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Does the Subsidy of Dental Care Lead to Overtreatment?

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Abstract

We examine the prevalence of moral hazard on the Swedish dental market. Dentists can use their information advantage to induce demand but are constrained by patients' ability to pay, suggesting that subsidies facilitate inducement. Furthermore, patients' demand for dental care may increase under extensive subsidy following from decreased costs. In collaboration with dentists at TLV, we define a patient group that has the same dental need for two treatments, *information* and *treatment of periodontal disease*, but differ in subsidy level (50/85 percent) to analyze the relationship between subsidy level and treatment intensity. We use data for 83 geographical regions for the years 2010-2012, and control for differences in socioeconomic and dental market specifics in the analysis. The results suggest that heavily subsidized patients are about 40 percent more intensively treated than less subsidized patients; either due to overtreatment of heavily subsidized patients or undertreatment of less subsidized patients. We argue that it is most likely due to overtreatment, emanating from demand inducement and moral hazard.

Keywords: subsidy, overtreatment, moral hazard, supplier-induced demand, RE model

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1. Introduction

Dentists[1] have more knowledge regarding dental care, quality of treatments and alternative treatments than patients, which implies that dentists have an information advantage on dental markets. If dentists use the information advantage to perform more dental treatments than the patient would have chosen having had the same information, it is a form of moral hazard referred to as supplier-induced demand (SID). The capacity to induce demand is constrained by patients' ability to pay, suggesting that subsidies relax the constraint. Moral hazard from patients implies that a patient demands more and higher quality treatments than what is actually needed when the patient does not bear the full cost.[2]

Moral hazard is a well-known phenomenon on dental markets. To reduce the risk of moral hazard on the Swedish dental market, where patients with large dental costs are subsidized by a high cost protection scheme, the Swedish Social Insurance Agency (SSIA) performs randomized and targeted ex-post controls of disbursements of subsidized treatments. A recent study states that the ex-post controls flaws in both the selection process and the following-up, and the question is whether the ex-post controls fails to prevent moral hazard. In our study, we examine this through analysing the relationship between subsidy level and treatment intensity. The results suggest that the subsidy of dental care leads to overtreatment of heavily subsidized patients. A revision of the high costs protection scheme, as well as an improvement of the ex-post controls, could thus lead to efficiency gains.

Previous studies have found evidence of moral hazard and demand inducement on national dental markets,[3] and Grönqvist (2006) finds indications of such on the Swedish dental market. To our knowledge, no study of moral hazard and SID has been performed since the latest dental reform of 2008 and we thereby contribute to previous literature with empirical evidence from the Swedish dental market.

1.1 The Study

The high cost protection scheme on the Swedish dental market provides financial support for individuals with a great need of dental care. The level of subsidy increases with dental costs; patients are subsidized with 50 percent of costs between 3 000 and 15 000 SEK and with 85

[1] We refer to caregivers as dentists, even though dental hygienists can perform the treatments, since the term caregiver is a broad concept.
[2] Ex-post moral hazard.
[3] See for instance Grytten, Holst & Laake (1990), Birch (1988), Chalkley & Tilley (2006)

percent for costs exceeding 15 000 SEK.[4] The costs are aggregated during a subsidy period that runs for twelve months after which it resets.

Through defining a patient group[5] that differ in subsidy level, but have similar dental health as well as similar dental need for two treatments; *information to patient* (311) and *treatment of periodontal disease* (342),[6] we examine the relationship between subsidy level and treatment intensity of the two treatments. The data set is aggregated on 83 geographical regions constituted by the two first digits in the postal code,[7] since data on individual dental health is not available due to secrecy. The data set consists of completed subsidy periods for the years 2010-2012, and is divided into clusters in the regions depending on caregiver type (private or public) and dental costs (10 000-15 000 or 15 000-35 000) and thus subsidy level. We estimate a Random Effects (RE) model, where the dependent variable is the mean number of treatment 311 or 342 separately, and control for socioeconomic and dental market specifics of a region. The variable of interest is a dummy variable taking the value of one if patients in a cluster have dental costs between 15 000 and 35 000 SEK, and thus are heavily subsidized.

The results show that the subsidy leads to more treatments. Heavily subsidized patient receive on average about 49 percent more of treatment 311 (*information to patient*) and about 40 percent more of treatment 342 (*treatment of periodontal disease*) compared to less subsidized patients. The results are statistically significant[8] and imply either that heavily subsidized patients are overtreated or that less subsidized patients are undertreated.

1.2 Discussion

We argue that the difference in treatment intensity is most likely to be due to overtreatment of heavily subsidized patients. Compensation to the dentist or to the clinic is the same regardless of subsidy level, indicating that a potential undertreatment arises from patients' financial constraints. The construction of the high cost protection scheme implies that the subsidy level increases with dental costs, suggesting that a patient that cannot afford the treatment when

[4] The thresholds are based on reference prices set by TLV. Dentists are not bound by reference prices when setting their own prices.
[5] See Table 2.3 in Appendix 2. Another patient group is also defined but due to missing values we disregard that group in the analysis (see Table 2.4 in Appendix 2).
[6] Treatment 605 (acrylic splint) and 604 (soft acrylic splint) were also selected, but due to a large share of missing values we disregard those treatment in the analysis. See Table 3.1 in Appendix 3.
[7] See Table 1.1 and Map 1.1 in Appendix 1. We also received data on county level, but due to lack of variation in the regions the results became vary sensitive (see Table 1.2 and map 1.2 in Appendix 1).
[8] On a ten percent level.

being subsidized with 50 percent should not be able to afford the treatment when being subsidized with 85 percent either; even though the marginal price of the treatment has decreased, the overall dental costs have increased.[9]

The aim of the high cost protection scheme is to primarily allocate resources towards patients with the greatest dental care needs in order for them to receive dental care at reasonable cost (TLV 2012). An increase in treatment intensity is thus not the main purpose of the system. Heavily subsidized patients could experience some benefit from treatments 311 and 342, but the alternative cost of not using the funds more efficiently are likely to rule out the marginal benefit of the patients.

Our data does not allow us to distinguish whether the overtreatment arises from SID or moral hazard from the patients, but the characteristics of the treatments can provide some guidance. According to dentists at the Dental and Pharmaceutical Benefits Agency (TLV), dentists are not very likely to ask for patients' consent before performing treatment 311 (*information to patient*), nor can patients assess the need or quality of the treatment. This suggests that the increase in treatment intensity of treatment 311 is likely to be due to SID rather than moral hazard from patients. Concerning treatment 342, on the other hand, patients that have had previous experience of periodontitis may be able to assess the need for a treatment and demand more extensive treatments than actually needed when they are heavily subsidized. However, not all patients can assess the need, and even if the patient can, it is important to emphasize that it is the dentists that decides on a specific treatment. The increase in treatment intensity of treatment 342 can therefore be a combination of moral hazard from the patient and SID, but is not likely to occur only due to moral hazard from patient.

The results of our study suggest that the subsidy of dental care leads to overtreatment, which in turn leads to welfare losses since more, or more extensive treatments than what are socially optimal is performed. This is an important finding since it indicates that the funds allocated towards the high cost protection scheme are not used in the best possible way. SSIA estimates that incorrect disbursements to dentists correspond to between 0.2 and 1.2 billions SEK, implying that there is a significant potential gain from more efficient ex-post controls and a revision of the high cost protection scheme.

[9] See Tables 2.5 and 2.6, in Appendix 2, where the mechanism of the high cost protection scheme is described.

A weakness of the study is the use of aggregated data. The robustness of the results could be enhanced through the use of data on individual dental health and data on, for instance, patients' home address and socioeconomic factors, the address of the dental clinic as well as remuneration systems of dentists. However, such data is not available to us due to secrecy considerations.

The paper is organized as follows; the next section presents an overview of the dental care benefits scheme and describes the concepts of moral hazard and supplier-induced demand in more detail. After that, the theoretical and empirical model and data and methodology are presented. The concluding sections feature the results from the regression analysis and suggestion for future research.

2. Dental Care Benefits Scheme

The Swedish Dental Services Act (1985:125) states that dental care should be accessible on equal terms for the entire population and the government therefore intervenes on the Swedish dental market trough a dental care benefit scheme. The current dental care benefits scheme was implemented on the 1st of July 2008 and aims at maintaining good dental health for patients with minor dental care needs and provide financial support for patients with great dental care needs (ISF 2011:18). It consists of two parts; a general dental care grant[10] and a high cost protection scheme, and is provided for dental care treatments completed as of the year the patient turns 20 years of age (SFS 2008:145).

The high cost protection scheme subsidizes preventive dental care and dental care that is performed in order to give relief from pain and illnesses, give the patient ability to eat, chew and speak properly and provide an acceptable visual appearance (SFS 2008:145).[11] The scheme enables patients with great dental care needs to receive dental care at a reasonable cost, since the government bears a part of the cost. The primary objective of the high cost protection scheme is to allocate resources towards patients with the greatest need of dental care and not to reduce costs for patients in general (TLV 2012).

[10] 300 SEK/year for patients aged 20-29 and 75+, 150 SEK/year for patients aged 30-74.
[11] For instance, teeth whitening is not a reimbursable treatment.

