	Sydney
		Sydney	
		Melbourne	
		Queensland	
		Adelaide	
		Western Australia	
2. Capital	No. surgeries utilised	1	1
		2	
		3 +	
	No. x-ray units	1	1
		2	
		3 +	
3. Labour	Dentist hrs/day (chairside)	≤ 4	>4 - 8
		> 4 – 8	
		8 +	
	No. extra-oral auxiliaries	0	1
		1	
		2	
		3+	
	No. intra-oral auxiliaries	0	0
		1	
		2 +	

Table 3.3 *continued.*

Independent variables (input factors)	Categories of independent variables	Subcategories of independent variables	Reference group
4. Practice	Configuration	Solo	Solo
		Partner	
		Associate	
		Assistant	
		Locum	
	Size	0	0
		1	
		2	
		3	
		4 +	
	Perceived busyness	As busy as would like	Less busy
		Less busy than would like	
		More busy than would like	
	Length of wait for appt (wks)	0 – 0.9	0 – 0.9
		1.0 – 1.9	
		2.0 – 3.9	
		4.0 +	
	State location of main practice	ACT	NSW
		NSW	
		Vic	
		Qld	
		SA	
		WA	
		Tas	
		NT	

Following these initial calculations, univariate, bivariate and multivariate analyses were executed.

Descriptive analysis

The distribution of each independent variable was examined within sex and year group. This was repeated for each year of the survey. Tables 4.3 to 4.15 summarise this information for independent variables. This enabled an examination of how these distributions varied not only by sex but also across time. For example, by comparing tables that summarised the distributions of the labour and capital inputs, it was possible to ascertain if practice style was becoming more labour or capital intensive over time, and if this varied between male and female dentists.

The univariate analysis carried out for the dependent variables was slightly different.

For each of the variables, descriptive statistics comprising the sample size, mean, minimum, maximum, standard deviation and skewness were estimated. This was repeated for each year of the survey and the results for these calculations are presented in Tables 4.16 to 4.19. Frequency distributions for each of the dependent variables are presented in Figures 4.1 to 4.4.

Bivariate analysis

Following the initial descriptive statistics, bivariate analysis of the dependent productivity variables and the independent input variables was conducted. This was repeated for each year of the survey. The results are presented systematically, with each of the productivity variables and their associated bivariate analyses presented separately. The results for each individual productivity variable by input variable, and by year, are presented in Tables 4.20 to 4.43. Analysis of variance was applied to test for associations between input factors and productivity, with a significance level set at $p<0.05$. A 2-way ANOVA was applied to test for significant differences between survey years for each sex and overall. It is depicted as 'Year x "Input factor'" and also set at $p<0.05$.

The bivariate analysis specifically addressed the primary objective of the project, which was to determine which input factors influence productivity and to examine how the influence of these input factors has changed over time. By presenting the results from the bivariate analysis by year within the same table and also highlighting which associations were significant, it was possible to clearly show the findings to the first part of the study objective. By presenting the mean productivity rate per input variable, by year, again within the same table, it was possible to clearly show the findings to the second part of the study objective which was related to changes in productivity trends across time, where productivity was indexed by a range of productivity variables. A number of summary tables (Tables 4.44 to 4.47) are presented to highlight the main findings associated with the bivariate analyses.

Multivariate analysis

The multivariate analysis involved Ordinary Least Squares (OLS) regression models for the cross-sectional production functions and pooling of data known as the panel

approach for the longitudinal production functions. These are presented in Tables 4.48 to 4.77.

In order to estimate a cross-sectional dental production function for each individual year of the survey, a multivariate model was formulated using OLS estimation with the SPSS statistical package (SPSS, 2002). The method used to specify the production function was the 'general-to-specific' approach, where the model was initially specified using the maximum number of independent variables and progressively revised to include a smaller group of independent variables, the majority of which were significant and exhibited the expected signage (Gujarati, 1999). This technique is popular in econometric modelling, offering the supposed advantage of reproducibility of the model by different users of the package.

One of the assumptions of OLS regression modelling in producing best linear unbiased estimators (BLUE), is the absence of multicollinearity between independent variables, where multicollinearity is defined as a linear relationship existing between explanatory variables. Multicollinearity is expected to be present to some degree, however, it is only in the presence of 'high' multicollinearity, where correlation coefficients between independent variables are in the range of approximately 0.7 – 1.0, that the integrity of OLS models is seriously compromised. The consequences of the presence of 'high' multicollinearity include: larger variances and standard errors of OLS estimators, wider confidence intervals, insignificant t ratios and, a high R^2 value but few significant t ratios (Gujarati, 1999, p.320). Therefore if 'high' correlation is suspected, testing is deemed necessary.

In the study, one specific example of suspected high multicollinearity between independent variables was between: length of wait for an appointment and perceived level of busyness. For rigour, bivariate correlations between all independent variables, for each survey year and for the longitudinal panel data, were carried out using Kendall's tau-b, 2-tailed analysis which is recommended for testing relationships between ordinal variables (Bryman and Cramer, 1999).

It was shown that no correlation coefficient greater than 0.604 was found. Consistently in each survey year and in the longitudinal panel data set, the highest correlation coefficient was found between: state location of main practice and

university of graduation, and was in the range of 0.57 and 0.60.

In summary, multicollinearity was measured and was found to be present but not to the extent of posing a limitation to the study.

3.3.5 Panel data analysis

A panel data set is a cross-section, in our case a sample of individuals, who have been surveyed periodically (at five-yearly intervals) over a given period of time (1983 to 1998). In our study the panel data consists of a group of individual dentists with observations that range from between one and four points in time. That is, there is a mix of dentists with data that include all four points in time; any three out of the four points in time; any two out of the four points in time; or only one out of the four points in time. This type of data set is referred to as an unbalanced panel data set due to not every individual dentist having an observation for each year of the survey. Panel data analytic models include Fixed Effects (FE), Random Effects (RE) and Ordinary Least Squares (OLS) regression models. Each model has different assumptions about the intercept and slopes. The FE model assumes that the slopes are constant between individual dentists but the intercept will be significantly different between individual dentists. This model was rejected on the grounds that due to the fact that a dummy variable is required to be computed for each individual dentist, too many degrees of freedom are lost and hence the model becomes inefficient. A second reason that the model was not used is that it is not suitable for use in data which contains time invariant variables, i.e. variables that do not change over time for the individual such as sex or country of birth. This is because the FE model is computed by subtracting the means of each variable value from the variable mean and running a regression using the transformed variable. It makes sense that for time-invariant variables, where the mean and actual value will always be the same, a regression cannot be run using a data set containing variables whose entire set of transformed values are equal to zero. The next model discussed is the RE model. The RE model allows for time-invariant variables and assumes the intercept is significantly different between individual dentists but that the slopes are constant. That is, the intercept captures all the unobserved characteristics of each individual dentist which are assumed to be significantly different between dentists but normally

distributed. Hence, the intercept has its own mean value plus error term. However, for correct modelling the error term of the intercept must be uncorrelated with the error term of the variables. This leads us to the OLS model, which was chosen on the following grounds. Using the OLS model, the intercept and slopes are assumed to be constant, with variation between individual dentists captured in the error term of the variables. On the grounds that whatever unobserved time-invariant individual dentist characteristics do exist between individual dentists are small, we accept the OLS model for use in the panel analysis assuming this variation will be captured in the random noise element. Hence, for analysis of the longitudinal data, an OLS model was specified for each individual productivity variable which resulted in four panel OLS models in total, representing each of the four productivity measures. The OLS model was estimated by pooling all the data across all four survey years to create a panel data set using only data items that appeared in all four surveys. 'Pooling time series and cross-section data provides more efficient estimation, inference, and possibly prediction' (Gujarati, 1999). Additionally, a data item for 'year of survey' was included to allow for testing the significance of time on productivity, and whether this varied between the four different measures for productivity.

3.4 Data caveats

The integrity of the findings reported in this study depend heavily on the reliability of the data items recorded in the service log (Section B) of the LSPDA which were used to formulate three out of the four productivity measures. Thus a major assumption underlying the study is that the service log recorded by dentists was representative and did not contain bias. Possible limitations of the service log that may violate this assumption were that it is based on a self-selected day, which presumably could introduce bias, and also it is only one day out of many that the dentist practises. For this reason, the service log could potentially be construed as a crude record of typical service provision. There is, however, a report which shows 'there was no significant difference in service rates in all 10 main areas of service between data collected over a 10-day continuous sampling period compared with estimates based on one typical day nominated from the 10-day sampling period by the responding dentists' (Brennan et al., 1996). Although this report addresses the

issue of 1-day sampling, there is still the question of seasonal variation, that is whether there exists a significant difference in service provision profiles at different times of the year. Another potential source of bias that could arise from the use of a self-selected typical day is related to dentists' avoidance of particularly busy clinical days when selecting the day to complete the service log. If busier days were avoided and if the service profile of busier days was statistically different from less busy days, then this could bias the sampled service profile by underestimating productivity.

In terms of fee estimation to formulate the gross billings variable, the main limitation here was that one dental inflation index is applied across all services. This could misrepresent individual service fees if different categories of dental services have inflated or deflated at different rates over time. Other caveats include the rather dated responsibility loadings used to formulate the RVU measure and the assumption of constant technology across dentists and across time for production function modelling.

4 Results

The results presented in this chapter include sample summary statistics such as sample response rates, descriptions of the distributions of the independent input variables and dependent output variables compared across time and between sex, frequency distributions of output variables, bivariate distributions between input variables and output variables and the multivariate production function models (cross-sectional and longitudinal) estimated for the dependent output variables. There are five separate production function models presented under the four different types of productivity variables. These five models include four cross-sectional production functions for each survey year (1983, 1988, 1993, 1998) and one longitudinal production function model which includes data from all four years of the survey (1983-1998) with 'year of survey' included as an input variable to test for productivity differences across time. This was then repeated systematically for each of the four productivity variables (patients/services/RVUs/$GB per day). Summary tables are presented at the end of each set of production functions per productivity variable.

All statistics presented in the results section relate to private general dentists only, and with the exception of Table 4.1, which presents sample response, all results use weighted data.

4.1 Sample summary statistics

Table 4.1 presents the age and sex distribution of responding dentists for each survey year. The sample sizes were 367, 481, 441 and 489 dentists for the survey years 1983, 1988, 1993 and 1998 respectively. Response rates were in excess of 70% across all survey years.

The high percentages observed for female dentists in the age groups of 20-29 and 30-39 years were related to the over sampling of female dentists (40 %) compared to male dentists (10 %) to provide large enough sample sizes in each age group in each year so that acceptable precision of estimates could be obtained.

Table 4.1: Sample response by age, sex and year

	Year of survey							
	1983		1988		1993		1998	
	Male	Female	Male	Female	Male	Female	Male	Female
Dentist age (years)								
20-29	13.1	37.7	13.2	37.9	12.8	27.5	10.7	28.5
30-39	30.9	36.5	34.5	38.4	30.3	45.5	26.1	39.9
40-49	22.3	14.1	25.3	12.4	28.5	18.0	31.0	25.0
50-59	23.1	8.0	12.8	8.5	15.3	6.0	21.5	6.1
60+	10.6	3.5	14.1	2.8	13.1	3.0	10.7	0.4
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total (n)	282	85	304	177	274	167	261	228
Response rates (%)	73.0		75.0		74.0		71.0	

Table 4.2 presents the descriptive statistics for the independent variables. The percentage of male and Australian-born dentists decreased across the survey period, while the average number of years of experience remained reasonably stable, increasing slightly from 17.76 years (1983) to 18.11 years of experience (1998). In terms of capital usage, the number of surgeries utilised per dentist remained the same (1.69 in 1983 and 1.66 in 1988); however, the number of x-ray units increased from 1.94 in 1983 to 2.40 in 1998. Labour input, measured as dentist chairside hours per day, remained stable, while auxiliary usage increased from 2.37 auxiliaries per dentist in 1983 to 2.75 auxiliaries per dentist in 1998. In relation to practice-related characteristics, both the proportion of dentists reporting they were as busy as they would like to be and the size of non-solo practice exhibited somewhat of an inconsistent pattern over time. There was, however, a marked increase in the average waiting time for an appointment to see a dentist, increasing from 1.20 weeks wait to 2.78 weeks wait from 1983 to 1998.

Table 4.2: Descriptive statistics of independent variables (input factors)

	Year of survey							
	1983		1988		1993		1998	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
Dentist								
% Male	88.6	—	86.2	—	82.6	—	81.4	—
% Non-Australian	25.8	—	31.6	—	34.9	—	39.6	—
Yrs experience	17.76	12.30	17.15	12.28	18.41	12.13	18.11	11.96
Capital								
No. surgeries	1.69	0.78	1.68	1.00	1.56	0.76	1.66	1.27
No. x-ray units	1.94	1.37	2.14	1.36	2.36	1.59	2.40	1.98
Labour								
Dentist hrs/day	7.09	1.49	7.20	1.42	6.95	1.51	7.13	1.52
No. auxiliaries	2.37	2.90	2.55	1.56	2.70	1.80	2.75	2.37
Practice								
% Busy as would like	51.6	—	51.5	—	46.5	—	56.6	—
Size (no. dentists)	1.51	0.92	1.83	1.30	0.94	1.27	1.44	1.46
Wait for appt (wks)	1.20	1.66	1.27	1.78	1.17	2.46	2.78	1.12

4.2 Description of the distributions of independent input variables

4.2.1 Input: dentist characteristics

Years of experience

Table 4.3 presents the distribution of dentist years of experience by sex and year and shows a significant distribution in all four survey years with the exception of female dentists in 1998. The variable of 'years of experience' was calculated as the difference between two data items, one reported by the participant: 'year of graduation' and the other one being 'year of survey'. It was used in preference to age, since some participants may have graduated at a later age compared to others and the variable of years of experience provided more information in terms of a dentist characteristics that may affect productivity, compared to age of dentist.

Male dentists exhibited a negatively skewed distribution for years of clinical experience across age groups, with the largest proportion of male dentists having either more than 25 years of experience (1983, 1988) or between 15 and 25 years of experience (1993, 1998). The smallest proportion of male dentists had between 10

and 15 years of experience in 1983 and 1988, while in 1993 and 1998 the smallest proportion was represented by male dentists with between 5 and 10 years, and less than 5 years of experience, respectively. Conversely, female dentists exhibited a positively skewed distribution for years of clinical experience across age groups. Cumulatively, less than two-thirds of female dentists had less than 10 years of experience in the first three surveys (1983, 1988, 1993) while in 1998 the distribution was somewhat more normal, with approximately half of female dentists having less than 10 years of experience. There was a significant difference in the distribution of male dentists' experience between years but no significant difference was found for female dentists' experience between years.

In summary, dentists overall tended to exhibit a greater number of years of experience in each successive wave of the survey. This was with the exception of 1988 where there was a bimodal distribution for experience with two peaks (>5-10 and >15-25 years).

Table 4.3: Distribution of dentist years of experience by sex and year

		Experience (years)				
		≤5	>5-10	>10-15	>15-25	25+
Sex	Year	(%)	(%)	(%)	(%)	(%)
Male	1983***	18.0	15.8	14.8	17.7	33.8
	1988***	16.0	20.4	13.5	23.2	26.8
	1993***	12.2	11.9	17.5	30.0	28.3
	1998***	10.1	14.6	14.3	33.1	27.5
	(Year x Experience)***					
Female	1983***	42.9	19.5	9.5	17.1	11.9
	1988***	36.9	19.7	15.4	15.4	12.1
	1993***	30.0	27.1	15.7	20.0	7.1
	1998^{ns}	32.4	17.6	15.7	21.6	12.7
	(Year x Experience)^{ns}					
All	1983***	20.9	16.2	14.2	17.6	31.2
	1988***	18.9	20.3	13.8	22.1	24.8
	1993***	15.3	14.5	17.2	28.3	24.7
	1998***	15.3	15.3	14.6	30.4	24.0
	(Year x Experience)***					

***($p<0.001$); χ^2 test
ns (not significant)

Country of birth

Table 4.4 presents the distribution of dentist country of birth by sex and year. In all categories of sex and year of survey, Australian-born dentists comprised a majority

compared to non-Australian-born dentists, except for the category of female dentists in 1998 where the distribution for country of birth was approximately even. The proportion of non-Australian-born dentists consistently increased in each survey year for male dentists, and while the proportion of non-Australian-born female dentists increased from 1983 to 1998 the growth was less consistent. Overall, the proportion of Australian-born dentists decreased from 74.0% to 60.3% across the period of data collection (1983 to 1998). There was a significant difference in the distribution of male dentists' experience between years but no significant difference was found for female dentists' experience between years.

Table 4.4: Distribution of dentist country of birth by sex and year

		Born in Australia	
		Yes	No
Sex	Year	(%)	(%)
Male	1983***	76.3	23.7
	1988***	71.4	28.6
	1993***	66.6	33.4
	1998***	63.6	36.4
	(Year x Country)***		
Female	1983***	56.1	43.9
	1988^{ns}	48.5	51.5
	1993***	57.5	42.5
	1998^{ns}	49.5	50.5
	(Year x Country)^{ns}		
All	1983**	74.0	26.0
	1988***	68.2	31.8
	1993	65.0	35.0
	1998*	60.3	39.7
	(Year x Country)***		

***(p<0.001), *(p<0.05); χ^2 test
ns (not significant)

University of graduation

Table 4.5 presents the dentist's university of graduation by sex and year. The majority of male dentists who had graduated in Australia were either Sydney or Melbourne graduates, followed in order of frequency by Queensland, Adelaide and Perth graduates. While overseas dental graduates comprised only 10.0% of male dentists in 1983, by 1998 the sample of male dentists consisted of just over 14.0% of overseas dental graduates. The majority of female dentists were also Sydney or Melbourne graduates and minorities followed in the same order as male dentists. However, the proportion of overseas graduates was particularly high at the start of

the survey in 1983 (24.4%), although this subsequently reduced to 15.5% by the 1998 wave of the survey. Overall, these estimates had a counterbalancing effect in the overall summary statistics, showing a small increase in overseas graduates and typically, the majority of graduates being from Melbourne or Sydney. Not surprisingly, there was no significant difference in the distribution of university of graduation between years for male or female dentists, or when both sexes were grouped together.

Table 4.5: Distribution of dentists' university of graduation by sex and year

		University of Graduation					
		O/S	Syd	Melb	QLD	Adel	WA
Sex	Year	(%)	(%)	(%)	(%)	(%)	(%)
Male	1983***	10.0	38.9	19.9	16.2	7.2	7.8
	1988***	11.5	32.2	21.0	17.3	10.5	7.6
	1993***	14.0	33.5	15.8	15.8	12.0	8.9
	1998***	14.2	31.2	15.1	16.6	11.3	11.6
	(Year x University)^{ns}						
Female	1983***	24.4	39.0	14.6	7.3	9.8	4.9
	1988^{ns}	21.9	32.8	18.8	10.9	12.5	3.1
	1993***	16.4	27.4	26.0	12.3	12.3	5.5
	1998^{ns}	15.5	27.2	22.3	11.7	16.5	6.8
	(Year x University)^{ns}						
All	1983^{ns}	11.6	39.0	19.3	15.2	7.5	7.5
	1988^{ns}	12.9	32.3	20.7	16.5	10.8	7.0
	1993^{ns}	14.5	32.5	17.5	15.2	12.1	8.3
	1998^{ns}	14.5	30.2	16.8	15.5	12.5	10.5
	(Year x University)^{ns}						

***($p<0.001$); χ^2 test
ns (not significant)

4.2.2 Input: capital

Surgery utilisation

Table 4.6 presents the distribution of surgeries utilised by sex and year. The majority of male and female dentists predominately utilised one surgery across each year of the survey. While more male dentists initially utilised two surgeries (45.7%) compared to one surgery (43.1%) in 1983, multiple surgery utilisation steadily declined across time, falling from 57.0% in 1983 to 46.4% in 1998 (summing of 2 and 3+ surgery utilisation proportions) as single surgery use increased from 43.1% to 53.7% during the same period. The proportion of male dentists utilising three or more surgeries was relatively small, in the range of 9.0 to13.2% (1983 to 1998). A

much larger proportion of female dentists utilised one surgery compared to two surgeries, and only between 5.0% to 6.9% utilised three or more surgeries (1983 to 1998). Overall, single surgery use was most common, increasing in frequency over time. This was an indication of decreased capital investment of surgeries over the 1983 to 1998 period; however, the non-significance of the interaction variables shows the change was not actually significant between years for male or female dentists, or when both sexes were grouped together.

Table 4.6: Distribution of surgeries utilised by sex and year

Sex	Year	Number of surgeries utilised		
		1 (%)	2 (%)	3+ (%)
Male	1983***	43.1	45.7	11.3
	1988***	49.9	37.0	13.2
	1993***	54.5	36.4	9.0
	1998***	53.7	36.3	10.1
	(Year x Surgery)^{ns}			
Female	1983**	57.5	37.5	5.0
	1988^{ns}	63.3	31.7	5.0
	1993***	62.5	30.6	6.9
	1998^{ns}	62.1	31.6	6.3
	(Year x Surgery)^{ns}			
All	1983^{ns}	44.7	44.7	10.5
	1988^{ns}	51.6	36.3	12.1
	1993^{ns}	55.9	35.4	8.7
	1998^{ns}	55.6	35.2	9.2
	(Year x Surgery)^{ns}			

***(p<0.001), **(p<0.01); χ^2 test
ns (not significant)

X-ray unit utilisation

Table 4.7 presents the distribution of number of x-ray units by sex and year. The time trend evident in x-ray unit utilisation was quite different compared to surgery utilisation. Although the majority of male and female dentists utilised predominantly one x-ray unit, the remaining proportion of dentists was reasonably evenly distributed across the categories of 3 and 3 or more x-ray unit utilisation. Across time there was a shift toward increased utilisation of x-ray units with the proportion of dentists (male and female) using one x-ray unit decreasing from just over half of the 1983 sample (50.1%) to just over a third (37.3%) in 1998. Over the same period (1983 to 1998) multiple x-ray unit utilisation increased from 25.8% to

33.0% (dentists using 2 x-ray units) and from 24.0% to 29.7% (dentists using 3 or more x-ray units). Female dentists tended to follow the same pattern of x-ray unit utilisation as male dentists; however, more male dentists utilised either one or 2 x-ray units in each of the survey years compared to female dentists whose utilisation of either 1, 2 or 3 or more x-ray units was more evenly distributed. Overall, there was significantly greater utilisation of x-ray units across time for male dentists only as depicted by the significance of the interaction variable. The difference in number of x-ray units used between male and female dentists may be attributed to a different practice style, where a higher proportion of male dentists tended to work in solo practice compared to female dentists, where a higher proportion was involved in non-solo practice and may have had greater access to more than one x-ray unit.

Table 4.7: Distribution of number of x-ray units by sex and year

Sex	Year	Number of x-ray units		
		1 (%)	2 (%)	3+ (%)
Male	1983***	50.6	26.1	23.3
	1988*	40.7	28.8	30.5
	1993^{ns}	36.3	29.7	34.0
	1998*	39.2	31.6	29.2
	(Year x X-ray)**			
Female	1983^{ns}	46.3	24.4	29.3
	1988^{ns}	39.7	29.6	31.7
	1993^{ns}	28.8	37.0	34.2
	1998^{ns}	30.5	37.9	31.6
	(Year x X-ray)^{ns}			
All	1983^{ns}	50.1	25.8	24.0
	1988^{ns}	40.6	28.8	30.7
	1993^{ns}	35.0	31.0	34.0
	1998^{ns}	37.3	33.0	29.7
	(Year x X-ray)^{ns}			

***(p<0.001), **(p<0.01), *(p<0.05); χ^2 test
ns (not significant)

4.2.3 Input: labour

Dentist hours worked per day

Table 4.8 presents the distribution of dentist chairside hours by sex and year. Dentist chairside hours were divided into the following three categories: less than or equal to four hours per day, more than four and up to eight hours per day, and eight or more hours per day chairside. The categories approximately equate to what is informally

considered within the dental labour force as 1 session, 2 sessions and daily overtime, respectively, where a clinic session tends to be half a day of clinic chair-side time.

Approximately three-quarters of dentists, male and female, worked between four and eight hours per day chairside consistently over the 1983 to 1998 period. Between 1983 and 1988, there was a slight decline in the proportion of male dentists working the four- to eight-hour chairside shifts with a subsequent increase in the proportion of male dentists working more than eight hours per day. By 1998 this trend was somewhat reversed. Less than 6.5% of male dentists reported that they worked less than four hours per day chairside in any one of the survey years. A relatively high proportion (17.1%) of female dentists worked less than four hours per day chairside in 1983 but this proportion declined markedly to 9.2% by 1998. Comparatively across time, 1988 had the highest proportion of both male and female dentists working more than eight hour per day chairside shifts (17.6% and 15.6%, respectively); however, this was followed in 1993 by a moderate decline in the proportion of both male and female dentists working more than eight chairside hours per day (15.0% and 10.0%, respectively) which was subsequently followed by an increase in the proportion of dentists working more than eight hours per day in 1998. The non-significance of all interaction variables shows there was no significant difference in the distribution of dentist chairside hours between years for male, female and combined sex categories.

Overall, the proportion of dentists working from four to eight hours per day chairside was fairly stable, with more movement occurring in the proportions of dentists working either less than four or more than eight hours per day chairside.

Table 4.8: Distribution of dentist chairside hours by sex and year

Sex	Year	Dentist hours per day chairside		
		≤4 (%)	>4 – 8 (%)	>8 (%)
Male	1983***	3.5	79.3	17.2
	1988***	3.5	79.0	17.6
	1993***	6.5	78.5	15.0
	1998***	4.0	79.2	16.8
	(Year x Hours)^{ns}			
Female	1983***	17.1	73.2	9.8
	1988^{ns}	12.5	71.9	15.6
	1993***	11.4	78.6	10.0
	1998^{ns}	9.2	76.5	14.3
	(Year x Hours)^{ns}			
All	1983***	5.1	78.6	16.3
	1988**	4.7	78.0	17.3
	1993^{ns}	7.3	78.5	14.1
	1998^{ns}	5.2	78.6	16.2
	(Year x Hours)^{ns}			

***(p<0.001), **(p<0.01); χ^2 test
ns (not significant)

Auxiliaries per dentist

Table 4.9 presents the distribution of the number of extra-oral auxiliaries by sex and year. This variable was computed as the sum of the number of dental assistants (certified/non-certified), receptionists and administrative staff that the dentist reported to be working with. The number of dental technicians and managers/bookkeepers has not been included in the auxiliary total as these categories of auxiliary providers were not consistently included in each survey year questionnaire. The category of '0' was included to account for the very small proportion of dentists who reported this as the number of extra-auxiliaries they worked with; 1983 and 1988 only. Consistently throughout the survey period, the greatest proportion of dentists worked alongside 2 extra-oral auxiliaries, with the exception of female dentists in 1983 where 45.0% reported working with one extra-oral auxiliary only. At the start of the survey period (1983) approximately a quarter of male dentists worked with one extra-oral auxiliary staff but this proportion declined to just over 10% by 1998. A dentist reporting to work with only one auxiliary most likely represents practices where one auxiliary has the dual role of assisting chairside and conducting reception duties such as answering the phone and making appointments. Across time, there was a significant change in the

distribution of number of extra-oral auxiliary staff, with a shift in the number of male and female dentists working alongside smaller numbers of extra-oral auxiliary staff (either 1 or 2 auxiliary staff) toward increased use of auxiliary staff (3 or more auxiliary staff). In 1983, there were 28.5% of dentists who reported to work with one auxiliary staff and 22.6% of dentists who reported to work with 3 or more auxiliary staff, compared to 1998 where the proportion of dentists who reported to work with one extra-oral auxiliary staff decreased to 11.1% while the proportion of dentists who reported to work with 3 or more auxiliaries increased to 51.6%. Patterns of extra-oral auxiliary use between female and male dentists tended to be quite similar. There was a sizeable decline in the proportion of female dentists working alongside one extra-oral auxiliary staff from 45.0% in 1983 to just 13.9% in 1998, while the subsequent increase in the proportion of female dentists working alongside 3 or more auxiliary staff was also high, increasing from 20.0% in 1983 to 49.4% in 1998. Overall, the significant change in extra-oral auxiliary utilisation patterns comprised an increase over time resulting in a shift from lower levels of auxiliary use (2 or less auxiliary staff) to higher auxiliary use (3 or more auxiliary staff).

Table 4.9: Distribution of number of extra-oral auxiliaries by sex and year

Sex	Year	Number of extra-oral auxiliaries (dental assistants & clerical staff)			
		0 (%)	1 (%)	2 (%)	3+ (%)
Male	1983***	0.6	26.3	50.2	22.9
	1988***	-	17.6	36.9	45.5
	1993***	0.9	15.1	35.5	48.5
	1998***	-	10.4	37.5	52.1
	(Year x Aux[E-O])***				
Female	1983*	-	45.0	35.0	20.0
	1988^{ns}	-	24.6	34.4	41.0
	1993***	-	17.1	32.9	50.0
	1998^{ns}	-	13.9	36.7	49.4
	(Year x Aux[E-O])**				
All	1983^{ns}	0.6	28.5	48.5	22.6
	1988^{ns}	-	18.7	36.5	44.8
	1993^{ns}	1.0	15.4	35.0	48.6
	1998^{ns}	-	11.1	37.3	51.6
	(Year x Aux[E-O])***				

***(p<0.001), **(p<0.01), *(p<0.05); χ^2 test
ns (not significant)

Table 4.10 presents the distribution of number of intra-oral auxiliaries by sex and year. This variable was computed as the sum of the number of dental therapists and dental hygienists that the dentist reported to be working with them. The category of '0' was included to account for the small proportion of dentists who reported this as the number of extra-auxiliaries they worked with. However, it was evident when looking at the data that a sizeable number of dentists had only answered the question relating to number of intra-oral auxiliaries they worked with if it was a positive number. That is, the category for '0' was virtually nil. Therefore, some imputation was required where '0' was inserted if it seemed consistent with the remaining of the dentists' responses to auxiliary staff. The results for this particular variable are thus not as reliable and may explain why there is no particular trend. The main points to highlight are that firstly although it appears that the majority of dentists reported working with 1 intra-oral auxiliary this is very likely an inflated estimate due to the non-response of dentists who did not work with any intra-oral auxiliaries and secondly, the non-significance of the interaction variables suggests no significant change over time between categories of intra-oral auxiliary utilisation.

Table 4.10: Distribution of number of intra-oral auxiliaries by sex and year

Sex	Year	Number of intra-oral auxiliaries (dental hygienists and dental therapists)			
		0 (%)	1 (%)	2 (%)	3+ (%)
Male	1983**	3.2	73.7	15.4	7.7
	1988***	6.1	82.8	7.4	3.7
	1993***	9.4	65.6	21.9	3.1
	1998***	6.3	70.7	13.1	9.8
	(Year x Aux[I-O])^{ns}				
Female	1983 ^{ns}	3.0	49.7	47.6	-
	1988 ^{ns}	14.1	85.9	-	-
	1993 ^{ns}	12.5	75.0	12.5	-
	1998 ^{ns}	8.8	71.4	14.3	5.5
	(Year x Aux[I-O])^{ns}				
All	1983 ^{ns}	3.1	78.6	14.3	7.1
	1988 ^{ns}	7.7	87.1	6.5	6.5
	1993 ^{ns}	10.2	69.2	17.9	5.1
	1998 ^{ns}	7.5	68.8	13.2	10.5
	(Year x Aux[I-O])^{ns}				

***(p<0.001), **(p<0.01); χ^2 test
ns (not significant)

4.2.4 Input: practice characteristics

Practice configuration

Table 4.11 presents the distribution of practice configurations by sex and year. The most frequent practice configuration of male dentists were in solo practice consistently throughout all survey years. For male dentists, this was followed by associateships which subsequently declined across the survey period from 18.5% (1983) to 16.8% (1998), while the proportion of male assistant dentists increased from 13.5% (1983) to 20.1% (1998). The greatest proportion of female dentists, in the range of 42.9 to 51.9%, were also in solo and associateship arrangements. With the exception of male dentists (7.2%) in 1983, a generally small proportion of male or female dentists reported working as locum dentists at any one time during the survey.

Table 4.11: Distribution of practice configurations by sex and year

Sex	Year	Practice configuration				
		Solo	Partner	Associate	Assistant	Locum
		(%)	(%)	(%)	(%)	(%)
Male	1983***	48.6	12.2	18.5	13.5	7.2
	1988***	46.9	14.7	17.7	18.7	2.0
	1993***	47.6	12.7	19.9	17.5	2.3
	1998***	50.7	11.5	16.8	20.1	0.9
	(Year x Configuration)^{ns}					
Female	1983***	51.2	12.2	19.5	12.2	4.9
	1988^{ns}	42.9	14.3	14.3	23.8	4.8
	1993***	47.3	16.2	18.9	16.2	1.4
	1998^{ns}	51.9	8.9	13.9	24.1	1.3
	(Year x Configuration)^{ns}					
All	1983^{ns}	48.9	12.5	18.6	13.3	6.9
	1988^{ns}	46.3	14.7	17.3	19.3	2.4
	1993^{ns}	47.3	12.1	19.5	18.2	2.9
	1998^{ns}	50.3	11.1	16.4	20.9	1.3
	(Year x Configuration)^{ns}					

***($p<0.001$); χ^2 test
ns (not significant)

Number of other dentists in the practice

Table 4.12 presents the distribution of the number of other dentists in the practice by sex and year. The majority of dentists who answered this question reported to work with 0 other dentists, which is not surprising considering the high proportion of dentists in solo practice (Table 4.11). Approximately a quarter of male dentists

reported working alongside only one other dentist. However, this proportion declined from 26.9 % (1983) to 22.5% (1998). In 1983, most male dentists in group practice worked with predominantly one or two other dentists, but in successive years of the survey there was a shift toward an increase in group practice size with the proportion of male dentists who worked with three other dentists increasing from 1.9% (1983) to 6.6% (1998). The significance of the interaction variables shows that there was a significant change in the distribution of practice size, between years. Although generally there were few male dentists reporting to work with four or more dentists at any one period during the survey, there was still an increase in this proportion from 0.6% (1983) to 4.1% (1998). Female dentists' patterns of group practice were more evenly distributed between 0, 1 and 2 other dentists compared to male dentists, and were not significantly different between years.

Table 4.12: Distribution of number of other dentists in the practice by sex and year

Sex	Year	Number of other dentists in the practice				
		0	1	2	3	4+
		(%)	(%)	(%)	(%)	(%)
Male	1983***	60.0	26.9	10.6	1.9	0.6
	1988***	54.9	26.9	8.5	5.3	4.4
	1993***	55.4	27.0	9.1	4.5	4.0
	1998***	55.8	22.5	11.0	6.6	4.1
	(Year x Size)*					
Female	1983**	31.0	35.7	19.0	9.5	4.8
	1988^{ns}	36.4	28.8	22.7	9.1	3.0
	1993*	31.5	35.6	17.8	11.0	4.1
	1998^{ns}	51.7	24.7	12.4	6.7	4.5
	(Year x Size)^{ns}					
All	1983^{ns}	56.5	28.0	11.6	2.8	1.1
	1988^{ns}	52.4	27.2	10.5	5.7	4.2
	1993^{ns}	51.3	28.5	10.6	5.6	4.0
	1998^{ns}	55.0	22.7	11.3	6.9	4.2
	(Year x Size)^{ns}					

***(p<0.001), **(p<0.01), *(p<0.05); χ^2 test
ns (not significant)

Perceived level of busyness

Table 4.13 presents the distribution of the perceived level of busyness of the practice by sex and year. Generally the majority of dentists, both male and female, reported to be less busy as they would like, a proportion which increased from 53.2% (1983) to 54.8% (1998) for male dentists and from 46.3% (1983) to 62.0% (1998) for female dentists. The proportion of male and female dentists reporting to be busier than they

would like steadily increased across the period from 7.3% in 1983 to 12.9% in 1998. There was a particularly marked increase over time in the category of "busier than would like to be" for female dentists, where the proportion more than doubled from 7.3% in 1983 to 16.0% in 1998.

Overall, the proportions of dentists who were either less busy as or more busy than they would like to be increased, while the proportion of dentists who were as busy than they would like to be decreased. In essence, this reflects a progressive mismatch between patients' demand for care and dentists' capacity to supply care, exacerbated with the increasing maldistribution of the number of dentists between high and low demand areas.

Table 4.13: Distribution of perceived level of busyness of the practice by sex and year

Sex	Year	Perceived busyness relative to level of busyness dentist would prefer		
		Less busy (%)	As busy (%)	More busy (%)
Male	1983***	39.5	53.2	7.3
	1988***	39.4	51.5	9.1
	1993***	43.2	45.8	11.0
	1998***	33.2	54.8	12.0
	(Year x Busyness)^{ns}			
Female	1983**	46.3	46.3	7.3
	1988^{ns}	36.9	55.4	7.7
	1993***	42.5	49.3	8.2
	1998^{ns}	22.0	62.0	16.0
	(Year x Busyness)^{ns}			
All	1983^{ns}	40.3	52.4	7.3
	1988^{ns}	39.1	52.0	8.9
	1993^{ns}	43.1	46.4	10.5
	1998^{ns}	30.6	56.5	12.9
	(Year x Busyness)**			

***(p<0.001), **(p<0.01); χ^2 test
ns (not significant)

Waiting time for an appointment

Table 4.14 presents the distribution of length of wait for an appointment by sex and year. Consistently, the majority of dentists across all age and survey year categories reported the length of wait for an appointment to be up to one week. Across time, however, the proportion of dentists, both male and female, who reported the length of wait for an appointment to be between 1.0 and 1.9 weeks increased from 14.8% (1983) to 20.5% (1998). Similar increasing trends were evident for lengths of wait for

an appointment between 2.0 to 3.9 weeks and 4.0+ weeks, increasing slightly from 18.8% to 19.4%, and 7.0% to 10.9% respectively over the 1983 to 1998 period. The proportion of dentists reporting up to one week's length of wait declined from 59.4% to 49.3% from 1983 to 1998, and was accompanied by the subsequent increase in the proportion of dentists reporting more than a week's length of wait for an appointment. While the proportion of male dentists reporting between two to four weeks wait remained fairly stable across time, there was a reasonable increase in the proportion of dentists reporting one and two weeks' wait between 1983 (14.9%) and 1998 (20.8%). A smaller increase was found in the proportion of dentists reporting more than four weeks' wait, increasing from 7.0% (1983) to 8.7% (1998). Female dentists reported consistently lower levels of waiting time for an appointment in the first two survey periods (1983, 1988) compared to male dentists, but by 1998 female dentists reported longer waiting times compared to male dentists. The significance of the interaction variable (Year x Wait) for female dentists shows that there was a significant change in the distribution of appointment waiting time for female dentists over the survey period.

Overall, there was a shift toward increased length of wait for an appointment reported by both male and female dentists.

Table 4.14: Distribution of length of wait for an appointment by sex and year

Sex	Year	Length of wait for an appointment (weeks)			
		0 – 0.9 (%)	1.0– 1.9 (%)	2.0 – 3.9 (%)	4.0 + (%)
Male	1983***	58.4	14.9	19.7	7.0
	1988***	56.1	16.9	18.4	8.6
	1993***	64.7	16.5	13.9	4.9
	1998***	52.8	20.8	17.7	8.7
	(Year x Wait)^{ns}				
Female	1983***	66.7	14.3	11.9	7.1
	1988^{ns}	53.0	25.8	16.7	4.5
	1993***	55.6	25.0	16.7	2.8
	1998^{ns}	36.8	19.7	25.0	18.4
	(Year x Wait)**				
All	1983^{ns}	59.4	14.8	18.8	7.0
	1988^{ns}	55.7	18.1	18.1	8.0
	1993^{ns}	63.2	17.9	14.4	4.5
	1998**	49.3	20.5	19.4	10.9
	(Year x Wait)**				

***(p<0.001), **(p<0.01); χ^2 test
ns (not significant)

State location of main area of practice

Table 4.15 presents the distribution of state location of main practice by sex and year. Unsurprisingly, the state location for main area of practice for the majority of dentists was in New South Wales, followed in order of proportion by Victoria and Queensland. The Northern Territory, Tasmania and Australian Capital Territory represented the smallest proportions of state location for main area of practice. These trends were consistent for both male and female dentists and across time. Not surprisingly, there was no significant change in the distribution of state location over time as depicted by the non-significance of all interaction variables.

Table 4.15: Distribution of state location of main practice by sex and year

		State location of main practice							
Sex	**Year**	**ACT**	**NSW**	**VIC**	**QLD**	**SA**	**WA**	**TAS**	**NT**
Male	1983***	2.2	38.4	26.3	13.4	8.4	9.4	0.9	0.9
	1988***	2.5	35.3	26.0	16.4	8.3	8.8	2.0	0.7
	1993***	3.4	37.7	20.0	16.3	9.1	11.1	1.4	0.9
	1998***	2.1	37.9	19.2	18.3	6.5	13.9	0.9	1.2
	(Year x State)^{ns}								
Female	1983***	4.9	41.5	31.7	4.9	7.3	9.8	-	-
	1988^{ns}	3.1	38.5	30.8	9.2	7.7	6.2	3.1	1.5
	1993***	1.4	31.5	34.2	12.3	6.8	8.2	2.7	2.7
	1998^{ns}	1.0	30.1	25.2	17.5	10.7	10.7	3.9	1.0
	(Year x State)^{ns}								
All	1983^{ns}	2.5	38.8	26.9	12.5	8.3	9.4	0.8	0.8
	1988^{ns}	2.5	35.8	26.6	15.4	8.2	8.5	2.1	0.8
	1993^{ns}	3.1	36.6	22.5	15.6	8.7	10.6	1.7	1.2
	1998^{ns}	1.8	36.1	20.6	18.1	7.5	13.2	1.6	1.1
	(Year x State)^{ns}								

***($p<0.001$); χ^2 test
ns (not significant)

4.2.5 Summary: description of the distributions of input variables

Across the period 1983 to 1998, the distributions of dentist characteristics have changed in relation to the sex, experience level, country of birth and university of graduation of the sample of private general dentists. There has been an increase in the proportion of female dentists, in the average number of years of experience within the dentist labour force and in the proportion of dentists not born in Australia. While there has been growth in the number of overseas dental graduates and in the number of graduates from the Adelaide and Western Australian dental schools, the proportion of Sydney dental school graduates has declined and Queensland dental school graduates has remained stable.

