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Cost-Sharing Design Matters:

A Comparison of the Rebate and Deductible in Healthcare

Revised version

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Cost-Sharing Design Matters: A Comparison of the Rebate and Deductible in Healthcare[1]

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Since 2006, the Dutch population has faced two different cost-sharing schemes in health insurance for curative care: a mandatory rebate in 2006 and 2007, and a mandatory deductible since 2008. With administrative data for the entire Dutch population and using a difference-in-differences design, we compare the effect of these schemes on healthcare consumption. We draw upon a regression discontinuity design to extrapolate effects to the cut-off age 18 and incorporate the size of the cost-sharing scheme. Our estimate shows that for individuals around the age of eighteen, one euro of the deductible reduces healthcare expenditures 18 eurocents more than one euro of the rebate. This demonstrates that different designs of a cost-sharing scheme can have substantially different effects on total healthcare expenditure.

Keywords: deductible, rebate, cost-sharing, healthcare consumption, difference-in-differences design, regression discontinuity design, panel data

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1. Introduction

Health insurance reduces a person's risk of unexpected high healthcare expenditures (Finkelstein et al., 2017). However, insurance can also induce moral hazard: an increased use of medical care driven by the reduction in price of care as a result of health insurance (Zweifel and Manning, 2000). In many countries, policymakers have introduced demand-side cost-sharing to reduce such moral hazard (see e.g. Paris et al., 2010). A wide range of cost-sharing schemes exist, including deductibles, co-payments, co-insurance rates, two-tier systems, rebates, and shifted deductibles. In addition, policymakers have to decide on the amount of cost-sharing and which groups or treatments to target. All these schemes have in common that they shift (part of) healthcare expenditures to users in order to incentivize them to reduce their healthcare use. However, different schemes may lead to different responses.

This paper sheds light on the effects of two different demand-side cost-sharing schemes that were in place in the Dutch curative healthcare sector between 2006 and 2013. In 2006 and 2007, the Dutch population faced a mandatory no-claims rebate of 255 euros as part of the government mandated basic insurance package. A no-claims rebate, from here on referred to as a rebate, implies that a person who spends y euros on healthcare in a given year receives a $255 - y$ euro reward at the end of the year as long as this amount is positive, i.e., if he or she makes no or few claims. The rebate was introduced in 2005 by the Dutch government as a consumer-friendly cost-sharing scheme (Holland et al., 2009). Cost-sharing was, and still is, a politically-controversial issue in the Netherlands, especially cost-sharing for low-income individuals with poor health status. The rebate was initially preferred over a deductible because it was perceived as an end-of-year bonus for low healthcare consumption during that year, instead of a penalty for consuming healthcare. Also, deductibles were seen as a financial hurdle for someone in need of care.

In 2008, however, a new government replaced the rebate with a mandatory deductible of 150 euros. Under a mandatory deductible, a person pays the first 150 euros of his or her healthcare consumption out-of-pocket, while costs above 150 euros are covered by health insurance. The reasoning for abolishing the rebate in 2008 was threefold: preliminary evaluations showed only modest effects of the rebate on reducing healthcare consumption, it was (now) perceived as unfair that chronically ill individuals would never receive the end-of-year bonus, and the government could lower the health insurance premium paid by consumers by replacing the rebate with a deductible (Goudriaan et al., 2007; Holland et al., 2009).[1] The mandatory deductible has

[1] To finance the end-of-year rebate, each citizen has to pay a higher premium at the beginning of the year. For the deductible, the premium is lower at the beginning of the year because out-of-pocket payments have to be paid during the year.

been raised annually since 2008, reaching 350 euros in 2013. Importantly, both cost-sharing mechanisms only applied to individuals of 18 years and older; younger individuals were fully insured (no cost-sharing).

The aim of this paper is to compare the effect of a rebate and a deductible on healthcare consumption. To estimate and compare causal effects of the rebate and the deductible on healthcare expenditure, we use a difference-in-diferences design that exploits two features of the Dutch healthcare system: (i) cost-sharing applies only to persons above 18 years old. This splits our sample into a treatment group (persons above 18) and a comparison group (persons below 18) (Lee and Lemieux, 2010). (ii) The cost-sharing scheme switched from a rebate to a deductible in 2008. This provides us with a pre and post period. As a result, we can estimate the effect of cost-sharing kicking in at age 18 and make a further distinction between the effect of the *rebate* kicking in at 18 and the *deductible* kicking in at 18.