The subsidy thresholds in the high cost protection scheme are based on reference prices set by TLV, and not on the dentists' price.[12] The reference prices are in turn based on odontological methods that, according to science and experience, result in good dental outcomes at reasonable costs. Dentists are not bounded by reference prices when setting prices, but patients are entitled to know the cost of a treatment beforehand (SFS 1985:125).

A patient pays the full price for total treatment costs with reference prices up to 3 000 SEK, above which the high cost protection scheme steps in. A patient is subsidized with:

- 50 percent of dental costs with a reference price between 3 000 and 15 000 SEK
- 85 percent of dental costs with a reference price exceeding 15 000 SEK[13]

If a dentist sets a price above the reference price, the difference between the two prices is fully transferred to the patient. After performed treatment, a subsidized patient only pays the difference between the dentist's price and the subsidy, and it is the dentist that reports to SSIA in order to be reimbursed with the subsidized amount. The dentist has to report a diagnosis together with performed treatment to prevent unjustified treatments (RiR 2012:12). A subsidy period runs for twelve months, under which dental costs for each dental treatment is aggregated, and then a new subsidy period begins.[14] A dentist can on the request from a patient report a new period in the high cost protection scheme to SSIA before the prior period has ended (SFS 2008:145).

Ex-post controls, which are based on random selection or on suspicions of incorrect disbursements, are performed after reimbursement in order to identify both intentional and unintentional errors in dentists' reports to SSIA (IFS 2011:18). If an ex-post control reveals an incorrect disbursement, SSIA decides on repayments. Only the difference between the incorrect and the correct disbursement is reclaimed in cases where another reimbursable treatment has been carried out than the one reported to SSIA. Normally, repayments of incorrect disbursements are done by pairing-off future disbursements (ISF 2011:18), implying that a dentist who has reported incorrectly is not obliged to pay back a lump sum to SSIA.

[12] Unless the dentists' price is lower than the reference price.
[13] See Table 2.5 and Table 2.6 in Appendix 2 for further explanation.
[14] A subsidy period is thus not dependent on the calendar year.

In a report from 2011, the Swedish Social Insurance Inspectorate (ISF) review the efficiency of ex-post controls and states that the system flaws in both the selection process and the follow-up of the ex-post controls (ISF 2011:18). SSIA estimates that between 5 and 25 percent of the total disbursements can be incorrect, which is equivalent to between 0.2 and 1.2 billions SEK, but decisions on repayments only correspond to about one percent of all disbursements. This implies that there is a significant potential gain from an efficiency improvement of the ex-post controls.[15] ISF also concludes that there are few possible sanctions if SSIA suspect that a dentist has reported incorrectly with intention to deceive the scheme; SSIA could file a police report, but between July 2008 and October 2011, only six police reports were filed out of which none led to conviction. ISF argues that the small probability of being ex-post controlled together with few sanctions of reporting incorrectly provides dentists with weak financial incentives to report correctly.

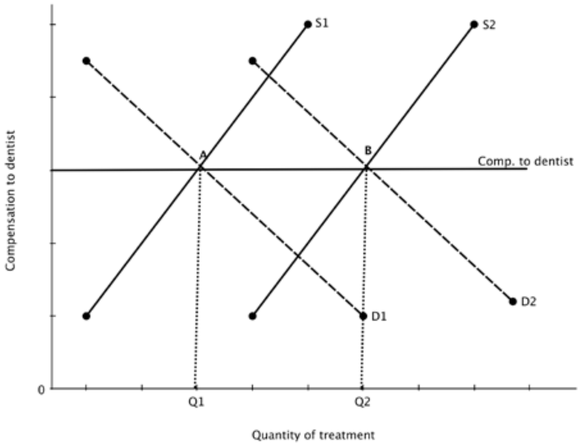
3. Moral Hazard and Supplier-Induced Demand (SID)

The dental market is characterized by asymmetric information, where dentists have an information advantage about diagnosis, appropriate treatments and expected price and quality (SOU 2007:19). Even after completed treatment, it is hard to assess the quality of a treatment for a patient. Patients delegate the treatment decision to the dentist and merely decide whether to follow the dentist's advice or not, but the patient is not fully sovereign even in this decision since the patient relies on the dentist's competence. Factors that usually influence the choice of the consumer, as price and quality, do not seem to have a significant impact on the dental market; instead, trust in the dentist appears to play a major role (Grönqvist 2006).

Dentists can use the information advantage to perform more dental treatments than the patient would have chosen having had the same information in order to secure a high volume of business. This is referred to as supplier-induced demand (SID). The capacity to induce demand is constrained by patients' ability to pay, implying that SID is facilitated if patients are covered by a comprehensive health insurance or subsidy (Zweifel, Breyer & Kifmann 2009).[16] Previous research suggests that remuneration systems such as the high cost protection scheme, where dentists are reimbursed on a per treatment basis, can result in SID.[17]

[15] During 2011, less than 3 % of the disbursement from the dental care benefits scheme was ex-post controlled (ISF 2011:18).
[16] Alternative cost associated with dental treatments still has to be considered.
[17] See for instance Iversen and Lurås (2000), Sørensen and Grytten (2003), Ellis and McGuire (1986)

Graph I: Mechanism of SID



Source: Dalin & Wolff, 2013

In Graph I, the mechanism of SID is described. The x-axis measures the quantity of treatments and the y-axis measures compensation to the dentists. S1 represents the dental supply from dentists when patients have a lower subsidy level and S2 represents the dental supply from dentists when patients have a higher subsidy level. The compensation to the dentist of a performed treatment is fixed, but the price paid by the patient differs with the subsidy level. D1 represents the dental demand for patients with a lower subsidy level and D2 represents the dental demand for patients with a higher subsidy level, and the demand curves are to a great extent determined by dentists. Given that the socially optimal amount is supplied in point A, the increase in demand due to demand inducement is the shift from point A to point B (Q1 to Q2). Even though the compensation of a treatment to the dentist is the same in point A and B, the quantity increases by ΔQ when the subsidy increases, indicating that the total compensation increases.

Two kinds of moral hazard can arise from patients; ex-ante and ex-post. Ex-post moral hazard refers to when patients demand more and higher quality treatment when they do not bear the full cost and ex-ante moral hazard refers to when patients become incautious with dental care when they do not bear the full costs (Arrow, 1970). Ex-ante moral hazard is not likely to occur in this setting since a subsidy period only runs for 12 months after which it resets. Patients that neglect dental health during one subsidy period will thereby increase the probability of dental outlays in the next subsidy period,[18] as well as experience alternative costs and possible discomfort. In this paper, we focus on ex-post moral hazard, simply referred to as moral hazard. The mechanism of moral hazard is the same as that of a downward sloping demand curve; demand increase when prices decrease. However, the

[18] Patients pay the full costs up to 3 000 SEK in reference prices, before the high cost protection scheme steps in.

incentives of patients may have less effect than the incentives of dentists, since dentists are in control of cost and treatments. SID and moral hazard results in welfare losses since more, or more extensive, dental care than what is socially optimal is performed.

4. Model Specification

4.1 Theoretical Model

We assume that dentists seek to maximize the utility of treating a patient and that the utility function of dentists depends on income and treatment intensity, $U(Y(t),t)$. The marginal utility of income is increasing with decreasing speed, whilst treatment intensity is costly in terms of time but has a positive effect on the income of a clinic or a self-employed dentist as well as an altruistic value for the dentists (Chalkley & Tilley 2006). The treatment intensity is constrained by patients' ability to pay, indicating that the constraint is relaxed when patients are heavily subsidized, which facilitate SID (Zweifel et al. 2009).

The utility function of patients is dependent on the health state the patient is in. Jacob and Lundin (2005) assume that the utility of an individual in poor health depends on consumption for general goods and consumption of medical care, $U(c,m)$, which both have a positive marginal utility. Heavily subsidized patient can consume more dental care than less subsidized patients when consuming the same amount of general goods, given that the patients have the same income in a period. Since an increase in dental care consumption leads to an increase in utility, patients have incentives to demand more and higher quality dental treatments when being covered by an extensive subsidy, i.e. moral hazard.

4.2 Empirical Strategy

In order to investigate how the subsidy level influences treatment intensity, a patient group is defined in collaboration with dentist at TLV. Within the group, the patients have had many less extensive treatments (see Appendix 2, Table 2.3) and have similar dental health. The patients have dental costs in two reference price spans during a completed subsidy period, where patients in the lower span have dental costs between 10 000 and 15 000 SEK (50 percent subsidy), and patient in the upper span have dental costs between 15 000 and 35 000 SEK (85 percent subsidy). The sizes of the price spans are chosen to ensure that the patients in the group are comparable. To analyze difference in treatment intensity, two treatments are selected for further analysis, 311 (*information to patient*) and 342 (*treatment of periodontal disease*), defined in Table I below. The treatments are selected since the dental need for the two treatments are similar in the patient group regardless of subsidy level. The extra patient costs of the treatments is very small under extensive subsidy compared to total dental costs, as can be seen in Table I.