Capital and labour usage across time has changed. Capital usage in terms of surgeries and x-ray units has seen a decline in the number of surgeries utilised but an increase in the number of x-ray units utilised. This may be related to decreased capital investment, coupled with increased provision of diagnostic services requiring x-ray unit usage. The dental labour force has exhibited a relatively stable input by dentists at the same time as an increase in input by auxiliaries, particularly extra-oral.

At a practice level, there has been a decline in solo and partnership configurations, while associateships and assistant dentist arrangements have increased. At the same time, the group practice size has increased. The length of waiting time for an appointment has increased, and while the proportion of dentists reporting to be as busy as they would like has increased only marginally, there has been a tendency toward dentists reporting to be more busy than would like.

4.3 Distributions of output variables

Tables: 4.16 to 4.19, and Figures: 4.1 to 4.4, present the summary descriptive statistics and frequency distributions of the four productivity measures: patients, services, RVUs and $GB per day. An approximately normal distribution was exhibited for all measures, but less so for the measure of $GB. This may be due to the small number of private general dentists in the earlier survey samples who reported providing a high number of orthodontic services which amounted to high $GB estimates compared to later survey years where less orthodontic services were reported by private general dentists.

4.3.1 Output: patients per day

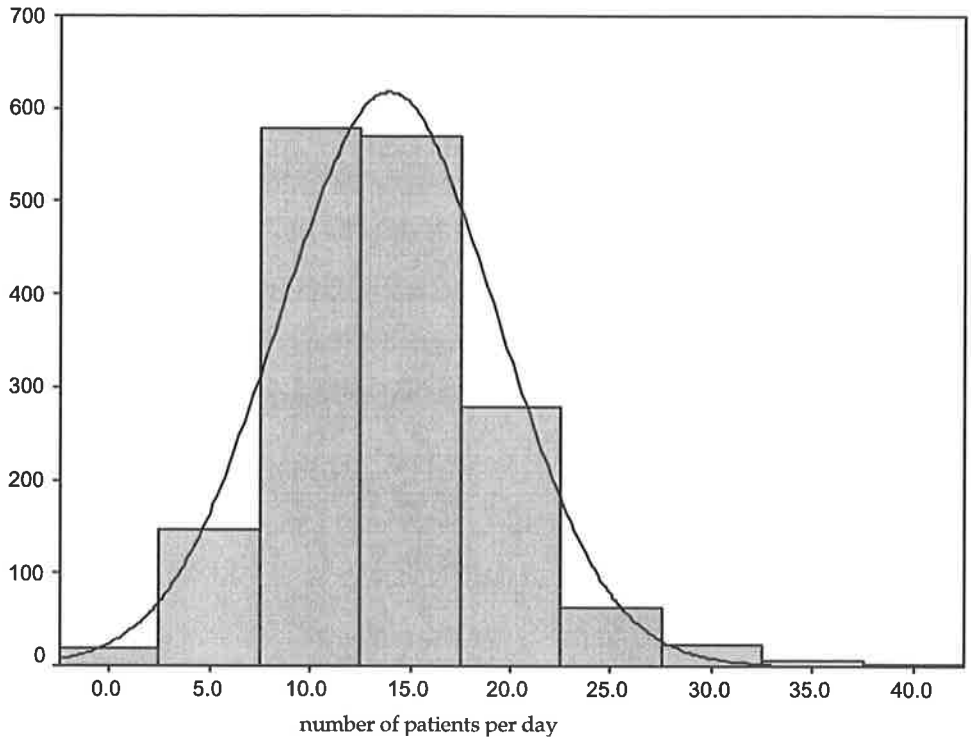
Table 4.16 presents the descriptive statistics for the output variable of patients per day. The table shows a steady decline in the mean number of patients per day, with an average of 15.9 in 1983 decreasing to an average of 12.6 in 1998. Across the period 1983 to 1998 the mean number of patients per day was 13.9. The minimum–maximum ranges for this variable were approximately equal between survey years.

Table 4.16: Descriptive statistics for patients per day

	n	Mean	Min	Max	Std Dev	Skewness
1983	357	15.9	2	36	6.0	0.7
1988	456	14.5	1	40	5.6	0.8
1993	407	13.1	2	30	4.8	0.3
1998	467	12.6	1	30	4.8	0.4
1983-1998	1687	13.9	1	40	5.4	0.7

The frequency distribution of patients per day depicted in Figure 4.1 shows a reasonably normal distribution for this variable.

Figure 4.1: Frequency distribution of patients per day, 1983-98.



4.3.2 Output: services per day

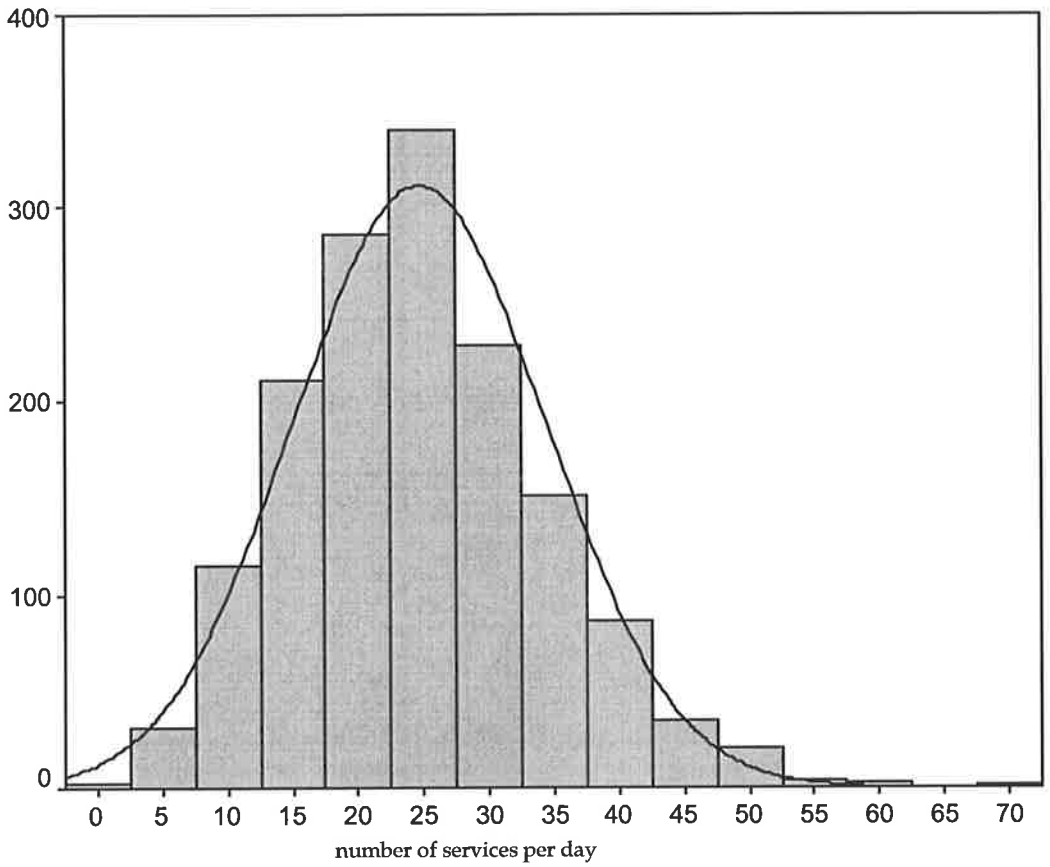
Table 4.17 presents the descriptive statistics for the output variable of services per day. The table shows a steady decline in the mean number of services per day, with an average of 26.1 in 1983 decreasing to an average of 23.2 in 1998. Across the period 1983 to 1998 the mean number of services per day was 24.9. The minimum-maximum ranges for this variable were approximately equal between survey years.

Table 4.17: Descriptive statistics for services per day

	n	Mean	Min	Max	Std Dev	Skew
1983	316	26.1	3	68	10.4	0.6
1988	431	25.8	1	69	9.6	0.4
1993	400	24.0	1	66	9.1	0.2
1998	367	23.2	4	60	9.6	0.7
1983-1998	1514	24.8	1	69	9.7	0.5

The frequency distribution of patients per day depicted in Figure 4.2 shows a reasonably normal distribution for this variable.

Figure 4.2: Frequency distribution of services per day, 1983-98.



4.3.3 Output: RVUs per day

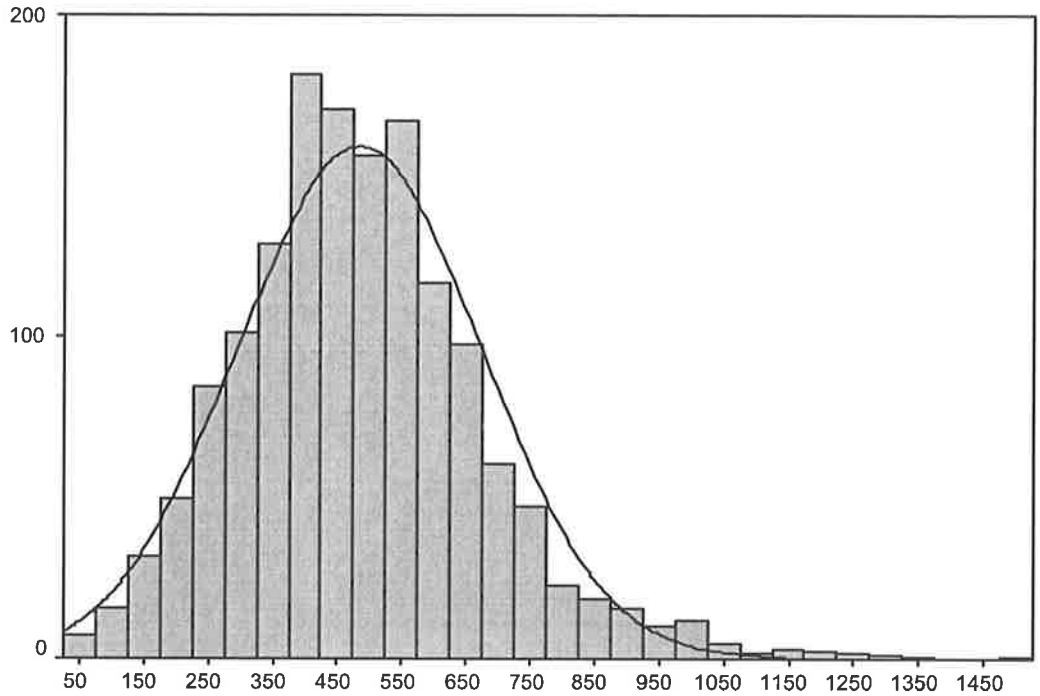
Table 4.18 presents the descriptive statistics for the output variable of RVUs per day. The table shows the mean number of RVUs per day remained stable between 1983 to 1993. In 1983 the mean RVUs per day was 429.85, increasing only slightly to 444.19 in 1998. Across the period 1983-1998 the mean number of RVUs per day was 437.22. The minimum-maximum ranges for this variable also remained fairly stable.

Table 4.18: Descriptive statistics for RVUs per day

	n	Mean	Min	Max	Std Dev	Skew
1983	266	429.85	33.75	1028.00	154.60	0.35
1988	149	454.81	67.50	846.80	146.90	0.20
1993	197	428.34	33.75	1070.00	195.37	0.54
1998	157	444.19	153.80	1029.00	140.58	0.49
1983-1998	769	437.22	33.75	1070.00	162.10	0.38

The frequency distribution of RVUs per day depicted in Figure 4.3 shows a reasonably normal distribution for this variable.

Figure 4.3: Frequency distribution of RVUs per day, 1983-98.



4.3.4 Output: gross billings per day

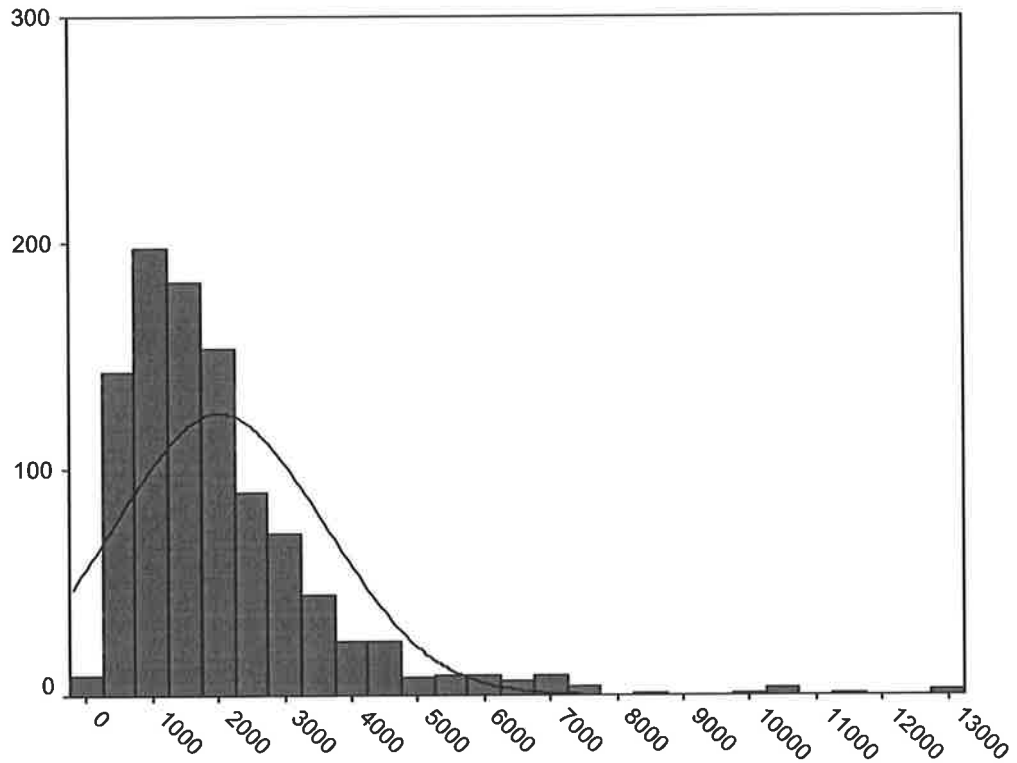
Table 4.19 presents the descriptive statistics for the output variable of $GB per day. The table shows a steady increase in the mean 'real' (accounted for inflation) $GB per day between 1983 and 1998, increasing from $1251.02 per day in 1983 to more than double, $2826.18 per day, in 1998 . The minimum-maximum ranges for this variable were similar in the last three survey years, quite large, most likely due to a high number of orthodontic services provided by private general dentists.

Table 4.19: Descriptive statistics for gross billings per day

	n	Mean	Min	Max	Std Dev	Skew
1983	270	$1251.02	$49.38	$590.75	$773.61	1.67
1988	191	$1559.59	$112.48	$10327.55	$1297.75	4.03
1993	227	$2268.18	$173.69	$11714.94	$1271.55	1.64
1998	301	$2826.18	$225.50	$13105.10	$2009.30	1.99
1983-1998	989	$2023.57	$49.38	$13105.10	$1580.29	2.52

The frequency distribution of $GB per day depicted in Figure 4.1 below shows a reasonably normal distribution of this variable.

Figure 4.4: Frequency distribution of gross billings per day, 1983-98.



4.3.5 Summary: output variables

Figure 4.5 summarises the proportional change in each of the mean productivity measures for each survey year with each data point starting at 0% change at the origin (1983). Estimates have been joined by lines to illustrate the trends in growth over time.

It appears that the mean number of patients and services per day followed similar time trends, both steadily declining across the 1983 to 1998 period. In contrast, RVUs per day remained relatively stable if not slightly positive as compared with patients or services per day, while 'real' $GB per day experienced significant positive growth between 1983 and 1998 increasing by 126% compared

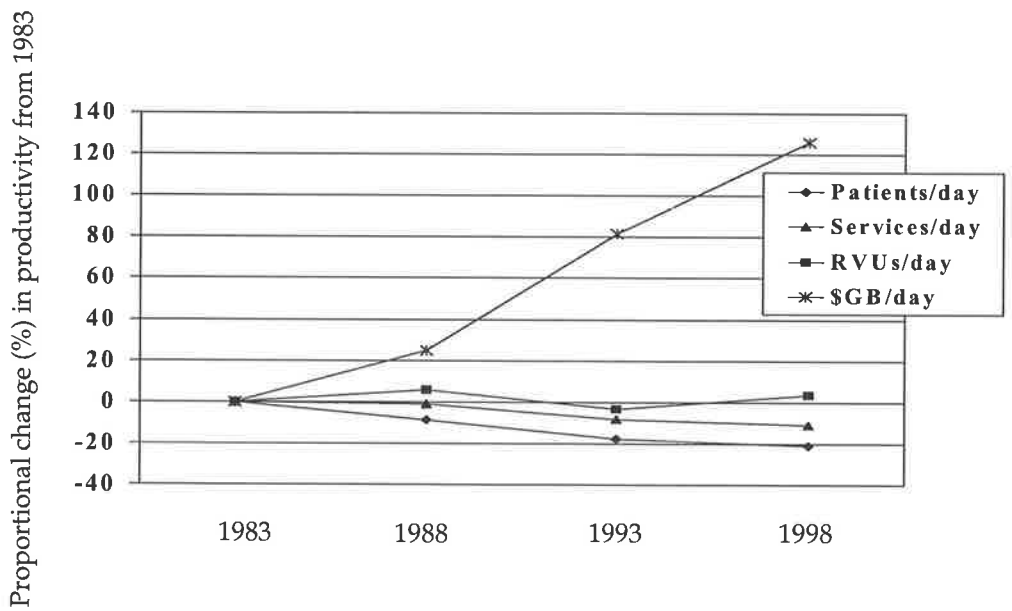


Figure 4.5: Summary of changes in the mean productivity measure during 1983-98.

4.4 Bivariate associations between input factors and outputs

Before presenting the results for bivariate associations between input factors and output, some explanation is required pertaining to the relationships and trends that were tested for statistical significance and how these have been presented in the tables of this section. The 1-way ANOVA analysis was used to test for significant differences in the mean productivity rates between subcategories of an input factor within each survey year (these relate to the symbols located horizontally under each respective survey year). The symbols which are directly next to the input factor, i.e. sex, male, female, are related to 1-way ANOVA analyses carried out to test for significance in the productivity time trend for that particular variable. The interaction variable depicts the 2-way ANOVA analyses that tested for significant differences in the productivity time trends between subcategories of the input factors.

4.4.1 Output: patients per day

Input: dentist characteristics

Table 4.20 presents the mean number of patients per day by dentist sex and years of experience across time. Both sex and experience of the dentist were significantly associated with the productivity variable of patients per day in all survey years, with the exception of 1998, in which sex was not significantly related to productivity. Productivity time trends were significant for male dentists, all experience categories and experience overall, but not for female dentists or sex overall. The significance of the interaction variable (sex x year) showed there was a significant difference in productivity time trends between the sexes over time, while the non-significance of the interaction variable (experience x year) showed there was no significant difference in productivity time trends between categories of experience over time.

Males saw on average 16.4 patients per day in 1983, almost four more patients per day than female dentists, who reported an average productivity rate of 12.6 patients per day in the same survey year. Both male and female dentists exhibited declining

productivity trends across the 1983 to 1998 period. Male dentists' average productivity rate declined by 3.7 patients per day between 1983 and 1998, while female dentists' average productivity rate was virtually unchanged, declining by a comparatively smaller amount of 0.3 patients per day. Due to the variation in the degree of decline between male and female dentists' productivity, the resultant effect was towards convergence in the productivity rate in 1998. By 1998 male dentists averaged 12.7 patients per day with female dentists not far behind with an average of 12.3 patients per day.

As expected, years of experience showed signs of an inverse relationship to productivity. In the first two years of the survey (1983, 1988), the peak productivity rate was 16.5 and 16.1 patients per day respectively, and occurred in the category of dentists with between 10 and 15 years of experience, while in 1993 and 1998, peak productivity was relatively lower at 14.0 and 13.2 patients per day, respectively, and occurred in the more experienced category of dentists, with between 15 and 25 years, or more than 25 years, of experience. This could possibly be related to a cohort effect of relatively more productive dental graduates of a certain era compared to dental graduates of other eras.

Table 4.20: Mean number of patients per day by dentist sex and years of experience, across time

	Output = number of patients per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sex^{ns}								
	***		***		*		ns	
Male***	16.4	6.0	14.8	5.7	13.3	4.9	12.7	4.8
Female^{ns}	12.6	4.9	12.1	4.3	11.9	4.2	12.3	4.6
(Sex x Year)**								
Years of experience ***								
	**		***		**		***	
≤ 5***	14.4	5.0	12.2	3.6	11.6	4.1	11.6	4.0
> 5 – 10***	16.2	5.4	13.7	4.8	12.3	3.5	12.1	4.1
> 10 – 15***	16.5	5.5	16.1	5.2	13.1	4.6	12.0	3.9
> 15 – 25**	15.8	6.8	14.9	5.8	14.0	4.8	13.2	5.2
25 +***	16.3	6.7	15.6	6.9	13.3	5.3	13.2	5.4
(Experience x Year)^{ns}								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.21 presents the mean number of patients per day by dentist country of birth and university of graduation, across time. Australian-born dentists reported consistently higher productivity rates compared to non-Australian-born dentists, in all survey years, with significant differences in the first three survey waves (1983, 1988, 1993). Productivity time trends were significant for Australian and non-Australian-born dentists and country of birth overall. The non-significance of the interaction variable (country of birth x year) showed there was no significant difference in productivity time trends between Australian- and non-Australian-born dentists over time.

Overall, both Australian- and non-Australian born dentists reported declining trends in productivity rates across time. The average productivity rate of Australian-born dentists declined from 16.4 (1983) to 12.9 (1998) patients per day, a decrease of 3.5 patients per day, while non-Australian-born dentists' average productivity declined slightly less, from 14.5 (1983) to 12.1 (1998) patients per day, a difference of 2.4 patients per day. The variation in the decline of productivity rates between the two categories of country of birth resulted in a trend towards convergence in productivity rates between Australian- and non-Australian-born dentists.

University of graduation did not show signs of significant association with productivity in any of the survey years. Productivity time trends were significant for all university categories and university overall but not for overseas-university-trained dentists. The non-significance of the interaction variable (university of graduation x year) showed there was no significant difference in productivity time trends between universities over time. Generally, there was a declining trend in productivity reported from overseas, Melbourne, South Australian, Queensland and Western Australian graduates. Sydney graduates' productivity declined steadily from 1983 to 1993, but remained stable in the last two waves of the survey in 1993 and 1998.

Table 4.21: Mean number of patients per day by dentist country of birth and university of graduation, across time

	Output = number of patients per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Born in Australia* **								
	**		***		***		ns	
Yes***	16.4	5.7	15.2	5.5	13.7	4.5	12.9	4.7
No**	14.5	6.7	13.0	5.7	12.0	5.1	12.1	4.8
(COB x Year)^{ns}								
University of graduation*								
	ns		ns		ns		ns	
O/S^{ns}	15.4	7.1	14.2	6.6	13.2	5.6	12.8	5.2
Syd***	15.7	6.3	14.8	6.4	12.5	5.1	12.7	5.0
Melb***	16.9	5.9	14.3	5.1	13.6	4.9	12.9	4.3
QLD**	15.7	6.4	14.5	5.2	13.4	4.5	12.4	3.9
Adel**	15.4	3.8	13.5	4.5	12.9	3.8	11.6	4.6
WA*	15.6	3.4	15.3	4.4	13.2	3.7	12.7	5.4
(University x Year)^{ns}								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: capital

Table 4.22 presents the mean number of patients per day by capital inputs: number of surgeries and number of x-ray units utilised, across time. The number of surgeries utilised was a consistently significant capital input of productivity in each consecutive survey year. Productivity time trends were significant for all categories of surgery utilisation and surgeries overall, while the non-significance of the interaction variable (surgery x year) showed there was no significant difference in productivity time trends between surgery utilisation categories over time. Increased utilisation of surgeries resulted in an increase in the average number of patients per day in all survey years. The variation in the average productivity rate between dentists reporting different categories of surgery utilisation (1, 2, 3+ surgeries) varied from as little as 0.1 patients per day in 1993 (when surgery use increased from 2 to 3+) to as high as 3.2 patients per day in 1983 (when surgery use increased from 2 to 3+ surgeries). The average number of patients per day for each category of surgery utilisation (1, 2, 3+) steadily decreased across time from 1983 to 1993. In 1998, the productivity rate of dentists who reported to use 3+ surgeries had increased to 15.3 patients per day from the 1993 productivity rate of 14.8 patients per day.

X-ray units were not significantly associated with productivity except in the last survey period (1998), where there was a significant association ($p<0.01$). Productivity time trends were significant for all categories of x-ray unit utilisation and x-rays overall, in addition to the interaction variable (x-ray x year), which showed there was a significant difference in productivity time trends between x-ray utilisation categories over time. Generally, the average productivity rate of dentists increased with increased x-ray unit utilisation but declined for each category of x-ray unit utilisation (1, 2, 3+) across time. Similar to surgery use, the trend was consistent with the exception of 1998, where productivity increased marginally for the category of 3+ x-ray units from 14.0 in 1993 to 14.1 patients per day in 1998.

Table 4.22: Mean number of patients per day by capital: number of surgeries and number of x-ray units utilised, across time

	Output = number of patients per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Number of surgeries* **	***		***		***		***	
1***	13.7	4.8	12.7	5.1	11.8	4.5	11.7	4.4
2***	17.2	5.6	15.8	4.6	14.7	4.5	13.7	4.5
3 + ***	20.4	7.9	18.0	5.8	14.8	5.2	15.3	4.2
(Surgery x Year)^{ns}								
Number of x-ray units* **	ns		ns		ns		**	
1***	15.2	6.0	14.0	5.9	12.1	5.2	11.4	4.5
2***	16.4	5.8	13.8	5.1	13.2	4.3	13.0	4.7
3 + ***	16.7	6.2	15.8	5.6	14.0	4.7	14.1	4.2
(Xray x Year)*								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: labour

Table 4.23 presents the mean number of patients per day by number of dentist chairside hours and extra- and intra-oral auxiliaries per dentist.

Overall, both labour inputs of dentist hours per day chairside and number of extra-oral auxiliaries per dentist were consistently significant inputs to productivity at each level of input use (except for 0 extra-oral auxiliaries). Productivity time trends were significant for the >4-8 and 8 + categories of dentist hours per day chairside, the 1, 2 and 3 + categories of extra-oral auxiliary utilisation and dentist hours per day

chairside overall, while the non-significance of both interaction variables: (hours x year) and (auxiliary (E-O) x year) showed there was no significant difference in productivity time trends between dentist hours chairside and number of extra-oral auxiliary categories over time. The intra-oral auxiliary variable did not exhibit significant associations with productivity in individual survey years or across time.

Not surprisingly, an increase in dentist hours per day chairside resulted in an increase in the average productivity rate. Across all survey years, average productivity more than doubled when dentist hours per day were increased from less than four hours per day to between four and eight hours per day. For dentists who reported in excess of eight chairside hours per day, the increased productivity rate compared to dentists who reported working between four and eight hours was in the range of 4.0 patients per day in 1983 and 2.7 patients per day in 1998. For the categories of dentists who reported working between four and eight hours, or more than eight hours per day, productivity steadily declined from 14.7 (1983) to 11.9 patients per day (1998) and from 18.7 (1983) to 14.6 patients per day (1998), respectively. Dentists who reported working less than four hours per day exhibited a less obvious trend, with average productivity marginally increasing between 1983 and 1988, decreasing between 1988 and 1993 and remaining stable thereafter.

Slightly less consistent but still evident was the pattern between productivity and increased number of auxiliaries per dentist within each survey year. Additionally, the average productivity rate steadily declined per each category of number of auxiliaries across time.

Table 4.23: Mean number of patients per day by number of chairside hours worked per day and number of auxiliaries worked per dentist, across time

	Output = number of patients per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dentist hrs/day* **								
	***		***		***		***	
≤4[ns]	6.3	3.2	6.5	3.8	5.4	2.4	5.4	3.2
>4 – 8***	14.7	4.8	13.3	4.8	12.4	3.9	11.9	4.6
8 + ***	18.7	5.9	17.0	5.5	15.8	4.1	14.6	3.7
(Hours x Year)[ns]								
No. auxiliaries (E-O)* **								
	***		***		***		***	
0[t]	6.5	0.7	-	-	8.5	1.7	10.9	5.4
1**	13.0	5.5	12.1	6.0	9.6	4.5	12.2	3.9
2***	17.0	5.8	15.4	5.8	13.2	4.0	14.2	4.4
3 + ***	17.0	5.1	15.8	5.2	14.2	4.5	13.1	4.5
(Aux [E-O] x Year)[ns]								
No. auxiliaries (I-O)[ns]								
	ns		ns		ns		*	
0[t]	15.8	6.0	14.9	5.8	13.0	4.8	12.6	4.7
1[ns]	16.3	3.2	13.6	4.7	12.8	3.7	14.2	4.5
2 + [ns]	13.7	2.9	17.3	4.6	12.4	2.8	14.2	6.4
(Aux [I-O] x Year)[ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)
t (not computed due to small n)

Input: practice characteristics

Presented in Table 4.24 are the mean number of patients per day by configuration, size and state location. Neither of the two practice characteristics comprising configuration and size of group practice were significant in any of the individual survey years, while state location was significant in 1993. Productivity time trends were significant for the solo, partnership, associate and assistant categories of practice configuration, and for the 0 and 1 categories of practice size and all states with the exception of ACT, Tas and NT. The non-significance of interaction variables (configuration x year, size x year, state x year) showed there was no significant difference in productivity time trends between configuration types, practice sizes and state locations over time.

Table 4.24: Mean number of patients per day by practice configuration, size and state location of main practice, across time

	Output = number of patients per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Configuration^{ns}								
	ns		ns		ns		ns	
Solo***	16.0	6.1	14.6	5.5	13.0	4.8	12.7	4.8
Partner**	15.6	6.1	14.3	7.2	12.4	4.8	12.1	3.5
Associate*	14.9	5.4	14.7	5.1	13.3	4.5	12.7	5.8
Assistant***	16.1	6.7	14.1	5.3	13.4	5.0	12.5	4.6
Locum^{ns}	17.1	5.8	13.7	5.1	13.8	6.4	13.3	3.5
(Configuration x Year)^{ns}								
No. other dentists^{ns}								
	ns		ns		ns		ns	
0***	15.9	6.3	15.0	5.7	13.0	5.3	11.9	5.2
1***	16.7	5.4	14.8	5.0	12.9	4.5	12.3	4.4
2^{ns}	15.1	6.1	13.8	5.0	13.4	4.6	12.6	4.0
3^{ns}	14.6	3.0	13.7	5.0	13.4	4.1	14.1	4.5
4 + ^{ns}	16.0	2.1	13.9	3.6	11.4	2.3	12.4	5.0
(Size x Year)^{ns}								
Location of main practice *								
	ns		ns		*		ns	
ACT^{ns}	14.8	4.3	14.7	2.8	16.0	2.7	12.8	3.8
NSW***	15.1	6.4	14.5	6.1	12.2	5.1	12.5	4.9
Vic***	17.5	6.0	14.7	5.8	14.0	4.9	12.5	4.1
QLD*	15.9	7.0	14.2	6.0	13.9	5.2	12.9	4.9
SA**	15.4	4.4	13.4	4.9	12.2	3.2	11.6	4.6
WA*	15.2	3.8	14.2	4.0	12.7	3.5	12.7	5.5
Tas^{ns}	14.7	5.9	17.3	5.9	14.8	5.8	17.3	3.3
NT^{ns}	14.2	1.2	13.5	3.3	13.9	5.3	11.3	2.5
(State x Year)^{ns}								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.25 presents the mean number of patients per day by waiting time for an appointment and perceived level of busyness. Length of wait for an appointment was strongly associated with productivity. Generally, an increase in the length of wait for an appointment resulted in an increase in the number of patients per day, with the exception of four or more weeks' length of wait in 1983 and 1993, where productivity was lower compared to the category of two to four weeks' length of wait. A steady decline in productivity levels was evident within each category for length of wait, across time. Perceived level of busyness reported by the dentist was a strongly significant factor associated with productivity in each survey year. Significant productivity time trends were evident for the categories of less busy, as

busy and more busy than would like, while the non-significance of the interaction variable (busyness x year) showed there was no significant difference in productivity time trends between categories of perceived busyness over time. As expected, average number of patients per day increased with increased level of perceived busyness. That is, the average productivity rate for the 'as busy' category was consistently higher than the average productivity rate for the 'less busy' category and consistently lower than the 'more busy' category. Average productivity steadily declined across successive periods of the survey for each category of perceived busyness level. Dentists reporting 'as busy' declined from an average of 17.2 (1983) to 13.3 (1998) patients per day, 'less busy' declined from an average of 13.4 (1983) to 10.3 (1998) patients per day and "more busy" declined from an average of 20.0 (1983) to 15.2 (1998) patients per day.

Significant productivity time trends were evident for all categories of waiting time and perceived busyness, and waiting time and perceived busyness overall. The non-significance of the interaction variables (wait x year) and (busyness x year) suggest there was no significant difference in productivity time trends between the categories of length of wait over time and perceived busyness over time.

Table 4.25: Mean number of patients per day by waiting time for appointment and perceived busyness, across time

	Output = number of patients per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Length of wait (wks)* **	***		***		***		***	
0 - 0.9***	14.3	5.6	13.1	5.2	12.0	4.7	11.4	4.
1.0 – 1.9**	16.8	5.1	15.6	5.9	14.2	3.8	13.6	5.3
2.0 – 3.9***	19.2	6.3	16.3	6.0	15.6	5.0	14.2	4.7
4.0 + ***	18.9	4.6	17.4	4.1	14.3	4.0	14.8	3.5
(Wait x Year) ^{ns}								
Perceived busyness * **	***		***		***		***	
Less busy ***	13.4	5.5	11.9	4.5	10.8	4.5	10.3	3.3
As busy ***	17.2	5.5	15.7	5.6	14.3	4.2	13.3	4.9
More busy ***	20.0	6.4	18.5	5.9	16.2	4.5	15.2	5.1
(Busyness x Year)^{ns}								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.4.2 Output: services per day

Input: dentist characteristics

Table 4.26 presents the mean number of services per day by dentist sex and years of experience over time. Sex of the dentist was significantly associated with productivity in 1983 and 1988. Male dentists provided on average a higher number of services per day compared to female dentists. The largest variation in productivity between male and female dentists was in 1983, when male dentists averaged 26.6 services per day compared to female dentists, whose average productivity rate was 21.5 services per day. Productivity time trends were significant for male dentists, the experience categories of >5-10, >10-15 and 25+ and sex overall, but not for female dentists, the remaining experience categories or experience overall. The non-significance of the interaction variables (sex x year) and (experience x year) showed there was no significant difference in productivity time trends between the sexes or experience categories over time.

Years of experience was significantly associated with productivity in all survey years with the exception of 1983. In the first three waves of the survey (1983, 1988, 1993), dentists with 10 to 15 years of experience had the highest productivity rate with an estimated 30.1, 28.7 and 25.6 average number of services per day, respectively. In the last survey wave (1998) the more experienced category of dentists with 15 to 25 years of experience had the highest average productivity rate of 24.4 services per day.

There was a significant trend of declining productivity across time for male dentists and for dentists with >5-10, >10-15 and 25 years of experience. However, there were no consistent trends in productivity across time for the remaining sex and experience categories.

Table 4.26: Mean number of services per day by dentist sex and years of experience, across time

	Output = number of services per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sex**								
	**		*		ns		Ns	
Male***	26.6	10.4	26.2	9.4	24.3	8.9	23.5	9.4
Female[ns]	21.5	9.4	23.2	10.5	22.2	9.7	22.0	10.1
(Sex x Year)[ns]								
Years of experience[ns]								
	ns		***		***		***	
≤ 5[ns]	24.0	9.4	22.7	7.7	21.0	8.0	21.5	7.7
> 5 – 10*	26.5	10.2	25.9	9.5	24.2	8.2	22.2	9.4
> 10 – 15**	30.1	10.5	28.7	10.3	25.6	9.9	23.7	9.2
> 15 – 25[ns]	24.9	10.6	26.9	9.9	24.9	8.6	24.4	9.4
25 + *	26.1	10.8	25.6	9.6	23.5	7.3	23.8	11.0
(Experience x Year)[ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.27 presents the mean number of services per day by dentist country of birth and university of graduation, across time. Country of birth was significantly associated with productivity in all survey years. Australian-born dentists provided on average a consistently higher number of services per day compared to non-Australian-born dentists. Both groups exhibited a declining productivity trend across time, with the average number of services per day declining from 27.1 (1983) to 24.4 (1998) for Australian-born dentists and declining from 23.5 (1983) to 21.1 (1998) for non-Australian-born dentists. However, significant productivity time trends were evident only for Australian born dentists, Sydney, Melbourne and Queensland graduates and country of birth overall. University of graduation exhibited only a weakly significant ($p<0.05$) association with productivity in the 1993 survey, in which Queensland graduates delivered the highest average number of services per day (26.9).

Table 4.27: Mean number of services per day by dentist country of birth and university of graduation, across time

	Output = number of services per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Born in Australia* **								
Yes***	27.1	10.2	27.3	9.4	25.3	8.5	24.4	9.4
No[ns]	23.5	10.7	22.4	9.2	21.5	9.7	21.1	9.5
(Country x Year)[ns]								
University of graduation[ns]								
O/S[ns]	24.0	9.9	24.5	10.1	21.6	9.2	22.6	12.6
Syd**	26.6	11.3	25.7	10.6	24.0	10.0	24.4	9.3
Melb***	28.0	9.9	24.9	8.5	24.9	7.9	22.1	8.1
QLD***	25.2	11.2	27.3	10.0	26.9	8.4	22.7	8.1
Adel[ns]	25.0	8.3	26.9	7.6	22.9	7.7	23.6	9.1
WA[ns]	24.1	6.3	25.8	8.6	22.5	9.5	22.2	11.1
(University x Year)[ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: capital

Table 4.28 presents the mean number of services per day by number of surgeries and x-ray units, across time. Both of the capital inputs, number of surgeries and x-ray units utilised by the dentist were significantly associated with productivity in each of the survey years. Productivity time trends were similar for both surgery and x-ray unit capital, with significance found in all categories of input usage (with the exception of the single surgery category) and surgery and x-ray unit utilisation overall, but non-significance in the interaction variables of (surgery x year) and (x-ray x year) suggesting no significant difference in productivity time trends between categories of input usage over time.

Generally, increased utilisation of surgeries resulted in an increase in the average number of services per day, consistently across time. However, the increased productivity or *marginal productivity* resulting from increased surgery utilisation, that is an increase from one to 2 surgeries, or an increase from 2 to 3+ surgeries, declined across time. The difference in the productivity rate in 1983 between utilising one, and utilising 3+ surgeries was 7.2 services per day. By 1998, the difference in the productivity rate between utilising one, and utilising three or more surgeries was just

2.7 services per day.

X-ray unit utilisation followed a similar pattern, with increased x-ray unit utilisation resulting in an increase in the average number of services per day, consistently across time. The increased productivity or *marginal productivity* from increased x-ray unit utilisation again occurred in smaller increments across time, decreasing from a 5.5 services per day difference in the productivity rate between utilising one x-ray unit (24.2 services per day) and utilising 3+ x-ray units (29.7 services per day) in 1983, to a 4.5 services per day difference in the productivity rate between utilising one x-ray unit (20.3 services per day) and utilising 3+ units (24.8 services per day) in 1998.

Table 4.28: Mean number of services per day by capital: number of surgeries and number of x-ray units utilised, across time

	Output = number of services per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Number of surgeries* **								
1[ns]	23.6	9.5	23.6	9.1	22.4	9.0	21.2	8.6
2**	27.6	10.4	26.6	8.7	25.5	8.8	26.1	9.7
3 + *	30.8	11.7	32.6	9.8	27.5	9.2	23.9	9.4
(Surgery x Year) [ns]								
Number of x-ray units* **								
1***	24.2	9.9	23.1	9.3	21.7	9.4	20.3	8.4
2*	26.6	8.7	25.6	9.2	24.7	8.2	25.4	9.5
3 + **	29.7	12.2	29.8	9.2	25.6	9.0	24.8	9.7
(X-ray x Year)[ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: labour

Table 4.29 presents the mean number of services per day by number of dentist chairside hours and intra- and extra-oral auxiliaries per dentist. There were significant associations between labour inputs (dentist chairside hours and number of auxiliaries per dentist) and productivity in all survey years. Productivity time trends were significant for the >4-8 categories of dentist hours per day chairside, the '2' category of extra-oral auxiliary utilisation and dentist hours per day chairside overall, while the non-significance of both interaction variables (hours x year) and (auxiliary (E-O) x year) showed there was no significant difference in productivity

time trends between dentist hours chairside and number of extra-oral auxiliary categories over time. The intra-oral auxiliary variable did not exhibit significant associations with productivity in individual survey years or across time, similarly to the bivariate testing when productivity was measured as patients per day. Predictably, an increase in the number of dentist hours per day resulted in an increase in the average number of services per day, consistently across time. As the number of hours per day increased from ≤ 4 to 8+, the average productivity rate increased from 11.3, 12.4, 14.4 and 14.2 (1983, 1988, 1993, 1998) services per day to 31.0, 29.3, 27.6 and 27.4 (1983, 1988, 1993, 1998) services per day, respectively. The category of dentists who worked up to four hours per day became relatively more productive across time, their productivity changing from an average of 11.3 services per day (1983) to 14.2 services per day (1998), while the category of dentists who worked more than eight hours per day became relatively less productive across time, increasing their productivity from an average of 31.0 services per day (1983) to 27.4 services per day (1998). Again, an increase in auxiliary utilisation resulted in a consistent increase in productivity for each of the survey years. There did not appear to be, however, a consistent trend in productivity for each of the categories of auxiliary utilisation across time.