We modify the difference-in-differences regression by drawing upon a regression discontinuity design to extrapolate effects to the cut-off age 18 and by incorporating the size of the cost-sharing scheme into our regression. Also, we include time and individual fixed effects to control for factors affecting healthcare consumption other than the rebate or deductible. Potential selection effects are largely absent because basic insurance is mandatory in the Netherlands, and the basic insurance package is set by the government. We use administrative data that cover the entire Dutch population.

We find that the reduction of healthcare consumption due to the mandatory deductible is significantly larger than the reduction due to the mandatory rebate of comparable size. One euro of the deductible reduces healthcare expenditures by 18 eurocents more than one euro of the rebate. Furthermore, we find that persons who live in an area with a low average household income do not respond to the rebate, but do respond strongly to the deductible. These findings may appear puzzling as in a standard economic framework a deductible and a rebate induce the same budget constraint. We discuss three possible explanations for our findings: prospect theory, discounting, and liquidity constraints (see Section 6).

Our paper contributes to the health economics literature on cost-sharing a comparison of the effects of the rebate and deductible.[2] Stockley (2016) also compares the effect of two types of cost-sharing: the deductible and co-payments. She finds that people are substantially more responsive to co-payments than to deductibles. The RAND Experiment compared the effect of multiple co-insurance rates, which differ in size and upper limit (Newhouse, 1993). Spending of persons with a 95 percent coinsurance rate (basically a deductible plan) was 31 percent lower

[2]We do not review this large body of literature here. The interested reader is referred to Baicker and Goldman (2011) and McGuire (2012).

than those without any cost-sharing, corresponding to a price elasticity of approximately -0.2. These reductions in healthcare consumption did not result in a worse health status, except for persons who already had a poor health status and low income. Recently, Brot-Goldberg et al. (2017) compared a situation where a firm switches from free healthcare insurance to insurance with a high deductible. They find that a high deductible reduces healthcare expenditure. As in Newhouse (1993), they find that individuals reduce both high value care as well as 'wasteful' care. In a standard rational framework, consumers would most likely cut only the latter type of care. Brot-Goldberg et al. (2017) also show that even the sickest quartile in their sample reduces healthcare expenditure, even though they tend to exceed the deductible.

There is little literature on demand responses of a rebate in healthcare. The Netherlands seems to be the only country to have implemented a rebate in healthcare on a national level. Some small-scale experiments have been carried out in Switzerland and Germany, and some private health insurers implemented a rebate in Switzerland in the 1980s and 1990s (Zweifel, 1987). The Swiss rebate was different from the Dutch rebate because individuals could only voluntarily choose for a rebate if they had low healthcare expenditures for five consecutive years. Zweifel reports a decrease in healthcare consumption due to the rebate. An experiment with a rebate for corporate sickness funds in Germany in the 1990s led to rather small effects (Groenewegen and de Jong, 2004). Finally, Goudriaan et al. (2007) and Holland et al. (2009) use a survey to evaluate the effect of the mandatory rebate in the Netherlands and report that 3 to 4 percent of the respondents claimed to reduce their healthcare consumption because of the rebate.

Hayen et al. (2018) also study the change from a rebate to a deductible in Dutch healthcare. They can compare healthcare expenditure before and after the rebate or deductible is exhausted, because they have claims data from a Dutch healthcare insurer which includes the billing date of healthcare. Selection can however occur, as they use a subsample from one insurer, while our data cover the whole Dutch population. Hayen et al. (2018) also find that a deductible has a bigger effect on expenditure than the rebate.