Table I: Definition and price of treatment 311 and 342

Treatment	Definition	Description	Ref. price (2011)	50 % subsidy	85 % subsidy
311	Information to patient	Information about causality and dental hygiene, instructions concerning self-care etc. The treatment is reimbursable once per patient, day and caregiver.	370 SEK	185 SEK	56 SEK
342	Treatment of periodontal disease	Treatment of periodontal disease or peri-implantatis, more extensive. Often performed by a dental hygienist. The treatment is reimbursable once per patient, day and caregiver.	720 SEK	360 SEK	108 SEK

Source: TLVFS (2011:2)

The data set is aggregated on 83 geographical areas constituted by the first two digits in the postal code. Because of the Public Access to Information and Secrecy Act (2009:400), data on individual dental health is not available to us. Within each region, the patients are divided into clusters depending firstly on the reference price span, and secondly on whether patients have been treated by public or private dentist or by both. This result in six clusters in every region, and each cluster is treated as one observation that is observed for the years 2010, 2011 and 2012.[19] There is a minimum of three patients in each reported cluster, and clusters with less than three individuals are reported as missing values. Since the dental need for treatment 311 and 342 is the same, regardless of dental costs and thus subsidy level, there should not be a significant difference in treatment intensity between clusters. To investigate if there is a difference, we perform a regression analysis.

4.2.1 Empirical Model

The regression model is defined in Equation 1:

$$Y_{it} = \alpha + \beta_1 subsidy_{it} + \beta_2 private_{it} + \beta_3 item_{it} + \beta_4 price_{it} + \gamma' dentist_{it} + \theta' socioeconomic_{it} + \vartheta' regional_{it} + \varepsilon_{it} \quad [1]$$

[19] For instance; patients that have visited a dentist in postal code 11, have dental costs between 15 000 and 35 000 (85 percent subsidy), have been treated by a private dentist and have a completed subsidy period in 2010.

where it refers to patient cluster i, in time t and Y_{it} denotes the log of mean number of treatment 311 or 342 respectively.

$subsidy_{it}$ is a dummy variable taking the value of one if patients in cluster *i* have dental costs between 15 000 and 35 000 SEK in time *t*, and zero otherwise. The variable is our variable of interest and if β_1 is positive and significant this implies that heavily subsidized patients on an average receive more of treatment 311 or 342 respectively than less subsidized patients. Given the definition of the patient group, and thus no correlation between subsidy level and dental need for treatment 311 and 342, this indicates that there is a difference in treatment intensity as a consequence of the subsidy.

$private_{it}$ is a dummy variable taking the value of one if private dentists exclusively have treated patients in a cluster. If β_2 is positive and significant it indicates that private dentists treat patients more intensively compared to public and mixed caregivers.[20]

$item_{it}$ is log of the mean number of total treatments performed in a cluster during a subsidy period. The variable is included to control for an overall increase in dental treatments. $price_{it}$ is log of the mean amount of the total reference price in a cluster that exceeds 3 000 SEK and thus falls within the high cost protection scheme during a subsidy period. The variable is included to control for dental costs.

$dentist_{it}$ is a matrix that refers to dental specifics in a postal code (log of practices per 1 000 inhabitants and log share of private dentist) to account for competition and alternative cost.[21] Previous studies have shown that competition on dental markets leads to an increase in dental treatments (Grytten, Holst & Laake 1990). However, Birch (1988) argues that a fall in access cost, i.e. an increase in practices per 1 000 inhabitants, imply that individuals can visit the dentist more frequently and have more preventive dental care, which leads to a decrease in dental need and thereby a decrease in treatments. The log share of private dentists is included to account for the dentist structure of a region. It is likely that regions with a high share of private dentists also have a high practice density and thereby a higher level of regional competition, since sparsely populated regions often have few and mostly public dentists.

[20] Mixed caregiver: both private and public dentists have treated patient.
[21] Such as time costs and travelling cost etc.

$socioeconomic_{it}$ and $regional_{it}$ are matrices including socioeconomic and region specific variables. The log of the mean income in a region accounts for patients' ability to pay. A high income can lead to an increase in the number of visits to the dentist, leading to good dental health (Tuominen & Eriksson, 2001). Education is known to be correlated with health status, and we include share of the adult population with tertiary or higher education in the region. The mean age and mean age squared in a region accounts for demographics. Older people may have a greater need for dental care, but the increased demand due to a higher age is diminishing. Previous studies have shown that males are more intensively treated than females (Chalkley & Tilley, 2006). To account for this, the log share of females in a cluster is included.

The log share of inhabitants born outside of Sweden in a region accounts for cultural differences in dental hygiene. In 2007, 30 percent of individuals born outside of Europe reported that they had bad or very bad dental health, compared to only 9 percent of individuals born in Sweden (The National Board of Health and Welfare, 2010). Moreover, the log of the perceived dental health in postal codes is included.

The log net cost of dental care[22] in the county council/councils controls for the dental care administration in a region and the log of county/counties tax rate is included to control for the political rule. In addition, a dummy variable that takes the value of one if the region includes one of the major cities in Sweden is included to control for the characteristics of large cities.[23]

[22] Log of deficit for a county council, measured in millions of SEK.
[23] Stockholm, Göteborg and Malmö.

Table II: Descriptive statistics[24]

Variables	Definition	Region level	Expected sign	Obs.	Mean	Std. Dev.	Data source
Dependent							
Treatment 311	Mean number if treatment 311 in cluster	Postal code		1 100	0.42	0.29	SSIA
Treatment 342	Mean number of treatment 342 in cluster	Postal code		1 273	0.82	0.43	SSIA
Independent							
50 % subsidy (A1)	Dummy variable, equals 1 if patients in cluster have dental costs between 10 000 and 15 000 SEK	Postal code	-	1 506	0.51	0.50	SSIA
85 % subsidy (A2)	Dummy variable, equals 1 if patients in cluster have dental costs between 15 000 and 35 000 SEK	Postal code	+	1 506	0.49	0.50	SSIA
Mean treatment	Mean number of treatments of patients in cluster	Postal code	+	1 427	16.14	3.28	SSIA
Share female	Share of females in cluster	Postal code	-	1 230	0.46	0.09	SSIA
Private	Dummy variable, equals 1 if patients in cluster solely treated by private dentist	Postal code	+	1 506	0.35	0.48	SSIA
Price	Mean amount of total dental cost in cluster within the high cost protection scheme	Postal code	+ /-	1 427	15 026	3 430	SSIA
Practice density	No. of practices per 1 000 inhabitants in postal code	Postal code	+ /-	1 435	0.31	0.13	Cegedim
Share private dentists	Share of private dentists in postal code	Postal code	+	1 435	0.48	0.14	Cegedim
Mean age	Mean age in postal code. 2011 is used as a proxy for 2010 and 2012	Postal code	+	1 506	48.01	2.30	InsightOne Nordic
Mean income	Mean income in postal code. 2011 is used as a proxy for 2010 and 2012	Postal code	+ /-	1 473	251 868	32 172	InsightOne Nordic
Education	Share of the adult population with tertiary or higher education in postal code. 2011 is used as proxy for 2010 and 2012	Postal code	-	1 473	0.25	0.09	InsightOne Nordic
Ethnicity	Share of the population born outside of Sweden in postal code. 2011 is used as proxy for 2010 and 2012	Postal code	+	1 506	0.11	0.06	InsightOne Nordic
Population density	Population density. 2011 is used as proxy for 2010 and 2012	Postal code	+/-	1 473	345	980	InsightOne Nordic / SCB
Dental health	Share of population in county reported to have bad or vary bad dental health. Estimation for postal code. 2011 used as a proxy for 2010 and 2012	County	+	1 473	9.70	1.07	Swedish National Institute of Public Health
Tax rate	Tax rate in county. Estimation for postal code	County	-	1 491	10.62	1.28	SCB
Dental deficit	Deficit for dental care in county measured in millions, pharmaceutical expenses excluded. Estimated for postal code. 2011 used as a proxy for 2010 and 2012	County	+	1 473	12.45	16.50	Swedish Association of Local Authorities and Regions
Big city	Dummy variable, equals 1 if one of three major cities is located in postal code	Postal code	+	1 473	0.17	0.38	Own estimation

[24] For descriptive statistics for patient group B, and patient group A and B on county level, see Appendix 5.

5. Data and Methodology

5.1 Data

SSIA provided data on the number of treatments 311 (*information to patient*) and 342 (*treatment of periodontal disease*) in each cluster as well as the total number of treatments performed during a subsidy period. We also received data on the total aggregated amount of reference prices within the high cost protection scheme during a subsidy period, as well as the caregiver type, and the number of individuals and females in each cluster.

For definition and data sources of control variables, see Table II above.

5.2 Limitations of the Data

A problem can arise if dentists charge different prices when patients are subsidized with 50 percent compared to 85 percent. This can bias the results of the analysis, since patients may not experience the expected decrease in prices, indicating that the effect of the subsidy is not as apparent. We cannot control for this given our data, but argue that it is not likely that dentists change prices dependent on subsidy level in a systematic way, since dental clinics have price lists and dentists are obliged to inform patients about the cost of a treatment beforehand.