Table 4.29: Mean number of services per day by number of chairside hours worked per day and number of auxiliaries worked per dentist, across time

	Output = number of services per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dentist hrs/day* **								
	***		***		***		***	
≤4[ns]	11.3	4.4	12.4	7.3	14.4	8.3	14.2	6.0
>4 – 8***	23.8	8.0	24.0	8.5	22.9	8.4	20.4	8.4
8 +[ns]	31.0	9.9	29.3	9.1	27.6	8.4	27.4	9.3
(Hours x Year)[ns]								
No. auxiliaries (E-O)* **								
	***		*		***		***	
0[t]	12.0	-	-	-	14.0	-	-	-
1[ns]	20.0	9.0	18.6	10.5	15.8	7.7	19.2	11.7
2***	27.6	9.8	21.2	7.9	24.1	9.2	21.2	7.3
3 +[ns]	27.4	11.6	23.2	8.0	25.3	7.8	25.3	9.4
(No.aux [E-O] x Year)[ns]								
No. auxiliaries (I-O)[ns]								
	ns		ns		ns		ns	
0[ns]	25.5	10.6	21.6	8.6	23.3	9.0	22.9	9.3
1[ns]	29.6	9.8	21.8	7.3	22.6	8.7	21.2	7.6
2 +[ns]	22.3	5.8	-	-	27.6	5.6	29.7	11.4
(No.aux [I-O] x Year)[ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)
t (not computed due to small n)

Input: practice characteristics

Table 4.30 presents the mean number of services per day by practice configuration, size and state location, across time. There was no significant association between the practice characteristics of configuration, number of other dentists and state location (with the exception of 1993) with productivity measured by number of services per day in any of the survey years. Significant productivity time trends were found for solo dentists, those reporting to have 0 other dentists sharing costs in the practice and all states with the exception of WA, Tas and NT, which may be due to small n. All three interaction variables (configuration x year, size x year and state x year) were not found to be significant. Partnership arrangements tended to have the highest or second highest average number of services per day.

Table 4.30: Mean number of services per day by practice configuration, size and perceived busyness, across time

	Output = number of services per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Configuration[ns]								
	Ns		ns		ns		ns	
Solo***	25.8	10.8	25.3	9.3	23.9	9.4	21.8	9.0
Partner[ns]	27.7	10.2	26.9	10.7	24.3	8.8	25.8	8.7
Associate[ns]	26.3	9.2	25.8	8.7	22.6	8.7	23.9	11.3
Assistant[ns]	24.7	9.4	25.9	9.7	24.8	8.9	24.2	9.6
Locum[ns]	30.7	12.6	26.0	13.7	21.6	8.6	21.3	7.3
(Configuration x Year)[ns]								
No. other dentists[ns]								
	Ns		ns		ns		ns	
0***	28.1	8.8	28.0	7.7	26.5	7.5	25.5	8.5
1[ns]	26.8	9.3	27.0	8.9	23.4	8.7	24.3	10.1
2[ns]	27.7	11.1	24.7	9.0	25.3	9.1	24.8	8.7
3[ns]	24.1	10.0	27.6	10.0	26.2	9.4	25.3	8.4
4 +[ns]	27.0	10.4	27.5	12.7	26.3	6.7	23.0	7.4
(Size x Year)[ns]								
Location of main practice[ns]								
	Ns		ns				ns	
ACT*	29.9	6.7	28.2	6.1	27.5	6.6	21.0	7.1
NSW**	25.5	11.6	25.0	10.4	22.9	10.1	23.7	9.8
Vic***	28.0	9.7	25.1	8.6	24.2	8.0	22.2	9.6
QLD*	25.6	11.2	28.1	10.8	27.1	8.9	23.2	8.6
SA*	25.0	9.1	27.4	8.3	22.5	7.2	26.1	9.6
WA[ns]	24.0	7.6	25.0	8.0	21.9	9.1	22.4	10.4
Tas[ns]	22.1	6.9	26.4	11.5	26.4	7.1	23.4	6.1
NT[ns]	30.2	6.1	26.5	9.2	26.9	10.5	18.5	6.8
(State x Year)[ns]								

***(p<0.001); **(p<0.01); *(p<0.05); ANOVA test
ns (not significant)

Table 4.31 presents the mean number of services per day by waiting time and perceived busyness, across time. Length of wait for an appointment was strongly associated with productivity, consistently in each survey year. Generally, an increase in the length of wait for an appointment resulted in an increase in the number of services per day, with a couple of exceptions: 4.0+ weeks' length of wait in 1993 and 2.0 to 3.9 weeks' length of wait in 1998. Perceived level of busyness reported by the dentist, as expected, resulted in an increase in the average number of services per day with an increased level of perceived busyness. The average productivity rate generally declined across successive periods of the survey for each category of perceived busyness level (less busy, as busy, more busy), but this productivity time

trend was only statistically significant for the category of dentists reporting to be as busy as they would like. Dentists who reported to be as busy as they would like had decreased average productivity ranging from 28.4 (1983) to 24.6 (1998) services per day, while dentists who reported to be less busy than they would like had decreased average productivity from 21.8 (1983) to 20.1 (1998) services per day. The dentists who reported to be more busy than they would also like had decreased average productivity from 32.0 (1983) to 26.1 (1998) services per day.

Table 4.31: Mean number of services per day by waiting time for appointment and perceived busyness, across time

	Output = number of services per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Length of wait (wks)* **								
0 - 0.9 ns	23.4	10.3	23.3	9.1	22.4	8.5	22.1	8.7
1.0 – 1.9 ns	27.0	8.3	27.3	8.3	26.0	8.3	25.9	9.7
2.0 – 3.9***	31.7	10.0	29.3	10.7	27.5	9.1	23.4	9.9
4.0 + ns	30.2	9.4	31.5	6.8	26.0	10.6	28.3	10.4
(Wait x Year) ns								
Perceived busyness*								
Less busy ns	21.8	9.3	21.5	8.4	20.9	8.7	20.1	7.7
As busy***	28.4	9.9	27.8	9.0	26.0	8.8	24.6	9.7
More busy***	32.0	11.3	32.2	10.4	26.9	8.5	26.1	11.3
(Busyness x Year) ns								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.4.3 Output: RVUs per day

Input: dentist characteristics

Table 4.32 presents the mean number of RVUs per day by dentist sex and years of experience, across time. Both sex and experience of the dentist were significantly associated with the productivity variable of RVUs per day in all years of the survey with the exception of 1998, in which sex was not significantly related to productivity. Significant productivity time trends were evident for the experience categories of >5-10 and >15-25 years, and for sex and experience overall. No significance was found for the remaining experience groups and for the interaction variables (sex x year) and (experience x year).

Male dentists delivered on average 514.5 RVUs per day in 1983, almost 25% more RVUs per day than female dentists, who reported an average productivity rate of 412.1 RVUs per day in the same survey year. Male dentists exhibited a declining productivity trend across the 1983 to 1998 period compared to female dentists, whose average productivity remained stable. Male dentists' average productivity rate declined by 56.9 RVUs per day between 1983 and 1998, while female dentists' average productivity rate remained reasonably stable, increasing by 2.4 RVUs. Due to the variation in the degree of change between male and female dentists' productivity, the resultant effect was towards convergence in the productivity rate in 1998. By 1998 male dentists averaged 457.6 RVUs per day with female dentists not far behind with an average of 414.5 RVUs per day.

As expected, years of experience showed signs of an inverse relationship to productivity. In the first three years of the survey (1983, 1988, 1998) the peak productivity rate was 565.7, 601.9 and 479.8 RVUs per day respectively, and occurred in the category of dentists with between 10 and 15 years of experience. In 1998, peak productivity was relatively lower at 463.6 RVUs per day, and occurred in the more experienced category of dentists, with between 15 and 25 years of experience.

Table 4.32: Mean number of RVUs per day by dentist sex and years of experience, across time

	Output = number of RVUs per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sex* **								
Male[ns]	514.5	199.7	547.2	194.4	454.5	159.3	457.6	175.6
Female[ns]	412.1	186.4	457.2	195.0	394.0	169.5	414.5	194.8
(Sex x Year)[ns]								
Years of experience** ns				***		***		***
≤ 5[ns]	474.9	165.4	479.9	191.6	386.2	138.2	414.6	159.6
> 5 – 10*	529.9	194.8	534.2	187.2	445.6	138.0	451.9	199.8
> 10 – 15[ns]	565.7	189.8	601.9	196.6	479.8	178.7	449.1	171.3
> 15 – 25*	476.8	216.3	553.8	190.7	457.2	156.9	463.6	164.5
25 + [ns]	493.3	219.0	520.0	200.4	443.9	169.4	444.2	204.8
(Experience x Year) [ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.33 presents the mean number of RVUs by dentist country of birth and university of graduation, across time. Australian-born dentists reported consistently higher productivity rates compared to non-Australian-born dentists, in all survey years; however, the differences were significant in the last three survey waves (1988, 1993, 1998). Overall, even though both Australian and non-Australian-born dentists reported declining trends in productivity rates across time, those trends were not statistically significant. The average productivity rate of Australian-born dentists declined from 514.5 (1983) to 468.9 (1998) RVUs per day, a decrease of 45.6 RVUs per day, while non-Australian-born dentists' average productivity declined slightly more, from 473.1 (1983) to 415.1 (1998) patients per day, a difference of 58.0 RVUs per day.

University of graduation did not show signs of significant association with productivity in any of the survey years. In addition, there were no significant productivity time trends evident in any of the categories for country of birth, university of graduation or the interaction variables of (country x year) and (university x year).

Table 4.33: Mean number of RVUs per day by dentist country of birth and university of graduation, across time

	Output = number of RVUs per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Born in Australia[ns]								
	ns		***		**		**	
Yes[ns]	514.5	201.2	556.1	196.0	462.5	154.9	468.9	168.7
No[ns]	473.1	197.6	489.7	190.3	409.4	171.1	415.1	194.1
(Country x Year) [ns]								
University of graduation[ns]								
	ns		ns		ns		ns	
O/S[ns]	477.4	194.4	546.6	226.3	422.0	173.9	433.5	236.7
Syd[ns]	507.8	212.4	532.6	224.4	435.1	183.3	472.6	184.6
Melb[ns]	529.8	180.3	493.7	155.4	448.0	139.0	436.7	168.0
QLD[ns]	504.1	246.6	545.3	181.0	494.5	146.2	428.8	158.5
Adel[ns]	456.2	121.2	574.5	182.0	430.5	134.6	449.9	144.6
WA[ns]	499.7	153.8	571.1	163.4	435.0	164.2	449.4	177.7
(University x Year) [ns]								

***(p<0.001), **(p<0.01); ANOVA test
ns (not significant)

Input: capital

Table 4.34 presents the mean number of RVUs per day by number of surgeries utilised and number of x-ray units, per dentist, across time. The number of surgeries utilised was a consistently significant capital input of productivity in each consecutive survey year. Increased utilisation of surgeries resulted in an increase in the average number of RVUs per day, in all survey years. This was with the exception of 1998, where use of 3+ surgeries resulted in 49.7 RVUs per day less than use of 2 surgeries. The variation in the average productivity rate between dentists reporting different categories of surgery utilisation (1, 2, 3+ surgeries) varied from as little as 33.5 RVUs per day in 1993 (when surgery use increased from 2 to 3+ surgeries) to as high as 124.8 RVUs per day in 1983 (when surgery use increased from 2 to 3+ surgeries). A significant productivity time trend was evident for surgeries overall but not for individual categories of surgery utilisation or for the interaction variable of (surgery x year).

X-ray units were consistently significantly associated with productivity in all survey years. Generally, the average productivity rate of dentists increased with increased number of x-ray unit utilisation but again with the exception of 1998 where the use of 3+ x-ray units resulted in 31.4 RVUs per day less than use of two x-ray units. In contrast to surgery input, there was a significant productivity time trend evident for number of x-rays overall, a weakly significant trend for each category of x-ray unit utilisation and a strongly significant trend for the interaction variable (x-ray x year), suggesting a significant difference in productivity time trends between categories of x-ray unit utilisation over time.

Table 4.34: Mean number of RVUs per day by capital: number of surgeries and number of x-ray units utilised, across time

	Output = number of RVUs per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Number of surgeries*	***		***		**		***	
1[ns]	460.5	178.8	478.4	179.6	413.7	157.9	406.6	157.1
2[ns]	518.2	188.9	569.9	193.6	473.7	156.0	509.3	177.2
3 +[ns]	643.0	263.0	664.5	173.0	507.2	178.6	459.6	183.6
(Surgery x Year)[ns]								
Number of x-ray units*	***		***		***		***	
1*	462.0	183.9	475.2	183.7	394.5	163.2	398.6	172.6
2*	517.4	166.5	532.5	197.7	458.6	156.7	499.2	175.8
3 + *	579.1	245.3	624.6	182.1	480.6	155.7	467.8	168.6
(Xray x Year) ***								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: labour

Table 4.35 presents the mean number of RVUs by number of dentist chairside hours and intra- and extra-oral auxiliaries per dentist. Overall, all three labour inputs of dentist hours per day chairside and number of extra-oral and intra-oral auxiliaries per dentist were consistently significant inputs to productivity for each type of input use, and across time. Productivity time trends were significant for the ≤ 4 and 8+ categories of dentist hours per day chairside but not for individual categories of auxiliary utilisation. The non-significance of all interaction variables (hours x year, auxiliary (E-O) x year, auxiliary (I-O) x year) showed there was no significant difference in productivity time trends between dentist hours chairside categories and number of extra-oral auxiliary categories over time. The intra-oral auxiliary variable did not exhibit significant associations with productivity in individual survey years, similarly to the bivariate testing when productivity was measured as services per day and patients per day.

Not surprisingly, an increase in dentist hours per day chairside resulted in an increase in the average productivity rate. The gain in RVUs per day resulting from an increase in dentist hours per day from ≤ 4 hours to >4-8 hours decreased across time. In 1983, the marginal productivity gain was 238.6 RVUs per day, while in 1998 the marginal productivity gain was 135.8 RVUs per day. For dentists who reported

in excess of 8 chairside hours per day, the increased productivity rate compared to dentists who reported working between >4-8 hours was in the range of 148.4 RVUs per day in 1983 and 119.9 RVUs per day in 1998. For the categories of dentists who reported working >4-8 hours, or 8+ hours per day, productivity steadily declined from 455.9 (1983) to 403.6 RVUs per day (1998) and from 604.3 (1983) to 523.5 RVUs per day (1998), respectively. Dentists who reported working ≤ 4 hours per day exhibited a different trend, with average productivity marginally increasing between 1983 and 1988, decreasing between 1988 and 1993 and increasing again in 1998.

Productivity generally increased with increased auxiliary utilisation and overall average productivity rates per each category of auxiliary utilisation declined across the 1983 to 1998 period, with some inconsistencies in the 1988 and 1993 survey years.

Table 4.35: Mean number of RVUs per day by number of chairside hours worked per day and number of auxiliaries worked per dentist, across time

	Output = number of RVUs per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dentist hrs/day* **								
	***		***		***		***	
≤4***	217.3	89.3	266.0	140.7	255.4	146.0	267.8	117.8
>4 – 8[ns]	455.9	160.9	494.2	173.5	421.5	142.2	403.6	164.1
8 + *	604.3	199.5	614.1	188.2	521.1	153.0	523.5	174.3
(Hours x Year) [ns]								
No. auxiliaries (E-O)* **								
	***		***		ns		**	
0[t]	306.3	148.4	-	-	247.5	-	-	-
1[ns]	368.8	155.0	358.3	146.3	428.6	171.3	357.2	91.5
2[ns]	447.4	148.9	439.9	137.0	376.1	179.9	419.4	121.6
3 +[ns]	460.6	155.7	511.2	122.2	440.0	212.5	478.9	151.4
(No.aux[E-O] x Year)[ns]								
No. auxiliaries (I-O)* **								
	ns		*		*		ns	
0[ns]	426.9	155.1	452.1	145.7	406.5	182.9	443.9	141.5
1[ns]	579.8	182.9	550.9	62.6	605.2	282.7	441.6	166.2
2 + [ns]	373.3	44.7	-	-	441.6	266.4	500.4	26.7
(No.aux[I-O] x Year)[ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)
t (not computed due to small n)

Input: practice characteristics

Table 4.36 presents the mean number of RVUs by practice configuration, size and state location, across time. All three practice characteristics were not found to be significant in any of the survey years, while location overall was weakly significant across time. An overall decline in productivity across time was noted for all configuration types and most categories of group practice size; however, these trends were not statistically significant.

Table 4.36: Mean number of RVUs per day by practice configuration, size and state location, across time

	Output = number of RVUs per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Configuration[ns]								
	ns		ns		ns		ns	
Solo[ns]	484.4	197.7	535.8	177.4	442.6	162.7	426.4	167.9
Partner[ns]	509.4	198.2	555.6	228.6	449.8	151.6	495.2	178.5
Associate[ns]	522.1	190.6	530.8	201.7	432.6	156.5	448.6	183.5
Assistant[ns]	515.1	227.0	532.5	216.1	453.4	172.1	476.0	200.3
Locum[ns]	552.3	199.9	470.2	230.5	342.9	136.1	461.4	155.1
(Configuration x Year)[ns]								
No. other dentists[ns]								
	ns		ns		ns		ns	
0[ns]	429.8	149.9	472.4	144.4	429.7	159.6	426.9	144.7
1[ns]	517.1	189.3	535.9	163.7	434.5	158.5	424.3	177.8
2[ns]	554.5	222.4	541.4	210.7	461.5	127.2	462.2	150.2
3[ns]	445.0	117.4	544.6	187.9	447.0	144.1	475.8	136.2
4 +[ns]	491.1	181.8	513.7	199.9	455.4	103.9	431.9	158.6
(Size x Year)[ns]								
Location of main practice*								
	ns		ns		ns		ns	
ACT[ns]	544.0	223.1	547.4	146.8	497.9	142.8	331.4	85.5
NSW[ns]	493.0	217.5	520.4	210.9	422.4	178.9	458.3	192.9
Vic[ns]	525.9	172.9	501.4	159.9	440.7	148.5	429.3	192.1
QLD[ns]	527.9	251.2	560.9	201.3	501.2	162.8	436.5	153.4
SA[ns]	466.2	158.9	583.0	194.4	416.4	133.3	495.3	151.5
WA[ns]	483.9	162.5	598.7	221.6	439.3	153.3	463.7	172.9
Tas[ns]	446.1	163.6	546.1	240.8	473.1	91.9	516.5	136.1
NT[ns]	442.8	161.0	554.4	134.0	455.1	178.2	321.5	108.3
(State x Year)[ns]								

*($p<0.05$); ANOVA test
ns (not significant)

Table 4.37 presents the mean number of RVUs by waiting time and perceived busyness, across time. Length of wait for an appointment was strongly associated with productivity, consistently in each survey year. Generally, an increase in the length of wait for an appointment resulted in an increase in the average number of RVUs per day, with the exception of 4.0+ weeks' length of wait in 1988 and 1993, where productivity was lower compared to the category of 2.0 to 3.9 weeks' length of wait. There were some inconsistencies exhibited in 1998, with the category of 1.0 to 1.9 weeks' wait having peak productivity compared to the two categories of longer waiting times. Significant productivity time trends were evident for the 1.0 to 1.9 and 2.0 to 3.9 categories of waiting time, the 'as busy' category, perceived busyness and waiting time overall. The non-significance of the interaction variables (wait x year, busyness x year) suggest there was no significant difference in productivity time trends between the categories of length of wait over time and perceived busyness over time.

Perceived level of busyness reported by the dentist was a strongly significant factor associated with productivity in three survey years (1983, 1988, 1993). As expected, the average RVUs per day increased with increased level of perceived busyness. That is, the average productivity rate for the 'as busy' category was consistently higher than the average productivity rate for the 'less busy' category and consistently lower than the 'more busy' category. Average productivity showed an overall decline from the 1983 survey to the 1998 survey for each category of perceived busyness level. Dentists reporting 'as busy' declined from an average of 549.2 (1983) to 480.4 (1998) RVUs per day, 'less busy' declined from an average of 421.0 (1983) to 390.9 (1998) RVUs per day and 'more busy' declined from an average of 618.9 (1983) to 486.1 (1998) RVUs per day.

Table 4.37: Mean number of RVUs per day by waiting time for appointment and perceived busyness, across time

	Output = number of RVUs per day							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Length of wait (wks)* **	***		***		***		***	
0 - 0.9 ns	455.1	190.0	484.6	187.2	421.3	158.2	431.9	164.9
1 – 1.9**	518.3	180.2	561.9	182.1	469.7	146.4	510.7	202.6
2.0 – 3.9 ns	596.7	203.3	628.6	214.1	492.6	156.3	469.8	185.8
4 + *	610.1	193.6	611.4	131.3	468.6	223.3	502.6	170.3
(Wait x Year) ns								
Perceived busyness* **	***		***		***		ns	
Less busy ns	421.0	166.1	448.4	186.9	381.5	545.2	390.9	182.6
As busy *	549.2	192.3	579.0	179.3	483.5	156.5	480.4	157.7
More busy ns	618.9	227.3	631.1	194.1	506.5	165.5	486.1	191.3
(Busy x Year) ns								

***(p<0.001), *(p<0.05); ANOVA test
ns (not significant)

4.4.4 Output: gross billings per day

Input: dentist characteristics

Table 4.38 presents the mean gross billings per day by dentist sex and years of experience, across time. Sex of the dentist was significantly associated with productivity in the first three survey years (1983, 1988, 1993). Male dentists grossed on average higher billings per day compared to female dentists consistently in each survey year. The largest variation in productivity was in 1983 when male dentists averaged $2685.91 per day compared to female dentists whose average productivity rate was $1975.47 per day. Significant productivity time trends were found for both male and female dentists and sex overall but not for the interaction variable (sex x year), suggesting there was no significant difference in productivity time trends between male and female dentists over time.

Years of experience was significantly associated with productivity in the middle two survey years (1988, 1993). In the first two waves of the survey (1983, 1988) dentists with 10 to 15 years of experience had the highest productivity rate at an estimated $3151.37 and $3015.08 of gross billings per day, respectively. In 1993, dentists with 15 to 25 years of experience were the most productive ($2469.21), while in the last survey wave (1998) the less experienced category of dentists with 10 to 15 years of experience had the highest productivity rate $2272.32 per day. Significant productivity time trends were found for all categories of experience and experience overall but not for the interaction variable (experience x year), suggesting there was no significant difference in productivity time trends between dentists of different experience levels over time.

Estimates showed an overall decline in productivity for both male and female dentists and all experience categories between 1983 and 1998; however, there was no consistent trend of decline within the individual years.

Table 4.38: Mean gross billings per day by dentist sex and years of experience, across time

	Output = gross billings per day ($)							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sex* **		*		**		**		ns
Male***	2685.91	2170.99	2819.67	1858.43	2340.96	1571.48	2028.10	1759.63
Female***	1975.47	1331.47	2115.95	1274.78	1740.06	1426.93	1694.90	1316.61
(Sex x Year)^{ns}								
Years of experience**		ns		**		**		ns
≤ 5***	2486.62	1511.30	2109.62	962.24	1756.97	907.68	1469.98	1027.71
> 5 – 10***	2642.30	1525.91	2772.21	2047.76	2116.32	1145.64	2272.32	2384.78
> 10 – 15***	3151.37	4119.71	3015.08	1799.01	2345.88	1594.78	1820.55	1231.88
> 15 – 25***	2426.63	1391.68	2925.40	1960.03	2469.21	2021.96	2187.42	1990.21
25 + ***	2489.29	1535.60	2712.79	1784.69	2291.34	1432.80	1778.58	1020.53
(Experience x Year)^{ns}								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.39 presents the mean gross billings per day by dentist country of birth and university of graduation, across time. Country of birth was significantly associated with productivity in 1988 and 1993. Australian-born dentists grossed on average consistently higher billings per day compared to non-Australian-born dentists. Both groups exhibited a declining productivity trend when individual survey years were compared with average gross billings per day, increasing initially between 1983 and 1988, then decreasing thereafter. The decline in gross billings across the 1983 to 1998 period was similar between Australian and non-Australian dentists, with gross billings for Australian-born dentists decreasing by $619.50 while gross billings for non-Australian-born dentists decreased by $615.38. Significant productivity time trends were found for both Australian-and non-Australian-born dentists, country of birth overall but not for the interaction variable (country x year), which suggests there was no significant difference in productivity time trends between Australian- and non-Australian-born dentists over time. University of graduation exhibited only a weakly significant ($p<0.05$) association with productivity in the 1988 survey, in which Adelaide graduates had the highest gross billings ($3353.41) across all states and time. Significant productivity time trends were found for each university of graduation and for the interaction variable of (university x year), suggesting there were significant differences between universities over time.

Table 4.39: Mean gross billings per day by dentist country of birth and university of graduation, across time

	Output = gross billings per day ($)							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Born in Australia* **								
	ns		*		**		ns	
Yes***	2652.84	2269.35	2843.23	1908.38	2390.95	1646.75	2033.34	1538.27
No***	2456.21	1493.48	2466.50	1524.36	1948.30	1347.61	1840.83	1913.74
(Country x Year)^{ns}								
University of graduation^{ns}								
	ns		*		Ns		ns	
O/S***	2719.58	1624.64	2849.60	1997.44	2189.63	1778.92	1853.41	1729.88
Syd***	2586.53	1572.65	2763.80	1890.10	2256.34	1645.76	2337.12	2324.35
Melb***	3007.92	3736.85	2277.41	1607.97	2067.47	1297.50	1767.77	1350.36
QLD***	2280.01	1528.45	2589.85	1196.68	2234.88	1150.09	1722.26	1098.21
Adel***	2234.07	889.83	3353.41	2403.95	2407.20	2046.71	1840.48	956.43
WA***	2599.51	1621.67	2958.63	1512.26	2302.17	1301.80	1796.88	926.18
(University x Year)*								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: capital

Table 4.40 presents the mean gross billings per day by number of surgeries utilised and x-ray units, per dentist, across time. Almost all of the capital inputs, number of surgeries and x-ray units utilised by the dentist were significantly associated with productivity in each of the survey years, with the exception of surgery utilisation in 1983. Significant productivity time trends were found for surgeries and x-ray units overall, for each category of capital usage and for the interaction variable of (x-ray x year).

Generally, increased utilisation of surgeries resulted in an increase in gross billings per day, consistently in each survey year. However, the marginal productivity (change in gross billings) resulting from increased surgery utilisation, that is an increase from one to 2 surgeries, or an increase from 2 to 3+ surgeries, declined across time. The difference in the productivity rate in 1983 between utilising one, and utilising 3+ surgeries was $732.97 per day. By 1998, the difference in the productivity rate between utilising one, and utilising 3+ surgeries was just $243.99 per day.

X-ray unit utilisation followed a similar pattern, with increased x-ray unit utilisation resulting in an increase in gross billings per day, consistently in each survey year. The increased productivity from increased x-ray unit utilisation again occurred in smaller increments across time, decreasing from a $968.18 per day difference in the productivity rate between utilising one x-ray unit ($2297.42 per day) and utilising 3+ x-ray units ($3265.60 per day) in 1983, to a $474.73 per day difference in the productivity rate between utilising one x-ray unit ($1505.75 per day) and utilising 3+ units ($1980.48 per day) in 1998.

Table 4.40: Mean gross billings per day by capital: number of surgeries and number of x-ray units utilised, across time

	Output = gross billings per day ($)							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Number of surgeries*								
	ns		***		*		**	
1***	2298.98	1280.86	2363.90	1551.52	2001.71	1164.08	1652.73	1098.22
2***	2866.32	2763.65	2953.24	1787.64	2451.67	1625.02	2392.62	2198.58
3 + ***	3031.95	1599.85	3538.46	2300.62	2680.58	2596.16	1896.72	1029.61
(Surgery x Year)^{ns}								
Number of x-ray units* **								
	**		**		***		**	
1***	2297.42	1301.22	2472.41	1788.76	1824.27	1375.80	1505.75	923.82
2***	2635.09	1537.27	2625.50	1449.65	2442.86	1456.56	2478.73	2419.99
3 + ***	3265.60	3545.91	3212.57	2048.50	2463.34	1750.18	1980.48	1055.46
(X-ray x Year)***								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Input: labour

Table 4.41 presents the mean gross billings per day by number of dentist chairside hours and intra- and extra-oral auxiliaries, per dentist, across time. There were significant associations between labour inputs (dentist chairside hours and number of extra-oral auxiliaries per dentist) and productivity in almost all years of the survey, with the exception of extra-oral auxiliary utilisation in 1988. Productivity time trends were significant for all categories of dentist hours per day chairside and almost all categories of auxiliary utilisation. However, no significance was found for both extra- and intra-oral auxiliaries overall and the interaction variable of (auxiliary (I-O) x year), showing there was no significant difference in productivity

time trends between categories of these variables over time. The intra-oral auxiliary variable did not exhibit significant associations with productivity in individual survey years, similarly to the bivariate testing when productivity was measured as RVUs per day, services per day and patients per day. Predictably, an increase in the number of dentist hours per day resulted in an increase in average gross billings per day, consistently across time. As the number of hours per day increased from ≤ 4 to 8+, the average productivity rate increased from $1020.23, $1527.05, $1140.07 and $1116.72 (1983, 1988, 1993, 1998) in gross billings per day to $3220.11, $3179.32, $1825.68 and $2362.74 (1983, 1988, 1993, 1998) in gross billings per day, respectively. The category of dentists who worked ≤4 hours per day became relatively more productive across time, increasing their productivity from an average of $1020.23 per day (1983) to $1116.72 per day (1998). This is in contrast to the category of dentists who worked 8+ hours per day who became relatively less productive across time, their productivity changing from an average of $3220.11 per day (1983) to $2362.74 per day (1998).

Table 4.41: Mean gross billings per day by number of chairside hours worked per day and number of auxiliaries worked per dentist, across time

	Output = gross billings per day ($)							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Dentist hrs/day* **								
≤4***	1020.23	761.02	1527.05	974.42	1140.07	841.99	1116.72	771.47
>4 – 8***	2308.03	1276.10	2471.47	1459.86	1984.77	1067.18	1699.35	1123.84
8 + ***	3220.11	2806.84	3179.32	2126.63	1825.08	1844.04	2362.74	2169.61
(Hours x Year) ***								
No. auxiliaries (E-O)[ns]								
	**		ns		**		*	
0[t]	525.00	-	-	-	1466.46	-	-	-
1***	988.94	616.26	1448.86	817.15	1655.73	921.88	3431.56	2005.46
2***	1315.00	731.68	1426.25	768.61	2357.96	1265.43	2467.90	1452.73
3 + ***	1358.27	959.11	1809.52	1687.91	2373.02	1132.86	3108.87	2400.67
(No.aux[E-O] x Year) *								
No. auxiliaries (I-O)[ns]								
	ns		ns		ns		ns	
0***	1229.96	768.84	1568.71	1314.71	2261.01	1218.98	2859.49	2098.90
1[ns]	1636.72	1015.46	1787.16	1303.70	2183.89	871.23	2453.65	1466.07
2 + *	805.14	97.24	-	-	2109.74	664.08	3771.34	1761.01
(No.aux[I-O] x Year) [ns]								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)
t (not computed due to small n)

Input: practice characteristics

Table 4.42 presents the mean gross billings per day by practice configuration, size and state location. Significant productivity time trends were found for all categories of configuration except for locum, practice size overall, the 0, 1, 2, and 4+ size categories, almost all states with the exception of Tas and NT (this may be due to smaller n), and state location overall. No significance was found for any of the interaction variables, suggesting there were no significant differences between categories of the above mentioned variables over time. There was no significant association between the practice characteristics of configuration and size with productivity in all of the survey years except for 1983, where configuration was weakly significant ($p<0.05$). State location of main practice was significantly associated with productivity in 1988 and 1998.

Table 4.42: Mean gross billings per day by practice configuration, size and state location, across time

	Output = gross billings per day ($)							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Configuration^{ns}								
	*		ns		ns		ns	
Solo***	2390.15	1398.36	2873.63	1864.86	2229.64	1413.31	1766.12	1232.21
Partner***	3673.04	4518.03	2640.58	1658.53	2249.08	1309.67	1949.27	1225.387
Associate***	2566.91	1225.01	2668.32	1838.64	2160.07	1751.11	2113.22	1512.88
Assistant***	2431.27	1432.32	2527.65	1832.14	2315.21	1773.62	2085.05	1981.40
Locum^{ns}	2579.37	1626.40	2441.50	1100.02	1321.56	779.58	2203.33	1332.21
(Configuration x Year)^{ns}								
No. other dentists^{ns}								
	ns		ns		ns		ns	
0***	1263.74	814.71	1495.82	867.93	2173.62	1257.94	2770.31	2149.28
1***	2711.56	1456.81	2564.57	1461.91	2430.92	1922.58	2240.59	2124.02
2**	2476.73	1349.24	3066.63	2518.90	2095.27	1133.55	1938.83	1032.33
3^{ns}	2086.54	1038.15	2405.31	1333.66	1957.33	920.42	1778.70	798.00
4 + *	1907.84	665.30	2038.34	791.58	1961.54	629.72	1724.75	991.85
(Size x Year)^{ns}								
Location of main practice **								
	ns		**		ns		*	
ACT*	2179.22	1713.85	2511.39	852.68	2298.99	1116.37	1183.51	467.88
NSW***	2619.26	1596.14	2763.83	1882.74	2196.94	1611.05	2368.77	2379.79
Vic***	2844.86	3251.14	2344.47	1782.45	2053.40	1334.50	1551.77	968.10
QLD***	2286.39	1362.95	2529.92	1119.62	2362.48	1598.17	1705.59	1060.80
SA***	2415.80	1027.96	3786.35	2667.01	2481.16	2335.02	2168.95	1015.32
WA***	2591.38	1553.33	3069.07	1597.98	2484.46	1320.23	1882.74	936.56
Tas^{ns}	2526.89	1483.60	2739.39	1275.64	1978.51	550.23	1594.82	407.70
NT^{ns}	2579.11	-	3103.06	422.94	1707.94	523.78	991.69	252.61
(State x Year)***								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.43 presents the mean gross billings per day by waiting time and perceived busyness. Length of wait for an appointment was associated with productivity in the middle two survey years (1988, 1993). Generally, an increase in the length of wait for an appointment resulted in an increase in gross billings per day, with some exceptions: 4.0+ weeks' length of wait in 1983, 1988 and 1993 and in 1998, when productivity declined as length of wait increased, from the average productivity level at 1.0 to 1.9 weeks' wait ($2228.65). Significant productivity time trends were found for all categories for length of wait, length of wait overall and the interaction variable of (wait x year).

Perceived level of busyness reported by the dentist was consistently and significantly associated with productivity in all waves of the survey. An increase in the perceived level of busyness reported by the dentist resulted in an increase in gross billings per day. The average productivity rate generally declined across successive periods of the survey for each category of perceived busyness level (less busy, as busy, more busy). Dentists who reported to be as busy as they would like grossed an average productivity rate in the range of $2871.54 (1983) to $2237.26 (1998) in billings per day, while dentists who reported to be less busy than they would like grossed on average between $2204.83 (1983) to $1563.10 (1998) in billings per day. The dentists who reported to be more busy than they would like grossed between $2962.61 (1983) to $2628.36 (1998) in billings per day. Across time, from 1983 to 1998, the average productivity rate per category of perceived busyness increased between 1983 and 1988, but decreased thereafter.

Table 4.43: Mean gross billings per day by waiting time for appointment and perceived busyness, across time

	Productivity = gross billings per day ($)							
	1983		1988		1993		1998	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Length of wait (wks)* **								
	ns		***		***		ns	
0 - 0.9***	2442.18	2484.11	2380.06	1270.59	2115.01	1289.28	1935.79	1984.70
1.0 – 1.9***	2754.19	1538.18	2914.43	2213.20	2317.70	1130.49	2228.65	1543.52
2.0 – 3.9***	2975.52	1427.94	3493.74	2382.79	2360.57	1990.72	2150.44	1695.84
4 + **	2750.12	1223.61	2932.45	1891.24	2077.89	1874.38	1983.30	1091.46
(Wait x Year)^{ns}								
Perceived busyness**								
	*		***		***		**	
Less busy***	2204.83	2721.76	2248.78	1570.11	1791.51	1025.34	1563.10	969.30
As busy***	2871.54	1551.78	2951.38	1723.97	2425.83	1327.32	2237.26	2049.70
More busy*	2962.61	1567.85	3251.46	2488.22	2698.97	2443.91	2628.36	1005.72
(Busyness x Year)^{ns}								

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.4.5 Summary: bivariate associations

Table 4.44 to Table 4.47 present summaries of the bivariate associations between each of the input factors with all four productivity measures and year of survey.

Dentist characteristics generally, with the exception of university of graduation, were significantly associated with productivity, in each survey. The high number of non-significant interaction variables suggests that across time, the categories of dentist characteristics followed similar trends in productivity.

Capital inputs exhibited a consistent and strong association with productivity for all four productivity measures and in each survey year. The capital input of xray units was the only one whose categories were significantly different across time, as depicted by the significance of the interaction variable (xray x year).

Similar to capital inputs, labour inputs consisting of dentist chairside hours and extra-oral auxiliaries exhibited a consistently strong association with productivity for all four productivity measures and in each survey year. Intra-oral auxiliaries did not feature as a significant variable. The non-significance of all interaction variables with the exception of dentist chairside hours suggests that there was no significant difference in the productivity time trends between categories of labour inputs. The significance of the interaction variable (dentist hours x year) suggests that the categories of dentist chairside hours (≤4, >4-8, 8+) experienced a significantly different productivity trend across time.

Lastly, the results for practice characteristics were less uniform. Overall, factors describing practice size and configuration were not significantly associated with productivity in any one year, while state location was infrequently and weakly associated with productivity. Strong and consistent associations were observed between perceived level of busyness and length of wait for an appointment across time and for all four productivity measures. Overall, the majority of interaction variables were not significant.

Table 4.44: Summary of bivariate associations between dentist characteristics and all productivity output variables

	Year of survey				
	1983	1988	1993	1998	Time trend 1983-1998
Patients/day					
Sex	***	***	*	ns	
Sex x Year					**
Experience	**	***	**	***	
Experience x Year					ns
COB	**	***	***	ns	
COB x Year					ns
University	ns	ns	ns	ns	
University x Year					ns
Services/day					
Sex	**	*	ns	ns	
Sex x Year					ns
Experience	ns	***	***	***	
Experience x Year					ns
COB	**	***	***	**	
COB x Year					ns
University	ns	ns	*	ns	
University x Year					ns
RVUs/day					
Sex	**	***	***	ns	
Sex x Year					ns
Experience	ns	***	***	***	
Experience x Year					ns
COB	ns	***	***	**	
COB x Year					ns
University	ns	ns	ns	ns	
University x Year					ns
$GB/day					
Sex	*	**	**	ns	
Sex x Year					ns
Experience	ns	**	**	ns	
Experience x Year					ns
COB	ns	*	**	ns	
COB x Year					ns
University	ns	*	ns	ns	
University x Year					*

ANOVA: *** (p<0.001); ** (p<0.01); * (p<0.05); ns (not significant).

Table 4.45: Summary of bivariate associations between capital inputs and all productivity output variables

	Year of survey				
	1983	1988	1993	1998	Time trend 1983-1998
Patients/day					
Surgery	***	***	***	***	
Surgery x Year					ns
Xray	ns	ns	ns	**	
Xray x Year					*
Services/day					
Surgery	***	***	**	***	
Surgery x Year					ns
Xray	**	***	**	***	
Xray x Year					ns
RVUs/day					
Surgery	***	***	**	***	
Surgery x Year					ns
Xray	***	***	***	***	
Xray x Year					***
$GB/day					
Surgery	ns	***	*	**	
Surgery x Year					ns
Xray	**	**	***	**	
Xray x Year					***

ANOVA: *** (p<0.001); ** (p<0.01); * (p<0.05); ns (not significant).

Table 4.46: Summary of bivariate associations between labour inputs and all productivity output variables

	Year of survey				
	1983	1988	1993	1998	Time trend 1983-1998
Patients/day					
Dentist hrs/day	***	***	***	***	
Dentist hrs/day x Year					ns
Aux (E-O)	***	***	***	***	
Aux (E-O) x Year					ns
Aux (I-O)	ns	ns	ns	*	
Aux (I-O) x Year					ns
Services/day					
Dentist hrs/day	***	***	***	***	
Dentist hrs/day x Year					ns
Aux (E-O)	***	*	***	***	
Aux (E-O) x Year					ns
Aux (I-O)	ns	ns	ns	ns	
Aux (I-O) x Year					ns
RVUs/day					
Dentist hrs/day	***	***	***	***	
Dentist hrs/day x Year					ns
Aux (E-O)	***	***	ns	**	
Aux (E-O) x Year					ns
Aux (I-O)	ns	*	*	ns	
Aux (I-O) x Year					ns
$GB/day					
Dentist hrs/day	***	***	***	***	
Dentist hrs/day x Year					***
Aux (E-O)	**	ns	**	*	
Aux (E-O) x Year					ns
Aux (I-O)	ns	ns	ns	ns	
Aux (I-O) x Year					ns

ANOVA: *** (p<0.001); ** (p<0.01); * (p<0.05); ns (not significant).