There are several papers that study the effect of the deductible in the Dutch context, although none of them are of an experimental or quasi-experimental nature. Need et al. (1992), van Tulder and Bruyns (1995), and van der Maat and de Jong (2010) show with survey data that the deductible reduces Dutch healthcare expenditure significantly. Esch et al. (2015) combine survey data with registration data from general practitioners (GPs) and claims data from healthcare insurers. They show that the share of persons that do not follow up their GP's referrals increases with the size of the deductible.[3]

[3]GP care in the Netherlands does not fall under the deductible. GPs serve as gatekeepers to other forms

We show that differences in the design of a cost-sharing scheme can lead to different effects. If the goal of policymakers is to reduce expenditure and to offer a low health insurance premium, a deductible is more suitable than a rebate. However, if policymakers are concerned that a deductible hampers low income individuals from using high value care then a rebate might be preferred.

The structure of this paper is as follows: Section 2 describes the institutional setting of the Dutch healthcare system. Section 3 explains our administrative data set and provides descriptive statistics. Section 4 describes the design comparing the effect of the rebate and the deductible. Section 5 presents and discusses our results. Section 6 offers three mechanisms why a rebate and deductible can have different effects on expenditure. Section 7 goes over a number of robustness checks, and Section 8 concludes.

2. Institutional setting

The main feature of the Dutch curative healthcare sector is managed competition, introduced through the Health Insurance Act ('Zorgverzekeringswet') in 2006. Each person who lives or works in the Netherlands is obliged to buy health insurance for a basic benefit package from a private health insurer (van de Ven and Schut, 2008). Insurers negotiate with healthcare providers about prices and may selectively contract care for their clients. Competition therefore takes place among healthcare insurers –for buyers of insurance– and among healthcare providers –for patients and contracts with healthcare insurers (van de Ven and Schut, 2008).

The basic benefit package is the same[4] for everyone and covers a wide range of curative health care, such as hospital care, GP care, and mental health care.[5] The government determines and changes the coverage of the basic benefit package.[6]

If people want to insure care that is not covered under the basic benefit package, such as orthodontic care, cosmetic surgery, or alternative medicine, they can buy supplementary health insurance. Healthcare insurers offer supplementary insurance independently from the basic package and individuals do not have to buy basic and supplementary insurance from the same insurer. During our sample period, over 85 percent of the population purchased supplementary

of healthcare, for example hospitals. The idea of the work of Esch et al. (2015) is that it is undesirable from a societal point of view if persons do not follow up on their GP's advice and referral because of the deductible. Therefore, they investigate how often this occurs.

[4]There exist small differences in basic benefit packages, not in terms of coverage but provider networks can differ between insurers (Nederlandse Zorgautoriteit, 2014).

[5]Long-term care is not part of the Health Insurance Act and is outside the scope of this study.

[6]For a list of changes in coverage over the period of our analysis, see Appendix A.1.

health insurance (Nederlandse Zorgautoriteit, 2014). Health insurers may not refuse anyone for the basic benefit package, for example because of pre-existing conditions. Instead, they must offer insurance for everyone at a community-rated premium. These features, as well as an extensive risk-equalization scheme, are in place to prevent cherry picking, selection, and other market failures (van de Ven and Schut, 2008; Nederlandse Zorgautoriteit, 2016).

All Dutch citizens, except children under 18 years old, pay for healthcare costs in three ways. The first is through an insurance premium, which persons pay directly to their health insurer. This annual premium is currently between 1000 to 1200 euros. Low-income groups receive an income dependent monthly subsidy to pay for their premium. The second component of the contribution is an income-dependent fee, which is levied on an individual basis through taxes (van de Ven and Schut, 2008). The Health Insurance Act establishes that these income-dependent fees should cover exactly 50 percent of total health expenditures in a year. The third component consists of demand side cost-sharing.

Cost-sharing is mandatory for all Dutch citizens of 18 years or older, and starts on the first day of the month after a person's eighteenth birthday.[7] In 2006 and 2007, the rebate was 255 euros,[8] but in 2008, the government replaced the rebate with a deductible of 150 euros. Since then, the deductible has been raised every year; see Table 1.[9]

Table 1: Mandatory rebate and deductible in the Netherlands for 2006-2013

type	rebate		deductible					
year	2006	2007	2008	2009	2010	2011	2012	2013
amount (in euros)	255	255	150	155	165	170	220	350

The rebate or deductible apply to almost all types of health services covered under the basic benefit package. Only maternal care, obstetrical care, GP care, and other types of primary care are exempted, to ensure accessibility to these types of care.[10] In most cases, these healthcare

[7]The size of the rebate or deductible for an 18-year old depends on how many months remain between his or her birthday and the end of the year.