The postal code regions cannot be considered as separate or independent markets, which imply that it is hard to control for competition. It is likely that people that live just outside of a city work in the city or regularly visit it, and therefore visit the dentists in another postal code than where they live.[25] In our data set, 18 percent of the patients have visited dentist in more than one postal code. The control variables for a postal code region may therefore not be applicable to the patients in that postal code.

The control variables are included as an average of the postal codes, but since the geographical areas are quite large the variables may not mirror the environment for all patients in the region. In addition, there is no variation between clusters within the same postal code in one year. The lack of variation in the data can lead to sensitive regression results.

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[25] For instance, the cities of Gävle, Sundsvall and Norrköping constitute their own two-digit postal code areas, but are surrounded on all sides by another two-digit postal code area.

Our data does not allow us to differentiate between the effects of moral hazard from the patients and supplier-induced demand with certainty.[26] The dimensions of the data imply that we have to be cautious when making inferences and suggest policy implications.

5.3 Econometric Approach

The data set contains information both across time (2010-2012) and across patient clusters. Such a data set is referred to as panel data and implies that we can investigate how variables and the relationship between them alter over time (Brooks, 2008). Some of the clusters in the data set are not observed for all years, for instance if it is less than three individuals in a cluster in one year, which implies that our data set is unbalanced.

One simple way to deal with panel data is to treat it as cross-sectional and run a simple Ordinary Least Square (OLS) model. The coefficient estimates are then assumed to be the same across time periods and patient clusters (Brooks, 2008). For the estimates to be consistent and unbiased in the OLS model, the error terms must be uncorrelated. This is not very likely since we repeatedly observe clusters in the same regions, which indicate that the OLS model is prone to be inefficient. In addition, the dependency of the observations makes it reasonable to assume that there can be unobservable region specific factors, as for instance an ambitious and driven population that can influence the need for dental care. A failure to control for this makes OLS inconsistent.

One way to control for unobservable region specific factors is to use the Random Effects (RE) model.[27] Hedeker, Gibbons and Flay (1994) argue that the Random Effects (RE) model provides a powerful tool for analysis of aggregated data when the number of individuals in clusters differs. In the setting with aggregated data, individual differences are lost and the data cannot be analyzed in a simple way. The RE model is then effective since it estimates and adjust for the within variation of the data and takes into account that the observations are not independent. The model is estimated through applying OLS on a transformed version of the data. It is assumed that there are unobservable regions specific effects but that the effects are random and not fixed. Under this assumption, the RE model is more suitable for our data set than the OLS model. The prevalence of region specific effects can be tested for by using the

[26] See for instance Barros, Machado and Sanz-de-Galdeano (2008)
[27] The Fixed Effects (FE) model can also be used. The FE model allows for correlation between unobservable region specific effects and the explanatory variables. However, the transformation of the data implies that we cannot interpret the effect of our variable of interest since it is a dummy variable. We argue that the RE model is more applicable on our data set.

Breusch-Pagan Lagrange multiplier test, where a rejection of the null hypothesis of no random effects indicates that the RE model is more suitable for the data.[28]

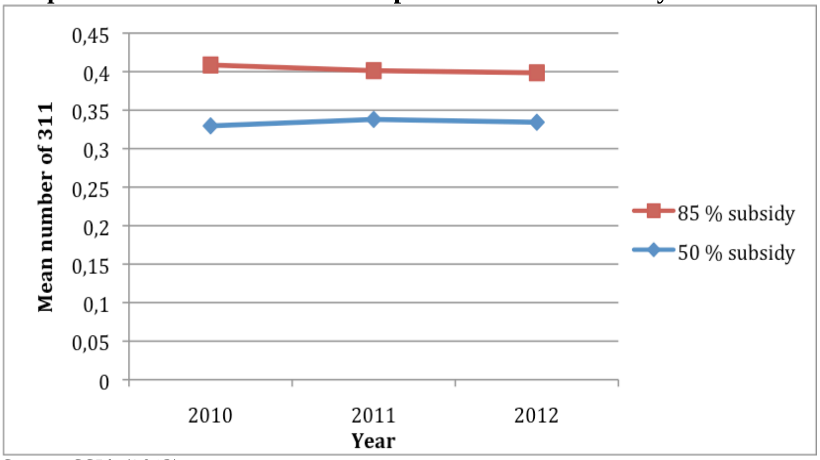
Given the dimensions of our data set, we argue that unobservable region specific effects are likely to be random and vary over time. The main argument for this is that the regions are quite large and the characteristics of individual patients may differ a lot within a region. Patients in the sample could all possess individual time invariant characteristics that influence the need for dental care, but since they are grouped together in clusters these characteristics do not have the same impact as it would have had with individual data. In addition, individuals in a cluster differ between years since the data consists of completed subsidy periods, and thus individual time invariant characteristics may not prevail from one year to another. This imply that a RE model is a suitable model for our data set. In the same way as Birch (1988), who uses region specific data to estimate if financial incentives of the remuneration system lead to SID, we include region specific variables to control for observable region specific effects.

6. Results

The descriptive statistics in Graph II and III show that patients with dental costs in the upper reference price span with a higher subsidy level on an average receive more of treatments 311 (*information to patient*) and 342 (*treatment of periodontal disease*) than patients with dental costs in the lower reference price span with a lower subsidy level.[29] However, we seek to investigate if the subsidy of dental care affects treatment intensity and without controlling for other factors that is likely to influence treatment intensity we cannot disentangle the impact of the subsidy level from just looking at the graphs. For instance, patients with dental costs in the upper reference price spans, i.e. with higher subsidy, could have received more treatments on an average and therefore also more of treatment 311 or 342 than patients in the lower reference price span with a lower subsidy.

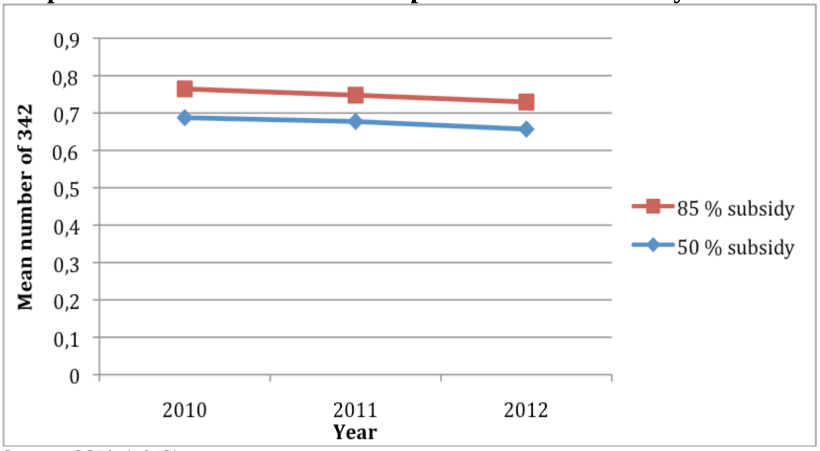
[28] See Appendix 4 for more detailed description of the econometric technique.
[29] This is also the case for treatment 604 and 605, in patient group A and B, and for the county level data (Table 3.2 and Table 3.3 in Appendix 3).

Graph II: Mean number of 311 in patient clusters for the years 2010-2012



Source: SSIA (2013)
Note: "50 % subsidy" refers to patients with dental costs in the span 10 000-15 000 SEK and "85 % subsidy" refers to patients with dental costs in the span 15 000-35 000 SEK

Graph III: Mean number of 342 in patient clusters for the years 2010-2012



Source: SSIA (2013)
Note: "50 % subsidy" refers to patients with dental costs in the span 10 000-15 000 SEK and "85 % subsidy" refers to patients with dental costs in the span 15 000-35 000 SEK

The regression analysis is performed using a RE model that is run with cluster robust standard errors to control for serial correlation and heteroskedasticity. The Breusch-Pagan Lagrange multiplier test rejects the null hypothesis, indicating that the RE model is better suited for our data than the OLS model. The results are presented in Table IV below.[30]

[30] The results for the regression analysis on county level data are presented in Table 6.1 and 6.2 in Appendix 6.