Table 4.47: Summary of bivariate associations between practice characteristics and all productivity output variables

	Year of survey				
	1983	1988	1993	1998	Time trend 1983-1998
Patients/day					
Configuration	ns	ns	ns	ns	
Configuration x Year					ns
Size	ns	ns	ns	ns	
Size x Year					ns
State	ns	ns	*	ns	
State x Year					ns
Busyness	***	***	***	***	
Busyness x Year					ns
Wait	***	***	***	***	
Wait x Year					ns
Services/day					
Configuration	ns	ns	ns	ns	
Configuration x Year					ns
Size	ns	ns	ns	ns	
Size x Year					ns
State	ns	ns	*	ns	
State x Year					ns
Busyness	***	***	***	***	
Busyness x Year					ns
Wait	***	***	***	**	
Wait x Year					ns
RVUs/day					
Configuration	ns	ns	ns	ns	
Configuration x Year					ns
Size	ns	ns	ns	ns	
Size x Year					ns
State	ns	ns	ns	ns	
State x Year					ns
Busyness	***	***	***	ns	
Busyness x Year					ns
Wait	***	***	***	***	
Wait x Year					ns
$GB/day					
Configuration	*	ns	ns	ns	
Configuration x Year					ns
Size	ns	ns	ns	ns	
Size x Year					ns
State	ns	**	ns	*	
State x Year					***
Busyness	*	***	***	**	
Busyness x Year					ns
Wait	ns	***	***	ns	
Wait x Year					ns

ANOVA: *** (p<0.001); ** (p<0.01); * (p<0.05); ns (not significant).

4.5 Multivariate modelling: production function

This section presents the results of multivariate models (production functions) specified for each type of productivity measure (patients/services/RVUs/$GB per day) by year (1983, 1988, 1993, 1998, 1983-1998 panel). The results have been divided into productivity measure type and further subcategorised by year. Summary results are presented at the end of the section for each productivity measure. For the productivity measure of patients per day, additional testing was required to explore the following two issues.

Firstly, whether the variable of patients per day taken from Section B (log data) of the questionnaire yielded different results to the variable of patients per day taken from Section A of the questionnaire, as reported by the dentist. Data for patients per day have thus far been retrieved from Section A of the questionnaire. This was an interesting issue since the remaining three productivity measures (services, RVUs, $GB) were all developed from the log data (Section B). The rationale to use Section A data for patients per day was based on the assumption that dentists responding to the log (Section B) were a representative subsample of the larger group of dentists who responded to Section A, therefore using the patients per day data from Section A was representative and offered the advantage of a larger sample. An additional assumption, however, assuming the subsample was representative, is that dentists' response to average number of patients per day (Section A) was the same as the actual number of patients per day reported in the log (Section B). This is heavily dependent on whether the log data is truly representative of a typically average clinic day.

The second issue explored was related to estimating the production functions using the true longitudinal cohort of dentists who appeared in all four survey years. This was only an option for the productivity measure of patients per day as the other measures of services, RVUs and $GB required the true longitudinal cohort of dentists who had responded to Section B (log data) of the questionnaire. This subsequently led to a very small n. Even while using patients per day as the dependent variable in the true-cohort production function, a number of independent variables were

required to be eliminated for a model to be estimated. Again, this is most likely due to the smaller n. Comparison of patients per day production functions between the true cohort and the non-true cohort sample of dentists allowed us to investigate the presence of sample bias. That is, whether productivity changes were due to the introduction of new dentists to the sample or whether they were a consequence of factors unrelated to the younger cohort of dentists sampled in later survey years.

The results for the regression models using patients per day from Section B have been labelled as 'patients per day (log data)', while the results for the regression models using the true longitudinal cohort of dentists have been labelled as 'patients per day (longitudinal cohort)'. For the regression models using patients per day from the larger data set (Section A), these have been labelled 'patients per day' and appear first in the results. The text relating to Table 4.58 on page 152 describes the results for the production function specified with 'patients per day (log data)' as the dependent variable as compared with the results for the production function specified with 'patients per day' as the dependent variable, while the text relating to Table 4.59 on page 158 describes the results for the production function specified with 'patients per day (longitudinal cohort)' as the dependent variable as compared with the results for the production function specified with 'patients per day' as the dependent variable.

4.5.1 Output: patients per day

Table 4.48 presents the multivariate production function model for 1983 with productivity measured as patients per day. The model explained 41% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (perceived busyness). No significant association was found for the variables related to dentist characteristics.

Productivity gains resulting from the utilisation of more than one surgery were in the range of 2.78 to 4.58 patients per day, but standardised regression coefficients showed the productivity gain was the same for dentists utilising 2 surgeries compared to dentists utilising 3 or more surgeries. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Dentists who reported working with 2 extra-oral auxiliaries were significantly more productive compared to those who worked with one extra-oral auxiliary. Perception of busyness was significantly associated with productivity levels, with dentists who reported being either as- or more busy than they would like having higher productivity; however, the standardised regression coefficients showed the increased productivity of these dentists compared to dentists who reported to be less busy than they would like to be was very similar.

Table 4.48: OLS regression model of patients per day, 1983

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-1.14	-0.06	(-2.87-0.58)
Experience (years)				
≤ 5	ns	-0.96	-0.07	(-2.50-0.58)
> 5 – 10	ns	0.06	0.00	(-1.57-1.69)
> 10 – 15	ns	0.11	0.01	(-1.59-1.81)
> 15 – 25	ns	0.41	0.03	(-1.15-1.98)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-0.98	-0.07	(-2.54-0.58)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.27	-0.02	(-2.69-2.15)
Melb	ns	-1.74	-0.11	(-4.25-0.78)
QLD	ns	-2.27	-0.14	(-5.23-0.69)
Adel	ns	-2.49	-0.11	(-6.30-1.32)
WA	ns	-1.10	-0.05	(-4.58-2.38)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	***	2.78	0.23	(1.66-3.90)
3 +	***	4.58	0.23	(2.61-6.55)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.48	-0.04	(-1.75-0.79)
3 +	ns	-0.42	-0.03	(-1.90-1.06)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-6.76	-0.25	(-9.19- -4.32)
8 +	***	2.95	0.24	(1.74-4.16)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-4.91	-0.06	(-11.32-1.51)
2	*	1.49	0.12	(0.21-2.77)
3 +	ns	1.42	0.10	(-0.16-3.01)

Table 4.48 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-0.18	-0.01	(-3.49-3.14)
2 +	ns	-1.93	-0.03	(-8.89-5.03)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-0.36	-0.02	(-2.00-1.28)
Associate	ns	-1.02	-0.07	(-2.41-0.37)
Assistant	ns	-0.29	-0.02	(-1.89-1.30)
Locum	ns	1.09	0.05	(-0.97-3.15)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-0.07	-0.10	(-1.35-1.21)
2	ns	-1.46	-0.08	(-3.39-0.48)
3	ns	-1.21	-0.03	(-4.96-2.55)
4 +	ns	3.49	0.06	(-1.29-8.28)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	*	1.21	0.10	(-0.03-2.46)
More busy	*	2.65	0.11	(0.20-5.09)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-0.12	-0.01	(-3.86-3.62)
Vic	ns	2.71	0.20	(-1.36-6.77)
QLD	ns	2.66	0.15	(-1.57-6.89)
SA	ns	1.64	0.08	(-3.20-6.47)
WA	ns	-0.17	-0.01	(-5.02-4.69)
Tas	ns	2.08	0.03	(-4.31-8.46)
NT	ns	0.70	0.01	(-6.72-8.11)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	0.83	0.05	(-0.77-2.43)
2.0 – 3.9	ns	1.25	0.08	(-0.35-2.85)
4.0 +	ns	1.03	0.04	(-1.40-3.47)
Adjusted R^2				41%
F – statistic				*** 6.73
n				354
Missing cases				13

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.49 presents the multivariate production function model for 1988 with productivity measured as patients per day. The model explained 36% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience, country of birth, university of graduation), capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, extra-oral auxiliaries), and practice characteristics (perceived busyness, state location).

The dentist characteristics comprising up to 5 years of experience, non-Australian country of birth and University of Adelaide graduates exhibited a negative association with productivity compared to their respective reference groups of more than 25 years of experience, Australian country of birth and Sydney University graduates. Productivity gains resulting from the utilisation of more than one surgery were in the range of 1.22 to 2.23 patients per day, with standardised regression coefficients showing that the productivity gain was slightly higher for dentists utilising 3 or more surgeries compared to dentists utilising 2 surgeries. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Extra-oral auxiliary utilisation was significantly associated with productivity, with the category of 2 extra-oral auxiliaries being significantly more productive than 1 extra-oral auxiliary only. Perception of busyness was significantly associated with productivity levels, with dentists reporting to be either as or more busy than they would like having higher productivity than the reference group of dentists who reported to be less busy than they would like. Standardised regression coefficients show the increased productivity of the dentists reporting to be more busy than they would like was slightly higher compared to dentists who reported to be as busy as they would like in comparison to the reference group.

Table 4.49: OLS regression model of patients per day, 1988

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-1.14	-0.07	(-2.46-0.17)
Experience (years)				
≤ 5	**	-2.08	-0.14	(-3.58- -0.58)
> 5 – 10	ns	-1.16	-0.08	(-2.52-0.19)
> 10 – 15	ns	-0.07	0.00	(-1.56-1.42)
> 15 – 25	ns	0.09	0.01	(-1.23-1.41)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	**	-1.63	-0.14	(-2.87- -0.40)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.20	-0.02	(-2.15-1.75)
Melb	ns	-1.90	-0.14	(-3.98-0.18)
QLD	ns	-1.61	-0.11	(-4.02-0.80)
Adel	*	-3.17	-0.17	(-5.85- -0.49)
WA	ns	-0.23	-0.01	(-2.97-2.51)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	*	1.22	0.10	(0.22-2.22)
3 +	**	2.23	0.13	(0.67-3.79)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.74	-0.06	(-1.90-0.43)
3 +	ns	0.57	0.05	(-0.76-1.89)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-5.63	-0.22	(-7.78- -3.49)
8 +	***	2.31	0.21	(1.34-3.29)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	*	1.48	0.12	(0.19-2.76)
3 +	ns	1.10	0.10	(-0.27-2.48)

Table 4.49 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-1.86	-0.08	(-3.94-0.23)
2 +	ns	1.04	0.02	(-3.93-6.02)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	0.11	0.01	(-1.21-1.44)
Associate	ns	-0.48	-0.03	(-1.70-0.75)
Assistant	ns	-0.19	-0.01	(-1.44-1.06)
Locum	ns	-0.05	0.00	(-3.02-2.92)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.12	0.01	(-1.02-1.26)
2	ns	-0.07	0.00	(-1.77-1.65)
3	ns	-0.51	-0.02	(-2.56-1.54)
4 +	ns	1.14	0.04	(-1.18-3.46)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	***	2.11	0.19	(1.05-3.17)
More busy	***	4.13	0.21	(2.01-6.26)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	1.69	0.14	(-1.01-4.39)
Vic	*	3.05	0.24	(0.03-6.06)
QLD	ns	1.76	0.11	(-1.51-5.04)
SA	ns	2.71	0.13	(-1.10-6.52)
WA	ns	1.32	0.07	(-2.22-4.86)
Tas	**	5.68	0.15	(1.59-9.78)
NT	ns	-1.16	-0.02	(-6.56-4.25)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	1.14	0.08	(-0.12-2.40)
2.0 – 3.9	ns	0.16	0.01	(-1.18-1.50)
4.0 +	ns	-0.37	-0.02	(-2.48-1.75)
Adjusted R^2				36%
F – statistic				*** 7.14
n				450
Missing cases				31

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.50 presents the multivariate production function model for 1993 with productivity measured as patients per day. The model explained 44% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for capital (multiple surgery utilisation) and labour inputs (dentist chairside hours), and practice characteristics (perceived busyness, size, state location). Productivity gains resulting from the utilisation of more than 1 surgery were significant only in the category of 2 surgeries but not in the category of 3 or more surgeries. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Auxiliary utilisation did not result in a significant association with productivity. Size of group practice resulted in dentists reporting to work with 4 or more other dentists in the practice having significantly lower productivity than those who reported to work with no other dentists. Perception of busyness was significantly associated with productivity levels, with dentists reporting to be either as busy as or more busy than they would like having higher productivity within the range of 1.59 to 2.43 patients per day. Dentists whose main practice was in the Australian Capital Territory, Victoria or Queensland had lower productivity by 2.81, 0.51 and 0.21 patients per day respectively, compared to New South Wales based dentists. However, dentists who were Tasmanian based had higher productivity by 1.38 patients per day compared to New South Wales based dentists.

Table 4.50: OLS regression model of patients per day, 1993

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.94	-0.08	(-1.95-0.08)
Experience (years)				
≤ 5	ns	-0.60	-0.05	(-1.88-0.69)
> 5 – 10	ns	-0.71	-0.05	(-1.99-0.58)
> 10 – 15	ns	-0.60	-0.05	(-1.79-0.59)
> 15 – 25	ns	0.57	0.05	(-0.51-1.64)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-0.72	-0.07	(-1.69-0.26)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.07	0.01	(-1.60-1.75)
Melb	ns	-0.73	-0.06	(-2.36-0.90)
QLD	ns	-1.59	-0.12	(-3.58-0.40)
Adel	ns	-1.12	-0.08	(-3.14-0.91)
WA	ns	-1.73	-0.10	(-4.07-0.61)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	***	1.83	0.19	(1.01-2.66)
3 +	ns	0.52	0.03	(-0.90-1.95)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.25	-0.02	(-1.21-0.71)
3 +	ns	0.32	0.03	(-0.76-1.39)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-4.91	-0.27	(-6.52- -3.29)
8 +	***	3.01	0.30	(2.15-3.86)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-0.62	-0.01	(-5.76-4.52)
2	ns	0.74	0.07	(-0.40-1.87)
3 +	ns	0.87	0.09	(-0.32-2.07)

Table 4.50 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-1.11	-0.06	(-2.73-0.50)
2 +	ns	-0.43	-0.01	(-3.13-2.27)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-0.24	-0.02	(-1.40-0.93)
Associate	ns	0.85	0.07	(-0.19-1.89)
Assistant	ns	0.11	0.01	(-0.81-1.03)
Locum	ns	-1.31	-0.02	(-5.54-2.92)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-0.65	-0.06	(-1.58-0.28)
2	ns	-0.01	0.00	(-1.40-1.37)
3	ns	-0.33	-0.02	(-1.99-1.34)
4 +	*	-2.30	-0.10	(-4.29- -0.31)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	***	1.59	0.17	(0.72-2.46)
More busy	***	2.43	0.16	(0.95-3.91)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	*	-2.81	-0.29	(-5.21- -0.40)
Vic	***	-0.51	-0.05	(-3.16-2.15)
QLD	**	-0.21	-0.02	(-2.30-2.58)
SA	ns	-1.20	-0.07	(-4.24-1.84)
WA	ns	-0.95	-0.06	(-4.09-2.18)
Tas	**	1.38	0.04	(-2.29-5.05)
NT	ns	-1.20	-0.03	(-5.41-3.01)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	0.40	0.03	(-0.77-1.33)
2.0 – 3.9	ns	0.93	0.07	(-0.21-2.26)
4.0 +	ns	-0.65	-0.03	(-2.67-1.57)
Adjusted R^2				44%
F – statistic				*** 8.31
n				396
Missing cases				45

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.51 presents the multivariate production function model for 1998 with productivity measured as patients per day. The model explained 37% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience), capital (multiple surgery and x-ray unit utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (perceived busyness, length of wait for an appointment).

Comparison of unstandardised regression coefficients showed dentists with experience of either up to 5 years, between 5 and 10, years or between 10 and 15 years were relatively less productive by 1.63, 1.59 and 1.24 patients per day respectively, compared to dentists with more than 25 years of experience. Productivity gains resulting from the utilisation of 2 or 3 or more surgeries were in the range of 1.35 to 1.65 patients per day, but standardised regression coefficients showed the productivity gain was less when dentists used 3 or more surgeries compared to using 2 surgeries. 1998 was the first year in which the second category of capital input (number of x-ray units) was significant with 3 or more x-ray unit utilisation resulting in significantly higher productivity (1.90 patients per day) compared to single x-ray unit utilisation. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. The use of 2 or 3 extra-oral auxiliaries had a significant and positive association with productivity compared to the use of 1 extra-oral auxiliary. Perception of busyness was significantly associated with productivity levels in the range of 1.74 to 2.93 patients per day, with dentists reporting being either as busy as or more busy than they would like having higher productivity respectively compared to the reference group of dentists reporting being less busy than they would like. Standardised regression coefficients, however, showed the increased productivity of these dentists compared to dentists who reported being less busy than they would like to be was approximately the same. Lastly, length of wait for an appointment of between 1.0 to 1.9 and 2.0 to 3.9 weeks resulted in higher productivity compared to the reference of up to 1.0 week.

Table 4.51: OLS regression model of patients per day, 1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	0.08	0.01	(-0.93-1.08)
Experience (years)				
≤ 5	*	-1.63	-0.12	(-2.94- -0.32)
> 5 – 10	**	-1.59	-0.12	(-2.82- -0.37)
> 10 – 15	*	-1.24	-0.09	(-2.46- -0.01)
> 15 – 25	ns	-0.85	-0.08	(-1.87-0.17)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	0.12	0.01	(-0.82-1.07)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.56	-0.05	(-2.08-0.95)
Melb	ns	0.28	0.02	(-1.47-2.03)
QLD	ns	-0.78	-0.06	(-2.69-1.12)
Adel	ns	-1.77	-0.12	(-3.72-0.18)
WA	ns	-1.17	-0.07	(-3.62-1.29)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	**	1.35	0.14	(0.51-2.19)
3 +	*	1.65	0.10	(0.18-3.11)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.05	-0.01	(-1.03-1.02)
3 +	**	1.90	0.18	(0.72-3.08)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-5.67	-0.26	(-7.34- -4.00)
8 +	***	2.22	0.23	(1.39-3.05)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	***	1.86	0.19	(0.77-2.96)
3 +	***	2.41	0.25	(1.30-3.51)

Table 4.51 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-0.27	-0.02	(-1.49-0.96)
2 +	ns	-0.22	-0.01	(-2.26-1.83)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-0.59	-0.04	(-1.90-0.72)
Associate	ns	-0.20	-0.02	(-1.24-0.85)
Assistant	ns	-0.41	-0.04	(-1.34-0.52)
Locum	ns	0.19	0.01	(-2.07-2.45)
SIze (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-0.50	-0.05	(-1.44-0.44)
2	ns	-1.19	-0.08	(-2.50-0.12)
3	ns	-0.37	-0.02	(-1.99-1.24)
4 +	ns	-1.97	-0.08	(-4.06-0.12)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	***	1.74	0.18	(0.87-2.60)
More busy	***	2.93	0.20	(1.57-4.29)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	0.05	0.01	(-2.73-2.84)
Vic	ns	-1.04	-0.09	(-4.04-1.96)
QLD	ns	-0.18	-0.01	(-3.05-2.69)
SA	ns	0.49	0.03	(-2.80-3.78)
WA	ns	0.66	0.05	(-2.68-4.00)
Tas	ns	3.00	0.07	(-1.23-7.24)
NT	ns	-1.71	-0.04	(-5.86-2.44)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	*	1.13	0.09	(0.08-2.17)
2.0 – 3.9	*	1.19	0.09	(0.08-2.30)
4.0 +	ns	0.92	0.05	(-0.60-2.43)
Adjusted R^2				37%
F – statistic				*** 7.65
n				462
Missing cases				27

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Panel longitudinal data analysis of patients per day, 1983-1998

Table 4.52 presents the multivariate production function model for combined data of the 1983, 1988, 1993 and 1998 samples with productivity measured as patients per day. Significant variables describing the year of survey were included to estimate the association of time on productivity, which is the productivity time trend. The model explained 42% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex, experience, country of birth, university of graduation), capital (surgery utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, size, perceived busyness, state location, length of wait for an appointment).

Significant variation in productivity was found between male and female dentists, with female dentists having slightly lower productivity (0.68 patients per day) compared to male dentists. Comparison of standardised regression coefficients showed dentists with experience of either up to 5 years, or between 5 and 10 years, were relatively less productive compared to dentists with more than 25 years of experience. Non-Australian-born dentists and graduates from Melbourne, Queensland and Adelaide universities were significantly less productive compared to their respective reference categories of Australian-born, and Sydney University graduates. Productivity gains resulting from the utilisation of 2 or 3 or more surgeries were in the range of 1.75 to 2.27 patients per day, but standardised regression coefficients showed the productivity gain was less when dentists used 3 or more surgeries compared to using 2 surgeries. X-ray unit utilisation overall was not significant. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between four and eight hours per day. The use of 2 or 3 extra-oral auxiliaries had a significant and positive association with productivity compared to the use of one extra-oral auxiliary. Configuration and size were among the practice characteristics associated with productivity, with associate dentists and practice sizes of either 2 or 4+ being relatively less productive compared to their reference categories of solo dentists and practice sizes of 1. Perception of

busyness was significantly associated with productivity levels in the range of 1.62 to 2.86 patients per day, with dentists reporting to be either as busy as or more busy than they would like having higher productivity respectively compared to the reference group of dentists reporting to be less busy than they would like. Dentists reporting 1.0 to 3.9 weeks length of wait for an appointment had higher productivity compared to the dentists reporting up to one week while, in order of magnitude, Tasmanian- and Victorian- based dentists had higher estimated productivity compared to New South Wales based dentists.

Time proved to be a consistently significant factor negatively associated with productivity. Productivity, when measured as patients per day, significantly declined across the 1983 to 1998 period, with successive increments of decline increasing for each survey year.

Table 4.52: OLS regression model of patients per day, 1983-1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	*	-0.68	-0.05	(-1.27- -0.09)
Experience (years)				
≤ 5	***	-1.39	-0.10	(-2.06- -0.71)
> 5 – 10	**	-0.93	-0.06	(-1.58- -0.27)
> 10 – 15	ns	-0.58	-0.04	(-1.25-0.09)
> 15 – 25	ns	-0.06	-0.01	(-0.64-0.52)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	*	-0.65	-0.06	(-1.19- -0.10)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.32	-0.03	(-1.20-0.57)
Melb	**	-1.11	-0.08	(-2.06- -0.17)
QLD	*	-1.45	-0.10	(-2.52- -0.38)
Adel	*	-1.76	-0.10	(-2.93- -0.58)
WA	ns	-0.72	-0.04	(-2.02-0.58)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	***	1.75	0.16	(1.30-2.32)
3 +	***	2.27	0.12	(1.52-3.01)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.35	-0.03	(-0.88-0.18)
3 +	ns	0.57	0.05	(-0.03-1.16)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-5.46	-0.23	(-6.39- -4.52)
8 +	***	2.47	0.22	(2.02-2.92)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-3.73	-0.03	(-7.75-0.29)
2	***	1.57	0.14	(0.99-2.14)
3 +	***	1.52	0.14	(0.90-2.14)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-0.52	-0.03	(-1.38-0.33)
2 +	ns	-0.04	-0.01	(-1.57-1.49)

Table 4.52 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-0.32	-0.02	(-1.01-0.29)
Associate	*	-0.22	-0.02	(-0.78-0.35)
Assistant	ns	-0.21	-0.02	(-0.82-0.26)
Locum	ns	0.46	0.02	(-0.63-1.75)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-0.27	-0.02	(-0.78-0.24)
2	*	-0.82	-0.05	(-1.56- -0.09)
3	ns	-0.59	-0.02	(-1.55-0.38)
4 +	*	-0.69	-0.02	(-1.87-0.50)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	***	1.62	0.15	(1.14-2.11)
More busy	***	2.86	0.16	(2.02-3.71)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	0.09	0.01	(-1.27-1.44)
Vic	*	1.46	0.12	(-0.03-2.95)
QLD	ns	1.18	0.08	(-0.36-2.72)
SA	ns	0.69	0.03	(-1.04-2.41)
WA	ns	0.35	0.02	(-1.38-2.07)
Tas	**	3.31	0.08	(1.19-5.44)
NT	ns	-0.52	-0.01	(-2.94-1.90)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	**	0.86	0.06	(0.27-1.44)
2.0 – 3.9	***	1.10	0.08	(0.47-1.72)
4.0 +	ns	0.83	0.04	(-0.09-1.75)
5. Year of survey				
1983	ref.	ref.	ref.	ref.
1988	***	-1.39	-0.11	(-1.99- -0.80)
1993	***	-2.38	-0.19	(-3.01- -1.75)
1998	***	-3.32	-0.27	(-3.94- -2.71)
Adjusted R^2				42%
F – statistic				*** 27.71
n				1664
Missing cases				114

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Summary of productivity analysis, patients per day

Table 4.53 presents the summary of all regression models specified using patients per day as the dependent productivity variable.

Overall, the models explained between 36 to 44% of the variation in the output measure, with 1983 appearing to have the least number of significant inputs compared to other survey years. The most consistent and strongest input measures were in the categories of capital and labour inputs and practice characteristics, while dentist characteristics did not show as strong a significant association with productivity in individual survey years. Number of surgeries utilised, dentist hours worked per day chairside, number of extra-oral auxiliaries, perceived level of busyness, state location of main practice and length of wait for an appointment were notable in terms of their contribution in explaining productivity. However, variables relating to university of graduation, practice size and configuration were generally not significant.

The panel longitudinal regression showed that across time, there was a consistently strong and significant decline in the productivity trend when measured as patients per day as compared with 1983.

Table 4.53: Summary-regression models of patients per day, 1983-1998

	1983	1988	1993	1998	Panel 1983 - 1998
1. Dentist characteristics					
Sex					
Male	ref.	ref.	ref.	ref.	ref.
Female	ns	ns	ns	ns	*(-)
Experience (years)					
≤ 5	ns	**(-)	ns	*(-)	***(-)
> 5 – 10	ns	ns	ns	**(-)	**(-)
> 10 – 15	ns	ns	ns	**(-)	ns
> 15 – 25	ns	ns	ns	ns	ns
25 +	ref.	ref.	ref.	ref.	ref.
Born in Australia					
Yes	ref	ref.	ref.	ref.	ref.
No	ns	**(-)	ns	ns	*(-)
University of graduation					
Syd	ref.	ref.	ref.	ref.	ref.
O/S	ns	ns	ns	ns	ns
Melb	ns	ns	ns	ns	***(-)
QLD	ns	ns	ns	ns	**(-)
Adel	ns	*(-)	ns	ns	*(-)
WA	ns	ns	ns	ns	ns
2. Capital inputs					
Number surgeries					
1	ref.	ref.	ref.	ref.	ref.
2	***(+)	*(+)	***(+)	**(+)	***(+)
3 +	***(+)	**(+)	ns	*(+)	***(+)
Number x-ray units					
1	ref.	ref.	ref.	ref.	ref.
2	ns	ns	ns	ns	ns
3 +	ns	ns	ns	**(+)	ns
3. Labour inputs					
Dentist hrs/day					
> 4 –8	ref.	ref.	ref.	ref.	ref.
≤ 4	*** (-)	*** (-)	*** (-)	*** (-)	*** (-)
8 +	***(+)	***(+)	***(+)	***(+)	***(+)
No. aux (E-O)					
1	ref.	ref.	ref.	ref.	ref.
0	ns	-	ns	ns	**(-)
2	*(+)	*(+)	ns	***(+)	ns
3 +	ns	ns	ns	***(+)	ns
No. aux (I-O)					
0	ref.	ref.	ref.	ref.	
1	ns	ns	ns	ns	ns
2 +	ns	ns	ns	ns	ns

Table 4.53 *continued.*

	1983	1988	1993	1998	Panel 1983 - 1998
4. Practice characteristics					
Configuration					
Solo	ref.	ref.	ref.	ref.	ref.
Partner	ns	ns	ns	ns	ns
Associate	ns	ns	ns	ns	ns
Assistant	ns	ns	ns	ns	ns
Locum	ns	ns	ns	ns	ns
Size (no. other dentists)					
0	ref.	ref.	ref.	ref.	ref.
1	ns	ns	ns	ns	ns
2	ns	ns	ns	ns	ns
3	ns	ns	ns	ns	ns
4 +	ns	ns	**(-)	ns	*(-)
Perceived busyness					
Less busy	ref.	ref.	ref.	ref.	ref.
As busy	*(+)	***(+)	***(+)	***(+)	***(+)
More busy	*(+)	***(+)	***(+)	***(+)	***(+)
State location					
NSW	ref.	ref.	ref.	ref.	ref.
ACT	ns	ns	*(+)	ns	ns
Vic	ns	*(+)	***(+)	ns	*(+)
QLD	ns	ns	**(+)	ns	ns
SA	ns	ns	ns	ns	ns
WA	ns	ns	ns	ns	ns
Tas	ns	**(+)	**(+)	ns	**(+)
NT	ns	ns	ns	ns	ns
Wait for appt.(wks)					
0 - 0.9	ref.	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	*(+)	ns	*(+)	**(+)
2.0 – 3.9	ns	ns	ns	*(+)	***(+)
4.0 +	ns	ns	ns	ns	*(+)
5. Year of survey					
1983					ref.
1988					***(-)
1993					***(-)
1998					***(-)
Adjusted R^2	41%	36%	44%	37%	42%
F – statistic	*** 6.73	*** 7.14	*** 8.31	*** 7.59	*** 28.86
n	354	450	396	462	1664

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.5.2 Output: patients per day (log data)

Table 4.54 presents the multivariate production function model for 1983 with productivity measured as patients per day. The model explained 30% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience), capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, length of wait for an appointment).

Productivity gains resulting from the utilisation of more than one surgery were in the range of 2.38 to 4.43 patients per day, but standardised regression coefficients showed the productivity gain was slightly higher for dentists utilising 3 or more surgeries compared to dentists utilising 2 surgeries. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Dentists who reported to work with 2, or 3 or more extra-oral auxiliaries were significantly more productive compared to those who worked with one extra-oral auxiliary, while the variable: number of intra-oral auxiliaries did not exhibit a significant association with productivity. Locum dentists or those reporting a length of wait for an appointment to be between 2.0 to 3.9 weeks were significantly more productive compared to their reference counterparts of solo dentists and those reporting an appointment waiting time of up to one week, by 4.58 and 4.23 patients per day, respectively.

Table 4.54: OLS regression model of patients per day (log data), 1983

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.86	-0.03	(-4.68-2.96)
Experience (years)				
≤ 5	ns	-1.42	-0.06	(-4.75-1.92)
> 5 – 10	ns	0.57	0.02	(-3.08-4.21)
> 10 – 15	*	4.54	0.15	(0.76-8.32)
> 15 – 25	ns	2.12	0.08	(-1.38-5.62)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-1.73	-0.07	(-5.06-1.60)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	3.51	0.10	(-4.33-11.34)
Melb	ns	6.07	0.28	(-2.26-14.40)
QLD	ns	6.71	0.25	(-1.47-14.89)
Adel	ns	4.70	0.16	(-5.06-14.45)
WA	ns	2.56	0.07	(-10.46-15.59)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	*	2.38	0.11	(-0.07-4.82)
3 +	*	4.43	0.13	(0.13-8.72)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.28	-0.01	(-3.08-2.53)
3 +	ns	1.96	0.08	(-1.28-5.20)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-8.90	-0.19	(-14.11- -3.69)
8 +	***	5.57	0.20	(2.22-8.91)

Table 4.54 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-5.58	-0.04	(-21.67-10.52)
2	**	4.05	0.19	(1.16-6.94)
3 +	*	3.89	0.15	(0.36-7.42)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-1.57	-0.02	(-10.71-7.56)
2 +	ns	-5.62	-0.05	(-19.44-8.21)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-1.58	-0.05	(-5.18-2.02)
Associate	ns	-0.58	-0.02	(-3.70-2.54)
Assistant	ns	-1.58	-0.05	(-5.09-1.93)
Locum	*	4.58	0.11	(0.01-9.15)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-1.89	-0.08	(-4.70-0.92)
2	ns	-0.40	-0.01	(-4.55-3.74)
3	ns	-0.12	-0.01	(-8.85-8.61)
4 +	ns	0.70	0.01	(-10.93-12.33)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	2.29	0.11	(-0.47-5.05)
More busy	ns	4.20	0.11	(-0.96-9.36)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-5.03	-0.23	(-13.79-3.73)
Vic	ns	-3.99	-0.17	(-13.72-5.74)
QLD	ns	-2.68	-0.09	(-12.45-7.09)
SA	ns	-4.02	-0.11	(-17.38-9.34)
WA	ns	-3.63	-0.10	(-14.93-7.67)
Tas	ns	-4.93	-0.05	(-18.75-8.88)
NT	ns	-5.60	-0.03	(-27.94-16.74)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	0.59	0.02	(-2.89-4.07)
2.0 – 3.9	*	4.23	0.16	(0.76-7.69)
4.0 +	ns	2.42	0.06	(-2.80-7.64)
Adjusted R^2				30%
F – statistic				*** 3.75
n				269
Missing cases				98

***(p<0.001); **(p<0.01); *(p<0.05); ANOVA test
ns (not significant)

Table 4.55 presents the multivariate production function model for 1988 with productivity measured as patients per day. The model explained 22% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, number of intra-oral auxiliaries), and practice characteristics (state location of main practice).

Productivity gains resulting from the utilisation of 3 or more x-ray units were equal to 5.37 patients per day. Dentists working up to 4 hours per day were significantly less productive by 7.93 patients per day than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive by 7.95 patients per day than the group of dentists working between 4 and 8 hours per day. Utilisation of 1 or more intra-oral auxiliary resulted in productivity losses of 5.56 patients per day, while dentists whose main practice was in the Northern Territory also had lower estimated productivity (-5.52 patients per day) when compared to New South Wales based dentists.

Table 4.55: OLS regression model of patients per day (log data), 1988

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.68	-0.03	(-4.14-2.79)
Experience (years)				
≤ 5	ns	-2.36	-0.11	(-6.40-1.68)
> 5 – 10	ns	1.25	0.06	(-2.38-4.87)
> 10 – 15	ns	1.56	0.05	(-3.44-6.56)
> 15 – 25	ns	0.70	0.03	(-3.21-4.61)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-0.82	-0.04	(-4.50-2.86)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	0.08	0.00	(-7.81-7.97)
Melb	ns	1.87	0.10	(-6.21-9.95)
QLD	ns	-1.47	-0.06	(-10.13-7.19)
Adel	ns	-6.02	-0.24	(-17.08-5.04)
WA	ns	1.58	0.06	(-7.17-10.33)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	-1.91	-0.10	(-4.82-1.00)
3 +	ns	-2.89	-0.10	(-7.54-1.75)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.78	0.04	(-2.55-4.11)
3 +	**	5.37	0.27	(1.22-9.53)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-7.93	-0.22	(-13.22- -2.63)
8 +	***	7.95	0.29	(3.69-12.22)

Table 4.55 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	-1.28	0.07	(-2.86-5.42)
3 +	ns	1.49	0.09	(-2.78-5.77)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1+	*	-5.56	-0.19	(-10.92- -0.19)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	3.78	0.15	(-0.08-7.64)
Associate	ns	0.75	0.03	(-2.80-4.31)
Assistant	ns	-3.79	-0.16	(-7.80-0.23)
Locum	ns	4.23	0.08	(-3.54-12.00)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.06	0.00	(-3.13-3.25)
2	ns	1.53	0.06	(-3.06-6.11)
3	ns	2.41	0.05	(-4.38-9.20)
4 +	ns	0.34	0.01	(-7.18-7.86)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	1.83	0.10	(-1.54-5.20)
More busy	ns	0.19	0.01	(-7.26-7.63)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-6.22	-0.35	(-16.23-3.78)
Vic	ns	-0.74	-0.04	(-11.51-10.03)
QLD	ns	2.57	0.10	(-10.81-15.95)
SA	ns	0.35	0.01	(-11.88-12.58)
WA	ns	-0.17	-0.01	(-12.14-11.80)
Tas	ns	5.57	0.10	(-7.55-18.70)
NT	*	-5.52	-0.22	(-45.98- -5.07)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	3.37	0.15	(-0.46-7.21)
2.0 – 3.9	ns	-0.37	-0.02	(-4.29-3.55)
4.0 +	ns	0.17	0.01	(-7.01-7.34)
Adjusted R^2				22%
F – statistic				*** 2.30
n				190
Missing cases				291

***(p<0.001); **(p<0.01); *(p<0.05); ANOVA test
ns (not significant)

Table 4.56 presents the multivariate production function model for 1993 with productivity measured as patients per day. The model explained 31% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (university of graduation), labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, length of wait for an appointment). No significant inputs were found for capital inputs. Productivity gains were exhibited for dental graduates from the Universities of Melbourne, Queensland and Adelaide equal to 10.22, 10.06 and 6.76 patients per day, respectively. Dentists working up to 4 hours per day were significantly less productive by 6.57 patients per day than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive by 5.20 patients per day than the group of dentists working between 4 and 8 hours per day. Utilisation of extra-oral auxiliaries resulted in positive productivity gains in the range of 3.58 to 3.89 patients per day, as did an appointment waiting time of between 2 and 4 weeks result in 4.88 more patients per day, while assistant dentist configurations were significantly less productive by 3.13 patients per day as compared with solo configurations.

Table 4.56: OLS regression model of patients per day (log data), 1993

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-1.61	-0.07	(-3.78-1.87)
Experience (years)				
≤ 5	ns	-0.25	-0.01	(-7.05-0.43)
> 5 – 10	ns	0.95	0.04	(-5.53-2.09)
> 10 – 15	ns	1.41	0.06	(-5.81-1.75)
> 15 – 25	ns	2.34	0.11	(-0.79-5.85)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-0.56	-0.03	(-3.53-2.10)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	5.53	0.20	(-4.98-6.26)
Melb	**	10.22	0.53	(1.89-12.64)
QLD	**	10.06	0.40	(-1.77-9.12)
Adel	*	6.76	0.28	(2.70-11.21)
WA	ns	7.72	0.27	(-13.93- -1.31)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	0.05	0.00	(-1.33-4.12)
3 +	ns	-0.85	-0.03	(-5.14-3.34)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.35	0.02	(-1.31-4.60)
3 +	ns	1.36	0.07	(-0.59-6.30)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-6.57	-0.18	(-12.38- -2.19)
8 +	*	5.20	0.18	(0.56-7.97)

Table 4.56 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-6.01	-0.05	(-26.27-0.91)
2	*	3.89	0.20	(-2.92-4.31)
3 +	*	3.58	0.20	(-1.17-6.21)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-0.72	-0.02	(-6.03-3.89)
2 +	ns	-0.95	-0.02	(-8.77-8.20)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	1.32	0.05	(-3.47-3.40)
Associate	ns	-1.66	-0.07	(-4.41-1.91)
Assistant	*	-3.13	-0.14	(-4.08-1.81)
Locum	ns	-11.22	-0.08	(-24.85-8.46)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.36	0.02	(-2.55-2.98)
2	ns	3.86	0.13	(-4.61-3.70)
3	ns	2.04	0.06	(-6.60-2.67)
4 +	ns	5.07	0.12	(-5.52-5.96)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	1.77	0.10	(-0.74-4.56)
More busy	ns	4.43	0.14	(3.53-12.92)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-1.12	-0.06	(-4.94-7.23)
Vic	ns	-1.42	-0.06	(-8.87-4.04)
QLD	ns	5.63	0.23	(-7.46-6.47)
SA	ns	-2.39	-0.07	(-15.44-1.96)
WA	ns	2.61	0.09	(-2.92-12.65)
Tas	ns	2.46	0.04	(-12.99-5.09)
NT	ns	3.12	0.04	(-4.79-19.21)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	1.35	0.06	(-1.47-5.05)
2.0 – 3.9	*	4.88	0.18	(-2.33-5.51)
4.0 +	ns	-2.35	-0.05	(--11.55-4.19)
Adjusted R^2				31%
F – statistic				*** 3.40
n				226
Missing cases				215

**(p<0.01); *(p<0.05); ANOVA test
ns (not significant)

Table 4.57 presents the multivariate production function model for 1998 with productivity measured as patients per day. The model explained 36% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience, country of birth, university of graduation), capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, size, perceived busyness).

Comparison of regression coefficients showed dentists with experience of between 5 and 10 years, 15 and 25 years, non-Australian country of birth and Western Australian dental graduates were relatively less productive by 2.61, 1.45, 1.06 and 2.47 patients per day, respectively, compared to dentists with more than 25 years of experience, Australian country of birth and Sydney University graduates. Productivity gains resulting from the utilisation of 2 surgeries were equal to 1.38 patients per day. Dentists working up to 4 hours per day were significantly less productive by 3.57 patients per day than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive by 2.88 patients per day than the group of dentists working between 4 and 8 hours per day. The use of 3 or more extra-oral auxiliaries had a significant and positive association with productivity compared to the use of one extra-oral auxiliary by 1.61 more patients per day Perception of busyness was significantly associated with productivity levels with a gain of 1.69 more patients per day for dentists reporting to be more busy than they would like having higher productivity compared to the reference group of dentists reporting to be less busy than they would like. Lastly, group practice size of either one or, 4 or more dentists resulted in positive productivity gains of 1.00 and 4.34 more patients per day, respectively.

Table 4.57: OLS regression model of patients per day (log data), 1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.97	-0.09	(-2.00-0.07)
Experience (years)				
≤ 5	ns	-1.39	-0.11	(-2.89-0.11)
> 5 – 10	***	-2.61	-0.23	(-3.91- -1.31)
> 10 – 15	ns	-0.61	-0.06	(-1.88-0.66)
> 15 – 25	**	-1.45	-0.17	(-2.57- -0.32)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	*	-1.06	-0.13	(-2.09- -0.02)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.51	-0.06	(-2.45-1.42)
Melb	ns	-1.66	-0.16	(-3.60-0.27)
QLD	ns	-1.69	-0.16	(-3.95-0.57)
Adel	ns	-0.47	-0.04	(-3.17-2.23)
WA	*	-2.47	-0.18	(-4.92- -0.03)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	**	1.38	0.17	(0.47-2.29)
3 +	ns	1.09	0.07	(-0.70-2.88)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.40	0.05	(-0.70-1.50)
3 +	ns	0.45	0.05	(-0.90-1.79)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-3.57	-0.15	(-5.97- -1.16)
8 +	***	2.88	0.27	(1.77-4.00)

Table 4.57 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	0.70	0.08	(-0.63-2.12)
3 +	*	1.61	0.20	(0.26-2.96)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-1.39	-0.10	(-2.87-0.09)
2 +	ns	-1.55	-0.06	(-4.19-1.08)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	0.12	0.01	(-1.36-1.59)
Associate	ns	-0.19	-0.02	(-1.40-1.02)
Assistant	*	1.03	0.11	(0.05-2.00)
Locum	ns	-1.69	-0.04	(-5.47-2.09
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	*	1.00	0.11	(0.00-1.99)
2	ns	0.62	0.05	(-0.73-1.98)
3	ns	1.06	0.06	(-0.83-2.94)
4 +	***	4.34	0.19	(1.88-6.80)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	0.59	0.07	(-0.35-1.52)
More busy	*	1.69	0.14	(0.20-3.18)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	0.78	0.09	(-2.11-3.67)
Vic	ns	1.57	0.17	(-1.44-4.58)
QLD	ns	1.21	0.11	(-1.71-4.12)
SA	ns	1.52	0.10	(-1.96-5.00)
WA	ns	1.69	0.14	(-1.57-4.94)
Tas	ns	0.63	0.01	(-4.43-5.69)
NT	ns	-5.09	-0.08	(-12.07-1.89)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	1.03	0.10	(-0.04-2.10)
2.0 – 3.9	ns	0.94	0.08	(-0.35-2.23)
4.0 +	ns	1.48	0.08	(-0.49-3.46)
Adjusted R^2				36%
F – statistic				*** 5.13
n				300
Missing cases				189

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Summary of productivity analysis of patients per day (log data) 1983-1998

Table 4.58 presents the multivariate production function model for combined data of the 1983, 1988, 1993 and 1998 samples with productivity measured as patients per day. Variables describing the year of survey were included to estimate the effect of time on productivity, which is the productivity time trend. The model explained 44% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience, country of birth, university of graduation), capital (surgery and x-ray unit utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (perceived busyness, length of wait for an appointment).