[8]Cost-sharing before 2006 is not reported, because the curative healthcare sector was organized very differently before the Health Insurance Act of 2006. Insurance was mandatory for low and middle incomes and offered by public insurers. Persons with a high income could purchase insurance at a private healthcare insurer, but were not obliged to. Deductibles were voluntary and often chosen, as the reduction in premium was quite generous. The rebate was introduced in public health insurance in 2005, just before the large healthcare reform of 2006.

[9]The mandatory deductible was raised to 365 euros in 2014, 375 euros in 2015, 385 euros in 2016, and 385 euros in 2017 and 2018 as well. Table 1 shows deductibles for 2006 up to 2013, as we have data for these years.

[10]See Table 2 for an overview of the data. Appendices A.2 and A.3 give a summary of the raw data and our cleaning procedure.

categories account for a small share of total healthcare expenditure.[11] In our data, cost-sharing does not apply to 8% of total healthcare expenditure.[12] In addition to the mandatory rebate or deductible, persons aged 18 or more can also choose a voluntary deductible (also in 2006 and 2007) of maximally 500 euros. Only about a tenth of the Dutch population chooses such a voluntary deductible.[13]

Reinsurance of the mandatory deductible is allowed under special circumstances, for example for seasonal workers, people with a low income, or students. Less than 1.5 percent of the population has this reinsurance (Nederlandse Zorgautoriteit, 2014).

3. Data and descriptives

3.1. Data

Our data are proprietary healthcare claims data from 2006 to 2013 and include all 17 million insured inhabitants in the Netherlands. The data originate from Vektis, a private organization that collects and maintains data on behalf of all healthcare insurers in the Netherlands.[14] After cleaning, the data set consists of 130 million observations.[15] A common problem with claims data is that people with low healthcare expenditures do not claim their bills with their insurer, because they do not expect to receive any compensation in return or to exceed their deductible. This is, however, not a problem in our data, because healthcare providers have a strong incentive to report all costs to patients' health insurers directly. If they do not report the costs, they will not be reimbursed by the health insurer. Providers send –often electronically– their bills to the insurer, who will then bill the patient.

The data include for each person his or her total annual healthcare expenditures. These total annual healthcare expenditures have been broken down into expenditures of 21 categories of healthcare, such as hospital care, GP care, mental health care, and dental care.[16] In addition to healthcare expenditures, our data include several characteristics of individuals such as gender, four digit zip code, and age. Age is given in years and reported for December 31st in a particular year.[17] Lastly, we know the level of an individual's voluntary deductible in each year.

[11]Pregnant women or women who have given birth are exceptions.

[12]See 'other care without cost-sharing' in Appendix A.2.

[13]The percentage of insured individuals choosing a voluntary deductible has increased since 2006, from about 3 percent in 2006 to 8 percent in 2013.

[14]The data are pseudonymized and not publicly available.

[15]See Appendix A.3 for the data cleaning procedure and Appendix A.2 for summary statistics of the entire dataset.

[16]Table 2 is a list of all 21 categories.

[17]A person who turns 18 on November 1st in 2008 is classified as 18 years old in 2008 in our data, even though

Using the four digit zip code in our data, we can link additional information on the average standardized disposable household income in a zip code area, using publicly available data from Statistics Netherlands.[18] Based on the full, uncleaned sample, we constructed disposable household income quintiles.

In our empirical analysis we focus on young adults around the age of 18 when a rebate or deductible kicks in. For the baseline model, we select all persons between the age of 15 and 21, but exclude people aged 18.[19] As our data do not contain the exact date of birth, we cannot distinguish someone who becomes 18 at January 1st from someone who becomes 18 on December 31st (in the same year). Formally, the deductible starts in the month after a person's 18th birthday, which means that the former faces the deductible for almost the whole year while the latter does not have a deductible at all in this year.