Table IV: Regression results: RE and OLS
Dependent variable: log of mean number of treatment 311 and 342 in a cluster

	RE_311	**RE_342**	**OLS_311**	**OLS_342**
	robust s.e.	*robust s.e.*	*robust s.e.*	*robust s.e.*
85 % subsidy (A2)	0.490*	0.403*	0.545	0.348
	(0.28)	(0.24)	(0.35)	(0.24)
Share female (log)	0.137	-0.008	0.166	0.030
	(0.09)	(0.08)	(0.12)	(0.09)
Mean treatment (log)	3.084***	2.175***	4.399***	2.435***
	(0.42)	(0.30)	(0.42)	(0.31)
Price (log)	-2.650***	-2.269***	-3.852***	-2.348***
	(0.73)	(0.57)	(0.89)	(0.59)
Mean age	-1.101	0.343	-1.475**	0.436
	(0.79)	(0.60)	(0.64)	(0.47)
Mean age squared	1.102	-0.320	1.462**	-0.422
	(0.82)	(0.62)	(0.66)	(0.49)
Ethnicity (log)	0.166	0.349***	0.125	0.342***
	(0.12)	(0.08)	(0.11)	(0.06)
Tax rate (log)	3.030***	-0.674	1.967**	0.165
	(0.80)	(0.69)	(0.88)	(0.64)
Education	-1.301	0.157	-2.241**	-0.065
	(1.17)	(0.81)	(0.95)	(0.63)
Mean income (log)	0.774	2.569***	1.005	2.419***
	(1.21)	(0.79)	(0.90)	(0.61)
Big city	-0.240	-0.144	-0.228	-0.135
	(0.19)	(0.12)	(0.14)	(0.10)
Share private dentist	0.477	0.311	0.282	0.201
	(0.40)	(0.29)	(0.30)	(0.23)
Practice density (log)	-0.585***	0.082	-0.557***	0.055
	(0.22)	(0.15)	(0.16)	(0.11)
Private	0.012	-0.086*	0.135**	-0.067
	(0.08)	(0.05)	(0.06)	(0.04)
Population density (log)	0.073	0.002	0.063*	0.017
	(0.05)	(0.04)	(0.04)	(0.03)
Dental deficit (log)	-0.011	-0.079***	-0.015	-0.082***
	(0.03)	(0.02)	(0.02)	(0.02)
Dental health (log)	0.564	-0.257	0.513**	-0.322*
	(0.35)	(0.25)	(0.26)	(0.18)
Constant	24.606	-22.664*	42.216***	-24.613**
	(17.29)	(13.26)	(14.63)	(10.92)
sigma_u	0.43	0.31		
sigma_e	0.37	0.32		
Rho	0.57	0.49		
Breusch-Pagan LM test, p-value	0.000	0.000		

Note: *** indicates significant on a one percent level, ** indicates significant on a five percent level, * indicates significant on a ten percent level.

The following section presents the results from the RE model; only variables significant on a 10 percent level and significant for both treatment 311 and 342 are commented on and the effects of the coefficient estimates are described as ceteris paribus.

The results shows that patients who have dental costs in the upper reference price span, and thus are subsidized with 85 percent of the reference price, on an average receive 49 percent more of treatment 311 than patients who have dental costs in the lower reference price span, and thus are subsidized with 50 percent of the reference price. The corresponding figure for the mean number of treatment 342 is 40 percent. The results suggest that the treatment intensity of 311 (*information to patient*) and 342 (*treatment of periodontal disease*) increase when the subsidy level increase. Since the dental need for treatment 311 and 342 is similar regardless of subsidy level given the definition of the patient group, the differences in treatment intensity cannot be explained by differences in dental need.

The estimated coefficient for the log of the mean number of total treatments indicates that a one percent increase in the mean number of total treatments results in a 3.1 percent increase in the mean number of treatment 311 and a 2.2 percent increase in the mean number of treatment 342. This implies that the more dental treatments a patient receives, the more likely is it that the patient also receives treatment 311 and 342.

If the amount of the reference price that falls within the high cost protection scheme increase with one percent, the mean number of treatment 311 decrease with 2.7 percent and the mean number of treatment 342 decrease with 2.3 percent in a cluster. The negative effect that the price has on treatment intensity is likely to be due to increased costs. However, it cannot be considered as a change in patient demand since dentists may not consult patients prior to performing the treatment.

As can be seen in Table IV, some of the control variables in the analysis are significant for one of the treatments but not for the other. This is reasonable since the characteristics of the treatments differ as well as the price level.

7. Future Research

Our results show that the subsidy of dental care leads to overtreatment of two specific treatments; 311 (*information to patient*) and 342 (*treatment of periodontal disease*). The results are not general, but emphasize the importance of future research on the topic since overtreatment results in welfare losses.

With more information of dentists’ remuneration system, and potential turnover requirements for the clinics, one can investigate if there is a link between the remuneration of dentists and treatment intensity. Such an analysis would investigate the prevalence of SID on the Swedish dental market. In addition, individual level data on dental health and socioeconomic factors as well as dentists’ specifics would enhance the analysis. If one could define dental markets narrowly, and get access to the home addresses of patients and the addresses of dental clinics, the competition can be controlled for. Such an analysis can provide more reliable and robust results on which policy implications can be based. However, it could be problematic to access such data due to ethical concerns.

There is a possibility that dentists perform less costly treatments on less subsidized patients compared to heavily subsidized patients to treat the same diagnosis. If future research finds evidence of such, this would be a strong indication of moral hazard and/or supplier-induced demand. In addition, it would be very interesting to investigate if there are differences in treatment intensity between the months of a subsidy period. If there are signs that heavily subsidized patients receive significantly more treatments in the latter part of the subsidy period, i.e., just before the subsidy period ends, this can be an indication of moral hazard and/or supplier-induced demand.

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8.6.2 County

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9. Appendix

9.1 Appendix 1 – Geographical Regions

Postal code

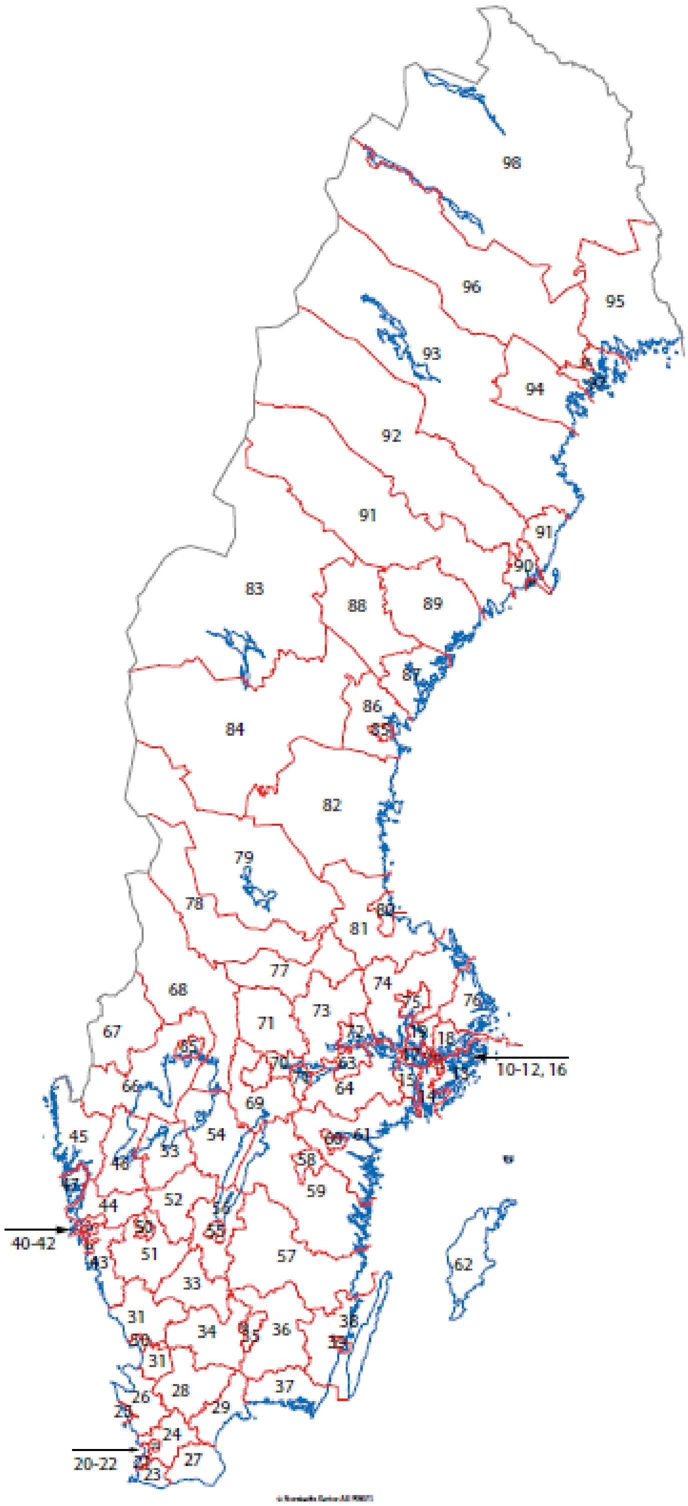
Table 1.1: Two-digit postal code, population, area and county

Postal code	Population	Area km2	County
11	311 468	51	Stockholm
12	308 928	102	Stockholm
13	244 754	2 974	Stockholm
14	216 165	1 253	Stockholm
15	94 607	885	Stockholm, Södermanland
16	240 407	83	Stockholm
17	165 182	474	Stockholm
18	220 140	1 194	Stockholm
19	164 104	824	Stockholm, Uppsala
21	281 866	150	Skåne
22	84 879	115	Skåne
23	144 001	867	Skåne
24	135 903	1 793	Skåne
25	118 152	339	Skåne
26	188 354	2 088	Halland, Skåne
27	93 893	1 948	Skåne
28	102 771	3 455	Halland, Kronoberg, Skåne
29	120 609	2 273	Blekinge, Kronoberg, Skåne
30	77 313	523	Halland
31	88 293	3 752	Halland, Jönköping, Kronoberg, Skåne, Västra Götaland
33	71 489	2 943	Halland, Jönköping, Kronoberg, Västra Götaland
34	61 925	4 002	Halland, Jönköping, Kronoberg, Skåne
35	64 626	541	Kronoberg
36	56 576	5 108	Blekinge, Jönköping, Kalmar, Kronoberg
37	123 042	3 123	Blekinge, Kalmar, Kronoberg
38	77 805	5 677	Kalmar, Kronoberg
39	48 537	701	Kalmar
41	303 375	148	Västra Götaland
42	202 501	417	Halland, Västra Götaland
43	263 678	2 382	Halland, Västra Götaland
44	174 943	2 317	Västra Götaland
45	115 823	4 530	Västra Götaland
46	129 534	3 332	Västra Götaland
47	41 220	1 024	Västra Götaland
50	73 395	327	Västra Götaland
51	91 484	3 677	Halland, Jönköping, Västra Götaland
52	76 122	3 146	Jönköping, Västra Götaland
53	85 228	3 097	Västra Götaland