Comparison of regression coefficients showed dentists with experience of either up to 5 years, or between 5 and 10 years were relatively less productive compared to dentists with more than 25 years of experience. Non-Australian-born dentists and graduates from Western Australia were significantly less productive compared to their respective reference categories of Australian-born, and Sydney University graduates. Productivity gains resulting from the utilisation of 2 or, 3 or more surgeries were in the range of 1.89 to 1.66 patients per day, but standardised regression coefficients showed the productivity gain was less when dentists used 3 or more surgeries compared to using 2 surgeries. X-ray unit utilisation was also significant with 3 or more x-ray unit utilisation generating 1.18 more patients per day compared to single x-ray unit utilisation. Dentists working up to 4 hours per day were significantly less productive by 5.24 patients per day than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive by 3.14 patients per day than the group of dentists working between 4 and 8 hours per day. The use of either 2 or 3 or more extra-oral auxiliaries resulted in positive productivity gain in the range of 1.35 to 1.69 patients per day while other variables such as configuration and size were not amongst the practice characteristics significantly associated productivity. Perception of busyness, however, was significantly associated with productivity levels in the range of 1.76 to 4.39 patients per day, with dentists reporting to be either as busy as or more busy than they would like having higher productivity respectively compared to the

reference group of dentists reporting to be less busy than they would like. The category of 1.0 to 1.9 weeks wait for an appointment exhibited higher productivity by 1.21 patients per day when compared to less than one week wait for an appointment.

Time proved to be a consistently significant factor negatively associated with productivity. Productivity, when measured as patients per day, significantly declined across the 1983 to 1998 period with successive increments of decline increasing over the 15 year period.

When the results in Table 4.58 were compared with the results in Table 4.52 to compare the difference between using the patients per day variable from Section A of the LSPDA questionnaire i.e. 'patients per day' to the variable patients per day from Section B of the LSPDA questionnaire (which is smaller in sample size), it was found that the two models achieved relatively similar results. The productivity time trends were the same and the type and sign of significant inputs were the same; with the exception that more significant practice characteristics (configuration, size, perceived busyness) were found in the model using the dependent variable obtained from a larger sample size. Both estimated models had R^2 values between 42 and 44% and were significant at $p<0.001$. Based upon these findings, the choice to use the patients per day variable obtained from the larger sample size (Section A, LSPDA) was considered preferable to using the patients per day variable obtained from the smaller sample size (Section B, LSPDA) and hence all estimates in summary tables and discussion notes are based on the models which used patients per day from Section A of the LSPDA.

Table 4.58: OLS regression model of patients per day (log data), 1983-1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.77	-0.04	(-1.77-0.23)
Experience (years)				
≤ 5	***	-2.21	-0.12	(-3.33- -1.08)
> 5 – 10	**	-1.53	-0.08	(-2.64- -0.42)
> 10 – 15	ns	-0.78	-0.04	(-1.94-0.39)
> 15 – 25	ns	0.07	0.00	(-0.95-1.08)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	*	-1.00	-0.06	(-1.91- -0.08)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-0.97	-0.06	(-2.60-0.66)
Melb	ns	0.30	0.02	(-1.39-1.98)
QLD	ns	-0.52	-0.03	(-2.47-1.43)
Adel	ns	-1.00	-0.04	(-3.28-1.28)
WA	*	-2.21	-0.08	(-4.38- -0.05)
2. Capital inputs				
No. of surgeries				
1	ref.	ref.	ref.	ref.
2	***	1.89	0.13	(1.10-2.68)
3 +	*	1.66	0.07	(0.32-3.00)
No. of x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.27	0.02	(-0.63-1.18)
3 +	*	1.18	0.07	(0.13-2.23)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-5.24	-0.16	(-6.91- -3.57)
8 +	***	3.14	0.15	(2.10-4.17)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-3.87	-0.03	(-10.48-2.74)
2	**	1.35	0.09	(0.32-2.39)
3 +	**	1.79	0.12	(0.67-2.91)

Table 4.58 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-0.78	-0.03	(-2.32-0.75)
2 +	ns	-1.31	-0.02	(-4.26-1.63)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	0.69	0.03	(-0.44-1.83)
Associate	ns	-0.69	-0.04	(-1.68-0.31)
Assistant	ns	0.51	0.03	(-0.44-1.45)
Locum	ns	0.76	0.02	(-1.40-2.91)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.16	0.10	(-0.71-1.03)
2	ns	-0.64	-0.03	(-1.85-0.58)
3	ns	-0.36	-0.10	(-2.10-1.39)
4 +	ns	1.12	0.03	(-1.08-3.32)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	***	1.76	0.12	(0.93-2.60)
More busy	***	4.39	0.18	(2.88-5.89)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-0.73	-0.05	(-3.07-1.60)
Vic	ns	-1.15	-0.07	(-3.67-1.36)
QLD	ns	-0.88	-0.04	(-3.52-1.76)
SA	ns	-2.00	-0.07	(-5.03-1.03)
WA	ns	-0.89	-0.04	(-3.77-1.99)
Tas	ns	-0.27	-0.10	(-3.86-3.13)
NT	ns	-1.19	-0.01	(-6.22-3.85)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	*	1.21	0.06	(0.22-2.22)
2.0 – 3.9	ns	0.93	0.05	(-0.17-2.03)
4.0 +	ns	0.83	0.03	(-0.94-2.59)
5. Year of survey				
1983	ref.	ref.	ref.	ref.
1988	**	-1.58	-0.09	(-2.65- -0.51)
1993	***	-5.47	-0.31	(-4.42- -0.65)
1998	***	-4.64	-0.29	(-5.64- -3.66)
Adjusted R^2				44%
F – statistic				*** 18.27
n				988
Missing cases				

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.5.3 Output: patients per day (longitudinal cohort)

Table 4.59 presents the longitudinal multivariate production function model for the true cohort sample (dentists with observations from all four survey years) and with productivity measured as patients per day. Variables describing the year of survey were included to estimate the association of time with productivity, which is the productivity time trend. The model explained 49% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex), capital (surgery utilisation) and labour inputs (dentist chairside hours), and practice characteristics (perceived busyness, state location).

Significant variation in productivity was found between male and female dentists, with female dentists having lower productivity compared to male dentists. Productivity gains resulting from the utilisation of 2 or 3 or more surgeries were in the range of 1.39 to 2.42 patients per day, but standardised regression coefficients showed the productivity gain was the same between using 3 or more surgeries compared to using 2 surgeries. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Perception of busyness was significantly associated with productivity levels in the range of 1.76 to 5.08 patients per day, with dentists reporting to be either as busy as or more busy than they would like having higher productivity respectively compared to the reference group of dentists reporting to be less busy than they would like. In order of magnitude, Victorian- and Queensland-based dentists had higher estimated productivity compared to New South Wales-based dentists.

Time proved to be a consistently significant and factor negatively associated with productivity. Productivity, when measured as patients per day, significantly declined across the 1993 to 1998 period, with successive increments of decline increasing between each survey year.

Table 4.59: OLS regression model of patients per day (longitudinal cohort), 1983-1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	*	-2.31	-0.14	(-4.34- -0.28)
Experience (years)				
≤ 5	ns	-1.35	-0.05	(-4.80-2.11)
> 5 – 10	ns	0.63	0.04	(-1.83-3.09)
> 10 – 15	ns	0.79	0.06	(-1.23-2.81)
> 15 – 25	ns	0.74	0.06	(-0.83-2.31)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-1.73	-0.12	(-3.99-0.54)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	0.30	0.03	(-3.05-3.66)
Melb	ns	-2.63	-0.18	(-5.86-0.60)
QLD	ns	-1.36	-0.07	(-4.85-2.14)
Adel	ns	-3.74	-0.20	(-12.98-5.50)
WA	ns	-4.30	-0.27	(-9.95-1.34)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	*	1.39	0.12	(0.05-2.73)
3 +	*	2.42	0.12	(0.17-4.67)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-4.52	-0.18	(-7.42- -1.61)
8 +	***	3.03	0.27	(1.70-4.35)

Table 4.59 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (E-O)				
2	ref.	ref.	ref.	ref.
1	ns	-0.87	-0.06	(-2.64-0.91)
3 +	ns	1.53	0.13	(-0.34-3.40)
4.Practice inputs				
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	*	1.76	0.15	(0.22-3.30)
More busy	***	5.08	0.28	(2.47-7.68)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	2.01	0.17	(-1.95-5.96)
Vic	**	6.93	0.53	(2.07-11.79)
QLD	**	7.59	0.36	(2.38-12.81)
SA	ns	5.03	0.24	(-4.98-15.04)
WA	ns	5.36	0.34	(-1.55-12.26)
NT	ns	0.82	0.02	(-9.76-11.40)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	0.79	0.05	(-0.92-2.50)
2.0 – 3.9	ns	-0.21	-0.02	(-2.02-1.59)
4.0 +	ns	-0.81	-0.04	(-3.56-1.94)
5. Year of survey				
1983	ref.	ref.	ref.	ref.
1988	ns	-1.28	-0.10	(-2.99-0.42)
1993	**	-3.02	-0.23	(-4.97- -1.06)
1998	***	-3.60	-0.25	(-5.76- -1.43)
Adjusted R^2				49%
F – statistic				*** 7.85
n				214
Missing cases				602

***(p<0.001), **(p<0.01), *(p0.05); ANOVA test
ns (not significant)

Summary of productivity analysis, patients per day (longitudinal cohort)

When the results in Table 4.59 were compared with the results in Table 4.52 to compare the difference between using the patients per day variable from Section A of the LSPDA questionnaire i.e. non-cohort sample, to the variable patients per day from the sample containing only the true longitudinal cohort of dentists who participated in the LSDPA in all four survey years (1983, 1988, 1993, 1998), the two models achieved had some notable differences. Although both estimated models had R^2 values between 42 and 49%, were significant at $p<0.001$, showed similar productivity time trends and type and sign of significant inputs, there were however fewer significant inputs achieved from the smaller sample size. The common variables of significance included sex, surgeries utilised, dentist chairside hours, perceived busyness and state location of main practice. The main issue with the true cohort sample was the much smaller n leading to the smaller number of significant variables. However, despite this, the models were still quite similar in terms of the fit, R^2 value, sign and magnitude of coefficients. To fit the model, various combinations were tried with the following variables removed: x-ray units, configuration, size, intra-oral auxiliaries and state location (Tasmania). Additionally, the true-cohort model had to be reweighted by representative sex proportions for each survey year but it was not reweighted by age groups as the respective categories would have led to a very small n. A true-cohort model using services, RVUs and $GB per day as the dependent variable was specified however, due to an even smaller n using the service log data (Section B, LSPDA), it was not possible to fit an acceptable model. In summary, the similarity in results between panel longitudinal models using non-cohort and true-cohort samples suggests that sample bias *may* not be present, however, due to the inability to fit models for each survey year with the same number of explanatory variables in each model does not allow for an accurate comparison and therefore we cannot be sure there is no sample bias present.

4.5.4 Output: services per day

Table 4.60 presents the multivariate production function model for 1983 with productivity measured as services per day. The model explained 30% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience), capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, extra-oral auxiliaries) and practice characteristics (configuration, perceived busyness, length of wait for an appointment).

Productivity gains were significant for the group of dentists with experience in the range of between 10 and 15 years providing on average 4.54 more services per day compared to dentists with more than 25 years' experience. In terms of capital inputs, dentists utilising 3 or more surgeries were relatively more productive by 4.43 services per day. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Auxiliary utilisation was also significantly associated with productivity, with dentists reporting to work with either 2 or, 3 or more extra-oral auxiliaries providing 4.05 and 3.89 more services per day respectively. Perception of busyness was significantly associated with productivity levels, with dentists reporting to be as busy as they would like having higher productivity by 2.29 services per day than those reporting to be less busy than they would like; however, dentists reporting to be more busy than they would like were not significantly more productive. A waiting time of between 2.0 and 3.9 weeks wait resulted in an average of 4.23 more services per day compared to less than a week waiting time for an appointment. The remaining significant variable related to practice characteristics was configuration where dentists whose reported type of practice was locum were significantly more productive by 4.23 services per day. State location and group practice size was not significantly associated with productivity.

Table 4.60: OLS regression model of services per day, 1983

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.87	-0.03	(-4.68-2.96)
Experience (years)				
≤ 5	ns	-1.42	-0.06	(-4.75-1.92)
> 5 – 10	ns	0.57	0.02	(-3.08-4.21)
> 10 – 15	*	4.54	0.15	(0.76-8.32)
> 15 – 25	ns	2.12	0.08	(-1.38-5.62)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-1.73	-0.07	(-5.06-1.60)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	2.56	0.12	(-2.75-7.87)
Melb	ns	3.20	0.12	(-2.65-9.05)
QLD	ns	1.19	0.04	(-5.98-8.36)
Adel	ns	-0.94	-0.03	(-12.70-10.81)
WA	ns	-3.51	-0.08	(-11.34-4.33)
2. Capital inputs				
No. of surgeries				
1	ref.	ref.	ref.	ref.
2	ns	2.38	0.11	(-0.07-4.82)
3 +	*	4.43	0.13	(0.13-8.72)
No. of x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-0.28	-0.01	(-3.08-2.53)
3 +	ns	1.96	0.08	(-1.28-5.20)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-8.90	-0.19	(-14.11- -3.69)
8 +	***	5.57	0.20	(2.22-8.91)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-5.58	-0.04	(-21.67-10.52)
2	**	4.05	0.19	(1.16-6.94)
3 +	*	3.89	0.15	(0.36-7.42)

Table 4.60 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-1.57	-0.02	(-10.71-7.56)
2 +	ns	-5.62	-0.05	(-19.44-8.21)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-1.58	-0.05	(-5.18-2.02)
Associate	ns	-0.58	-0.02	(-3.70-2.54)
Assistant	ns	-1.58	-0.05	(-5.09-1.93)
Locum	*	4.58	0.11	(0.01-9.15)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-1.89	-0.08	(-4.70-0.92)
2	ns	-0.40	-0.01	(-4.55-3.74)
3	ns	-0.12	-0.01	(-8.85-8.61)
4 +	ns	0.70	0.01	(-10.93-12.33)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	*	2.29	0.11	(-0.47-5.05)
More busy	ns	4.20	0.11	(-0.96-9.36)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-5.03	-0.23	(-13.79-3.73)
Vic	ns	-3.99	-0.17	(-13.72-5.74)
QLD	ns	-2.68	-0.09	(-12.45-7.09)
SA	ns	-4.02	-0.11	(-17.38-9.34)
WA	ns	-3.63	-0.10	(-14.93-7.67)
Tas	ns	-4.93	-0.05	(-18.75-8.88)
NT	ns	-5.60	-0.03	(-27.94-16.74)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	0.59	0.02	(-2.89-4.07)
2.0 – 3.9	*	4.23	0.16	(0.76-7.69)
4.0 +	ns	2.42	0.06	(-2.80-7.64)
Adjusted R^2				30%
F – statistic				*** 4.49
n				269
Missing cases				98

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.61 presents the multivariate production function model for 1988 with productivity measured as services per day. The model explained 22% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (country of birth), capital (multiple x-ray unit utilisation) and labour inputs (dentist chairside hours), and practice characteristics (configuration, state location of main practice).

Non-Australian-born dentists were significantly associated with lower productivity equal to 0.77 services per day compared to Australian-born dentists. Productivity gains resulting from the utilisation of 3 or more x-ray units were equal to 5.41 services per day, while no significant association was found for multiple surgery utilisation. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. Auxiliary utilisation was not significantly associated with productivity. Partnership configuration generated a significant association with productivity equal to 3.77 more services per day compared to solo practice configuration. The only other remaining practice characteristic that showed a significant association with productivity was state location of main practice where Northern Territory-based dentists provided significantly less services per day (25.62) compared to New South Wales-based dentists.

Table 4.61: OLS regression model of services per day, 1988

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.65	-0.03	(-4.13-2.82)
Experience (years)				
≤ 5	ns	-2.37	-0.11	(-6.41-1.67)
> 5 – 10	ns	1.24	0.06	(-2.39-4.86)
> 10 – 15	ns	1.64	0.05	(-3.35-6.62)
> 15 – 25	ns	0.71	0.03	(-3.20-4.62)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	**	-0.77	-0.04	(-4.45-2.90)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	2.04	0.11	(-3.89-7.96)
Melb	ns	-1.37	-0.06	(-7.42-4.68)
QLD	ns	-5.97	-0.24	(-15.22-3.29)
Adel	ns	1.83	0.07	(-5.71-9.38)
WA	ns	0.95	0.03	(-7.15-9.04)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	-1.88	-0.10	(-4.78-1.03)
3 +	ns	-2.86	-0.10	(-7.50-1.79)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.79	0.04	(-2.54-4.12)
3 +	**	5.41	0.27	(1.25-9.57)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-7.91	-0.22	(-13.20- -2.61)
8 +	*	7.97	0.29	(3.70-12.23)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	1.26	0.07	(-2.88-5.40)
3 +	ns	1.42	0.08	(-2.86-5.71)

Table 4.61 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1+	ns	-5.65	-0.19	(-11.02- -0.28)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	*	3.77	0.15	(-0.09-7.63)
Associate	ns	0.74	0.03	(-2.81-4.30)
Assistant	ns	-3.83	-0.16	(-7.85-0.18)
Locum	ns	4.26	0.08	(-3.52-12.03)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.04	0.00	(-3.14-3.23)
2	ns	1.51	0.06	(-3.07-6.09)
3	ns	2.39	0.05	(-4.40-9.18)
4 +	ns	0.32	0.01	(-7.21-7.84)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	1.81	0.10	(-1.56-5.18)
More busy	ns	0.09	0.00	(-7.36-7.55)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-6.28	-0.35	(-16.28-3.73)
Vic	ns	-0.70	-0.04	(-11.47-10.06)
QLD	ns	2.65	0.10	(-10.75-16.05)
SA	ns	0.26	0.01	(-11.97-12.49)
WA	ns	-0.75	-0.02	(-12.80-11.31)
Tas	ns	5.22	0.10	(-7.81-18.25)
NT	**	-25.62	-0.22	(-46.08- -5.17)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	3.35	0.15	(-0.48-7.19)
2.0 – 3.9	ns	-0.36	-0.02	(-4.29-3.56)
4.0 +	ns	0.25	0.01	(-6.93-7.43)
Adjusted R^2				22%
F – statistic				*** 2.31
n				190
Missing cases				291

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.62 presents the multivariate production function model for 1993, with productivity measured as services per day. The model explained 30% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, length of wait for an appointment). No dentist characteristics or capital inputs were found to have a significant association with productivity.

Dentists working up to 4 hours per day were significantly less productive (6.45 services per day) than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive (5.20 services per day) than the group of dentists working between 4 and 8 hours per day. Use of 2 extra-oral auxiliaries resulted in significantly lower productivity by 3.89 services per day compared to use of one extra-oral auxiliary. Assistant dentist configuration type resulted in significantly less services per day (3.31) compared to the reference category of solo dentists while dentists reporting a length of wait for an appointment between 2.0 and 3.9 weeks resulted in 4.80 less services per day compared to dentists reporting an appointment waiting time of up to one week.

Table 4.62: OLS regression model of services per day, 1993

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-1.66	-0.07	(-4.62-1.31)
Experience (years)				
≤ 5	ns	-0.36	-0.02	(-4.07-3.35)
> 5 – 10	ns	0.99	0.04	(-2.79-4.76)
> 10 – 15	ns	1.47	0.06	(-2.28-5.22)
> 15 – 25	ns	2.53	0.12	(-0.76-5.82)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-0.20	-0.01	(-2.99-2.59)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	5.38	0.28	(-0.19-10.95)
Melb	ns	5.13	0.21	(-0.20-10.46)
QLD	ns	2.62	0.11	(-2.77-8.02)
Adel	ns	2.88	0.10	(-4.01-9.77)
WA	ns	-3.68	-0.10	(-9.94-2.57)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	0.11	0.01	(-2.59-2.81)
3 +	ns	-0.51	-0.02	(-4.71-3.69)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.31	0.02	(-2.62-3.24)
3 +	ns	1.12	0.06	(-2.29-4.53)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-6.45	-0.18	(-11.50- -1.40)
8 +	**	5.20	0.18	(1.53-8.87)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-5.86	-0.05	(-19.33-7.61)
2	*	3.89	0.20	(0.31-7.47)
3 +	ns	3.53	0.19	(-0.13-7.19)

Table 4.62 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-0.45	-0.01	(-5.37- 4.47)
2 +	ns	-1.13	-0.02	(-9.54-7.28)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	1.19	0.05	(-2.22-4.59)
Associate	ns	-1.59	-0.07	(-4.72-1.54)
Assistant	*	-3.31	-0.15	(-6.22- -0.39)
Locum	ns	-11.15	-0.08	(-27.65-5.36)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.45	0.02	(-2.29-3.18)
2	ns	3.90	0.13	(-0.22-8.01)
3	ns	2.04	0.06	(-2.56-6.63)
4 +	ns	5.32	0.13	(-0.37-11.01)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	1.78	0.10	(-0.85-4.41)
More busy	ns	4.28	0.14	(-0.38-8.93)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-1.22	-0.06	(-7.25-4.81)
Vic	ns	-1.38	-0.06	(-7.77-5.02)
QLD	ns	4.83	0.20	(-2.07-11.73)
SA	ns	-2.42	-0.07	(-11.04-6.20)
WA	ns	1.96	0.07	(-5.76-9.67)
Tas	ns	2.30	0.04	(-6.65-11.26)
NT	ns	2.90	0.04	(-8.99-14.79)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	1.57	0.07	(-1.66-4.80)
2.0 – 3.9	*	4.80	0.17	(0.92-8.69)
4.0 +	ns	-2.06	-0.04	(-9.86-5.74)
Adjusted R^2				30%
F – statistic				*** 3.31
n				226
Missing cases				215

**(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.63 presents the multivariate production function model for 1998 with productivity measured as services per day. The model explained 30% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience, country of birth, university of graduation), labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, length of wait for an appointment).

Comparison of unstandardised regression coefficients showed dentists with experience of 5 to 10 years were relatively less productive by 3.82 services per day compared to dentists with more than 25 years of experience, as were non-Australian born and Queensland University trained dentists significantly less productive (2.72 and 5.74 services per day respectively) compared to Australian born and Sydney University trained dentists. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. The use of 3 or more extra-oral auxiliaries had a significant and positive association with productivity compared to the use of 1 extra-oral auxiliary by 3.51 services per day. Size, perception of busyness and state location of main practice were not found to have a significant association with productivity. However, the category of assistant dentist within practice configuration and appointment waiting time of between 1.0 and 1.9 weeks was found to be significantly associated with productivity by 3.51 and 4.23 services per day, respectively.

Table 4.63: OLS regression model of services per day, 1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-0.79	-0.03	(-3.34-1.77)
Experience (years)				
≤ 5	ns	-0.38	-0.01	(-4.08-3.32)
> 5 – 10	*	-3.82	-0.15	(-7.02- -0.62)
> 10 – 15	ns	-1.08	-0.04	(-4.21-2.05)
> 15 – 25	ns	-1.25	-0.06	(-4.03-1.52)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	*	-2.72	-0.14	(-5.27- -0.18)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-2.79	-0.13	(-7.56-1.98)
Melb	ns	-4.54	-0.19	(-9.30-0.22)
QLD	*	-5.74	-0.24	(-11.31- -0.18)
Adel	ns	-4.42	-0.15	(-11.07-2.22)
WA	ns	-5.31	-0.17	(-11.33-0.72)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	1.97	0.10	(-0.28-4.23)
3 +	ns	-0.76	-0.02	(-5.16-3.65)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	1.20	0.06	(-1.50-3.90)
3 +	ns	1.76	0.08	(-1.55-5.07)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	ns	-4.89	-0.09	(-10.82-1.05)
8 +	***	6.79	0.27	(4.05-9.54)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	0.88	0.05	(-2.37-4.14)
3 +	*	3.67	0.19	(0.34-7.01)

Table 4.63 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-2.96	-0.09	(-6.61-0.69)
2 +	ns	3.63	0.06	(-2.86-10.12)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	2.24	0.07	(-1.40-5.87)
Associate	ns	2.69	0.10	(-0.29-5.67)
Assistant	**	3.51	0.16	(1.12-5.90)
Locum	ns	-5.66	-0.06	(-14.98-3.66)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	1.29	0.06	(-1.17-3.75)
2	ns	2.52	0.09	(-0.82-5.86)
3	ns	1.26	0.03	(-3.38-5.90)
4 +	ns	0.15	0.00	(-5.91-6.22)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	1.24	0.07	(-1.07-3.54)
More busy	ns	3.37	0.12	(-0.30-7.04)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	1.70	0.09	(-5.43-8.82)
Vic	ns	1.01	0.05	(-6.40-8.43)
QLD	ns	1.51	0.06	(-5.67-8.68)
SA	ns	7.30	0.21	(-1.27-15.87)
WA	ns	2.92	0.10	(-5.09-10.94)
Tas	ns	1.15	0.01	(-11.32-13.62)
NT	ns	-9.13	-0.06	(-26.31-8.06)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	**	4.23	0.18	(1.59-6.87)
2.0 – 3.9	ns	-0.05	0.00	(-3.23-3.13)
4.0 +	ns	3.01	0.07	(-1.77-7.97)
Adjusted R^2				30%
F – statistic				*** 4.06
n				300
Missing cases				189

***(p<0.001); **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Panel longitudinal data analysis of services per day, 1983-1998

Table 4.64 presents the multivariate production function model for combined data of the 1983, 1988, 1993 and 1998 samples with productivity measured as services per day. Variables describing the year of survey were included to estimate the association of time with productivity, which is the productivity time trend. The model explained 27% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex, university of graduation), capital (x-ray unit utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (configuration, perceived busyness, length of wait for an appointment).

Significant variation in productivity was found between male and female dentists. Comparison of un-standardised regression coefficients showed female dentists were significantly less productive compared to male dentists by 1.66 services per day. Graduates from Melbourne were significantly less productive compared to Sydney University graduates while x-ray unit utilisation overall was significant at the level of 3 or more x-ray units by 2.22 services per day. Dentists working up to 4 hours per day were significantly less productive than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day. The use of either 2 or, 3 or more extra-oral auxiliaries exhibited a significantly positive association with productivity resulting in 2.38 and 2.96 more services per day respectively compared to the use of one extra-oral auxiliary. Configuration was significant with locum arrangements generating 3.21 more services per day while perception of busyness was significantly associated with productivity levels in the range of 2.40 to 4.01 services per day, with dentists reporting to be either as busy as or more busy than they would like having higher productivity respectively compared to the reference group of dentists reporting to be less busy than they would like. Similarly, appointment waiting time was significantly associated with productivity levels in the range of 1.82 to 2.30 more services per day for dentists reporting an appointment waiting time of one to 3.9 weeks compared to dentists reporting an appointment waiting time of up to one week.

Time proved to be a significant factor negatively associated with productivity in all three survey years (1988, 1993, 1998) compared to the base year (1983). Productivity, when measured as services per day, significantly declined across the 1988 to 1998 period.

Table 4.64: OLS regression model of services per day, 1983-1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	*	-1.66	-0.06	(-3.16- -0.15)
Experience (years)				
≤ 5	ns	-1.12	-0.05	(-2.81-0.57)
> 5 – 10	ns	0.42	0.02	(-1.26-2.09)
> 10 – 15	ns	1.29	0.05	(-0.47-3.04)
> 15 – 25	ns	0.75	0.03	(-0.78-2.28)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-1.11	-0.05	(-2.49- -0.26)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	1.10	0.05	(-1.36-3.56)
Melb	*	-0.02	0.00	(-2.56-2.52)
QLD	ns	-1.43	-0.06	(-4.37-1.51)
Adel	ns	-1.88	-0.06	(-5.32-1.56)
WA	ns	-2.35	-0.07	(-5.62-0.92)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	1.15	0.06	(-0.05-2.34)
3 +	ns	0.33	0.01	(-1.69-2.35)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	0.89	0.04	(-0.48-2.25)
3 +	*	2.22	0.10	(0.63-3.81)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-7.15	-0.16	(-9.67- -4.63)
8 +	***	6.22	0.23	(4.65-7.79)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-6.85	-0.04	(-16.83-3.13)
2	**	2.38	0.12	(0.81-3.94)
3 +	***	2.96	0.15	(1.27-4.65)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-2.20	-0.06	(-4.52-0.12)
2 +	ns	1.15	0.02	(-3.30-5.59)

Table 4.64 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	1.59	0.05	(-0.12-3.31)
Associate	ns	0.35	0.01	(-1.15-1.85)
Assistant	ns	0.01	0.00	(-1.43-1.43)
Locum	*	3.21	0.06	(-0.05-6.47)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	0.15	0.01	(-1.16-1.46)
2	ns	1.18	0.04	(-0.66-3.02)
3	ns	1.06	0.02	(-1.57-3.69)
4 +	ns	1.44	0.03	(-1.88-4.76)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	***	2.40	0.12	(1.14-3.65)
More busy	***	4.01	0.12	(1.73-6.28)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-1.65	-0.08	(-5.18-1.88)
Vic	ns	0.01	0.00	(-3.79-3.81)
QLD	ns	1.41	0.05	(-2.58-5.39)
SA	ns	2.04	0.06	(-2.54-6.61)
WA	ns	-0.40	-0.01	(-4.75-3.95)
Tas	ns	2.52	0.03	(-2.89-7.94)
NT	ns	-3.77	-0.03	(-11.36-3.83)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	*	1.82	0.07	(0.30-3.34)
2.0 – 3.9	**	2.30	0.09	(0.64-3.96)
4.0 +	ns	1.36	0.03	(-1.31-4.02)
5. Year of survey				
1983	ref.	ref.	ref.	ref.
1988	***	-3.60	-0.15	(-5.22- -1.99)
1993	**	-2.00	-0.09	(-3.59- -0.41)
1998	***	-3.28	-0.16	(-4.77- -1.78)
Adjusted R^2				27%
F – statistic				*** 9.26
n				988
Missing cases				790

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Summary of productivity analysis, services per day

Table 4.65 presents the summary of all regression models specified using services per day as the dependent productivity variable.

Overall, the models explained between 22 to 30% of the variation in the output measure, with significant inputs appearing in all categories of input factors. The most consistent and strongest input measure was in the category of labour inputs, dentist hours worked per day chairside, while most other input factors only weakly influenced productivity. These included all dentist characteristics, number of intra-oral auxiliaries, number of x-ray units, configuration, size, state location of main practice and length of wait for an appointment. Similarly, variables relating to number of surgeries utilised and practice size were generally not significant.

The panel longitudinal regression showed that across time, there was a consistently strong and significant decline in the productivity trend when measured as services per day as compared with 1983.

Table 4.65: Summary-regression models of services per day, 1983-1998

	1983	1988	1993	1998	Panel 1983 - 1998
1. Dentist characteristics					
Sex					
Male	ref.	ref.	ref.	ref.	ref.
Female	ns	ns	ns	ns	*(-)
Years of experience					
≤ 5	ns	ns	ns	ns	ns
> 5 – 10	ns	ns	ns	*(-)	ns
> 10 – 15	*(+)	ns	ns	ns	ns
> 15 – 25	ns	ns	ns	ns	ns
25 +	ref.	ref.	ref.	ref.	ref.
Born in Australia					
Yes	ref.	ref.	ref.	ref.	ref.
No	ns	**(-)	ns	*(-)	ns
University of graduation					
Syd	ref.	ref.	ref.	ref.	ref.
O/S	ns	ns	ns	ns	ns
Melb	ns	ns	ns	ns	*(-)
QLD	ns	ns	ns	ns	ns
Adel	ns	ns	ns	*(-)	ns
WA	ns	ns	ns	ns	ns
2. Capital inputs					
Number of surgeries					
1	ref.	ref.	ref.	ref.	ref.
2	ns	ns	ns	ns	ns
3 +	*(+)	ns	ns	ns	ns
Number of x-ray units					
1	ref.	ref.	ref.	ref.	ref.
2	ns	ns	ns	ns	ns
3 +	ns	**(+)	ns	ns	*(+)
3. Labour inputs					
Dentist hrs/day					
> 4 –8	ref.	ref.	ref.	ref.	ref.
≤ 4	*** (-)	*** (-)	** (-)	ns	*** (-)
8 +	***(+)	*(+)	**(+)	***(+)	***(+)
No. aux (E-O)					
1	ref.	ref.	ref.	ref.	ref.
0	ns	ns	ns	ns	***(-)
2	**(+)	ns	*(+)	ns	**(+)
3 +	*(+)	ns	ns	*(+)	***(+)
No. aux (I-O)					
0	ref.	ref.	ref.	ref.	ref.
1	ns	ns	ns	ns	ns
2 +	ns	ns	ns	ns	ns

Table 4.65 *continued.*

	1983	1988	1993	1998	Panel 1983 - 1998
4. Practice inputs					
Configuration					
Solo	ref.	ref.	ref.	ref.	ref.
Partner	ns	*(+)	ns	ns	ns
Associate	ns	ns	ns	ns	ns
Assistant	ns	ns	ns	**(+)	ns
Locum	*(+)	ns	ns	ns	*(+)
Size (no. other dentists)					
0	ref.	ref.	ref.	ref.	ref.
1	ns	ns	ns	ns	ns
2	ns	ns	ns	ns	ns
3	ns	ns	ns	ns	ns
4 +	ns	ns	ns	ns	ns
Perceived busyness					
Less busy	ref.	ref.	ref	ref.	ref.
As busy	*(+)	ns	ns	ns	***(+)
More busy	ns	ns	ns	ns	***(+)
State location					
NSW	ref.	ref.	ref.	ref.	ref.
ACT	ns	ns	ns	ns	ns
Vic	ns	ns	ns	ns	ns
QLD	ns	ns	ns	ns	ns
SA	ns	ns	ns	ns	ns
WA	ns	ns	ns	ns	ns
Tas	ns	ns	ns	ns	ns
NT	ns	**(-)	ns	ns	ns
Wait for appt.(wks)					
0 - 0.9	ref.	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	ns	ns	*(+)	*(+)
2.0 – 3.9	*(+)	ns	*(+)	ns	**(+)
4.0 +	ns	ns	ns	ns	ns
5. Year of survey					
1983					ref.
1988					***(-)
1993					**(-)
1998					***(-)
Adjusted R^2	30%	22%	30%	30%	27%
F – statistic	*** 4.49	*** 2.31	*** 3.31	*** 4.06	*** 9.26
n	269	190	226	300	988

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.5.5 Output: RVUs per day

Table 4.66 presents the multivariate production function model for 1983 with productivity measured as RVUs per day. The model explained 20% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for labour inputs (dentist chairside hours), and practice characteristics (perceived busyness).

Dentists working up to 4 hours per day were significantly less productive by 130.33 RVUs per day than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive (88.66 RVUs per day) than the group of dentists working between 4 and 8 hours per day. Perception of busyness was significantly associated with productivity levels with dentists reporting to be as busy as they would like having higher productivity by 42.28 RVUs per day compared to dentists who were less busy than they would like to be.

Table 4.66: OLS regression model of RVUs per day, 1983

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-20.68	-0.04	(-81.42-40.05)
Experience (years)				
≤ 5	ns	17.86	0.05	(-34.68-70.40)
> 5 – 10	ns	11.76	0.03	(-45.53-69.05)
> 10 – 15	ns	38.30	0.09	(-21.00-97.60)
> 15 – 25	ns	6.32	0.02	(-49.26-61.90)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	7.25	0.02	(-45.38-59.88)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	13.64	0.04	(-70.49-97.77)
Melb	ns	79.67	0.20	(-12.48-171.82)
QLD	ns	18.48	0.04	(-95.24-132.19)
Adel	ns	11.64	0.02	(-187.71-210.98)
WA	ns	41.68	0.07	(-81.14-164.50)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	33.17	0.11	(-5.66-72.00)
3 +	ns	46.61	0.09	(-24.30-117.53)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	13.80	0.04	(-30.68-58.27)
3 +	ns	27.11	0.07	(-23.80-78.02)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-130.33	-0.19	(-212.97- -47.69)
8 +	***	88.66	0.21	(35.33-141.99)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-54.13	-0.02	(-306.65-198.39)
2	ns	33.22	0.11	(-12.61-79.05)
3 +	ns	46.61	0.13	(-9.45-102.68)

Table 4.66 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	83.32	0.07	(-71.30-237.94)
2 +	ns	-50.67	-0.03	(-267.86-166.53)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	38.62	0.08	(-19.53-98.77)
Associate	ns	29.89	0.08	(-19.21-78.98)
Assistant	ns	30.04	0.07	(-25.70-85.77)
Locum	ns	33.96	0.06	(-38.00-105.91)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-40.32	-0.12	(-85.01-4.38)
2	ns	7.62	0.02	(-57.94-73.17)
3	ns	-38.08	-0.04	(-176.23-100.08)
4 +	ns	-27.22	-0.02	(-211.33-156.89)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	*	42.28	0.14	(-1.13-85.69)
More busy	ns	19.22	0.03	(-62.47-100.91)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-10.92	-0.04	(-156.44-134.60)
Vic	ns	-32.12	-0.09	(-190.92-126.67)
QLD	ns	10.19	0.02	(-148.32-168.71)
SA	ns	-27.08	-0.05	(-254.79-200.62)
WA	ns	-29.15	-0.06	(-213.69-155.38)
Tas	ns	-185.92	-0.13	(-408.08-36.24)
NT	ns	-103.86	-0.04	(-465.32-257.60)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	-7.34	-0.02	(-62.17-47.50)
2.0 – 3.9	ns	40.42	0.10	(-14.81-95.64)
4.0 +	ns	26.83	0.05	(-56.31-109.97)
Adjusted R^2				20%
F – statistic				*** 2.54
n				265
Missing cases				102

***(p<0.001), *(p<0.05); ANOVA test
ns (not significant)

Table 4.67 presents the multivariate production function model for 1988 with productivity measured as RVUs per day. The model explained 42% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience), capital (x-ray unit utilisation) and labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (size, state location).

Dentists with experience between 10 and 15 years were positively associated with productivity generating 60.74 more RVUs per day compared to more experienced dentists in the 25 years plus range. Productivity gains resulting from the utilisation of 3 or more x-ray units were equal to 111.25 RVUs per day as use of three or more extra-oral auxiliaries generated 101.51 more RVUs per day compared to use of only one extra-oral auxiliary. Dentists working up to 4 hours per day were significantly less productive (-132.24 RVUs per day) than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive (+124.69 RVUs per day) than the group of dentists working between 4 and 8 hours per day. Auxiliary utilisation did not result in a significant association with productivity. Dentists whose main practice was in the Northern Territory were associated with lower productivity (433.33 RVUs per day) compared to New South Wales based dentists. Lastly, dentists reporting to work with just one other dentist (group practice size of 2) were significantly less productive by 69.69 RVUs per day compared to solo practising dentists.

Table 4.67: OLS regression model of RVUs per day, 1988

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-35.45	-0.08	(-97.45-26.54)
Experience (years)				
≤ 5	ns	-28.71	-0.06	(-116.54-59.12)
> 5 – 10	*	60.74	0.17	(1.77-119.71)
> 10 – 15	ns	52.99	0.12	(-22.00-127.99)
> 15 – 25	ns	29.53	0.09	(-30.17-89.22)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	28.98	0.09	(-32.41-90.38)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-18.66	-0.06	(-111.62-74.29)
Melb	ns	-7.13	-0.02	(-109.03-94.77)
QLD	ns	72.37	0.17	(-72.61-217.36)
Adel	ns	31.87	0.06	(-124.19-187.94)
WA	ns	-64.73	-0.10	(-255.72-126.25)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	-31.29	-0.11	(-79.17-16.58)
3 +	ns	-47.21	-0.10	(-133.03-38.61)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	12.93	0.04	(-42.32-68.18)
3 +	***	111.25	0.34	(41.31-181.20)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-132.24	-0.24	(-216.87- -47.60)
8 +	***	124.69	0.26	(47.93-201.45)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	56.89	0.19	(-13.66-127.44)
3 +	**	101.51	0.34	(27.26-175.74)

Table 4.67 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1+	ns	-11.46	0.02	(-101.05-123.96)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	8.16	0.02	(-55.35-71.68)
Associate	ns	38.05	0.10	(-18.00-94.11)
Assistant	ns	-84.20	-0.16	(-173.27-4.86)
Locum	ns	-71.38	-0.07	(-225.55-82.80)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	**	-69.69	-0.21	(-124.40- -14.98)
2	ns	38.41	0.08	(-42.77-119.59)
3	ns	-77.42	-0.11	(-184.35-29.50)
4 +	ns	-89.43	-0.10	(-231.58-52.71)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	45.49	0.16	(-15.63-106.60)
More busy	ns	65.98	0.12	(-56.56-188.53)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-105.72	-0.36	(-273.57-62.14)
Vic	ns	-92.15	-0.27	(-280.41-96.11)
QLD	ns	-197.64	-0.42	(-421.61-26.34)
SA	ns	-155.15	-0.26	(-379.86-69.56)
WA	ns	42.08	0.07	(-209.99-294.15)
Tas	ns	-79.40	-0.08	(-334.99-176.18)
NT	**	-433.43	-0.26	(-771.70- -95.15)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	25.06	0.06	(-44.16-94.28)
2.0 – 3.9	ns	-47.45	-0.12	(-111.54-20.60)
4.0 +	ns	-23.15	-0.04	(-136.29-89.98)
Adjusted R^2				42%
F – statistic				*** 3.72
n				148
Missing cases				333

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.68 presents the multivariate production function model for 1993 with productivity measured as RVUs per day. The model explained 39% of the variation in the dependent variable and was significant at $p<0.05$. Significant variables were found for labour inputs (number of extra-oral auxiliaries), and practice characteristics (perceived busyness, length of wait for an appointment). No significant variables were found in the category of dentist characteristics or capital inputs.