To measure the effect of the mandatory rebate and deductible we construct a baseline sample. To obtain this baseline sample we chose to exclude certain individuals and expenditure categories from our dataset. In the robustness section we will come back to these choices and test how they influence the size of our estimates. First, we exclude all individuals who choose a voluntary deductible *at least once* between 2006 and 2013 from our main estimations. These individuals are taken from the sample, to rule out potential effects of the voluntary deductible, such as selection and moral hazard.[20] We also take out all persons with *any* mental healthcare expenditures between 2008 and 2013. Mental care was not part of the Health Insurance Act until 2008, thus the data contain no mental healthcare expenditures for 2006 and 2007. It is therefore impossible to estimate the effect of the rebate on mental health care expenditure in 2006 and 2007 and make comparisons with the deductible in the years after. Coverage of dental care changed for persons under 18 compared to persons over 18 between 2008 and 2011 (see Appendix A.1). As expenditures on dental care are low but common, we do not remove every person with any dental

he or she was 17 for 10 months that year.

[18]Average standardized disposable household income is gross household income minus taxes and premiums for public insurance policies. This income measure is standardized for differences in size and composition of households.

[19]Other papers that exclude individuals at the discontinuity are, for example those of Leuven and Oosterbeek (2004) and Ferreira (2010).

[20]The voluntary deductible is mostly chosen by persons with low healthcare expenditures, because it is profitable for them (Douven et al., 2016). They therefore differ from people who do not choose a voluntary deductible. Suppose we would only delete observations of people choosing a voluntary deductible in the *year* that they choose a voluntary deductible. That implies that we would delete for example a 19 year old in 2012, but keep observations of this same person in previous years (ages 15-17 without a voluntary or mandatory deductible). Health expenditures are likely to be already low at 15, 16, or 17 years old due to selection effects, which would bias our results. To avoid this selection bias, we delete observations of this individual in every year.

care.[21] Instead, we delete expenditure on dental care from our dependent variable: healthcare expenditure under the deductible. Although there can be an interaction effect between dental care expenditure and the deductible (e.g. people "filling up" their deductible or rebate on dental health care expenditure), this effect is likely to be small as the level of dental care expenditure is low (see Appendix A.2).

To sum up, our baseline sample includes young adults aged 15 to 21 (but not 18), who never had any mental health care expenditures between 2008 and 2013 nor a voluntary deductible between 2006 and 2013. The main dependent variable in our analyses is total healthcare expenditure for healthcare categories under the rebate or deductible, but without dental healthcare costs. We will henceforth refer to this dependent variable as healthcare expenditure with cost-sharing.[22]

3.2. Descriptives

Table 3 summarizes healthcare expenditures and characteristics of our baseline sample, divided into 15 to 17 year olds (the comparison group) and 19 to 21 year olds (the treatment group), and for the years the rebate was in place (2006 and 2007) and the years the deductible was in place (2008 to 2013).

Except for average healthcare expenditures, most characteristics are similar across the treatment and comparison group and across the years with a rebate and years with a deductible. Expenditures also differ substantially per healthcare category: the average expenditures are highest for hospital care, and lowest for physiotherapy. Overall, we see that our sample is healthy: less than 2 percent of the sample is a chronic user of healthcare and between 2 and 3 percent are chronic users of medication.[23] This of course is driven by the relative young age of the people in our sample. The mean household income quintile of 15 to 17 year olds is higher than the mean quintile of 19 to 21 year olds. The former group will live with their parents while the latter group tends to move to new accommodation either as student or in their first job with a relatively low wage. The mean household income quintile of 15 to 17 year olds increases slightly over time: from 3.12 when the rebate was in place to 3.21 when the deductible was in place.

Figures 1 and 2 provide a first indication that (i) cost-sharing reduces average healthcare expenditure and (ii) the deductible has a bigger effect on healthcare expenditure than the rebate. Figure 1 presents mean healthcare expenditure for all ages in the baseline sample, separately for

[21] Dental care is so common that excluding people with dental care expenditures would leave almost no observations.

[22] Table 2 summarizes the cost categories included in our main dependent variable (y_{it}).