54	115 963	5 073	Jönköping, Värmland, Västra Götaland, Örebro
55	66 874	301	Jönköping
56	90 018	3 230	Jönköping, Västra Götaland
57	157 558	9 621	Jönköping, Kalmar, Kronoberg, Östergötland
58	124 126	752	Östergötland
59	179 301	10 380	Jönköping, Kalmar, Örebro, Östergötland
60	102 074	379	Östergötland
61	142 338	7 120	Kalmar, Stockholm, Södermanland, Örebro, Östergötland
62	57 222	4 887	Gotland
63	81 027	841	Södermanland, Västmanland
64	116 074	4 708	Stockholm, Södermanland, Uppsala, Örebro, Östergötland
65	73 917	493	Värmland
66	100 286	8 088	Värmland, Västra Götaland
67	45 114	4 601	Värmland, Västra Götaland
68	80 660	11 416	Dalarna, Värmland
69	92 101	3 714	Värmland, Västra Götaland, Örebro, Östergötland
70	121 073	695	Örebro
71	65 942	4 855	Värmland, Västmanland, Örebro
72	130 548	1 198	Uppsala, Värmland
73	120 232	4 777	Dalarna, Södermanland, Uppsala, Västmanland, Örebro
74	145 170	6 866	Stockholm, Uppsala, Västmanland
75	161 826	687	Uppsala
76	53 004	3 731	Stockholm, Uppsala
77	73 845	4 550	Dalarna, Gävleborg, Västmanland, Örebro
78	87 976	8 764	Dalarna, Värmland
79	115 114	17 446	Dalarna, Gävleborg, Jämtland
80	76 875	825	Gävleborg
81	95 069	6 575	Dalarna, Gävleborg, Uppsala
82	129 109	15 401	Dalarna, Gävleborg, Jämtland
83	99 500	30 882	Jämtland, Västerbotten, Västernorrland
84	35 813	25 345	Gävleborg, Jämtland,Västernorrland
85	54 768	273	Västernorrland
86	58 741	4 338	Gävleborg, Jämtland, Västernorrland
87	43 836	3 453	Västernorrland
88	21 831	6 607	Jämtland, Västernorrland
89	55 180	7 160	Västerbotten, Västernorrland
90	95 479	1 582	Västerbotten
91	54 579	20 375	Jämtland, Västerbotten, Västernorrland
92	29 118	27 126	Norrbotten, Västerbotten
93	89 138	32 900	Norrbotten, Västerbotten
94	49 276	5 810	Norrbotten, Västerbotten
95	47 947	11 440	Norrbotten
96	32 294	22 348	Norrbotten
97	61 546	2 473	Norrbotten
98	48 165	46 536	Norrbotten

Source: Postnummerservice AB

Map 1.2: Sweden, divided into two-digit postal code regions



Source: Post och Telestyrelsen AB

County

Table 1.2: County, population and area

County	Population 2011	Area km2 2011
Blekinge	152 979	2 946.7
Dalarna	276 565	28 196.8
Gotland	57 308	3 151.4
Gävleborg	276 130	18 200.2
Halland	301 724	5 461.6
Jämtland	126 299	49 343.1
Jönköping	337 896	10 494.6
Kalmar	233 090	11 219.1
Kronoberg	184 654	8468
Norrbotten	248 545	9 8249
Skåne	1 252 933	11 035.4
Stockholm	2 091 473	6 519.3
Södermanland	272 563	6 103.1
Uppsala	338 630	8 208.4
Värmland	272 736	17 591.3
Västerbotten	259 667	55 189.7
Västernorrland	242 155	21 684.5
Västmanland	254 257	5 144.9
Västra Götaland	1 590 604	23 956.1
Örebro	281 572	8 546.3
Östergötland	431 075	10 604.6

Source: SCB

Map 1.2: Sweden, divided on county

Source: Länsstyrelsen

9.2 Appendix 2 – Definition and Prices

Dental treatments

Table 2.1: Definition of dental treatment series

Reimbursable treatment-series	Definition
100	Examination, risk assessment and health promoting measures
200	Illness preventive measures
300	Illness treatment measures
400	Surgical procedures
500	Root canal treatments
600	Dentition measures
700	Restorative measures
800	Prosthetic measures
900	Orthodontic and replacement measures

Source: TLVFS (2011:2)

Table 2.2: Definitions of treatments

Treatment	Definition	Reference price, 2011	50% subsidy	85% subsidy
311	Information, instruction in case of illness	370 SEK	185 SEK	56 SEK
342	Treatment of periodontal disease or peri-implantitis, more extensive	720 SEK	360 SEK	108 SEK
604	Soft acrylic splint, laboratory produced	2 060 SEK	1 030 SEK	309 SEK
605	Acrylic splint, laboratory produced	3 240 SEK	1 620 SEK	486 SEK

Source: TLVFS (2011:2)

Patient group A

Table 2.3: Definition of patient group A

A1: 10 000-15 000	**A2: 15 000-35 000**
At least 7 treatments	At least 7 treatments
Maximum one 801 (*dental crown)*, no other treatment in the 800-series can occur	Maximum one 801 (*dental crown)*, no other treatment in the 800-series can occur
Treatments from the 100-, 300-, 500-, and 700-series can occur	Treatments from the 100-, 300-, 500-, and 700-series can occur
Treatments from the 400-series can occur, besides 421-430	Treatments from the 400-series can occur, besides 421-430
Treatments 311 *(information)*, 342 (*treatment of periodontal disease)*, 604 (*soft acrylic splint)* and 605 (*acrylic splint)* can occur in unlimited amount	Treatments 311 *(information)*, 342 (*treatment of periodontal disease)*, 604 (*soft acrylic splint)* and 605 (*acrylic splint)* can occur in unlimited amount

Source: Dentists at TLV (2013)

Note: Implant measures cannot occur (in neither group A nor group B) and the patient groups only consist of completed subsidy periods for the years 2010, 2011 and 2012

Patient group B

Table 2.4: Definition of patient group B

A1: 10 000-15 000	**A2: 15 000-35 000**
Must have one, maximum two 801 (*dental crown)*	Must have 2, maximum four 801 (*dental crown)*
Maximum two 802/803 (*pin tooth)* or one 822/823 (*denture, dental plate)*	Maximum four 8 *(pin tooth)* or one 822/823 (*denture, dental plate)*
Maximum two treatments from the 700-series can occur	Maximum two treatments from the 700-series can occur
Occasional treatments from the 200-, 300-series can occur	Occasional treatments from the 200-, 300-series can occur
Occasional treatments from the 400-series can occur, besides 421-430	Occasional treatments from the 400-series can occur, besides 421-430
Treatments from the 100-series can occur	Treatments from the 100-series can occur
Treatments 501-504 *(root canal)* cannot occur	Treatments 501-504 *(root canal)* cannot occur
Treatments 311 *(information)*, 342 (*treatment of periodontal disease)*, 604 (*soft acrylic splint)* and 605 (*acrylic splint)* can occur in unlimited amount	Treatments 311 *(information)*, 342 (*treatment of periodontal disease)*, 604 (*soft acrylic splint)* and 605 (*acrylic splint)* can occur in unlimited amount

Source: Dentists at TLV (2013)

Note: Implant measures cannot occur (in neither group A nor group B) and the patient groups only consist of completed subsidy periods for the years 2010, 2011 and 2012

Example: reference prices

Table 2.5: Cost example in SEK with yearly grant (150 SEK) and high cost protection scheme when reference price below 15 000 SEK

Treatment Session	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Sum**
Cost for current treatment session	1 000	1 000	1 000	1 000	1 000	1 000	1 000	7 000
Earlier payments during the subsidy period	0	850	1 850	2 850	3 425	3 925	4 425	
Dental care grant	150	0	0	0	0	0	0	
Final payment patient for treatment session	850	1000	1000	575	500	500	500	4 925
Subsidy and grant	150	0	0	425	500	500	500	2 075

Source: TLVFS (2011:2)

Table 2.6: Cost example in SEK with yearly grant (150 SEK) and high cost protection scheme when reference price above 15 000 SEK