Utilisation of 1 intra-oral auxiliary resulted in greater productivity by 169.35 RVUs per day compared to the use of no intra-oral auxiliaries. This is the only significant association found between intra-oral auxiliaries and productivity. Of the practice-related characteristics, just two variables were significant also, dentists who reported to be more busy than they would like and those who reported the length of wait for an appointment to be over 4 weeks. Compared to their reference categories of being less busy than they would like and the length of wait for an appointment to be up to 1.0 week, dentists were more productive by 120.44 and 219.49 RVUs per day respectively.

Table 4.68: OLS regression model of RVUs per day, 1993

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-18.71	-0.03	(-101.99-64.56)
Experience (years)				
≤ 5	ns	21.66	-0.09	(-84.14-127.46)
> 5 – 10	ns	-9.04	-0.02	(-105.90-87.81)
> 10 – 15	ns	28.33	0.05	(-63.66-120.31)
> 15 – 25	ns	-54.68	0.02	(-136.93-27.58)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	33.49	0.05	(-41.85-108.82)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-86.07	-0.22	(-231.26-59.11)
Melb	ns	-13.26	-0.03	(-163.55-137.04)
QLD	ns	90.45	0.17	(-66.66-247.55)
Adel	ns	14.45	0.02	(-191.26-220.16)
WA	ns	42.13	0.05	(-129.89-214.15)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	-36.69	-0.10	(-110.23-30.85)
3 +	ns	13.89	0.02	(-96.26-124.04)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-72.64	-0.17	(-149.10-3.83)
3 +	ns	-77.02	-0.19	(-170.28-16.24)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	ns	-18.46	-0.02	(-150.16-113.24)
8 +	ns	-5.60	-0.10	(-103.41-92.22)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-163.51	-0.07	(-492.09-165.07)
2	ns	-63.18	-0.15	(-156.11-29.76)
3 +	ns	-40.61	-0.10	(-137.28-56.05)

Table 4.68 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	**	169.35	0.21	(36.63-302.07)
2 +	ns	-144.01	-0.09	(-430.69-142.67)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-20.14	-0.04	(-112.27-71.98)
Associate	ns	-1.90	-0.01	(-83.66-79.87)
Assistant	ns	33.07	0.07	(-41.96-108.10)
Locum	ns	-140.40	-0.05	(-544.99-264.20)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	21.97	0.05	(-50.04-93.97)
2	ns	-24.63	-0.04	(-133.10-83.84)
3	ns	35.89	0.05	(-78.81-150.59)
4 +	ns	37.98	0.04	(-119.62-195.59)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	53.30	0.14	(-16.96-123.56)
More busy	*	120.44	0.19	(2.57-238.30)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-119.15	-0.30	(-289.64-51.35)
Vic	ns	-173.67	-0.35	(-358.66-11.32)
QLD	ns	-188.63	-0.36	(-408.21-30.96)
SA	ns	-74.83	-0.10	(-337.51-187.84)
WA	ns	-183.96	-0.28	(-398.22-30.30)
Tas	ns	-120.85	-0.09	(-378.42-136.73)
NT	ns	-266.65	-0.11	(-720.06-186.76)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	-54.74	-0.11	(-138.17-28.69)
2.0 – 3.9	ns	4.95	0.01	(-96.93-106.84)
4.0 +	*	219.49	0.21	(19.43-419.54)
Adjusted R^2				39%
F – statistic				* 1.44
n				196
Missing cases				245

**(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.69 presents the multivariate production function model for 1998 with productivity measured as RVUs per day. The model explained 41% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex, experience, country of birth), capital (multiple surgery utilisation) and labour inputs (dentist chairside hours, number of intra-oral auxiliaries), and practice characteristics (length of wait for an appointment).

Comparison of standardised regression coefficients showed that female dentists, dentists with between 5 and 10 years of experience and non-Australian-born dentists were less productive compared to their reference counterparts: male dentists, dentists with more than 25 years experience and Australian-born dentists. Productivity gains resulting from the utilisation of 3 or more surgeries were equal to 117.97 RVUs per day, while dentists working more than 8 hours per day were significantly more productive than the group of dentists working between 4 and 8 hours per day by 115.38 RVUs per day. Utilisation of one intra-oral auxiliary was seen to exhibit a positive association with productivity resulting in 75.38 more RVUs per day compared to utilisation of no intra-oral auxiliary. Length of wait for an appointment of between one to 1.9 and 2.0 to 3.9 weeks resulted in higher productivity by 63.95 and 79.28 RVUs per day respectively compared to a length of wait up to one week.

Table 4.69: OLS regression model of RVUs per day, 1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	**	-81.46	-0.19	(-141.21- -21.72)
Experience (years)				
≤ 5	ns	-81.03	-0.19	(-93.90-11.43)
> 5 – 10	***	-332.12	-0.28	(-531.90- -132.35)
> 10 – 15	ns	-51.36	-0.09	(-139.14-36.43)
> 15 – 25	ns	-40.10	-0.14	(-90.51-10.30)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	*	-61.22	-0.19	(-116.07- -6.37)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-89.21	-0.30	(-187.23-8.82)
Melb	ns	-74.97	-0.21	(-191.82-41.88)
QLD	ns	-96.76	-0.27	(-217.97-24.46)
Adel	ns	149.75	0.32	(-85.41-384.90)
WA	ns	18.44	0.04	(-137.39-174.27)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	31.69	0.11	(-14.16-77.55)
3 +	**	117.97	0.21	(25.31-210.62)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-2.73	-0.01	(-56.24-50.79)
3 +	ns	-26.40	-0.08	(-98.88-46.08)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	ns	-141.31	-0.14	(-321.07-38.45)
8 +	***	115.38	0.34	(62.07-168.70)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	51.86	0.18	(-16.49-120.22)
3 +	ns	56.45	0.20	(-16.46-129.36)

Table 4.69 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	*	75.53	0.16	(-0.29-151.34)
2 +	ns	-17.42	-0.02	(-175.98-141.14)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-38.26	-0.07	(-121.40-44.88)
Associate	ns	-34.25	-0.09	(-93.39-24.88)
Assistant	ns	36.34	0.01	(-15.10-87.78)
Locum	ns	-43.44	-0.03	(-244.69-157.81)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	5.32	0.02	(-41.29-51.94)
2	ns	23.46	0.05	(-52.73-99.65)
3	ns	10.22	0.02	(-94.37-114.80)
4 +	ns	21.34	0.03	(-96.48-139.17)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	22.95	0.08	(-24.65-70.54)
More busy	ns	28.88	0.07	(-54.10-113.85)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	-99.28	-0.35	(-477.93-279.38)
Vic	ns	-122.22	-0.36	(-511.87-267.44)
QLD	ns	-157.41	-0.42	(-545.01-230.20)
SA	ns	-300.75	-0.58	(-749.27-147.77)
WA	ns	198.17	-0.43	(-596.99-200.66)
Tas	ns	-257.24	-0.20	(-684.89-336.06)
NT	ns	-376.67	-0.24	(-872.47-119.13)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	*	63.95	0.17	(8.26-119.64)
2.0 – 3.9	*	79.28	0.21	(7.03-151.52)
4.0 +	ns	-11.81	-0.02	(-114.00-90.38)
Adjusted R^2				41%
F – statistic				*** 3.68
n				156
Missing cases				333

***(p<0.001); **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Panel longitudinal data analysis of RVUs per day, 1983-1998

Table 4.70 presents the multivariate production function model for combined data of the 1983, 1988, 1993 and 1998 samples with productivity measured as RVUs per day. Variables describing the year of survey were included to estimate the association of time with productivity, which is the productivity time trend. The model explained 15% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex, experience), capital (x-ray unit utilisation) and labour inputs (dentist chairside hours), and practice characteristics (perceived busyness, state location, length of wait for an appointment).

Significant variation in productivity was found between male and female dentists, with female dentists having lower productivity (-53.39 RVUs per day) compared to male dentists. Comparison of standardised regression coefficients showed dentists with experience of 10 to 15 years were relatively more productive compared to dentists with more than 25 years of experience. Productivity gains resulting from the utilisation of 2 or 3 or more x-ray units varied surprisingly with utilisation of 2 x-ray units resulting in a negative association with productivity (-3.91 RVUs per day) while the utilisation of 3 or more x-ray units resulted in a positive association with productivity (7.55 RVUs per day). Dentists working up to 4 hours per day were significantly less productive (-65.50 RVUs per day) than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive (91.62 RVUs per day) than the group of dentists working between 4 and 8 hours per day. Configuration and size were not amongst practice characteristics significantly associated with productivity. However, perception of busyness was significantly associated with productivity levels in the range of 36.55 to 57.75 RVUs per day, with dentists reporting to be either as busy as or more busy than they would like having higher productivity respectively compared to the reference group of dentists reporting to be less busy than they would like. Dentists reporting a length of wait for an appointment to be between 2.0 to 3.9 weeks had higher productivity and in order of magnitude, Tasmanian-, South Australian-, Queensland-, Victorian- and Australian Capital Territory-based dentists exhibited lower estimated productivity compared to New South Wales-based

dentists.

Time, quite surprisingly when compared to the previous two productivity measures, did not feature as a significant variable associated with productivity suggesting there was no real productivity time trend for the productivity measure of RVUs.

Table 4.70: OLS regression model of RVUs per day, 1983-1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	***	-53.39	-0.11	(-87.23- -19.56)
Experience (years)				
≤ 5	ns	25.83	0.06	(-12.19-63.86)
> 5 – 10	ns	21.88	0.05	(-14.36-58.12)
> 10 – 15	**	37.40	0.08	(0.88-73.92)
> 15 – 25	ns	2.51	0.01	(-26.67-31.70)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	12.27	0.04	(-16.88-41.40)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-17.35	-0.05	(-67.70-32.99)
Melb	ns	16.90	0.04	(-37.55-71.35)
QLD	ns	12.34	0.03	(-50.86-75.54)
Adel	ns	57.21	0.10	(-30.69-145.10)
WA	ns	23.64	0.04	(-49.59-96.86)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	12.46	0.04	(-11.93-36.84)
3 +	ns	30.67	0.06	(-11.58-72.90)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	*	-3.91	-0.01	(-31.42-23.59)
3 +	*	7.55	0.02	(-24.99-40.08)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-65.50	-0.09	(-116.70- -14.30)
8 +	***	91.62	0.20	(59.09-124.15)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-92.29	-0.03	(-273.58-89.01)
2	ns	8.38	0.03	(-23.35-40.11)
3 +	ns	31.64	0.10	(-3.50-66.78)
No. aux (I-O)				
1	ref.	ref.	ref.	ref.
0	ns	41.12	0.06	(-11.20-93.43)
2 +	ns	-75.47	-0.05	(-187.76-36.82)

Table 4.70 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	8.92	0.02	(-26.87-44.71)
Associate	ns	15.53	0.04	(-14.03-45.09)
Assistant	ns	24.35	0.06	(-6.79-55.49)
Locum	ns	13.05	0.01	(-50.89-76.98)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-22.11	-0.06	(-48.77-4.55)
2	ns	-16.99	-0.03	(-56.39-22.40)
3	ns	-10.72	-0.01	(-64.54-43.10)
4 +	ns	-15.01	-0.02	(-84.19-54.17)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	**	36.55	0.11	(10.62-62.48)
More busy	*	57.75	0.10	(10.42-105.08)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	*	-91.78	-0.28	(-173.76- -9.80)
Vic	*	-97.02	-0.25	(-186.70- -7.34)
QLD	*	-98.56	-0.21	(-195.22- -1.90)
SA	*	-124.22	-0.20	(-243.30- -5.15)
WA	ns	-87.32	-0.15	(-190.68-16.04)
Tas	**	-158.83	-0.12	(-280.71- -36.95)
NT	ns	-161.57	-0.08	(-335.64-12.50)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	-0.48	-0.01	(-32.46-31.50)
2.0 – 3.9	*	42.18	0.10	(8.06-76.30)
4.0 +	ns	32.59	0.05	(-21.15-86.33)
5. Year of survey				
1983	ref.	ref.	ref.	ref.
1988	ns	28.44	0.07	(-3.67-60.55)
1993	ns	6.42	0.01	(-29.98-30.83)
1998	ns	6.90	0.02	(-27.24-41.03)
Adjusted R^2				15%
F – statistic				*** 3.96
n				768
Missing cases				1010

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Summary of productivity analysis, RVUs per day

Table 4.71 presents the summary of all regression models specified using RVUs per day as the dependent productivity variable.

Overall, the models explained between 15 to 42% of the variation in the output measure, with significant inputs appearing in all categories of input factors. The most consistent and strongest input measures were in the categories of labour inputs (dentist hours worked per day chairside), while most other input factors only weakly influenced productivity. These included all dentist characteristics with the exception of university of graduation, all capital inputs, both the number of extra-oral and intra-oral auxiliaries per dentist, perceived busyness level and length of wait for an appointment. In contrast, variables relating to university of graduation, practice configuration and size, and state location of main practice were generally not significant.

The panel longitudinal regression showed that across time, there was no productivity trend when productivity was measured as RVUs per day, as compared with 1983.

Table 4.71: Summary-regression models of RVUs per day, 1983-1998

	1983	1988	1993	1998	Panel 1983 - 1998
1. Dentist characteristics					
Sex					
Male	ref.	ref.	ref.	ref.	ref.
Female	ns	ns	ns	**(-)	***(-)
Experience (years)					
≤ 5	ns	ns	ns	ns	ns
> 5 – 10	ns	*(+)	ns	***(-)	ns
> 10 – 15	ns	ns	ns	ns	**(+)
> 15 – 25	ns	ns	ns	ns	ns
25 +	ref.	ref.	ref.	ref.	ref.
Born in Australia					
Yes	ref.	ref.	ref.	ref.	ref.
No	ns	ns	ns	*(-)	ns
University of graduation					
Syd	ref.	ref.	ref.	ref.	ref.
O/S	ns	ns	ns	ns	ns
Melb	ns	ns	ns	ns	ns
QLD	ns	ns	ns	ns	ns
Adel	ns	ns	ns	ns	ns
WA	ns	ns	ns	ns	ns
2. Capital inputs					
Number surgeries					
1	ref.	ref.	ref.	ref.	ref.
2	ns	ns	ns	ns	ns
3 +	ns	ns	ns	**(+)	ns
Number x-ray units					
1	ref.	ref.	ref.	ref.	ref.
2	ns	ns	ns	ns	*(-)
3 +	ns	***(+)	ns	ns	*(+)
3. Labour inputs					
Dentist hrs/day					
> 4 –8	ref.	ref.	ref.	ref.	ref.
≤ 4	*** (-)	*** (-)	ns	ns	** (-)
8 +	***(+)	***(+)	ns	***(+)	***(+)
No. aux (E-O)					
1	ref.	ref.	ref.	ref.	ref.
0	ns	ns	ns	ns	ns
2	ns	ns	ns	ns	ns
3 +	ns	**(+)	ns	ns	ns
No. aux (I-O)					
1	ref.	ref.	ref.	ref.	ref.
0	ns	ns	**(+)	*(+)	ns
2 +	ns	ns	ns	ns	ns

Table 4.71 *continued.*

	1983	1988	1993	1998	Panel 1983 - 1998
4. Practice inputs					
Configuration					
Solo	ref.	ref.	ref.	ref.	ref.
Partner	ns	ns	ns	ns	ns
Associate	ns	ns	ns	ns	ns
Assistant	ns	ns	ns	ns	ns
Locum	ns	ns	ns	ns	ns
Size (no. other dentists).					
0	ref.	ref.	ref.	ref.	ref.
1	ns	**(-)	ns	ns	ns
2	ns	ns	ns	ns	ns
3	ns	ns	ns	ns	*(-)
4 +	ns	ns	ns	ns	ns
Perceived busyness					
Less busy	ref.	ref.	ref	ref.	ref.
As busy	*(+)	ns	ns	ns	**(+)
More busy	ns	ns	*(+)	ns	*(+)
State location					
NSW	ref.	ref.	ref.	ref.	ref.
ACT	ns	ns	ns	ns	*(-)
Vic	ns	ns	ns	ns	*(-)
QLD	ns	ns	ns	ns	*(-)
SA	ns	ns	ns	ns	*(-)
WA	ns	ns	ns	ns	ns
Tas	ns	ns	ns	ns	**(-)
NT	ns	**(-)	ns	ns	ns
Wait for appt.(wks)					
0 - 0.9	ref.	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	ns	ns	*(+)	ns
2.0 – 3.9	ns	ns	ns	*(+)	*(+)
4.0 +	ns	ns	*(+)	ns	ns
5. Year of survey					
1983					ref.
1988					ns
1993					ns
1998					ns
Adjusted R^2	20%	42%	39%	41%	15%
F – statistic	*** 2.54	*** 3.72	* 1.44	*** 3.68	*** 3.96
n	265	148	196	156	768

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

4.5.6 Output: gross billings per day

Table 4.72 presents the multivariate production function model for 1983 with productivity measured as $GB per day. The model explained 18% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience, country of birth) and labour inputs (dentist hours per day chairside)only.

Dentists with either up to 5 years of experience or of non-Australian country of birth generated lower $GB per day by $305.03 and $264.35 respectively, compared to dentists with more than 25 years of experience and of Australian country of birth, respectively. An even higher loss in $GB per day was exhibited by dentists working up to 4 hours per day (-$513.19) while dentists who reported working more than 8 hours per day generated $462.79 more per day, both compared to the reference category of dentists working between 4 and 8 hours per day chairside.

Table 4.72: OLS regression model of $GB per day, 1983

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-140.73	-0.06	(-442.88-161.42)
Experience (years)				
≤ 5	*	-305.03	-0.17	(-568.98- -41.08)
> 5 – 10	ns	-218.98	-0.10	(-507.72-69.76)
> 10 – 15	ns	102.81	0.05	(-196.38-402.00)
> 15 – 25	ns	-103.85	-0.05	(-380.75-173.06)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	*	-264.35	-0.15	(-528.18- -0.53)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-161.26	-0.10	(-581.59-259.08)
Melb	ns	-3.13	0.00	(-466.41-460.16)
QLD	ns	-233.91	-0.11	(-801.23-333.42)
Adel	ns	-447.18	-0.16	(-1377.88-483.52)
WA	ns	-496.46	-0.16	(-1116.45-123.52)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	131.90	0.09	(-61.61-325.41)
3 +	ns	230.38	0.10	(-109.39-570.15)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	65.55	0.04	(-156.66-287.76)
3 +	ns	197.08	0.11	(-59.52-453.68)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	*	-513.19	-0.15	(-925.50- -100.89)
8 +	***	462.79	0.22	(198.15-727.44)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-379.64	-0.03	(-1654.22-894.94)
2	ns	178.57	0.12	(-49.92-407.06)
3 +	ns	252.13	0.13	(-27.47-531.72)

Table 4.72 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	181.72	0.03	(-541.56-904.99)
2 +	ns	390.89	-0.05	(-1485.39-703.60)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	162.56	0.07	(-122.37-447.49)
Associate	ns	158.04	0.08	(-89.22-405.30)
Assistant	ns	-89.84	-0.04	(-367.35-187.67)
Locum	ns	341.11	0.11	(-20.79-703.00)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-153.23	-0.09	(-375.61-69.16)
2	ns	-240.49	-0.10	(-568.83-87.85)
3	ns	-51.03	-0.01	(-742.20-640.15)
4 +	ns	-181.18	-0.03	(-1101.96-739.61)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	176.10	0.11	(-42.39-394.58)
More busy	ns	330.81	0.12	(-77.45-739.08)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	302.77	0.19	(-390.76-996.29)
Vic	ns	424.69	0.24	(-345.44-1194.83)
QLD	ns	322.01	0.14	(-451.56-1095.57)
SA	ns	469.32	0.17	(-588.71-1527.35)
WA	ns	314.02	0.12	(-580.67-1208.71)
Tas	ns	-295.26	-0.04	(-1389.24-798.73)
NT	ns	699.41	0.06	(-1069.51-2468.34)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	-113.38	-0.05	(-388.63-161.88)
2.0 – 3.9	ns	-197.07	-0.10	(-471.41-77.27)
4.0 +	ns	-86.53	-0.03	(-499.69-326.62)
Adjusted R^2				18%
F – statistic				*** 2.42
n				269
Missing cases				98

**(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.73 presents the multivariate production function model for 1988 with productivity measured as $GB per day. The model explained 31% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (experience, university of graduation), capital inputs (multiple surgery and x-ray unit utilisation), labour inputs (dentist chairside hours, number of extra-oral auxiliaries), and practice characteristics (size, perceived busyness, state location, length of wait for an appointment).

Dentists with experience of up to 5 years had significantly lower productivity by $752.10 per day compared to dentists with more than 25 years of experience as did Adelaide University dental graduates who were significantly less productive by $1026.17 compared to Sydney University graduates. Surprisingly, utilisation of either 2 or, 3 or more surgeries was negatively associated with productivity by $515.05 and $1260.35 per day, respectively, while utilisation of 3 or more x-ray units compared to utilisation of one x-ray unit resulted in positive productivity gains of $728.76 per day. A similar pattern for extra-oral auxiliaries was evident with 3 or more extra-oral auxiliaries resulting in $672.13 more in $GB per day compared to the use of one extra-oral auxiliary. Group practice size of 2 other dentists, the perception of being more busy than would like, South Australian- and Tasmanian-based dentists and a length of wait between one to 1.9 weeks were all significant and positively associated with productivity compared respectively to their reference counterparts: a group practice size of 1, the perception of being less busy than would like and New South Wales-based dentists. Dentists reported a length of wait for an appointment to be more than 4 weeks reported significantly lower $GB per day.

Table 4.73: OLS regression model of $GB per day, 1988

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1.Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-318.38	-0.09	(-798.22-161.47)
Experience (years)				
≤ 5	**	-752.10	-0.24	(-1310.77- -193.43)
> 5 – 10	ns	-3.46	0.00	(-504.55-497.63)
> 10 – 15	ns	-211.95	-0.05	(-900.56-476.66)
> 15 – 25	ns	-1.21	0.00	(-541.22-538.80)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-333.28	-0.12	(-841.62-175.06)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	154.78	0.06	(-663.93-973.48)
Melb	ns	-417.74	-0.12	(-1253.39-417.92)
QLD	ns	442.21	0.12	(-836.05-1720.46)
Adel	*	-1026.17	-0.26	(-2068.22-15.87)
WA	ns	-985.29	-0.21	(-2103.99-133.41)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	**	-515.05	-0.19	(-916.69- -113.41)
3 +	***	-1260.35	-0.31	(-1902.73- -617.97)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	-77.71	-0.03	(-537.74-382.32)
3 +	*	728.76	0.25	(154.15-1303.36)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	ns	-679.36	-0.13	(-1411.48-52.75)
8 +	**	946.82	0.24	(357.28-1536.37)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	240.87	0.09	(-331.03-812.77)
3 +	*	672.13	0.26	(79.79-1264.46)

Table 4.73 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1 +	ns	-293.36	-0.07	(-1035.49-448.78)
4.Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-116.40	-0.03	(649.97-417.16)
Associate	ns	-328.63	-0.10	(-819.38-162.13)
Assistant	ns	-447.23	-0.13	(-1002.37-107.92)
Locum	ns	-702.99	-0.09	(-1777.23-371.25)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	-188.04	-0.07	(-628.37-252.29)
2	**	824.27	0.22	(191.52-1457.03)
3	ns	329.47	0.05	(-608.84-1267.77)
4 +	ns	237.33	0.03	(-801.95-1276.62)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	60.92	0.02	(-404.49-526.34)
More busy	***	2141.50	0.40	(1111.30-3171.70)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	514.19	0.19	(-868.37-1896.75)
Vic	ns	681.03	0.24	(-806.59-2168.66)
QLD	ns	-628.54	-0.16	(-2480.07-1222.98)
SA	*	1768.32	0.36	(78.48-3458.16)
WA	ns	1570.69	0.34	(-95.42-3236.81)
Tas	*	1769.15	0.22	(-30.92-3569.22)
NT	ns	-2065.78	-0.12	(-4892.36-1251.92)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	**	722.34	0.22	(192.76-1251.92)
2.0 – 3.9	ns	192.09	0.06	(-349.93-734.10)
4.0 +	**	-1379.46	-0.26	(-2371.42- -387.49)
Adjusted R^2				31%
F – statistic				*** 3.14
n				190
Missing cases				291

***(p<0.001), **(p<0.01); ANOVA test
ns (not significant)

Table 4.74 presents the multivariate production function model for 1993 with productivity measured as $GB per day. The model explained 29% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex, university of graduation), labour inputs (dentist chairside hours), and practice characteristics (configuration, size, perceived busyness, state location of main practice, length of wait for an appointment). No significant variables were found in the category of capital inputs.

Dentists with less than 5 years of experience were relatively less productive by $615.54 per day compared to dentists with more than 25 years of experience as were dental graduates from Queensland as compared with Sydney by $887.67. Dentists working less than 4 hours per day were significantly less productive compared to dentists working between 4 and 8 hours, while dentists working more than 8 hours per day were significantly less productive than dentists working between 4 and 8 hours per day. Auxiliary utilisation did not result in a significant association with productivity. Of the practice-related characteristics a group practice size of 2, the perception of being more busy than would like and Australian Capital Territory-, Queensland- and Northern Territory-based dentists were all significantly more productive than their reference category counterparts: a practice size of one, the perception of being less busy than would like and New South Wales based dentists. As in 1988, dentists reporting a length of wait for an appointment to be more than 4 weeks were significantly less productive compared to dentists reporting a length of appointment wait of up to one week.

Table 4.74: OLS regression model of $GB per day, 1993

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-182.79	-0.06	(-592.71-227.13)
Experience (years)				
≤ 5	*	-615.54	-0.20	(-1128.20- -102.88)
> 5 – 10	ns	-492.58	-0.15	(-1014.60-29.44)
> 10 – 15	ns	-382.52	-0.11	(-900.55-135.52)
> 15 – 25	ns	-194.77	-0.07	(-649.76-260.32)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-104.40	-0.04	(-490.24-281.43)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-168.04	-0.06	(-938.22-602.15)
Melb	ns	188.43	0.06	(-548.33-925.18)
QLD	*	-887.67	-0.26	(-1623.71- -131.62)
Adel	ns	215.16	0.05	(-737.61-1167.94)
WA	ns	-200.66	-0.04	(-1065.28-664.56)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	-82.39	-0.03	(-455.83-291.04)
3 +	ns	-228.53	-0.05	(-809.64-352.59)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	ns	254.59	0.09	(-150.50-659.67)
3 +	ns	298.83	0.11	(-172.63-770.29)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	***	-1186.77	-0.24	(-1885.01- -488.54)
8 +	***	1346.01	0.35	(838.28-1853.73)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-1330.82	-0.08	(-3192.94-531.30)
2	ns	230.31	0.09	(-264.52-725.13)
3 +	ns	125.56	0.05	(-380.21-631.26)

Table 4.74 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	32.86	0.01	(-647.34-713.05)
2 +	ns	145.67	0.02	(-1016.97-1308.31)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	59.79	0.02	(-411.02-530.59)
Associate	ns	-205.85	-0.06	(-638.55-226.84)
Assistant	*	-438.68	-0.14	(-841.66- -35.70)
Locum	ns	-454.47	-0.02	(-2737.19-1828.25)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	*	392.47	0.14	(13.91-771.03)
2	ns	136.86	0.03	(-432.50-706.23)
3	ns	181.72	0.04	(-453.58-817.03)
4 +	ns	331.58	0.06	(-454.94-1118.09)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	16.83	0.01	(-380.10-346.44)
More busy	**	883.42	0.20	(240.25-1526.59)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	**	1140.65	0.43	(306.90-1974.41)
Vic	ns	96.12	0.03	(-788.18-980.41)
QLD	***	1611.50	0.48	(657.53-2565.47)
SA	ns	-136.94	-0.03	(-1328.66-1054.80)
WA	ns	488.78	0.12	(-577.98-1555.55)
Tas	ns	620.24	0.07	(-618.50-1858.99)
NT	*	1630.39	0.14	(-13.98-3274.76)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	186.22	0.06	(-260.43-632.88)
2.0 – 3.9	ns	-94.86	-0.03	(-631.83-442.12)
4.0 +	*	-1372.07	-0.19	(-2450.25- -293.90)
Adjusted R^2				29%
F – statistic				*** 3.24
n				226
Missing cases				215

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

Table 4.75 presents the multivariate production function model for 1998 with productivity measured as $GB per day. The model explained 19% of the variation in the dependent variable and was significant at $p<0.001$. Notably, there were only two significant variables in this regression model falling into the categories of capital inputs and practice characteristics. No significant inputs were found for the categories of dentist characteristics or labour inputs.

Comparison of regression coefficients showed productivity gains resulting from the utilisation of 2 x-ray units were equal to $714.99, while Victorian based-dentists were significantly less productive by $1856.03 per day compared to New South Wales-based dentists.

Table 4.75: OLS regression model of $GB per day, 1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	ns	-421.57	-0.04	(-1002.83-159.69)
Experience (years)				
≤ 5	ns	-487.00	-0.08	(-1328.67-354.66)
> 5 – 10	ns	227.11	0.04	(-500.57-954.78)
> 10 – 15	ns	-398.58	-0.07	(-1109.70-312.53)
> 15 – 25	ns	35.38	0.01	(-595.49-666.24)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	99.32	0.02	(-479.25-677.88)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-594.67	-0.14	(-1679.36-1490.02)
Melb	ns	816.77	0.16	(-264.66-1898.19)
QLD	ns	-314.91	-0.06	(-1581.27-951.46)
Adel	ns	-1162.79	-0.18	(-2673.31-347.74)
WA	ns	-213.67	-0.03	(-1583.35-1156.01)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	212.32	0.05	(-300.01-724.66)
3 +	ns	283.40	0.04	(-718.41-1285.21)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	*	714.99	0.17	(100.43-1329.56)
3 +	ns	472.05	0.10	(-280.70-1224.80)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	ns	399.90	0.03	(-949.33-1749.21)
8 +	ns	1374.46	0.26	(750.66-1998.27)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
2	ns	-336.78	-0.08	(-1076.58-403.02)
3 +	ns	-267.51	-0.07	(-1025.45-490.43)

Table 4.75 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
3. Labour inputs *cont.*				
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-359.85	-0.05	(-1189.77-470.08)
2 +	ns	358.63	0.03	(-1116.86-1834.11)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	-112.67	-0.02	(-938.95-713.62)
Associate	ns	116.68	-0.02	(-794.20-560.85)
Assistant	ns	178.40	0.04	(-365.15-721.95)
Locum	ns	9.90	0.00	(-2109.27-2129.08)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	63.51	0.01	(-495.35-622.37)
2	ns	-78.14	-0.01	(-837.84-681.57)
3	ns	-542.49	-0.06	(-1597.38-512.41)
4 +	ns	-3.89	0.00	(-1382.81-1375.04)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	ns	459.33	0.11	(-64.69-983.34)
More busy	ns	484.52	0.08	(-349.29-1318.33)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	23.22	0.01	(-1596.60-1643.03)
Vic	*	-1856.03	-0.40	(-3542.21- -169.86)
QLD	ns	-983.18	-0.19	(-2614.95-64.58)
SA	ns	1890.80	0.25	(-58.41-3840.01)
WA	ns	-589.21	-0.10	(-2411.52-1233.10)
Tas	ns	-518.54	-0.02	(-3353.62-2316.53)
NT	ns	-1214.08	-0.04	(-5122.17-2694.00)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	407.63	0.08	(-192.52-1007.77)
2.0 – 3.9	ns	-655.02	-0.12	(-1378.23-68.19)
4.0 +	ns	-102.52	--0.01	(-1209.99-1004.94)
Adjusted R^2				19%
F – statistic				*** 2.69
n				300
Missing cases				189

*(p<0.05); ANOVA test
ns (not significant)

Panel longitudinal data analysis of $GB per day, 1983-1998

Table 4.76 presents the multivariate production function model for combined data of the 1983, 1988, 1993 and 1998 samples with productivity measured as $GB. Variables describing the year of survey were included to estimate the association of time with productivity, which is the productivity time trend. The model explained 30% of the variation in the dependent variable and was significant at $p<0.001$. Significant variables were found for dentist characteristics (sex, experience), capital (x-ray unit utilisation) and labour inputs (dentist chairside hours), and practice characteristics (perceived busyness, state location).

Significant variation in productivity was found between male and female dentists, with female dentists having slightly lower productivity (-$267.59) compared to male dentists. Dentists with up to 5 years of experience were significantly less productive by $435.45 per day compared to dentists with more than 25 years of experience. Productivity gains resulting from the utilisation of either 2 or 3 or more x-ray units had significantly higher productivity by $248.64 and $345.10 per day, respectively. Dentists working up to 4 hours per day were significantly less productive (-$556.89) than dentists working between 4 and 8 hours per day, while those working more than 8 hours per day were significantly more productive ($1032.11) than the group of dentists working between 4 and 8 hours per day. Perception of busyness was significantly associated with productivity levels with dentists reporting to be either as busy or more busy than they would like exhibiting significantly higher productivity in the range of $218.15 to $688.73 per day compared to the reference group of dentists reporting to be less busy than they would like, as were South Australian-based dentists more productive by $1006.20 compared to New South Wales-based dentists.

Time proved to be a consistently significant factor positively associated with productivity. Productivity, when measured as $GB per day, significantly increased in 1988, 1993 and 1998 as compared with 1983.

Table 4.76: OLS regression model of $GB per day, 1983-1998

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
1. Dentist inputs				
Sex				
Male	ref.	ref.	ref.	ref.
Female	*	-267.59	-0.06	(-508.86- -26.32)
Experience (years)				
≤ 5	**	-435.45	-0.11	(-706.39- -164.52)
> 5 – 10	ns	-22.96	-0.01	(-290.76-244.83)
> 10 – 15	ns	-236.73	-0.05	(-517.65-44.18)
> 15 – 25	ns	-6.70	0.00	(-251.57-238.18)
25 +	ref.	ref.	ref.	ref.
Born in Australia				
Yes	ref.	ref.	ref.	ref.
No	ns	-158.38	-0.05	(-378.67-61.91)
University of graduation				
Syd	ref.	ref.	ref.	ref.
O/S	ns	-179.60	-0.05	(-573.67-214.47)
Melb	ns	119.79	0.03	(-286.59-526.16)
QLD	ns	-426.29	-0.10	(-897.14-44.55)
Adel	ns	-500.86	-0.10	(-1051.55-49.83)
WA	ns	-232.51	-0.04	(-755.70-290.67)
2. Capital inputs				
No. surgeries				
1	ref.	ref.	ref.	ref.
2	ns	63.08	0.02	(-128.21-254.37)
3 +	ns	-170.81	-0.03	(-493.88-152.26)
No. x-ray units				
1	ref.	ref.	ref.	ref.
2	*	248.64	0.07	(30.49-466.78)
3 +	**	345.10	0.10	(90.79-599.41)
3. Labour inputs				
Dentist hrs/day				
> 4 -8	ref.	ref.	ref.	ref.
≤ 4	**	-556.89	-0.08	(-960.48- -153.30)
8 +	***	1032.11	0.23	(781.63-1282.59)
No. aux (E-O)				
1	ref.	ref.	ref.	ref.
0	ns	-830.63	-0.03	(-2427.80-766.54)
2	ns	-12.43	0.00	(-262.44-237.58)
3 +	ns	177.81	0.06	(-92.56-448.18)
No. aux (I-O)				
0	ref.	ref.	ref.	ref.
1	ns	-201.21	-0.03	(-572.65-170.24)
2 +	ns	173.39	0.01	(-538.13-884.90)

Table 4.76 *continued.*

Independent Variable	p-value sig.	Beta (Unstandardised)	Beta (Standardised)	Confidence Interval (95%)
4. Practice inputs				
Configuration				
Solo	ref.	ref.	ref.	ref.
Partner	ns	13.75	0.00	(-260.68-288.19)
Associate	ns	-50.30	-0.01	(-290.55-189.94)
Assistant	ns	-13.60	0.00	(-242.59-215.40)
Locum	ns	-117.88	0.01	(-403.23-638.99)
Size (no. other dentists)				
0	ref.	ref.	ref.	ref.
1	ns	74.96	0.02	(-134.46-284.37)
2	ns	38.12	0.01	(-256.41-332.65)
3	ns	-178.73	-0.02	(-599.70-242.23)
4 +	ns	-40.61	0.00	(-571.22-490.00)
Perceived busyness				
Less busy	ref.	ref.	ref.	ref.
As busy	*	218.15	0.07	(17.10-419.19)
More busy	***	688.73	0.13	(324.71-1052.75)
State location				
NSW	ref.	ref.	ref.	ref.
ACT	ns	544.70	0.17	(-20.27-1109.66)
Vic	ns	-30.90	-0.01	(-638.60-576.80)
QLD	ns	366.42	0.08	(-270.85-1003.68)
SA	**	1006.20	0.17	(274.37-1738.03)
WA	ns	256.36	0.05	(-440.06-952.78)
Tas	ns	214.53	0.02	(-652.08-1081.14)
NT	ns	-157.97	-0.01	(-1373.60-1057.67)
Appt wait (wks)				
0 - 0.9	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	221.61	0.05	(-21.45-464.66)
2.0 – 3.9	ns	-110.50	-0.03	(-375.85-154.84)
4.0 +	ns	-316.98	-0.05	(-742.87-108.90)
5. Year of survey				
1983	ref.	ref.	ref.	ref.
1988	**	322.53	0.08	(64.62-580.43)
1993	***	1007.33	0.27	(752.95-1261.72)
1998	***	1440.53	0.42	(1201.14-1679.92)
Adjusted R^2				30%
F – statistic				*** 10.31
n				988
Missing cases				790

***(p<0.001), **(p<0.01), *(p0.05); ANOVA test
ns (not significant)

Summary of productivity analysis, $GB per day

Table 4.77 presents the summary of all regression models specified using $GB per day as the dependent productivity variable.

Overall, the models explained between 14 to 31% of the variation in the output measure. These regression models resulted in the least number of significant inputs and lowest proportion of variance explained. The most consistent and strongest input measure was similar to those of RVUs and was in the category of labour inputs (dentist hours worked per day chairside), while most other input factors only weakly influenced productivity. These included sex, experience, number of auxiliaries per dentist, number of x-ray units, practice size and configuration, state location of main practice and length of wait for an appointment. In contrast, variables relating to configuration and number of intra-oral auxiliaries were not significant.

The panel longitudinal regression showed that across time, there was a consistently strong and significant increase in the productivity trend when measured as $GB per day as compared with 1983.

Table 4.77: Summary - regression models of gross billings per day, 1983 - 1998

	1983	1988	1993	1998	Panel 1983 - 1998
1. Dentist inputs					
Sex					
Male	ref.	ref.	ref.	ref.	ref.
Female	ns	ns	ns	ns	*(-)
Experience (years)					
≤ 5	*(-)	**(-)	*(-)	ns	**(-)
> 5 – 10	ns	ns	ns	ns	ns
> 10 – 15	ns	ns	ns	ns	ns
> 15 – 25	ns	ns	ns	ns	ns
25 +	ref.	ref.	ref.	ref.	ref.
Born in Australia					
Yes	ref.	ref.	ref.	ref.	ref.
No	*(-)	ns	ns	ns	ns
University of graduation					
Syd	ref.	ref.	ref.	ref.	ref.
O/S	ns	ns	ns	ns	ns
Melb	ns	ns	ns	ns	ns
QLD	ns	ns	*(-)	ns	ns
Adel	ns	*(-)	ns	ns	ns
WA	ns	ns	ns	ns	ns
2. Capital inputs					
No. surgeries					
1	ref.	ref.	ref.	ref.	ref.
2	ns	**(-)	ns	ns	*(+)
3 +	ns	**(-)	ns	ns	**(+)
No. x-ray units					
1	ref.	ref.	ref.	ref.	ref.
2	ns	ns	ns	*(+)	ns
3 +	ns	*(+)	ns	ns	ns
3. Labour inputs					
Dentist hrs/day					
> 4 –8	ref.	ref.	ref.	ref.	ref.
≤ 4	*(-)	ns	***(-)	ns	**(-)
8 +	***(+)	**(+)	***(+)	ns	***(+)
No. aux (E-O)					
1	ref.	ref.	ref.	ref.	ref.
0	ns	ns	ns	ns	ns
2	ns	*(+)	ns	ns	ns
3 +	ns	ns	ns	ns	***(+)
No. aux (I-O)					
1	ref.	ref.	ref.	ref.	ref.
0	ns	ns	ns	ns	ns
2 +	ns	ns	ns	ns	ns

Table 4.77 *continued.*

	1983	1988	1993	1998	Panel 1983 - 1998
4. Practice inputs					
Configuration					
Solo	ref.	ref.	ref.	ref.	ref.
Partner	ns	ns	ns	ns	ns
Associate	ns	ns	ns	ns	ns
Assistant	ns	ns	ns	ns	ns
Locum	ns	ns	ns	ns	ns
Size (no. other dentists)					
0	ref.	ref.	ref.	ref.	ref.
1	ns	ns	ns	ns	ns
2	ns	**(+)	ns	ns	ns
3	ns	ns	ns	ns	ns
4 +	ns	ns	ns	ns	ns
Perceived busyness					
Less busy	ref.	ref.	ref	ref.	ref.
As busy	ns	ns	ns	ns	**(+)
More busy	ns	***(+)	ns	ns	ns
State location					
NSW	ref.	ref.	ref.	ref.	ref.
ACT	ns	ns	ns	ns	*(-)
Vic	ns	ns	ns	**(-)	ns
QLD	ns	*(+)	ns	ns	ns
SA	ns	ns	ns	ns	*(+)
WA	ns	ns	ns	ns	ns
Tas	ns	*(+)	ns	ns	ns
NT	ns	ns	ns	ns	ns
Wait for appt.(wks)					
0 - 0.9	ref.	ref.	ref.	ref.	ref.
1.0 – 1.9	ns	**(+)	ns	ns	ns
2.0 – 3.9	ns	ns	ns	ns	ns
4.0 +	ns	**(-)	*(-)	ns	ns
5. Year of survey					
1983					ref.
1988					**(+)
1993					***(+)
1998					***(+)
Adjusted R^2	18%	31%	14%	19%	30%
F – statistic	*** 2.42	*** 3.23	*** 314	*** 2.69	*** 10.31
n	269	425	190	300	988

***(p<0.001), **(p<0.01), *(p<0.05); ANOVA test
ns (not significant)

5 Discussion

The thesis focused on the investigation of three main issues: inputs which influence productivity, the variation in the influence of input factors depending on how productivity is measured and lastly, how productivity trends vary depending the type of productivity measure used. The findings will be discussed in terms of the significance of input factors compared across the four productivity measures, productivity time trends compared across the four different output measures, limitations of the research and the public health implications associated with the concepts introduced. The major strength of the study was to investigate productivity using longitudinal panel data in the form of production function regression modelling. This has until presently largely been the domain of cross-sectional production function regression modelling.