[23] Appendix A.2 shows the total population is less healthy.

rebate period (2006 and 2007) and for the deductible period (2008 to 2013). Mean healthcare expenditure increases with age, but drops for 19 year olds. If we extrapolate the trends in healthcare expenditure to the cut-off at age 18, we see that average expenditure below 18 (where no cost-sharing is in place) clearly exceeds average expenditure above 18 (where cost-sharing does apply). This difference is larger for years with the deductible than years with the rebate.

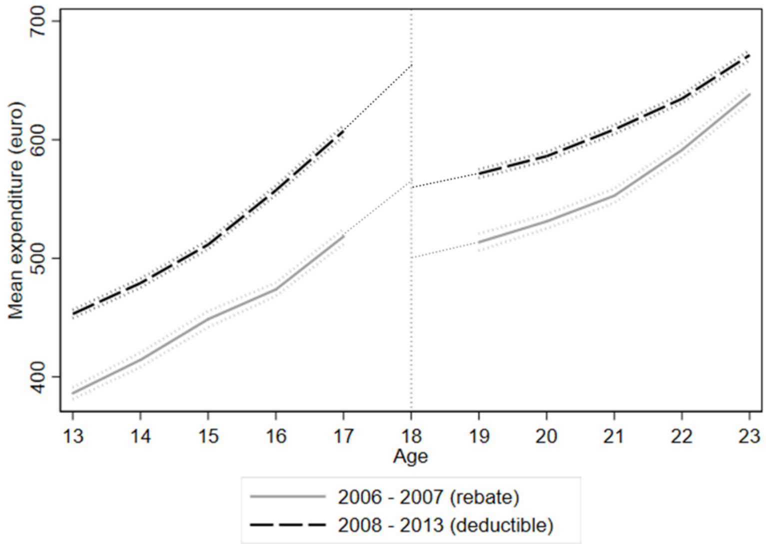
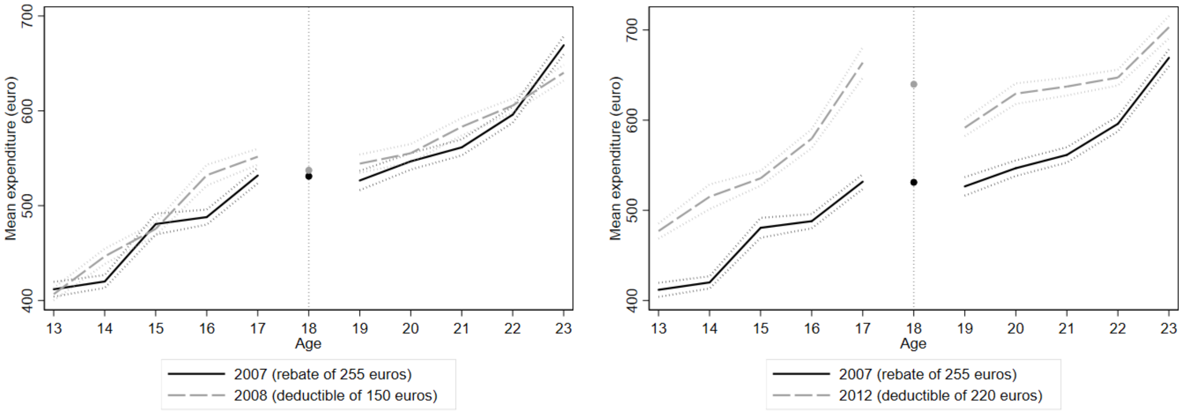


Figure 1: Mean healthcare expenditures by age and cost-sharing type

Figure 2 highlights the years 2007, 2008 and 2007, 2012 to illustrate the interplay with the size of the cost-sharing scheme. There is almost no jump in healthcare expenditure in 2007 and 2008, even though the deductible in 2008 was 105 euros lower than the rebate in 2007. The comparison of the years 2007 and 2012 shows a large gap, even though the level of the rebate and the deductible are similar (255 and 220 euros respectively).[24] Mean healthcare expenditure at 18 is also plotted in Figure 2. As expected, mean healthcare expenditure is roughly in the middle of healthcare expenditure at 17 and 19: some '18 year olds' actually turn 18 in January, and thus face the rebate or the deductible for almost the whole calendar year, whereas others turn 18 in December and do not face any cost-sharing that year.