Treatment Session	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Sum**
Cost for current treatment session	3 000	3 000	3 000	3 000	3 000	3 000	3 000	21 000
Earlier payments during the subsidy period	0	2 850	4 350	5 850	7 350	8 850	9 300	
Dental care grant	150	0	0	0	0	0	0	
Final payment patient for treatment session	2850	1500	1500	1500	1500	450	450	9750
Subsidy and grant	150	1500	1500	1500	1500	2550	2550	11 250

Source: Dalin & Wolff 2013

9.3 Appendix 3 – Dimension of Data

Table 3.1: Share if missing values for treatment 311, 342, 604 and 605 divided on patient group and region

	Postal code		**County**	
Treatment	**A**	**B**	**A**	**B**
311	27.0 %	59.4 %	2.9 %	31.5 %
342	15.5 %	35.2 %	1.7 %	12.5 %
604	89.9 %	95.2 %	65.5 %	84.8 %
605	57.1 %	72.2 %	19.7 %	49.4 %

Source: SSIA

Table 3.2: Mean treatments in subgroups, *postal code*

Treatment	**A1**	**A2**	**B1**	**B2**
mean311	0.34	0.52	0.14	0.20
mean342	0.72	0.94	0.38	0.44
mean604	0.02	0.04	0.02	0.03
mean605	0.07	0.12	0.05	0.11

Source: SSIA

Table 3.3: Mean treatment in subgroups, *county*

Treatment	**A1**	**A2**	**B1**	**B2**
mean311	0.33	0.48	0.12	0.16
mean342	0.74	0.93	0.34	0.39
mean604	0.02	0.03	0.02	0.03
mean605	0.05	0.09	0.04	0.08

Source: SSIA

9.4 Appendix 4 – Econometrics

Panel data

The characteristic of panel data makes it possible to specify and estimate more complicated econometric models than with cross-sectional or time series data, and makes analyses less sensitive to shocks. In addition, we can investigate how variables and the relationship between them alter over time (Brooks, 2008). The standard regression model used in our paper is defined as:

$$y_{it} = \beta_0 + x_{it}'\beta + \varepsilon_{it} \qquad [1]$$

where x_{it}' is a k-dimensional vector of independent variables. The error term in panel data models is often assumed to be composite; $\varepsilon_{it} = \alpha_i + u_{it}$, where u_{it} is believed to be homoskedastic, time variant and not correlated over time and α_i is believed to capture the time invariant, region specific characteristics of a region. The composite error term is assumed to be uncorrelated with the explanatory variable, but there may be reason to believe that the unobserved heterogeneity, α_i, are correlated with the explanatory variables, which can lead to poor estimates.

Pooled OLS

A simple way to deal with panel data is to pool the data together and run a simple OLS. In doing so, the average values of the variables and the relationship between them are assumed to be constant over time and across regions (Brooks, 2008). The coefficients are thus assumed to be the same for all regions and time periods (Verbeek 2008:356). In order to achieve unbiasedness, consistency and efficiency when estimating Equation 1 with OLS, the usual Gauss-Markov assumption must hold. For instance, the independent variables must be uncorrelated with the error term, $E\{x_{it}\varepsilon_{it}\} = 0$. However, given that we repeatedly observe the same observations it is unlikely that the error terms from different time periods are uncorrelated. This implies that the standard errors for OLS is misleading, and compared to an panel data estimator that exploits the correlation over time in the error term, OLS is likely to be inefficient (Verbeek, 2008). It is also reasonable to believe that α_i is correlated with x_{it}, which makes OLS inconsistent.

Random Effects Model

The Random Effects (RE) model exploits both the variation between and within regions when estimating the model, and assumes that both components of the error term are uncorrelated with the explanatory variables, i.e. that there is no unobserved heterogeneity in the data. Since the composite error terms possess a particular form of autocorrelation, the standard errors are incorrect if the RE model is estimated by the OLS estimator, as mentioned earlier. By using the structure of the error covariance matrix an estimator that is more efficient, called the GLS estimator, can be obtained (Verbeek, 2008). The GLS estimator is computed using an OLS estimator on a transformed version of the data, where the variables in the mean equation are multiplied with the variance of the error term. The transformed model is presented in equation 2, below:

$$\left(y_{it} - \vartheta \bar{y}_i\right) = \beta_0\left(1 - \vartheta\right) + \left(x_{it} - \vartheta \bar{x}_i\right)' \beta + \left(\varepsilon_{it} - \vartheta \bar{\varepsilon}_i\right) \qquad [2]$$

where $\vartheta = 1 - \psi^{1/2}$ and $\psi = \dfrac{\sigma_u^2}{\sigma_u^2 + T\sigma_\alpha^2}$

Since the variance of the components of the error terms are unknown, feasible GLS (EGLS) is used where the unknown variance are estimated in a first step (Verbeek, 2008).

Breusch-Pagan Lagrange Multiplier test

As argued above, the Pooled OLS model is not appropriate to use if there exists unobserved heterogeneity in the data. The Breusch-Pagan Lagrange multiplier test tests the null hypothesis of no variance in the time invariant component of the error term; $H_0 : Var\left(\alpha\right) = 0$ or equivalently if $\psi = \dfrac{\sigma_u^2}{\sigma_u^2 + T\sigma_\alpha^2} = 1$ (Verbeek, 2008). If the null hypothesis is rejected, this implies that there exists unobserved heterogeneity and the OLS estimator is thus not appropriate.

9.5 Appendix 5 – Descriptive Statistics

Table 5.1: Descriptive statistics, postal code, group B

Variable	Description	Obs	Mean	Std. Dev.
Dependent				
Treatment 311	Mean number if treatment 311 in cluster	571	0.16	0.13
Treatment 342	Mean number of treatment 342 in cluster	912	0.40	0.26
Independent				
50 % subsidy (B1)	Dummy variable, equals 1 if patients in cluster is subsidized with 50 percent	1408	0.52	0.50
85 % subsidy (B2)	Dummy variable, equals 1 if patients in cluster is subsidized with 85 percent	1408	0.48	0.50
Mean treatment	Mean number of treatments in of patients in cluster	1238	9.12	1.49
Share female	Share of females in patient cluster	980	0.52	0.09
Private	Dummy variable, equals 1 if patients in cluster solely treated by private dentist	1408	0.37	0.48
Price	Mean amount of dental cost of patients in cluster within the high cost protection scheme	1238	151.85	3 749
Practice density	No. of practices per 1 000 inhabitants in postal code	1351	0.32	0.13
Share private dentist	Share of private dentists in postal code	1351	0.48	0.14
Mean age	Mean age in postal code, 2011 is used as a proxy for 2010 and 2012	1408	47.99	2.24
Mean income	Mean income in postal code, 2011 is used as a proxy for 2011 and 2012	1376	252 559	328 58
Education	Share of the adult population with tertiary or higher education in postal code, 2011 is used as proxy for 2010 and 2012	1376	0.25	0.09
Ethnicity	Share of the adult population born outside of Sweden in postal code, 2011 is used as proxy for 2010 and 2012	1408	0.11	0.05
Population density	Population density. 2011 is used as proxy for 2010 and 2012	1376	343.11	994.02
Dental health	Share of population in county reported to have bad or vary bad dental health. Estimated for postal code. 2011 used as a proxy for 2010 and 2012	1376	9.69	1.10
Tax rate	Tax rate in county. Estimation for postal code	1394	10.63	1.29
Dental deficit	Deficit for dental care in county, pharmaceutical expenses excluded. Estimated for postal code. 2011 used as proxy for 2010 and 2012	1376	12.31	16.36
Big city	Dummy variable, equals 1 if one of three major cities is located in postal code	1376	0.17	0.37

Table 5.2: Descriptive statistics, county, group A

Variable	Description	Obs	Mean	Std. Dev.
Dependent				
Treatment 311	Mean number if treatment 311 in cluster	399	0.40	0.23
Treatment 342	Mean number of treatment 342 in cluster	404	0.83	0.35
Treatment 605	Mean number of treatment 605 in cluster	330	0.07	0.04
Independent				
50 % subsidy (A1)	Dummy variable, equals 1 if patients in cluster is subsidized with 50 percent	411	0.50	0.50
85 % subsidy (A2)	Dummy variable, equals 1 if patients in cluster is subsidized with 85 percent	411	0.50	0.50
Mean treatment	Mean number of treatment in of patients in cluster	409	16.57	3.22
Share female	Share of females in patient cluster	408	0.45	0.07
Private	Dummy variable, equals 1 if patients in cluster solely treated by private dentist	411	0.34	0.47
Price	Mean amount of dental cost of patients in cluster within the high cost protection scheme	409	15 201	3 411
Practice density	No. of practices per 1 000 inhabitants in postal code	378	0.31	0.04
Share private dentist	Share of private dentists in postal code	378	0.49	0.09
Mean age	Mean age in postal code, 2011 is used as a proxy for 2011 and 2012	378	42.14	1.31
Mean income	Mean income in postal code, 2011 is used as a proxy for 2010 and 2012	378	230 171	9 953
Education	Share of the adult population with tertiary or higher education in postal code, 2011 is used as proxy for 2010 and 2012	378	0.27	0.04
Ethnicity	Share of the adult population born outside of Sweden in postal code, 2011 is used as proxy for 2010 and 2012	378	0.12	0.04
Dental health	Share of population in county reported to have bad or vary bad dental health. Estimated for postal code. 2011 used as a proxy for 2010 and 2012	378	9.67	1.52
Tax rate	Tax rate in county. Estimation for postal code	378	32.19	0.88
Dental deficit	Deficit for dental care in county, pharmaceutical expenses excluded. Estimated for postal code. 2011 used as proxy for 2010 and 2012	378	8.33	14.01
Big city	Dummy variable, equals 1 if one of three major cities is located in postal code	378	0.14	0.35