5.1 Input factors

The following discussion of input factors relates to the results from the OLS regression models (Table 4.48 to Table 4.77) which were estimated for each of the input factors with each of the four productivity variables, for each survey year and across time. These models have been used in preference to the bivariate associations since the OLS multivariate regression models control for all other variables other than the variable in question.

Dentist characteristics

Female dentists were found to be less productive than male dentists when productivity was measured as patients per day (panel), services per day (panel) relative value units per day (1998, panel) and gross billings per day (panel); however, they were generally no less productive in individual survey years with the exception of relative value units in 1998.

The two noteworthy features here are that firstly, the productivity differences between sexes tends to be consistently teased out in the panel longitudinal regression models only, and secondly, that this pattern appears to be consistent across all productivity measures. In relation to the first feature, this was somewhat surprising as we would imagine that if female dentists exhibit lower productivity compared to male dentists it would be significant earlier (1983) rather than later (1998) in the survey as there would be a tendency for male and female dentists to become less different or 'converge' in their productivity levels over time. The mechanisms by which this could occur include: male dentists' productivity becoming more like female dentists' productivity, female dentists' productivity becoming more like male dentists' productivity or both male and female dentists' productivity changing so the end result is toward convergence. This is on the basis of what we presume to be broader social changes in the workplace and home environment leading to greater workforce equality between male and female dentists. The fact that only the panel regression models are significant rather than earlier survey years suggests that the sex differences in productivity in earlier individual survey years are not strong enough but become significant when individual survey year data is pooled into one data set. In relation to the second feature, we would want to explain when there is in fact a productivity difference between male and female dentists what it could be related to and how this could be constant between different productivity measures. The lower female dentist productivity (measured as patient visits) which has been documented elsewhere in Australia (Spencer and Lewis, 1986) could hypothetically be explained by female dentists taking more time in explaining procedures and greater care in patient management while the lower number of RVUs or $GB could be related to female dentists' preference toward less intensive or lower income generating procedures. The difference in productivity between male and

female dentists when measured as services per day could be that even though a higher proportion of female dentists provide more shorter length services in the service categories of diagnostic and preventive services (Kent, 1997) compared to male dentists, they may be taking proportionately longer on average due to more dentist-patient discussion. Overall, this may result in an lower number of services per day compared to male dentists of which there is a higher proportion doing longer length visits in the service categories of restorative and endodontic (Kent, 1997).

Experience of the dentist had a significant association with productivity when measured in either of the four productivity measures. Generally, lower levels of experience (≤ 5 years, >5-10 years) negatively influenced productivity when measured as patients and particularly gross billings per day, while higher levels of experience positively influenced productivity (>10-15 years) when measured as either services (1983) or RVUs per day (panel). The pattern observed may be related to the less experienced dentists having a smaller patient base compared to the more experienced dentists which would explain the significantly smaller number of services and hence gross billings per day estimated for this group compared to the reference group of dentists with 25+ years of experience. More experienced dentists (>10-15 years) on the other hand, who have built up an established patient base and history with patients may be relatively more skilled/adept in providing a greater number of services/RVUs in the same/shorter length of time compared to dentists with 25+ years of experience. Hypothetically, what the *more* experienced dentists may gain in quantitative service provision, the *most* experienced dentists gain through customising their service mix which could consist of a smaller number of services but not at a significantly lower gross billings per day rate. This may explain why services per day is significant but gross billings is not significant between the two categories of experience.

Country of birth (Australia/non-Australia) was significant in 1983 (gross billings per day); 1988 (patients and services per day) and 1998 (services and relative value units per day), and negatively associated with productivity. This may be related to a non-Australian born dentists having a smaller patient base, variation in service mix provision or perhaps even patient characteristics such as oral health needs,

attendance and socioeconomic variables. The significantly lower gross billings per day in 1983 for non-Australian-born dentists may be related to the fact that this was a period of oversupply in the dental market.

University of graduation was significant for three out of the four productivity measures (patients/services/gross billings per day) but not for relative value units per day. University of Adelaide graduates were significantly less productive in 1988 (patients and gross billings per day) and Queensland graduates were significantly less productive in 1993 (gross billings per day) and 1998 (services per day), both as compared to Sydney University graduates. Whether the lower productivity is related to a difference in the approach in teaching/training of the respective universities is difficult to hypothesise in the absence of an official evaluation consistent between the three universities. We could alternatively hypothesise that University of Adelaide or Western Australia graduates were more likely to practice within their respective states and therefore we should observe the same pattern of lower productivity for the dentists practising within South Australia or Western Australia. However, the state location has been controlled for in the regression model and also the pattern of significance for state location by productivity is different to the pattern of significance for university of graduation by productivity. Further, the presence of both variables, university of graduation and state location, if multicollinear could also be responsible for inconsistent results.

Capital inputs

Number of surgeries utilised was significantly and consistently associated with productivity when measured as patients per day, but much more weakly for the other three productivity measures. There was also variation in the significance between the two categories of surgery utilisation, i.e. 2, 3+ surgeries. Consistently, where surgery utilisation was significant, this resulted in significantly increased productivity. The fact that increased surgery utilisation resulted in more patients per day but not necessarily more services, RVUs or $GBs suggests that what the dentists who utilised more than one surgery gained in productivity (either seeing more patients per day) they lost in providing less services per patient, presumably due to having more than one patient to manage at any one time, i.e. darting between two or more surgeries. Often, when the standardised regression coefficients

were compared between the categories of 2 or 3+ surgeries the productivity gains resulting from utilising two surgeries was actually more than utilising 3+ surgeries, suggesting diminishing marginal returns to scale at the level of 2 surgeries. Interestingly, it was only in 1988 that multiple surgery utilisation made a significant difference to productivity as a gross billings estimate.

Number of x-ray units at the practice was generally not significant. It was only in 1988 that the use of 3 or more x-ray units resulted in significantly higher services, RVUs and $GB per day. This is slightly surprising since it would be expected that the significance of x-ray units run parallel with the significance of surgery utilisation, if in fact all surgeries utilised by the dentist are fully equipped surgeries. Reasons for this inconsistency could be related to a multitude of factors, including usage of a common x-ray room for x-ray taking by all dentists within the practice, service mix variation between dentists who utilise either one or more than one surgery (such that those utilising more than one surgery engage in less diagnostic services which generally require more x-rays) and, lastly, if dentists utilising more than one surgery are relatively more pushed for time, this may result in routinely less x-ray-taking compared to those with only one patient to manage at a time regardless of the service type.

Labour inputs

The labour input of dentist chairside hours can be regarded as the most consistently and strongly significant variable of all inputs considered. Interestingly, this pattern held more consistently for two out of four of the productivity variables (patients, services) but not as consistently for RVUs or $GB per day. While working either less than four hours or more than eight hours per day resulted in consistently lower and higher productivity respectively, for either patients or services per day this did not always necessarily translate to lower or higher billings respectively in all cases. For example, in 1983 and 1993 dentists who worked up to four hours per day, (considered a single session), did have significantly lower gross billings per day. However, in 1988 and 1998 they did not have significantly lower billings and in 1988 dentists who worked more than eight hours per day had significantly higher gross billings per day. By 1998, hours worked per day by the dentist had no significant effect on productivity at all. This highlights two points about the variation

in how dentists value their time on a gross billings basis. The first point is that the dentists working a more than eight hours per day but not generating significantly higher gross billings, must be attaching some value other than monetary as an incentive to do so. This could include behaviours which build practice good will, but do not necessarily lead to higher gross billings in the short term. Some examples could include seeing new patients, emergency patients or children of loyal patients to the practice, who do not have an appointment booked but are squeezed in between booked patients. This may then result in a short appointment which is not billed at the full rate or in some cases when billing is forgone completely. It was conceivable that working overtime for not significantly higher gross billings is not sustainable in the long term, but could have been a reasonable option in the short term before the owner dentist decides to take on additional dental staff. The second point is that dentists working one session (≤ 4 hours/day) did not gross significantly less than dentists working two sessions (>4-8hrs/day) in 1983 and 1998. Presumably these dentists working 1 session only must be engaging in service mix which theoretically minimises the gap against the gross billings value of those dentists working 2 sessions.

The main overall point here is that gross billings do not reflect a 'take-home' salary for dentists which will vary widely depending on the overhead costs of the business or in the case of salaried dentists the hourly/commission rate. Therefore, variation in gross billings may also be related to variation in overhead costs of dentists. For example, if the dentists working one session per day face a lower commission rate compared to dentists working two sessions a day who may be owners then although the gross billings are not significantly different, the take-home salary will be.

Extra-oral auxiliaries featured strongly as significant variables when productivity was measured as either patients or services per day, but not when productivity was measured as RVUs or $GB per day. This may reflect the notion that quantitatively increasing numbers of extra-oral auxiliary staff will enhance the number of patients and services delivered, but this does not necessarily translate into enhanced earnings or a more intensive service mix. It may be that qualitative differences in extra-oral auxiliary staff e.g. experience, training leads to higher billings.

Generally, the number of intra-oral auxiliaries utilised was not significant with the exception of the category for one intra-oral auxiliary in 1988 which significantly increased RVUs per day as compared with zero intra-oral auxiliaries. Although we would expect intra-oral auxiliary usage to follow a similar trend to dentist input, it is not too surprising that this is not the case since the category of auxiliaries here includes hygienists and therapists which are a mix of both complementary and substitutional staff. Since therapists work predominantly in the public sector (with the exception of Western Australia) and the number of hygienists working privately is very small and varied by state, it is more difficult to work out the individual contribution of hygienists, therapists or administrative staff. The scope of service provision for auxiliaries is fairly limited (particularly for hygienists who are privately based and appear most predominantly in the sample), and therefore the combined number of intra-oral auxiliaries did not significantly influence productivity.

Practice characteristics

Configuration influenced productivity for two out of the four productivity measures (services, $GB per day),but not when productivity was measured as patients or RVUs per day. Locums, partnerships and assistant dentist arrangements were significantly more productive (than solo dentist configuration) when productivity was measured as services per day in 1983, 1988 and 1998 respectively. However, in 1993, assistant dentist arrangements had significantly lower services and $GB per day compared to solo dentists. These results are somewhat inconsistent and should therefore be interpreted with caution since the classifications relating to partnerships, associateships and assistant dentist arrangements were not formally defined in the questionnaire and consequently there may be some overlap between categories.

Similarly to configuration, the variable 'number of other dentists in the practice' was not consistently found to be significant. While group practice was found to result in significantly lower productivity when measured in either patients or RVUs per day, the opposite association was found in relation to $GB per day with increased practice size resulting in significantly higher $GB per day. Although the main purpose of including this variable was to elicit information about whether the size of a group practice influences productivity it is challenged with the same ambiguity facing the variable configuration. That is, the number of other dentists reported by

dentists does not necessarily translate into a reliable variable for 'group practice size' that is constant across dentists. For example, scenarios where dentists might report working with one other dentist include: a solo dentist employing either a locum temporarily or an assistant dentist, two dentists in a partnership arrangement sharing overhead costs and profits, or two solo dentists sharing overhead costs but not profit. Even if dentists reported to be working with other dentists there will be variation in the incentive to share the workload via internal referral between different cost/profit sharing arrangements. Therefore, a standard group practice arrangement cannot be elicited from the variable describing the number of other dentists worked with alone. These reasons may be responsible for the absence of consistent significance of this variable.

State location of main practice significantly influenced productivity for each of the four productivity measures but least so for services per day. In 1988, Victoria and Tasmania had significantly higher patients per day, Northern Territory had significantly lower services and RVUs per day and South Australia and Tasmania had significantly higher $GB per day (compared to New South Wales). In 1993, the Australian Capital Territory, Victoria, Queensland and Tasmania had significantly lower patients per day while Tasmania had significantly higher patients per day, the Australian Capital Territory, Victoria and the Northern Territory had significantly higher $GB per day (compared to New South Wales). In 1998, Victoria had significantly lower gross billings per day (compared to New South Wales). As the results stand, there were no distinct patterns across states or across time to suggest there are peculiarities about a particular state which makes that state significantly more or less productive (compared to New South Wales). This infers that it may be more the attributes of groups of dentists within that state at different points in time rather than a general feature of the state per se. For example, as the dentist:population ratios change within states in particular areas so too would we expect productivity rates to change. Thus, the variable 'state' may be capturing attributes of the dentist or characteristics of the environment which were not included in the regression model.

Perceived busyness level of the dentist posed some interesting findings. Firstly, there was consistent and strong significance found when productivity was measured

as all four productivity measures. When productivity was measured as patients per day there was a definite consistency across dentists where both categories of perceived busyness (as, more busy than would like) were significant in all four survey years. However, when productivity was measured as services or RVUs per day, there was less consistency across busyness. This suggests that dentists generally associate seeing many patients with being 'busy' or 'productive', with less focus on the services, RVUs or gross billings that their patient-base generates. This may be related to the common notion among dentists of having a 'full book' at all times to counteract future times when the books may not be full. Understandably, the same level of consistency was not apparent for services per day, most likely due to variation in service mix provision between dentists which would result in a different number of services per day required to have a full book. Additionally, the dentist most often cannot recall with as much accuracy the number of services they provided as they can recall the number of patients they saw in a day. This could also be true in relation to RVUs per day. Significance of perceived busyness level was only found for the category of being more busy than would like when productivity was measured as $GB per day suggesting that there is much variation in $GB per day of the dentists who reported to be as busy as they would like. Again, the same complications described earlier in regards to $GB are applicable here. If there is variation in dentists overhead costs and target incomes then the mean $GB per day required to be 'as busy as they would like' will also vary across dentists. Being 'as busy as they would like' presumably involves payment of overhead costs and recouping a take-home salary they are satisfied with.

Lastly, length of wait for an appointment was weakly significant for all four productivity measures. Generally, when there was significance it was related to dentists who reported a length of wait for an appointment to be between one to two weeks- significantly more productive in terms of services per day (1998) and RVUs per day (1998); or two to four weeks- being significantly more productive in terms of patients per day (1998), services per day (1983, 1993), RVUs per day (1998) and $GB per day (1988), both compared to dentists whose reported length of wait for an appointment was up to one week. The two noteworthy points here are: firstly, a length of wait for an appointment of over four weeks resulted in significantly lower $GB which may imply that although being very busy with long waiting times

translates into more patients and services, it doesn't necessarily translate into higher billings if the waiting time becomes too long; and secondly, it is surprising that patients per day is not as consistently significant across categories for length of wait and across years, as we would expect. This is could be due to the notion that we associate 'length of wait' with number of patients waiting to be seen, rather than a small number of patients with multiple-visit treatment plans.

5.2 Productivity

5.2.1 Productivity measures

The focus of this section is to discuss productivity in relation to the initial hypothesis which stated that the trend in productivity will vary depending on how it is measured. The outline followed is to, firstly, summarise and discuss the individual results of each of the four productivity measures (patients/ services/ RVUs/ $GB per day) in terms of significant input factors and model 'goodness of fit'; secondly, discuss the productivity time trend as evidenced by the panel longitudinal production function in relation to the range of productivity measures and, lastly, propose a range of explanations and additional investigations that could be explored in response to the results presented.

Patients per day

Discussion on the patients per day productivity variable relates mainly to the results presented in Table 4.48 to Table 4.53. The main inputs which significantly influenced the productivity measure of patients per day across all four cross-sectional production functions were number of surgeries utilised, dentist hours worked per day chairside and perceived level of busyness. Input factors which did not feature as significant explanatory variables included sex, number of intra-oral auxiliaries per dentist and practice configuration. The individual survey year production function regression models achieved R^2 values in the range of 36 to 44%. The average number of patients per day declined from 15.9 to 12.6 over the 1983 to 1998 period representing a proportional decrease of 20.8%. The decline was statistically significant in 1988, 1993 and 1998 as compared with 1983.

Services per day

Discussion on the services per day productivity variable relates mainly to the results presented in Table 4.60 to Table 4.65. The main inputs which significantly influenced the productivity measure of services per day across all four cross-sectional production functions were number of surgeries utilised, dentist hours worked per

day chairside and number of extra-oral auxiliaries. Input factors which did not feature as significant explanatory variables included sex, number of intra-oral auxiliaries per dentist and practice configuration. The individual survey year production function regression models achieved R^2 values in the range of 22 to 30%. The average number of services per day declined from 26.1 to 23.2 over the 1983 to 1998 period representing a proportional decrease of 11.1%. The decline was statistically significant in 1988, 1993 and 1998 as compared with 1983.

RVUs per day

Discussion on the RVUs per day productivity variable relates mainly to the results presented in Table 4.66 to Table 4.77. The main inputs which significantly influenced the productivity measure of RVUs per day across all four cross-sectional production functions were dentist hours worked per day chairside and perceived level of busyness. Input factors which did not feature as significant explanatory variables included university of graduation and practice configuration. The individual survey year production function regression models achieved R^2 values in the range of 20 to 42%. The average number of RVUs per day increased marginally from 429.9 to 444.2 over the 1983 to 1998 period representing a proportional increase of 3.3%. However, the increase was not statistically significant in 1988, 1993 and 1998 as compared with 1983.

Gross billings per day

Discussion on the $GB per day productivity variable relates mainly to the results presented in Table 4.72 to Table 4.77. The main inputs which significantly influenced the productivity measure of patients per day across all four cross-sectional production functions were experience, dentist hours worked per day chairside and state location of main practice. Input factors which did not feature as significant explanatory variables included sex and number of intra-oral auxiliaries per dentist. The individual survey year production function regression models achieved R^2 values in the range of 20 to 42%. The average $GB per day increased markedly in 'real' terms from $1251.02 to $2826.18 over the 1983 to 1998 period representing a proportional increase of 126%. The decline was statistically significant in 1988, 1993 and 1998 as compared with 1983.

Overall, the model of best fit was attained when productivity was measured as patients per day followed by RVUs, services and lastly by $GB per day. This outcome was in line with what we observe in the literature with patient/service type productivity measures achieving the highest R^2 values (Mitry et al., 1975) and monetary productivity measures achieving the lowest R^2 values (Gray, 1982). Subsequently, although each of the four productivity measures had some inputs from all categories (dentist characteristics, capital, labour and practice characteristics) explain some of their variation at a significant level, it was gross billings which had the lowest number of significant inputs followed by relative value units, patients and lastly, services per day.

5.2.2 Productivity trends

Discussion of productivity time trends is possible through comparison of the panel longitudinal production functions between the four different productivity measures. An overall summary of the productivity trends depict a steady and significant decline in patients and services per day from 1983 to 1998, while RVUs remained reasonably stable with no significant time trend evident. Most notably, it was $GB per day, that, even when accounting for inflation increased a staggering 126% in real terms over the same period (1983-1998) while the time trends of the remaining productivity measures were negligible. This suggests that although the combined patient and service mix bundle appears to have decreased in 'quantitative' measures, qualitatively patients visits are more profitable now than before. This could very well be related to a number of factors, but namely, that the service mix shift toward more complex treatment services which take longer, and therefore result in a fewer patients and services per day generates higher $GB per day as compared to a service mix bundle consisting of shorter and simpler services. The interesting issue here is that if this is the case, the non-significance of the productivity time trend for RVUs per day suggests that although the service mix may have become more complex, or 'intensified', this has not lead to increased work effort, if we assume RVU to be a proxy for work effort, as defined by the product of time and responsibility loading.

One possible explanation for the observed productivity trends could be related to the

target income hypothesis, as described in the Introduction. If the hypothesis holds true, dentists work toward their optimal level of 'x' labour input, which can be measured in terms of either patients or services per day, in order to reach their target income. The target income will vary between dentists and over time. Since there is an observable trend, we could potentially assume that their target income is normally distributed and the factors which influence the actual level of target income will be approximately constant across dentists. For example, variation in target incomes between individual dentists could be influenced by age, sex, number of dependents, whether non-dental sources of income exist, target standard of living, degree of personal debt and so on. Factors that could influence the trend in target income levels over time which would be constant across dentists could be related to lifestyle trends (increasing preference toward simpler living), the increase in dual-income households, the decrease in number of dependents, the relative increase in cost of housing and so on.

Once the dentist's target income has been set, and subsequently achieved by the individual dentist, the willingness to contribute more time to productive work decreases. That is, if a patient visit is more profitable now, than before, and assuming that the increasing trend over time in target incomes has kept up with inflation, then there will be a reduced incentive to deliver more patient visits. We observe that while dentists have not increased their annual time devoted to work, their real gross billings have increased at the same time as a decreased rate of annual provision of patient visits. However, in the absence of data related to overhead costs we could not ascertain whether the increase in real gross billings resulted in a parallel increase in real net income over time to the same degree.

Since both patients and services per day declined across time, for an overall increase in services per patient at a constant number of dentist hours worked per year as previously cited the rate of decline in patients per day would need to be greater than the rate of decline in services per day-which was precisely what we observe. The mean number of patients per day declined from 15.9 (1983) to 12.6 (1998), decreasing by 20.8%, while the mean number of services per day declined from 26.1 (1983) to 23.2 (1998) decreasing by 11.1%. Although the results imply there may be a smaller pool of patients receiving a greater number of services, what should not be

overlooked is that the shift in service mix has coincidently resulted in an increase in the proportion of services which take longer, for example endodontics and fixed prosthodontics. This shift in service mix has offset the increase in services per patient such that the overall measure of services per day has also declined. For practicality, the phenomenon of a shift toward a smaller pool of patients and the combined increase in individual services received per patient will be described for the purposes of this study as an 'intensification' process.

The next challenge lies in identifying the relationship between the trend results of patients and services per day to the trend results of weighted measures of productivity - RVUs and $GB per day. By using RVUs as a proxy for work effort and $GB as a proxy for the monetary return on work effort, we can identify whether the intensification process has translated into increased work effort and/or financial gain over time. Table 5.1 provides summary statistics for the main trends discussed. Two new variables were calculated: total estimated annual $GB and total estimated annual RVUs. These were calculated by multiplying the estimate for daily $GB and RVUs estimated from the LSPDA data set for each respective year by the mean number of days worked per year (also obtained from the study) by the number of private, general practising dentists for each respective year (the same statistics used in the weighting process). The monetary estimates are all given in constant 1998 dollars to account for changes in inflation over the period and provide information on 'real' changes in output.

The proportional change in the total estimated annual $GB between 1983 to 1988, 1988 to 1993 and 1993 to 1998 is significantly high at 35.2, 77.8 and 46.4% respectively. This may be explained by the fact that estimates for $GB/day show a steady increase (Column A) in addition to substantial increases in the number of practising dentists over these periods of 7.9, 20.8 and 21.1% (refer to Column D), respectively. In effect, although the market has experienced an increase in the supply of dentists this has been more than offset by the increase in $GB. The more than proportional increase in $GB could be related to the shortage within the dental market driving up the price of services and hence individual dentist income, an increasing proportion of overhead costs such that although 'gross' income may be increasing, 'net' income may be either staying constant or not increasing at the same

rate and lastly, whether the service mix bundle has increased in monetary value over time reflecting increased $GB. The main caveat, of course, is ascertaining whether real individual dentist incomes have decreased at the same time as real gross billings; is the lack of information regarding overhead costs over the 1983 to 1998 period. The trend of increasing 'real' $GB per day over the 1983-1998 period was strongly evident. To what extent the trend in dentists' net income is matching the trend in $GB over time is determined by a number of factors. For the purposes of this discussion, we can broadly define the annual net income as the gross income (generated from gross billings) minus operating costs. The degree of which the proportion of operating costs compared to total gross income has changed over time will determine the extent to which dentists' net income has changed over time. Factors that would influence operating costs would include labour and material costs. We would imagine that with an increase in fixed and removable prosthodontics over time, material laboratory costs would also have increased. Whether the proportional increase in laboratory costs is equal to, less than or more than offset by the proportional increase in higher billings due to more expensive service mix provision is unknown. Additionally, we could suppose that over time efficiency in staffing would increase as would efficiency from capital investment. Capital equipment in dentistry (e.g. surgery chair, xray unit) can be described as 'lumpy'. Therefore new capital equipment is not always purchased at the most optimal profit maximising time. For example, building up a full week of utilisation of a second surgery chair may not happen immediately during which the second surgery chair is idle and non-profit returning. Equally, although there may be some improvement in accounting practices over time which enhance the dentists' net return, there may also be a trend toward increased expenditure in areas which have evolved over time e.g. advertising.

Overall, since the increase in real $GB per day for private general dentists has exhibited a very strong and consistent increase, it would be somewhat safe to assume it is most likely that dentists' real net income would also have increased. In the absence of data describing overhead costs (labour and material costs) it cannot be assumed that the rate of assumed increase in real net income would be equal to the rate of increase in real $GB, over the period.

The next point highlighted in Table 5.1 is that there has been a steady increase in work effort over the 1988 to 1998 period. The change in total annual RVUs estimates between 1988 to 1993, and 1993 to 1998, is strong at 13.3 and 18.8% respectively. This suggests that although daily RVUs estimates show a steady decline (refer to Column B) over the 1988 to 1998 period, this has been more than offset by the substantial increase in the number of practising dentists. Over time, the market has experienced an increase in both the supply of dentists and the overall work effort generated.

In summary, at an individual dentist level, estimated $GB/day have increased while work effort (RVUs) have remained stable, but at an aggregate market level we observe that the substantial increases in dentist supply have led to an overall increase in RVUs and $GB. If overhead costs have declined over the period, then real individual dentist income has increased; however, if overhead costs have either remained stable or increased, then real individual dentist income has also either remained stable or decreased, respectively.

The next task is to relate these productivity trends to the reported trends in actual dental services expenditure in Australia over the 1983 to 1998 period. The last column in the table below lists the 'real' private dental services expenditure in Australia as defined by the sum of dental expenditure of health insurance funds and individuals. Again, estimates are given in constant 1998 dollars to account for inflationary changes over the period. We observe the real trend in the total dental services expenditure between 1983 to 1988, 1988 to 1993 and 1993 to 1998, involved a proportional increase of 28.7 and 19.3%, and a proportional decrease of 5.5%, respectively. Although the decline in real growth rates follows a similar trend to that observed for estimated annual $GB from the study, the actual estimates and percentages vary considerably. This could be related to a number of factors. The $GB estimates were based on dentists' self-reported inclusion of all item numbers, whether they were charged to the patient or not. This would lead to an over-inflated $GB estimate which included both what was actually charged and the proportion of privately subsidised expenditure absorbed by the dentist. Privately subsidised expenditure could include services which were provided at no charge, at a reduced fee compared to the standard dentists' fee or at the level of dental benefits cover only. If the only inconsistency between the $GB estimates and dental services

expenditure was the proportion of private subsidisation expenditure, we would still expect to see a consistent time trend between the two measures when expressed in percentage changes over time. However, this would assume a constant rate of private subsidisation over time. This is perhaps not a valid assumption, since we would assume that as dental insurance cover has increased over the last 20 years, the extent of private subsidisation which involves forgoing the 'gap' above the health fund payments would subsequently increase. Therefore if the degree of private subsidisation has increased over time then we would assume the estimate for 1998 has a larger proportion of private subsidisation compared to 1993, which would in turn result in less of a percentage change between the 1993 and 1998 estimates as compared with the private dental services expenditure estimates for 1993 and 1998.

While the estimates obtained from this study shed light on productivity time trends, they do appear to deviate from actual reported estimates on dental expenditure. This leads us to identifying the holes that exist in the current body of knowledge in this area of research and the limitations which are specific to this particular study, as discussed in the next section.

Table 5.1: Summary of productivity trends (estimated and actual)

Survey year	Estimated* $GB/day(bil.)	Estimated* RVUs/day	Estimated* days/year	No. dentists [a]	Estimated $GB/year (bil.)	Estimated RVUs/year	Actual private dental services expenditure [b]
	(A)	(B)	(C)	(D)	= (A x C x D)	= (B x C x D)	(bil.)
1983	$1251.02	429.85	213.50	4862	$1.299	4.46	$1.487
1988	$1559.59	454.81	214.67	5244	$1.756	5.12	$1.913
1993	$2268.18	428.34	217.37	6333	$3.122	5.90	$2.283
1998	$2826.18	444.19	210.91	7667	$4.570	7.18	$2.157
	% real change 1983-1988			↑ 7.9%	↑ 35.2%	↑ 14.8%	↑ 28.7%
	% real change 1988-1993			↑ 20.8%	↑ 77.8%	↑ 15.2%	↑ 19.3%
	% real change 1993-1998			↑ 21.1%	↑ 46.4%	↑ 21.7%	↓ 5.5%

* estimates derived from LSDPA

(a) ADA, 1983; ADA, 1988; AIHW DSRU,1992; AIHW, 1994

(b) AIHW, 1991; AIHW, 2000

5.3 Limitations of approach and methods

There are a number of limitations which can be identified both within the general approach taken, the methodology implemented to answer the research question and the broader assumptions that have been made. These caveats will be specifically addressed in relation to the scientific approach, data collection, productivity inputs, productivity measures, methodology and assumptions made.

Scientific approach

It could be argued that the general approach taken to investigate productivity explores quantitative measures of dental productivity but makes no attempt to include measures which capture gains to oral health. On the contrary, what little information that exist suggests that increases in services per patient are associated with decreased patient welfare. Given the controversy in correctly defining what productivity is in dentistry, this adds yet another dimension for further investigation. This lateral dimension would involve exploring the association between quantitative productivity measures (visits, services received per patient) and weighted quantitative productivity measures (RVUs, gross billings generated per dentist) with dental patient welfare.

Data collection

The main caveats in regards to data collection were related to the log data which were used to calculate the RVUs and gross billings per dentist. Firstly, the log data provided information on services provided for generally one day. Although a pilot study (Brennan et al., 1996) showed there was no significant difference in service provision recorded over a ten-day log and a one-day log, there could hypothetically be some variation in service provision at different times of the year. As an example, in the period shortly before and after Christmas dentists anecdotally report slower business.

Asking dentists to record all service item numbers, whether charged to the patient or not, would have resulted in some degree of over-inflation of actual gross billings. In

turn, the annual gross billings estimated from the study and the total private dental services expenditure were quite different, even though in theory they should be very close in approximation. Had some provision been made for dentists to record services provided but not charged for, the extent of private subsidisation could have been tracked in each individual survey year and across time. Whether the unrecorded private subsidy is as large as the discrepancy between total gross and private expenditure is another issue to consider. If it was not, this infers the presence of another limitation that has not been accounted for.

In the first two survey waves, there was some attempt to capture variation in average fees charged by asking dentists to record the average fee for five service item numbers. Even if considered, the five service item numbers are not totally appropriate in comparing relative prices between individual dentists since we assume there will be variation in comparative fee setting of services depending on how the individual dentist perceives different categories of service. For example, an amalgam restoration was included as one of the five item numbers but composite resin restorations were not included. Had some provision been made for the collection of individual dentists' fee setting and/or work effort rating per individual service, then individually set fees or work effort ratings could have been used to calculate individual dentist productivity rather than applying weighted averages estimated across all dentists.

Productivity measures

All four productivity measures did not fully account for variation in service mix between dentists. The first two non-weighted productivity measures (patients, services) were further complicated by the 'intensification process' – the shift in service mix over time resulting in more services per patient and longer visit times. Since the change in these two productivity measures was largely attributable to underlying shifts in treatment trends, it is difficult to compare a unit of 'one patient visit' in 1983 to a unit of 'one patient visit' in 1998. The patient visit has changed in three ways: the number of services provided; the types of services provided; and the length of time taken for one patient visit The latter two weighted productivity measures (RVUs, gross billings) attempt to account for this variation by applying average fees, responsibility loadings and average times taken to deliver

individual services, respectively. However, there are still caveats associated with this approach. Due to the variation between dentists in fee schedules, skill level and average time taken, in addition to within-dentist variation in the preceding two factors depending on the type of service, the gross billings and relative value unit estimates calculated for individual dentists were rather crude estimations. In spite of this, there is value to these estimates at an aggregate level (Table 5.1), assuming that the variation in the above-mentioned factors is random and not biased.

Methodology

There were analytic limitations present in relation to the cross-sectional and panel longitudinal regression modelling and additionally in regards to more specific methodological approaches used for example to formulate a particular variable or the inclusion/exclusion of particular variables.

The exclusion of the public dental sector could plausibly contribute to the limitations of the study. However, this contribution is considered negligible, specifically in Australia for the following two reasons. The vast majority of dental services expenditure is sourced through the private dental sector (AIHW, 2004) and the majority of dentists are employed in the private general dental sector (approximately 85 per cent), (AIHW, 2002). Therefore, a sizeable public sector provision of dental care is not an issue in Australia. Additionally, the pool of patients accessing dental care in the public sector compared to the public sector would be not only substantially smaller, but significantly different with respect to socio-economic status, education and income. Thus, it is recognised that the results of this study should be discussed only in relation to the private dental sector domain.

There were limitations in the cross-sectional regression models in terms of whether all categories were well represented. Even though data had been weighted to represent the sex and age distribution of dentists reported in national dental registers, other characteristics with numerous categories, e.g. state location of main practice may not have been well represented. The pooling of data for the panel longitudinal regression model was limited in interpretation in that significant variables could either be a result of multiple weak associations present in individual surveys that become more pronounced in the presence of a large sample size, or the

result of a strong association in a single year, and should therefore be interpreted with caution. In formulating the RVU productivity measure, the weighted average time per service was used to calculate the RVU value but alternatively the individual dentist average time per service could have been used. This would have accounted for variation in time taken to perform the service between individual dentist. The overall average was used in preference to account for dentists who may have recorded a service provided but not the time taken to perform the service.

It should be noted that the inclusion of certain variables e.g. categorising auxiliaries into extra-oral and intra-oral auxiliaries may have compromised the sample size and therefore strength in association but was chosen in preference to not sub-categorising as means of representing different groups comprising of labour inputs.

Another limitation of the study included the issue of missing cases and how these were dealt with. Where missing values were either: imputed (intra-oral auxiliaries, group practice size) or led to the exclusion of cases, there was a risk of either error in assumption or decreased sample size. As discussed in the methodology and presented in the production function regression model tables, there is variation in the sample sizes used for different analyses depending on the dependent variable used. Additionally, there could be response bias in the smaller sample of private general dentists, resulting from the larger number of missing cases from dentists not responding to the log-entry component of the questionnaire.

Lastly, although multicollinearity was measured and correlation coefficients were found not to exceed 0.7 (deemed 'high' multicollinearity) the moderate presence of multicollinearity between some of the independent variables, for example, state location of main practice and university of graduation should be taken into consideration as a potential methodological limitation.

Assumptions

In addition to the limitations already mentioned, one that is in a stand-alone category is the basic assumption underlying the production function model and that is the assumption of constant technology. The cross-sectional regression models assume constant technology across dentists, while the panel longitudinal regression models

assume constant technology not only across dentists but also across time. The approach here has been to apply the assumption of constant technology between dentists and across time. This can be justified in a number of ways. The dental industry generally is relatively slow in the introduction and adaptation of new technology and when technology is introduced, due to the relatively small and concentrated nature of the private dental sector the majority of dentists are exposed to the technology within short spaces of time to each other and tend to use each other as advisors for feedback on new technology/equipment purchased. More specific information about age and type of equipment, other than surgeries and x-ray units, would need to be obtained to elicit whether the assumption of constant technology holds.

5.4 Implications

An intensification of the production process has occurred in that productivity is decreasing (when measured as patients per day) due to the trend of a smaller group of patients receiving a greater number of services and therefore exhausting dentists' resources, which in turn is reflected in declining productivity. At the same time, there has been a shift in service mix toward an increase in the proportion of service categories which are relatively more time-consuming and of higher monetary value e.g. endodontics, fixed prosthodontics. This may also explain why productivity also follows a declining trend when measured in services per day.

The impact of the service mix shift has seen the private, general dental sector experience a small increase in work effort with a significantly high increase in gross monetary return. This suggests that dentists may be operating highly efficiently, able to shift the focus of their service provision with relatively few reallocation costs. Equally, if the target income hypothesis holds true, shifting in service mix toward a more profitable patient visit (holding overhead costs constant), this could also imply that dentists in Australia have for the past 15 years or so reached a level of income which covers their economic needs such that there is no incentive to increase either: work effort, time devoted to work or number of patients/services provided per day, all which corresponds to the observed trends. Whether the service mix shift is purely a result of broader lifestyle and technology-related trends, or in addition, contains some component of supplier-induced demand is not conclusive by any means. However, in light of the implications of the observed trends, and the possibility of underlying target income setting, monitoring of the private general dental sector could be beneficial. Additionally, educators within the dental school curriculum may also be relatively efficient in customizing training to reflect current trends in dentistry e.g. training has become more concentrated in complex conservative and oral rehabilitation in recent years comparative to some 20 years ago. However, this service mix shift has come with the cost of higher priced services, which is reflected in $GB. The cost of increasingly higher priced dental services could have potentially significant impacts on a number of stakeholders, which include the dental patient (particularly those in the highest risk groups), the providers within the private dental

sector, and the dental market.

In relation to the dental patient, declining productivity in term of patients and services within private dental practice in the face of an already under-supplied labour force could lead to increasing fees, decreased access to dental care and longer waiting times for routine dental care. The consequences are further complicated by the fact that coupled with an under-resourced public dental system and maldistribution of private dentists, this leaves the highest risk groups most vulnerable to unaffordable dental care, decreased access to care and compromised treatment options when care is sourced. Implications of this kind warrant public intervention. Labour force shortages within the dental market leave the individual dental provider to cope with an increased number of patients visits (relative to what the provider has to offer) which demand a more intensified service profile. This situation will be more magnified in geographical areas where the dentist:population ratio is even less favourable. Reconfiguration of practice style could be considered to increase the efficiency of dentists' time. This may include increasing the scope of service provision of auxiliaries to manage the supply of simpler dental care, while dentists are granted increased chairside time to focus on the supply of more complex dental care. Government intervention into the private dental market in the form of regulatory changes would be required for such structural transformations.

6 Summary and conclusions

This section provides a summary of the main findings of the study under the following main headings: input factors, productivity measures, production function synthesis, productivity time trends and conceptual issues. These are directly related to the specific aim of the study which was to study productivity by investigating which inputs significantly affect productivity and examine how productivity is changing over time, depending on what measure is used.

6.1 Summary: input factors

Significant inputs associated with productivity when measured as patients per day:

Comparison of the four survey year cross-sectional production functions with productivity measured as patients per day, showed that the most consistent and significant inputs were in the categories of capital inputs (number of surgeries utilised), labour inputs (number of dentist chairside hours per day) and practice characteristics (perceived busyness). To a lesser extent, experience, number of extra-oral auxiliaries and state location of main practice also featured as significant inputs, but not as consistently. Input factors which consistently showed no significant association with productivity included sex, number of intra-oral auxiliaries and practice configuration and size.

Main inputs associated with productivity when measured as services per day:

Comparison of the four survey year cross-sectional production functions with productivity measured as services per day, showed that the most consistent and significant inputs were in the category of labour inputs (number of dentist chairside hours per day, number of extra-oral auxiliaries per dentist). To a lesser extent, experience and length of wait for an appointment also featured as significant inputs, but not as consistently. Input factors which consistently showed no significant association with productivity included sex, number of intra-oral auxiliaries and practice size.

Main inputs associated with productivity when measured as RVUs per day:

Comparison of the four survey year cross-sectional production functions with productivity measured as RVUs per day, showed that the most consistent and significant input was in the category of labour inputs (number of dentist chairside hours per day). To a lesser extent, number of intra-oral auxiliaries per dentist, length of wait for an appointment and perceived busyness also featured as significant inputs, but not as consistently. Input factors which consistently showed no significant association with productivity included university of graduation and practice configuration.

Main inputs associated with productivity when measured as $GB per day:

Comparison of the four survey year cross-sectional production functions with productivity measured as $GB per day, showed that the most consistent and significant inputs was in the category of dentist characteristics (experience), labour inputs (number of dentist chairside hours per day) and practice characteristics (state location of main practice). To a lesser extent, the perception of being more busy than would like also featured as a significant input, but not as consistently. Input factors which consistently showed no significant association with productivity included sex and number of intra-oral auxiliaries.