[24]Figures 1 and 2 display standard errors of the mean expenditures. These standard errors differ from standard deviations of individual expenditures as reported in, for example Appendix A.2 and Table 3.



2007 and 2008 *2007 and 2012*

Figure 2: Mean healthcare expenditures by age and year

4. Methods

In this section, we describe the empirical strategy. Results and robustness checks are presented in Sections 5 and 7.

4.1. Identifcation strategy

To estimate causal effects of the rebate and the deductible on healthcare expenditure, we use a difference-in-diferences design that is modified in two ways. First, it draws upon a regression discontinuity design to extrapolate effects to the cut-off age 18. Second, we incorporate the size of the cost-sharing scheme into our regression.

The difference-in-differences design exploits two features of the Dutch healthcare system: (i) cost-sharing applies only to persons above 18 years old. This splits our sample into a treatment group (persons above 18) and a comparison group (persons below 18) (Lee and Lemieux, 2010). (ii) The cost-sharing scheme switched from a rebate to a deductible in 2008. This provides us with a pre and post period. As a result, we can estimate the effect of cost-sharing kicking in at age 18 and make a further distinction between the effect of the *rebate* kicking in at 18 and the *deductible* kicking in at 18. We test if the effect of cost-sharing was significantly different in the years the rebate was in place (2006 and 2007) from the years the deductible was in place (2008 to 2013).

A key assumption for difference-in-differences estimation is that healthcare expenditure time trends for persons above and below 18 years old are parallel before the introduction of the deductible (Angrist and Pischke, 2009). When the parallel trends assumption is satisfied, persons below 18 years old serve as a valid counterfactual group for persons above 18 years old. In our set-up, the treatment is the deductible which replaced in 2008 the rebate that had been present in 2006 and 2007. Although a pre period of two years to establish a parallel trend is limiting, the size of the rebate was fortunately constant in 2006 and 2007.[25] To test for parallel trends we follow Pischke (2005) and estimate:

$$\begin{aligned} y_{it} =& \beta_{2006}T_{it} + \beta_{2008}T_{it} + \beta_{2009}T_{it} + \beta_{2010}T_{it} + \beta_{2011}T_{it} + \beta_{2012}T_{it} + \beta_{2013}T_{it} \\ &+\alpha_{2006} + \alpha_{2008} + \alpha_{2009} + \alpha_{2010} + \alpha_{2011} + \alpha_{2012} + \alpha_{2013} + \tau T_{it} + \alpha_i + \epsilon_{it} \end{aligned} \tag{1}$$

where y_{it} denotes healthcare expenditure with cost-sharing of individual i in period t, T_{it} is a binary variable indicating whether individual i faces cost-sharing in year t or not. α_i captures individual fixed effects and τ denotes the average (over the years) treatment effect. α_t denote year fixed effects, with 2007 as the reference category. The specification allows the year effects to differ for the treatment group (persons above 18) and the control group (persons below 18) as denoted with $\beta_{2006}T_{it}$, $\beta_{2007}T_{it}$, et cetera. For the parallel trends assumption to hold, $\beta_{2006}T_{it}$ is not allowed to be significantly different from $\beta_{2007}T_{it}$ as the deductible was not yet introduced and the size of the rebate was constant. $\beta_t T_{it}$ for years 2008-2013 may differ from $\beta_t T_{it}$ for years 2006 and 2007 because the deductible was introduced. Furthermore, $\beta_t T_{it}$ are also allowed to differ from each other in an arbitrary way *after* the introduction of the deductible in 2008. $\beta_{2008}T_{it}$ may for example differ from $\beta_{2013}T_{it}$. Indeed, as the deductible changes over time, this is likely to happen.