Table 5.3: Descriptive statistics, county, group B

Variable	Description	Obs	Mean	Std. Dev.
Dependent				
Treatment 311	Mean number if treatment 311 in cluster	280	0.14	0.11
Treatment 342	Mean number of treatment 342 in cluster	358	0.36	0.17
Treatment 605	Mean number of treatment 605 in cluster	207	0.06	0.03
Independent				
50 % subsidy (B1)	Dummy variable, equals 1 if patients in cluster is subsidized with 50 percent	409	0.50	0.50
85 % subsidy (B2)	Dummy variable, equals 1 if patients in cluster is subsidized with 85 percent	409	0.50	0.50
Mean treatment	Mean number of treatments in of patients in cluster	400	9.54	1.61
Share female	Share of females in patient cluster	365	0.53	0.08
Private	Dummy variable, equals 1 if patients in cluster solely treated by private dentist	409	0.34	0.47
Price	Mean amount of dental cost of patients in cluster within the high cost protection scheme	400	15 567	3 770
Practice density	No. of practices per 1 000 inhabitants in postal code	377	0.31	0.04
Share private dentist	Share of private dentists in postal code	377	0.49	0.09
Mean age	Mean age in postal code. 2011 is used as a proxy for 2011 and 2012	377	42.14	1.31
Mean income	Mean income in postal code. 2011 is used as a proxy for 2010 and 2012	377	230 218	9 924
Education	Share of the adult population with tertiary or higher education in postal code, 2011 is used as proxy for 2010 and 2012	377	0.27	0.04
Ethnicity	Share of the adult population born outside of Sweden in postal code. 2011 is used as proxy for 2010 and 2012	377	0.12	0.04
Dental health	Share of population in county reported to have bad or vary bad dental health Estimated for postal code. 2011 used as a proxy for 2010 and 2012	377	9.67	1.53
Tax rate	Tax rate in county. Estimation for postal code	377	32.19	0.88
Dental deficit	Deficit for dental care in county, pharmaceutical expenses excluded. Estimated for postal code. 2011 used as proxy for 2010 and 2012	377	8.35	14.03
Big city	Dummy variable, equals 1 if one of three major cities is located in postal code	377	0.14	0.35

9.6 Appendix 6 – Results

Table 6.1: Regression results from RE and OLS model, county, group A
Dependent variable log of mean number of treatment 311 and 342 in a cluster.

	RE_311	**RE_342**	**RE_605**	**OLS_311**	**OLS_342**	**OLS_605**
	robust s.e.	*robust s.e.*	*robust s.e.*	*robust s.e.*	*robust s.e.*	*robust s.e.*
85 % subsidy (A2)	-0.514	0.365	0.481	-0.262	0.460	0.382
	(0.59)	(0.41)	(0.69)	(0.63)	(0.44)	(0.82)
Share female (log)	0.414*	0.103	0.253	0.242	0.012	0.711***
	(0.21)	(0.18)	(0.24)	(0.20)	(0.17)	(0.24)
Mean treatments (log)	2.654***	1.140***	1.480	3.789***	1.101**	1.434
	(0.74)	(0.44)	(0.95)	(0.75)	(0.45)	(0.89)
Price (log)	-0.217	-1.340	-0.995	-1.727	-1.534	-0.639
	(1.42)	(1.04)	(1.91)	(1.61)	(1.14)	(2.18)
Mean age	11.696	26.602***	3.409	12.008	23.840***	19.794
	(8.84)	(5.94)	(13.22)	(8.78)	(5.40)	(12.31)
Mean age 2	-13.632	-31.237***	-3.804	-13.999	-27.980***	-23.040
	(10.41)	(6.99)	(15.53)	(10.33)	(6.35)	(14.46)
Ethnicity (log)	2.389***	-0.578*	-0.259	2.358***	-0.595**	-0.736
	(0.57)	(0.30)	(0.70)	(0.50)	(0.28)	(0.61)
Tax rate (log)	4.628	0.308	-4.689*	5.592	-0.244	-6.383
	(3.86)	(2.15)	(2.65)	(3.46)	(2.26)	(3.93)
Education	-3.095	4.304***	0.506	-1.471	3.809**	1.866
	(2.70)	(1.66)	(3.40)	(2.33)	(1.54)	(3.01)
Mean income (log)	-14.277***	4.767*	3.566	-14.408***	5.332***	5.387
	(4.62)	(2.50)	(4.17)	(3.44)	(2.03)	(3.66)
Big city	1.571***	0.460*	0.428	1.540***	0.408*	0.819
	(0.45)	(0.25)	(0.47)	(0.35)	(0.21)	(0.51)
Share private dentist	-3.970	7.836***	-0.933	-3.476	7.683***	1.633
	(2.88)	(1.63)	(3.46)	(2.52)	(1.48)	(2.72)
Practise density (log)	-2.171**	-2.924***	0.836	-2.517***	-2.731***	-0.335
	(0.92)	(0.60)	(1.41)	(0.89)	(0.55)	(1.14)
Private	-0.038	-0.243***	0.184	0.063	-0.251***	0.212**
	(0.12)	(0.05)	(0.12)	(0.10)	(0.05)	(0.10)
Dental deficit (log)	-0.444***	0.151**	-0.015	-0.430***	0.152**	0.025
	(0.12)	(0.07)	(0.13)	(0.09)	(0.06)	(0.10)
Dental health (log)	1.024**	-0.569**	-0.551	1.061***	-0.620***	-0.747*
	(0.41)	(0.23)	(0.44)	(0.32)	(0.19)	(0.40)
cons	-92.490	- 625.234***	-99.236	-91.077	- 569.391***	-471.110*
	(177.95)	(129.77)	(290.70)	(200.00)	(122.96)	(268.10)
sigma_u	0.28	0.15	0.32			
sigma_e	0.34	0.23	0.30			
rho	0.40	0.29	0.54			
Breusch-Page LM-test	0.000	0.003	0.001			

Table 6.2: Regression results from RE and OLS model, county, group B
Dependent variable log of mean number of treatment 311 and 342 in a cluster.

	RE_311	**RE_342**	**OLS_311**	**OLS_342**
	robust s.e.	*robust s.e.*	*robust s.e.*	*robust s.e.*
85 % subsidy (B2)	0.805	0.296	1.098	0.207
	(0.56)	(0.52)	(0.76)	(0.56)
Share female (log)	-0.040	-0.425***	0.232	-0.380**
	(0.33)	(0.16)	(0.33)	(0.17)
Mean treatments (log)	2.865***	2.285***	2.757***	2.235***
	(0.45)	(0.37)	(0.45)	(0.32)
Price (log)	-2.563**	-1.472	-3.187*	-1.294
	(1.26)	(1.23)	(1.67)	(1.25)
Mean age	25.810**	25.524***	22.791**	26.452***
	(11.18)	(8.19)	(11.49)	(6.99)
Mean age 2	-29.991**	-29.809***	-26.421*	-30.885***
	(13.16)	(9.65)	(13.49)	(8.22)
Ethnicity (log)	1.375**	-0.537	1.193**	-0.364
	(0.53)	(0.46)	(0.51)	(0.37)
Tax rate (log)	-9.359*	-7.444**	-9.194*	-7.678**
	(5.47)	(2.88)	(5.22)	(3.21)
Education	-4.467	-0.333	-3.812	-1.184
	(3.54)	(3.01)	(3.56)	(2.42)
Mean income (log)	-10.532**	2.874	-9.060***	1.998
	(4.08)	(3.44)	(3.40)	(2.71)
Big city	1.897***	1.272***	1.767***	1.412***
	(0.55)	(0.35)	(0.48)	(0.30)
Share private dentist	-2.439	2.336	-1.075	1.679
	(2.81)	(2.68)	(2.64)	(2.08)
Practise density (log)	-2.482**	-2.152**	-2.820*	-2.117***
	(0.97)	(0.96)	(1.08)	(0.74)
Private	-0.102	-0.189***	-0.109	-0.172***
	(0.10)	(0.06)	(0.08)	(0.05)
Dental deficit (log)	-0.411***	-0.103	-0.366***	-0.144
	(0.15)	(0.12)	(0.12)	(0.09)
Dental health (log)	1.252***	-0.685**	1.173***	-0.620**
	(0.40)	(0.32)	(0.36)	(0.26)
cons	-376.394	-551.192***	-326.564	-560.217***
	(233.26)	(186.76)	(251.41)	(163.16)
sigma_u	0.30	0.22		
sigma_e	0.35	0.28		
rho	0.42	0.39		
Breusch-Pagen LM-test	0.000	0.000		