Overall summary of input factors:

Overall, the most consistent and significant input factors were related to labour inputs consisting of dentist chairside hours per day and number of extra-oral auxiliaries per dentist. Inputs that did not show a significant association with productivity included sex, the number of intra-oral auxiliaries per dentist and practice characteristics such as configuration and size. The non-significance of the practice characteristics may be attributable to the way in which the LSPDA questions were worded; possibly resulting in inconsistency in the interpretation from participants, while intra-oral auxiliaries do not feature strongly as they are few in number and are more complementary rather than substitutional in terms of dental provision as compared with the dentist.

6.2 Summary: productivity measures

Productivity measured as patients per day:

The mean number of patients declined significantly across the 1983 to 1998 period, from 15.9 patients per day (1983) to 12.6 patients per day (1998). This represents a proportional decline of 20.8%.

Productivity measured as services per day:

The mean number of services declined significantly across the 1983 to 1998 period, from 26.1 services per day (1983) to 23.2 services per day (1998). This represents a proportional decline of 11.1%.

Productivity measured as RVUs per day:

RVUs per day as a productivity measure followed a different trend to the earlier measures of patients and services per day. The mean number of RVUs per day remained fairly stable over the 1983 to 1998 period; first increasing from 429.85 RVUs per day (1983) to 454.81 RVUs per day (1988) representing a proportional increase of 5.8%, then decreasing from 454.81 RVUs per day (1988) to 428.34 RVUs per day (1993) representing a proportional decrease of 3.5% and then increasing again from 428.34 RVUs per day (1993) to 444.19 RVUs per day (1998) representing a proportional increase of 3.3%.

Productivity measured as $GB per day:

$GB as a productivity measure followed a unique trend compared to the other three measures by exhibiting very high and consistent growth over the 1983 to 1998 period. The mean $GB per day increased in 'real' terms' from $1251.02 per day (1983) to $2826.18 per day (1998) representing a staggeringly high proportional increase of 126%.

6.3 Productivity time trends

One of the main strengths of the study was the opportunity to investigate productivity *'over time'* using the production function modelling technique which was applied to both cross-sectional and longitudinal panel data. Until now, production functions had only really been applied to cross-sectional data and therefore captured a snapshot of productivity at one point in time. In this study, not only were snapshots of productivity (as indexed by a range of measures) captured at multiple points in time, but an overall moving picture of productivity trends in Australia was captured. The picture that has emerged is not conclusively a declining or increasing trend in productivity, but rather, an *intensification* process which can be interpreted as having a different impact depending on what measure of productivity is used.

The *intensification* process:

The overall productivity time trend observed across the 1983 to 1998 period has seen a decline in patients and services per day, at a reasonably stable level of work effort (RVUs per day) but with very high monetary rewards in the form of greatly increased $GB per day for private general dentists.

During this time, there has also been an intensification of service provision where each patient visit is longer, has a higher mean number of services provided and has experienced a shift in service mix toward more complex dental treatment. A patient visit in 1983 is therefore not comparable to a patient visit in 1998. Due to the change in service mix and subsequent increase in the proportion of longer, more complex services, there has been an overall decline in the mean number of services provided in an average clinic day too. The intensification process has not led to increased work effort which could hypothetically be due to a number of reasons; a pre-existing surplus in resources prior to the service mix shift, efficiency in both dentist- and educator-ability in reallocating skill focus toward a different service mix bundle or a counterbalancing effect between the effort required for higher number, shorter and simpler services compared to lower number, longer and more complex services.

We do however, observe a comparatively higher $GB return generated for the

service mix in 1998 as compared with 1983. The issues with the higher $GB estimates are that due to a lack of information regarding overhead costs one cannot ascertain whether 'real' net income of dentists is actually increasing; what proportion of $GB estimates are privately subsidized and whether this proportion is changing over time, and lastly, considering the discrepancy between the estimated $GB from the study and nationally reported estimates of private dental expenditure, if, firstly, the data from the service provision log of the LSPDA is representative, and secondly whether the methodology in formulating estimates is the most appropriate means in obtaining accurate estimates. The productivity trend of increasing 'real' $GB is especially alarming given the currently reported shortage of dentists and the ripple effect that an undersupply of providers and combined price increases have on the dental marketplace, and particularly on the most vulnerable stakeholders e.g. lower socio-economic individuals with poorer oral health.

6.4 Production function synthesis

Comparison of production functions by type of productivity measure:

The production functions synthesised were OLS regression models which exhibited reasonably good fit and explained the variation in productivity within the range of 36 to 42% for patients per day, 22 to 30% for services per day, 15 to 41% for RVUs per day and 18 to 31% fore $GB per day. Overall, the production functions with the greatest number of significant explanatory input factors and best fit were those estimated with patients per day as the dependent variable, while the production functions estimated with $GB per day as the dependent variable achieved the least number of significant variables and least 'best fit'.

6.5 Conclusions: conceptual issues

Main limitations of the study:

While multiple productivity measures (patients, services, RVUs, $GB) have been used in the study as a means of addressing the different aspects of dental productivity, each productivity measure is not without its own set of caveats. The quantitative measures (patients, services) do not take into account service mix variation between dentists, and while relative value units and gross billings are weighted by the service type, the methodology in calculating these was based on assumptions which may not universally hold true. The RVU calculation uses responsibility loadings which are held constant across the period of the survey and do not take into account the introduction of new technology and other changes in dentistry. On the contrary, while computation of $GB was uniformly based on fees that had been inflated/deflated to reflect the dental price index specific to the survey year, there was no means to account for fee variation either between service categories or between dentists.

Lastly, the underlying assumption of constant technology across dentists for specification of the production function is another source of potential error and as is the lack of information in areas such as private subsidisation and practice overhead costs.

Broader issues:

Declining productivity within private dental practice in the face of an already under-supplied labour force could lead to increasing fees, decreased access to dental care and longer waiting times for routine dental care. The consequences are further complicated by the fact that coupled with an under-resourced public dental system and maldistribution of private dentists, this leaves the highest risk groups most vulnerable to unaffordable dental care, decreased access to care and compromised treatment options when care is sourced. Implications of this kind warrant various forms of public intervention.

7 Appendices

7.1 Appendix A: Questionnaire – Longitudinal Study of Dentists' Practice Activity, 1998

Appendix A

AIHW
AUSTRALIAN INSTITUTE OF HEALTH & WELFARE

LONGITUDINAL STUDY OF DENTISTS' PRACTICE ACTIVITY, 1998

Conducted by: Australian Institute of Health and Welfare's Dental Statistics and Research Unit
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Please return the completed questionnaire as soon as possible in the reply paid envelope provided.

LONGITUDINAL STUDY OF DENTISTS' PRACTICE ACTIVITY, 1998

CONFIDENTIALITY

This study is being conducted by the Australian Institute of Health and Welfare's Dental Statistics and Research Unit, The University of Adelaide.

Responses to this questionnaire are **STRICTLY CONFIDENTIAL** and will be reported in statistical form only such that individual identity is not revealed. Your questionnaire is identified by a serial number to control mailing procedures. Only the research team led by Professor John Spencer has access to the information you provide.

SECTION A

HOW TO ANSWER QUESTIONS

If your professional activities have recently changed or will soon change in any way, answer in terms of your **current, actual** situation.

Good estimates are acceptable if exact answers cannot be given.

Each dentist receiving a questionnaire in a group practice or partnership should complete a separate questionnaire.

Questions should be answered by putting a tick in the boxes provided, or by writing the answer when a space is provided.

PLEASE ANSWER ALL QUESTIONS. YOUR CO-OPERATION IS IMPORTANT AND APPRECIATED.

1 Please indicate your: ■ date of birth: ☐☐ day ☐☐ month ☐☐ year ■ sex: Male ☐ Female ☐

2 Were you born in Australia? Yes ☐ No ☐

If No, in what country were you born? ☐ country

3 Year and school of BDS/BDSc graduation: 19☐☐ ☐ University

The 1983, 1988 and 1993 waves of this study and recent research have indicated that a number of economic and social factors (peripheral to the profession) may influence a dentist's level of participation in dental practice. Questions 4 to 8 are included to explore these factors.

4 Do you have an activity outside of dentistry from which you derive an income? *(e.g., property developer, executive manager)*

Yes ☐ → *Please specify*: ☐

No ☐

5 Are you the sole earner of your family income? Yes ☐ No ☐

6 How many other people are dependent on the total family income? (excluding yourself) ☐

7 Please provide the ages of any dependent children

*(starting with the oldest child in **years** (or **months** for children less than one year)*

_____, _____, _____, _____, _____, _____, _____

8 **WORK STATUS:**

a) Please indicate your current work status:

Full-time work in dentistry	☐ →	Go to question 9
Part-time (less than 35 hours per week) or casual work in dentistry	☐ →	Complete 8 b), then continue
Not working in dentistry	☐ →	Complete 8 b), then DO NOT ANSWER ANY MORE QUESTIONS. **Thank you for your co-operation and time.**

b) If you are **not working in dentistry**, work **less than a total of 35 hours per week**, or work on a **casual basis**, please indicate your **major** reason for doing so:

House duties/child rearing	☐	Preference	☐
Further study	☐	Retired	☐
Illness /injury	☐	Other (please specify):	☐
Other employment	☐	☐	
Full-time work in dentistry not available	☐		

9 **AREA OF PRACTICE:** Please indicate in which main area of dentistry you work. If you have more than one job or practice location in the area of dentistry, indicate the area of dentistry for each job or location. *(please tick only one box in each column)*

	Main location	2nd location	3rd location
General Practice	☐	☐	☐
Registered Specialist Practice	☐	☐	☐
Restricted Practice	☐	☐	☐
Administration	☐	☐	☐
Research	☐	☐	☐
Education	☐	☐	☐
Other eg. instructor, insurance consultant (*please specify*)	☐	☐	☐

2

10 **TYPE OF PRACTICE:** Please indicate in which type of practice you work. If you have more than one job or location in the area of dentistry, indicate the type of practice for each job or location.

TYPE OF PRACTICE		Main location	2nd location	3rd location
Private Practice	Solo practitioner (no sharing of costs)	☐	☐	☐
	Partnership	☐	☐	☐
	Associateship	☐	☐	☐
	Employed as an assistant	☐	☐	☐
	Locum	☐	☐	☐
Public Practice	Dental hospital	☐	☐	☐
	Other hospital	☐	☐	☐
	School dental service	☐	☐	☐
	Health Centre/ Community Dental Clinic	☐	☐	☐
	Defence forces	☐	☐	☐
Tertiary Education Institution		☐	☐	☐
Industry		☐	☐	☐
Insurance Fund		☐	☐	☐
Other *(please specify)*				

IF IN PRIVATE PRACTICE: How many dentists, excluding yourself, in each practice? ☐ ☐ ☐

11 **SPECIALIST OR RESTRICTED PRACTICE:**

a) Are you in specialist or restricted practice? Yes ☐ → Complete 11 b), then continue
No ☐ → Go to question 12

b) If in specialist or restricted practice, please indicate area of practice:

Orthodontics ☐
Oral/Maxillofacial Surgery ☐
Periodontics ☐
Endodontics ☐
Prosthodontics ☐
Paediatric Dentistry ☐
Other *(please specify)* ☐ ☐

12 IF YOU ARE **NOT** CURRENTLY TREATING PATIENTS IN AUSTRALIA, PLEASE TICK THIS BOX AND RETURN THE QUESTIONNAIRE NOW. **THANK YOU FOR YOUR CO-OPERATION AND TIME.** ☐ Not currently treating patients

13 **CURRENT PRACTICE EXPERIENCE:** Please answer the following in terms of your practice experience using a **typical or average** day or week as indicated. If you work at more than one practice or location, please answer for each practice or location. *Use decimals and fractions as needed.*

	Main location	2nd location	3rd location
a) **Postcode** of place of work *(if postcodes unknown, fill in city, suburb or town name(s))*			
b) How many **patients per day**, on average, do you treat? *(Do not include patients whose treatment you supervised, but who are treated by other staff)*			
c) What would be your **preferred** average number of **patients per day**?			
d) Do you take **new patients**? *(Y for yes, N for no)*			
e) What is the average **total number of hours per day** worked by you including administration, lab. work, etc? *(exclude free time)*			
f) How many **hours per day** do you spend **chairside** with patients?			
g) How many **days per week** do you practice?			
h) How many **weeks** did you work in the last 12 months?			
i) Approximately how long does a patient requesting an appointment with you have to wait? *(Exclude patients with emergencies and those scheduled for a series of treatments)* *Please fill in only one box for each column.*	☐ days ☐ weeks ☐ months	☐ days ☐ weeks ☐ months	☐ days ☐ weeks ☐ months

14 How much time, as a percentage, would you prefer to spend practising in 1999 compared to 1998? *(Tick one box only and specify percentage if indicated)*

☐ _____ % more ☐ same ☐ _____ % less

15 Are you: *(please tick one)*

Less busy than you would like to be? ☐ About as busy as you would like to be? ☐ Busier than you would like to be? ☐

16 **EQUIPMENT:** Please answer the following, in the table provided, for each practice or location.

	Main location	2nd location	3rd location
a) What is the **total number of surgeries** in your practice(s)?			
b) How many of the above surgeries are **fully equipped**?			
c) How many of the above surgeries **do <u>you</u> use** in your practice(s)?			
d) How many **x-ray units in total** are in your practice(s)?			
e) Are any of the above units **Panorex or similar**? *(Y for yes or N for no)*			

17 **AUXILIARIES WORKING WITH YOU:** Please state the number of auxiliaries of each type working with you, for each location. For **EACH** one, state number of hours per week working with **YOU**. If 2 or more of each type are employed, please specify number of hours per week with you for each one separately.

Example: If you have 2 Dental Hygienists, both employed at your main practice, one working 24 hours per week with you and the other working 8 hours per week with you, then report:

Auxiliary Type		Number of hours per week		
		Main location	2nd location	3rd location
Dental Hygienist	1	24		
	2	8		
	3			

Auxiliary Type		Number of hours per week		
		Main location	2nd location	3rd location
Non-certificated Dental Chairside Assistant*	1			
	2			
	3			
Certificated Dental Chairside Assistant*	1			
	2			
	3			
Dental Hygienist	1			
	2			
	3			
Dental Therapist	1			
	2			
	3			
Laboratory Technician	1			
	2			
	3			
Secretary/Receptionist*	1			
	2			
	3			
Other *(please specify)*	1			
	2			
	3			

* If Secretary/Receptionist also works as a Chairside Assistant, specify hours spent in each role separately.

18 *(Answer if applicable)* What is the total number of **<u>your</u> patients per week** treated by your:

	Number of patients		
	Main location	2nd location	3rd location
Dental Hygienist(s)			
Dental Therapist(s)			

SECTION B - INSTRUCTION SHEET

SECTION B: SERVICES PROVIDED ON ONE (1) TYPICAL WORKING DAY IN PRIVATE GENERAL PRACTICE

IF YOU ARE IN PRIVATE GENERAL PRACTICE, PLEASE USE THIS INSTRUCTION SHEET TO COMPLETE THE DAILY LOG ON PAGE 6. **IF YOU ARE NOT IN PRIVATE GENERAL PRACTICE, PLEASE DO NOT ANSWER ANY MORE QUESTIONS.**
THANK YOU FOR YOUR CO-OPERATION AND TIME.

DAILY LOG INSTRUCTIONS

Please provide, on page 6, information on the services you performed on a typical day, by completing the daily log over one **TYPICAL** day in private general practice.

The Daily Log form provides space to record the following (see example over the page):

Column 1 – **PATIENT NUMBER**. Write in "01" for the first patient seen during the day, "02" for the second patient, etc.

Column 2 – **SERVICE ITEM CODE**. Record the dental service item code, ONE PER LINE, until ALL of the dental procedures performed on that day for any one patient have been listed. It does not matter if particular services are not completed. Multiple services of the same type (e.g., 2 one-surface amalgams) should be recorded as two separate services. Please use a copy of the A.D.A Inc. Schedule of Dental Services for the services codes.

NOTE: Please include ALL items, even if the patient was not charged for the procedure, e.g. oral hygiene instruction.

Column 3 – **FILLING CODE**. Please indicate for all fillings provided whether they are initial or replacement (full or partial) using the code below.

Code	Filling type
I	Initial
RF	Replacement (Full)
RP	Replacement (Partial)
NA	Not Applicable (for all other services)

Column 4 – **DENTIST TIME (IN MINUTES)**. Please ESTIMATE the number of minutes spent by YOU for each dental procedure performed for the patient.

Column 5 – **PATIENTS SEX**. M for Male, F for Female.

Column 6 – **PATIENTS AGE** in years. (If exact age is not known, please provide best estimate).

Column 7 – **NEW PATIENT**. Please indicate whether this is the first course of care you have provided for this patient. Y for Yes or N for No.

Column 8 – **INSURANCE STATUS**. Please indicate whether this patient has dental insurance. Y for Yes or N for No.

Column 9 – **POSTCODE OF PATIENT (RESIDENTIAL).** Please indicate 4-digit postcode for residential address of the patient.

Column 10 – **NUMBER OF NATURAL TEETH**. Record the number of NATURAL permanent teeth present at the beginning of the current visit (maximum 32).

Column 11 – **NUMBER OF DECAYED TEETH**. Please indicate the number of decayed teeth present at the beginning of the current visit. NB: Decayed teeth include recurrent decay (i.e., may be both

decayed and filled).

Column 12 – **REASON FOR COURSE OF TREATMENT**. Indicate the initial reason for the course of treatment by one of the following codes. A course of treatment is one or more visits involved in completing a treatment plan.

Code	Initial reason for course of treatment
C	Check-up
E	Emergency visit/relief of pain
O	Other reason (e.g., a dental problem not involving relief of pain)

Column 13 – **DIAGNOSIS**. Indicate the diagnosis of the patient's main dental complaint, or if a check-up, your diagnosis of the patient's main dental condition.

Code	Diagnosis	Code	Diagnosis
RE	Recall/maintenance care	FR	Failed restoration
CF	Cuspal fracture	OP	Occlusal problem
CP	Caries: primary	PD	Periodontal diseases
CRE	Caries: recurrent	PU	Pulpal/periapical infection
CRT	Caries: root	AP	Aesthetic problem
DP	Denture problem	TR	Trauma
DS	Dentinal sensitivity	OT	Other *(please specify)*

NOTE: Please do not include the procedures provided or time spent by a dental hygienist or dental therapist on patients you have seen on this typical day.

DAILY LOG EXAMPLES

The example below shows a sample entry for two patients seen during a typical day.

The entry for the first patient (a 20 year-old female) shows the following work being performed: a pair of bitewing radiographs and two two-surface amalgam fillings (both initial restorations). The patient is new to this dentist, does not have dental insurance, has a postcode of 5027, has 28 natural teeth, had two decayed teeth at the beginning of the visit, the reason for course of treatment is emergency/relief of pain and the diagnosis is caries: primary.

The entry for the second patient (a 73 year-old male) shows the following work being performed: an initial examination and removal of plaque and calculus. The patient is not new, has dental insurance, has a postcode of 5065, has 20 natural teeth, had no decayed teeth at the beginning of the visit, the reason for course of treatment is check-up and the diagnosis is periodontal disease.

EXAMPLE:

1	2	3	4	5	6	7	8	9	10	11	12	13
SERVICE INFORMATION				PATIENT AND VISIT INFORMATION					ORAL HEALTH AT CURRENT VISIT		COURSE OF CARE INFORMATION	
Patient number	Item code	Filling code (I,RF, RP or NA)	Dentist time (minutes)	Sex (M or F)	Age (Yrs)	New patient (Y or N)	Insur-ance status (Y or N)	Post-code of patient	Number of natural teeth (0-32)	Number of decayed teeth	Reason for course of treatment (C,E or O)	Diagnosis
01	023	NA	06	F	20	Y	N	5027	28	2	E	CP
01	512	I	18									
01	512	I	18									
02	011	NA	12	M	73	N	Y	5065	20	0	C	PD
02	112	NA	20									

SECTION B: DAILY LOG of typical clinical working day in private general practice.

Date: ____________

If in private general practice, please answer Section B questions using enclosed instruction sheet.

SERVICE INFORMATION				PATIENT AND VISIT INFORMATION					ORAL HEALTH AT CURRENT VISIT		COURSE OF CARE INFORMATION	
Patient number	Item code	Filling code (I, RF, RP or NA)	Dentist time (minutes)	Sex (M or F)	Age (Yrs)	New patient (Y or N)	Insur-ance status (Y or N)	Post-code of patient	Number of natural teeth (0-32)	Number of decayed teeth	Reason for course of treatment (C, E or O)	Diagnosis

6

SUPPLEMENTARY QUESTIONS

The following financial questions are voluntary. All information provided is treated as **STRICTLY CONFIDENTIAL**.

What fees do you charge for the following treatment items?

ADA Inc. Schedule of Dental Services			
011	–	Initial oral examination	$_____
112	–	Removal of supragingival calculus and plaque	$_____
311	–	Removal of permanent tooth, including routine post-operative care	$_____
512	–	Amalgam restoration - 2 surfaces - permanent tooth	$_____
719	–	Complete maxillary and mandibular denture	$_____

Thank you for your co-operation and time in answering this questionnaire.
Please return the completed questionnaire as soon as possible in the reply paid envelope provided.

COMMENTS:

7

7.2 Appendix B: Average time per service & responsibility loadings

Appendix B

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
11	1.25	10.5	11.52	11.87	13.61
12	1.25	8.85	10.5	9.89	11.32
13	1.25	11.06	9.87	10.88	11.78
14	1.25	11.93	12.62	13.2	14.29
15	1.25	23.78	21.53	33.47	26.42
16	1.25		55	10.51	6.02
17	1.25			31.05	
18	1.5	5	17.34	6	10
19	1.5	10	7.06	5.51	2.95
21	1	14.42	18.61	5.58	15.23
22	1	5.78	7.9	7.39	9.09
23	1	7.93	7.55	7.42	8.15
24	1	9.01	4.81	4.51	5.2
25	1.25	1	6.67		
32	1	30		15	5
35	1.25	12			
36	1.25		8.07	10	5
37	1.25	6.44	6.78	9.68	10.89
41	1	15	13.66		6.33
46	1			7	
48	1				5
51	1.75			15	
61	1	5.25	4.82	7.03	6.95
71	1	14.35	13.74	11.27	20.38
72	1	5		11.39	8.16
73	1			10	
81	1.5			10	
82	1.5		12		
111	1	9.34	10.16	9.49	9.58
112	1	16.86	16.7	14.56	15.32
113	1	9.14	7.38	9.36	8.9
114	1.25		19.85	18.52	18.66
115	1.25		13.1	18.13	16.48
121	1	11.33	8.4	7.25	6.93
122	1		35	20	3
131	1	5		7	
141	1	22.41	8.5	8.25	9.49
151	1	12.45	9	8.84	10.61
152	1	5			
161	1	13.9	10.21	7.32	8.87
165	1	4.45	7.96	6.83	7.82
171	1		10	10.7	8.84
181	1	13.35	10.86	10.72	

Appendix B *continued.*

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
182	1			7.45	1.72
211	1.75	33.63	15	5	
212	1.75	18.01	18		
213	1.5	11.58	12.05	14.61	14.76
214	1.5		13.69		
215	1.5	19.13	19.08		
216	1.5	17.71	20.75	8	
221	1.25		15	11.76	11.63
222	1.75		19.46	20.45	20.64
223	1.75		16.61	13.33	
225	1.5			18.84	
231	1.75		10		17.86
232	1.75		25	50	
233	1.75				60
234	1.75				5
245	1.5	12			10.99
246	1.75			5	25
281	1.5			27.3	
282	1.5			30	45
311	1.5	14.99	16.72	15.7	19.05
312	0.75	6.56	19.35	15.16	17.77
313	1.5	13.13	15.44	13.35	13.78
316	0.75	7.71	8.78	9.91	11.44
319	1	8			
321	1.5	34.37	31.22	36.72	41.83
322	1.75	20.55	24.76		32.12
323	1.75	31.61	47.44	28.94	16.18
324	1.75	36.82	90	33.67	30
325	1.5		4	16.78	22.66
326	1.75	47.25	22.28	35.42	10
327	1.75	20			
329	1	10	5	8.62	14.77
341	1.75		20		
342	1.75			30	
351	1.75		45		
371	1.75		5		
377	1.75	5	8.86		
387	1.75			30	
392	1.75		20.47	12.92	9.31
398	1.75		30	17.21	12
399	1.75	5	7.5	5	15
411	1.25	9.97	13.93	9.39	9.92
412	1.25	23.86	21.77	16.15	14.61

Appendix B *continued.*

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
413	1.5		15	11	23
414	1.25			17.19	15.55
415	1.5			24.91	24.74
416	1.5			16.96	17.39
417	1.5			23.28	22.83
418	1.5			16.66	17.08
419	1.5		30		20.99
421	1.5	31.24	31.79	33.59	
422	1.5	26.06	28.02		
423	1.5	39.87	43.73		
424	1.5	39.95	40.2		
425	1.75	42.65	45.09		
426	1.75	48.23	54.18		
431	1.75	10			
432	1.75				22.5
433	1.75				23
434	1.75		60		
436	1.75		49.81		
441	1.25	12.68	15.46	18.18	14.59
442	1.5	16.62	22.53		10
443	1.5	35.6	20	16.8	9.79
445	1.5		23.3	18.2	13.26
451	1.75		15	41.35	27.34
453	1.5				35
454	1.5		15.08	16.68	11.14
455	1.25	9.64	16.71	24.05	24.03
456	1.5	13.34			
458	1.5		19.61	14.37	9.32
511	1	14.52	16.34	15.35	14.92
512	1.25	19.44	21.57	19.97	20.55
513	1.25	25.71	26.72	23.34	21.83
514	1	12.09	18.1	13.17	16.09
515	1.25	12.9	19.31	19.95	17.46
516	1.25		14.1	19.73	
521	1	10.48	17.35	13.76	14.66
522	1.25	15.47	17.75	17.02	17.67
523	1.25	17.62	22.8	19.27	18.64
529	1.25			11.97	14.26
531	1.5		21.33	17.73	17.12
532	1	17.62	16.1	23.26	23.58
533	1.25	20.6	22.48	30.05	25.42
534	1.25	25.98	25.01		
537	1	17.76	19.79	16.61	17.72
538	1.25	22.46	23.35	20.66	20.41

Appendix B *continued.*

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
539	1.25	29.05	27.8	21.82	24.38
552	1.5	24.68	20		28
553	1.5	19.92			
554	1.5	30			
555	1.5		40		30
556	1.75	50.87	60	60	30
561	1.5	14	47.74	10	
563	1.5			20	50
565	1.5			20	
566	1.5			30	65.03
568	1.5			60	
569	1.5			41.66	36.57
571	1	12.23	11.04	19.02	15
572	1	11.61	11.11	12.64	17.58
573	1	34.85	16.4	21.96	26.74
574	1		20	26.78	23.38
575	0.5	6.45	8.26	8.83	10.61
576	1	40.99			
577	0.25	5	14.93	11.18	12.86
578	1.25		22.95	11.59	14.81
579	1.25		15	30	20
581	1.5		28	18	20
582	1.25	38.07	30.35	32.38	30.75
583	1.5		37.86	29.48	23.5
584	1.25		20	18.51	
597	1.5			15.96	14.92
598	1.5			29.7	27.45
599	1.5			28.12	33.78
611	1.5	30	42.24	57.82	18
612	1.5		30	17.37	
613	1.5	30	40.26	41.47	37.12
614	1.5	60	60	45	
615	1.5	41.93	45.17	40.64	43.64
616	1.5		5	11	
617	1.5		45	27.24	
618	1.5	50.81	47.12	43.94	56.07
619	1.5		22.5		
620	1.5	30	39.16	22.53	
621	1.5	60			
622	1.5	30	57.19	35.66	
623	1.5			33.3	51.89
624	1.5	15.44	15.1	31.22	
625	1.5	38.5	32.81	30.57	40.02
626	1.75	18.28	23.27		

Appendix B *continued.*

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
627	1.5	34.01	23.75	30.56	29.88
628	1.5	25	31.39	20.96	26.98
629	1.5			27	
632	1.5	38.2	43.32		
633	1.5	46.72	38.09		
635	1.5		40		
636	1.5	20			
642	1.75	76.91	29.06	26.42	30.12
643	1.75	45.73	47.25	20.46	13.9
645	1.75				30
646	1.5	60	60	60	13.82
647	1.5		31.24	25.77	
648	1.75	68			
649	1.75			14.82	15
651	1	14.96	16.83	19.13	18.89
652	1.5	22.07	25.61	22.76	20.42
653	1.5			40	
655	1	10	16.7	11.14	13.5
656	1.5	30	14.66		9.34
657	1.25			20	
658	1.25			20	15
659	1.25		16.15	22.2	20
661	1.75			30	
711	1.5	17.24	19.68	17.51	15.52
712	1.5	17.78	18.16	14.63	11.47
715	1.25	5			
716	1.5		30		15
719	1.5	20.63	23.12	19.92	17.54
721	1.25	16.87	17.58	15.01	14.67
722	1.25			10	10.05
725	1.5	16.31	15	15	15
727	1.5	24.79	20.18	18.18	18.25
728	1.5				20.04
730	1.5			5	
731	0.1	8.75	20	5.01	3.86
733	1.25	11.09		3.69	5.1
735	1.5	20	10		
736	1.25	6.1	10	9.36	5.65
737	1.25			22.1	
741	1.25	12.78	12.14	10.53	12.34
742	1.25	12.48	12.61	10.24	11.33
743	1.25	14.75	16.44	15.45	13.08
744	1.25	20.74	19.87	17.43	15.6

Appendix B *continued.*

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
745	1.25	50	16.55	15.94	
746	1.25			16	11.46
748	1.25	21.18	30	30	
749	1.25	15		12.5	10
751	1.25	10	22.96	21.29	23.37
752	1.25				27.61
753	1.25			5	
761	1			9.08	14.7
762	1.25	16.57	27.96	7.61	10
763	1.25	18.45	19.27	20.14	10.04
764	1.25	15.16	12.28	15.52	18.66
765	1.25	10		21.04	30
766	1.25	8.42	16.61	14.36	24.76
767	1.25	8.87	10	5	5.15
768	1.25	13.21	15.39	10.82	10.81
769	1.5		35	9.39	
771	1.75	14.26	17.2	20.71	15
772	1.5	23.33	8.33	20	
776	1.25	9.77	12.2	11.58	12.46
778	1.5			10	1
791	1.75			99	
811	1.75	10.81	11.75	7.88	15.86
812	1.75		12.98		
821	1.75	13.99	14.2	19.22	15
822	1.75		12.5	17.93	
823	1.75			17.5	
829	1.75		12.5	45	
831	1.75		15.86		
834	1.75	10.78	29.13	66.06	
841	1.75			26.94	
842	1.75		30		
845	1.5	30	22.52		
846	1.5				15
871	1.75	13.51	13.34	13.9	15.95
875	1.25		20		12.21
876	1.25		10		
881	1.75		15.09	25.08	22.43
911	1	12.7	15.24	11.64	15.63
912	1	12.4	15.11	15.46	15.09
915	1.25	18.62		10.97	
916	1			15	
921	1.5		12.5	3.67	
922	1.25			10	

Appendix B *continued.*

Item number	Responsibility loading	Average time 1983	Average time 1988	Average time 1993	Average time 1983
923	1.25			2	5
924	1.5	8.45	9.84	7.15	6.07
925	1.25	4.25	13.44	15	12.98
926	1			6.01	11.36
931	1.25		25		
932	1.25			30	
941	1.75		12	18	10
942	1.5	15.5	9.05	8.3	
943	1.25	12.53	17.68	13.01	17.74
949	1.5			22.96	
952	1.75				1
961	1.25	10.64	11.59	9.09	9.37
963	1.25	12.55	28.67	13.6	4.89
964	1.5	21	13.08	11.79	13.7
965	1.25	29.53	25.17	25.15	27.9
966	1	11.68	20.78	17.85	17.83
968	1.75	43.09	14.34	11.31	49.38
969	1.75		10	5	6
981	1.5	15	35	21.65	15
982	1.25				1
986	1.25	5	9.97	11.84	10

7.3 Appendix C: Fee per service estimates

Appendix C

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
11	12.60	20.69	27.50	34.00
12	11.25	18.29	24.20	29.00
13	9.76	15.83	21.32	26.32
14	12.30	20.00	27.41	33.71
15	13.97	22.65	30.51	37.67
16		38.97	52.48	64.74
17			55.64	
18	7.95	12.90	17.38	21.45
19	3.67	5.96	8.03	9.91
21	29.26	47.48	63.94	78.88
22	11.47	17.75	22.40	26.00
23	18.83	28.89	36.38	43.00
24	7.03	11.14	14.31	18.00
25	10.95	17.76		
32	10.95		24.08	29.62
35	18.02			
36		42.93	57.83	71.40
37	33.50	51.06	63.62	72.00
41	16.28	26.42		43.90
46			15.75	
48				19.45
51			50.10	
61	8.22	13.38	18.07	22.23
71	19.02	29.90	28.96	35.62
72	7.26		15.86	19.56
73			13.94	
81			24.52	
82		18.16		
111	14.55	22.49	29.01	35.00
112	22.47	34.34	45.26	55.00
113	5.13	8.32	11.21	13.85
114		34.17	46.03	56.83
115		32.19	43.36	53.53
121	6.31	7.96	6.75	7.00
122		7.96	6.75	7.00
131	6.48		14.21	
141	8.84	14.33	19.30	23.83
151	34.82	56.49	76.23	94.00
152	12.07			
161	14.89	19.69	24.62	29.00
165	6.83	11.08	14.93	18.43
171		50.00	67.50	83.05
181	4.06	6.59	8.87	

Appendix C *continued.*

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
211	26.33	42.88	57.90	
212	27.57	44.90		
213	15.67	25.41	34.23	42.26
214		25.41		
215	15.67	25.41		
216	15.67	25.41	34.23	
221		10.55	14.21	17.55
222		46.53	64.01	80.00
223		106.13	143.28	
225			26.08	
231		50.77		84.44
232		90.70	122.74	
233				240.00
234				104.00
245	15.67			42.26
246			71.40	88.08
281			32.43	
282			30.48	37.60
311	24.05	41.21	58.68	75.00
312	14.66	23.78	32.02	39.50
313	16.38	26.57	35.78	44.14
316	14.89	25.77	36.76	48.00
319	16.58			
321	35.61	57.78	77.82	96.00
322	38.74	62.83		104.49
323	57.13	92.62	125.33	155.00
324	66.91	112.33	151.65	186.58
325		39.67	53.42	65.91
326	32.59	52.87	71.20	87.83
327				
329	11.19	18.16	24.46	30.18
341		64.22		
342			156.44	
351		37.46		
371		37.46		
377	23.05	37.46		
387			100.00	
392		20.13	27.12	33.49
398		16.69	22.48	27.73
399	10.49	17.02	22.92	28.27
411	10.80	17.59	23.75	29.21
412	12.73	20.66	27.82	34.32
413		20.56	27.69	34.15

Appendix C *continued.*

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
414			34.23	42.26
415			115.31	144.00
416			48.25	62.00
417			114.31	137.00
418			48.31	59.00
419		42.20		70.20
421	120.52	191.42	258.42	
422	149.22	243.00		
423	165.80	270.00		
424	190.67	310.50		
425	202.11	322.87		
426	215.54	351.00		
431	26.02			
432				112.46
433				140.00
434		92.98		
436		36.93		
441	41.21	68.87	90.05	111.09
442	25.96	42.20		70.09
443	41.21	68.87	90.05	111.09
445		28.41	38.27	47.25
451		21.88	29.47	36.39
453				63.51
454		20.91	28.16	34.74
455	17.52	28.41	38.27	47.25
456	17.52			
458		36.93	49.75	61.42
511	23.12	36.47	49.70	63.00
512	28.44	89.78	61.15	77.00
513	36.24	57.18	76.34	94.00
514	17.04	27.64	37.23	45.93
515	21.69	35.20	47.41	58.49
516		42.71	57.52	
521	21.86	35.46	47.85	59.00
522	26.90	41.83	56.15	70.00
523	21.69	35.20	47.41	58.49
529			47.14	58.00
531		45.29	61.28	78.00
532	26.20	43.09	76.68	98.00
533	30.58	51.71	93.57	121.00
534	40.59	65.82		
537	28.53	44.50	59.04	72.00
538	33.63	52.67	70.31	86.00

Appendix C *continued.*

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
539	41.56	66.70	85.16	105.00
552	70.47	114.75		190.57
553	78.71			
554	67.69			
555		163.54		272.01
556	110.90	179.85	242.28	299.14
561	97.61	158.36	213.26	
563			302.53	373.22
566			302.53	373.22
568			293.40	
569			330.30	407.81
571	13.22	21.46	28.90	35.65
572	14.84	24.17	32.63	40.13
573	32.97	54.43	71.97	88.50
574		33.93	45.71	56.43
575	6.95	11.03	14.44	17.00
576	29.60			
577	7.78	12.62	17.03	21.00
578		10.55	14.21	17.55
579		79.96	107.69	132.85
581		87.18	117.40	144.83
582	52.21	84.88	117.21	145.00
583		300.14	406.14	495.00
584		118.96	160.20	
597			69.76	86.14
598			82.79	102.13
599			121.86	150.45
611	117.59	190.70	256.89	317.17
612		200.00	270.00	
613	295.55	479.31	645.68	797.19
614	331.60	540.00	728.40	
615	402.94	604.72	747.32	860.00
616		321.71	433.24	
617		400.00	540.00	
618	289.78	469.98	634.20	782.00
619		500.00		
620	223.53	362.52	488.35	
621	248.70			
622	373.05	607.50	820.35	
624	33.16	53.60	72.92	
625	52.04	84.41	113.71	140.39

Appendix C *continued.*

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
626	24.87	40.50		
627	27.90	45.25	60.96	75.27
628	62.95	50.97	137.56	169.70
629			151.65	
632	58.03	94.50		
633	68.91	114.71		
635		100.00		
636	62.18			
642	67.24	109.50	146.90	181.37
643	368.29	558.72	652.37	723.00
645				136.21
648	136.87			
649			73.48	90.72
651	22.61	36.66	49.47	61.00
652	24.47	39.69	53.46	66.01
653			159.43	
655	15.67	25.41	34.23	42.26
656	19.22	31.17		51.84
657			106.58	
658			62.66	77.36
659		42.20	56.85	70.20
661			45.00	
711	263.74	395.94	504.56	604.00
712	187.27	303.71	409.13	505.14
715				
716		109.05		181.37
719	468.46	704.88	898.46	1061.00
721	100.69	163.30	219.98	271.61
722			219.98	271.61
725	165.80	270.00	364.60	448.40
727	225.38	365.52	492.39	607.94
728				589.01
731	11.41	16.57	21.87	25.00
733	8.84		19.30	23.83
735	29.60	48.01		
736	8.84	14.33	19.30	23.83
737			88.35	
741	10.54	17.09	23.02	28.42
742	8.74	14.17	19.08	23.54
743	81.15	131.62	177.61	219.00
744	77.00	124.87	168.22	207.69
745	85.50	186.80	186.80	
746			177.67	219.36

Appendix C *continued.*

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
748	102.93	167.00	224.88	
749	80.11		175.02	215.91
751	28.68	46.51	62.66	77.36
752				77.36
753			29.47	
761			51.44	63.51
762	25.25	40.95	55.16	68.10
763	29.40	47.14	61.73	76.00
764	25.25	40.95	55.16	68.10
765	25.25		55.16	68.10
766	22.10	35.85	48.28	59.56
767	3.36	5.45	7.34	9.06
768	36.32	58.90	79.48	98.00
769		50.24	67.68	
771	15.67	25.41	34.23	42.26
772	50.49	81.89	110.32	
776	10.74	17.43	23.52	29.00
778			91.15	112.10
791				
811	66.70	108.18	145.98	180.00
812		150.00		
821	168.13	280.56	365.73	445.00
822		450.79	610.00	
823			967.10	
829		564.23	763.50	
831		805.71		
834	898.28	1456.18	1970.48	
841			610.80	
842		402.86		
845	75.45	122.36		
846				
871	16.58	27.00	36.46	44.85
875		47.14		78.30
876		40.95		
881		1434.28	1936.28	2382.34
911	10.24	16.60	22.36	27.61
912	15.62	25.49	35.18	48.00
915	13.68		30.00	
916			30.00	
921		14.84	19.99	
922			19.99	
923			13.17	16.25
924	4.92	7.98	10.75	13.26

Appendix C *continued.*

Item number	Estimated fee $1983	Estimated fee $1988	Estimated fee $1993	Estimated fee $1998
925	5.36	8.71	11.73	14.47
926			30.00	36.90
931		18.11		
932			24.09	
941		4.82	6.48	8.00
942	16.58	27.00	36.46	
943	9.48	15.44	20.86	25.65
949			32.66	
952				
961	16.25	23.37	29.48	36.26
963	12.42	20.13	27.12	33.49
964	17.82	28.89	38.92	48.06
965	86.75	140.70	189.54	234.01
966	13.97	22.65	30.51	37.67
968	25.10	40.70	54.83	67.70
969		30.70	44.83	57.70
981	10.86	17.62	23.73	29.30
982				23.02
986	8.54	13.84	18.65	23.02
925	5.36	8.71	11.73	14.47
926			30.00	36.90
931		18.11		
932			24.09	
941		4.82	6.48	8.00
942	16.58	27.00	36.46	
943	9.48	15.44	20.86	25.65
949			32.66	
952				
961	16.25	23.37	29.48	36.26
963	12.42	20.13	27.12	33.49
964	17.82	28.89	38.92	48.06
965	86.75	140.70	189.54	234.01
966	13.97	22.65	30.51	37.67
968	25.10	40.70	54.83	67.70
969		30.70	44.83	57.70
981	10.86	17.62	23.73	29.30
982				23.02
986	8.54	13.84	18.65	23.02
925	5.36	8.71	11.73	14.47
926			30.00	36.90
931		18.11		
932			24.09	
941		4.82	6.48	8.00

Appendix C *continued.*

Sources

Dental fees survey (ADA), 1983; 1988; 1993; 1998
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