The parallel trends assumption was tested for three age year bandwidths. Table 4 reports the results of estimating equation (1). For a three-year age bandwidth, $\beta_{2006}T_{it}$ is, as required, insignificant for fixed effects specification and hardly significant for ordinary least squares estimation. For the two-year age bandwidth, the treatment effect in 2006 is insignificant for both fixed effects and ordinary least squares estimation. Finally, for the one-year bandwidth, we cannot do a fixed effects estimation. In this case β_{2006} is not significant with ordinary least squares estimation. We conclude that the parallel trends assumption is satisfied in our data.

A second assumption for the validity of our identification strategy is that individuals cannot manipulate or influence the assignment variable (Lee and Lemieux, 2010), which clearly holds in our case as individuals cannot manipulate their age in our data as it is based on official records.

In a standard regression discontinuity design, a further requirement is that all factors de-

[25] A change in the size of the rebate may affect the trend in healthcare expenditure for persons above 18, but not for persons below 18. If for example the size of the rebate had increased by 100 euros in 2007, then the difference in healthcare expenditure between persons above and below 18 years old would have become smaller (note that healthcare expenditure of persons above 18 is on average higher than persons below 18). This could have resulted in non parallel trends.

termining the dependent variable, i.e., healthcare expenditures with cost-sharing, must evolve smoothly, except for the treatment variable. If this condition is satisfied, then a discontinuity or jump in the dependent variable can be ascribed to the treatment. This assumption does not necessarily hold in our design: several things change when a person turns 18, some of which may affect healthcare expenditure. To illustrate, the legal age for consumption of strong liquor and to drive a car is 18 during the period of our study.[26] This may cause an increase in healthcare expenditure due to (excessive) alcohol consumption and/or car accidents for people above 18. Also, 18 year olds are more likely to move out from their parental home to live on their own and/or to go to university. Moving out may reduce healthcare expenditures as 18 year olds may start paying their own bills after moving out.

However, this form of the assumption is not necessary for our difference-in-differences design. Even if discontinuities exist around 18 (other than the deductible or rebate), this does not invalidate our design as we focus on the *change* from a rebate to a deductible and compare the year-by-year estimates over time. Discontinuities at 18 do not influence our results as long as these discontinuities stay constant over time. In Section 7.2 we show that this assumption is plausible for relevant factors that may be discontinuous at 18 and can affect health expenditure.

4.2. The model

We implement our difference-in-differences strategy by estimating the following model:

$$y_{it} = \gamma r_t R_{it} + \delta d_t D_{it} + \beta \tilde{age}_{it} + \beta' T_{it} \tilde{age}_{it} + \alpha_t + \alpha_i + \epsilon_{it} \tag{2}$$

Here, y_{it} denotes healthcare expenditure with cost-sharing of individual i in period t. Age in years is the assignment variable: a person's age determines whether he or she is in the treatment or comparison group:[27]

$$T_{it} = \begin{cases} 1 & \text{if } age_{it} > 18 \\ 0 & \text{if } age_{it} < 18 \end{cases}$$

where age_{it} is the age of an individual i in year t and T_{it} is a binary variable indicating whether individual i faces cost-sharing in year t or not.

R_{it} and D_{it} are the same as T_{it}, but distinguish between a rebate in $t \in \{2006, 2007\}$ and deductible $t \in \{2008, 2009, 2010, 2011, 2012, 2013\}$, respectively. To illustrate, $R_{it} = 0$ for

[26] The legal age for consuming wine and beer was 16 in our study, but raised to 18 years in 2014.

[27] Similar to Behaghel et al. (2008), Card et al. (2008), Leuven and Oosterbeek (2004), Ferreira (2010), Lemieux and Milligan (2008), and Edmonds et al. (2005), our assignment variable *age* is only available on a yearly basis. Dong (2015) argues that rounding of the assignment variable, can bias results. If we apply Dong's suggested correction, the estimated coefficients become larger, but the relative effects stay the same: effect of the deductible is larger than the effect of the rebate.

$t \geq 2008$ and $R_{it} = T_{it}$ for $t = 2006, 2007$. The terms γ and δ identify the difference-in-differences effects: the former captures the effect of the rebate and the latter of the deductible. γ and δ are scaled with the size of the rebate $r_t \in \{255, 255\}$ and the size of the deductible $d_t \in \{150, 155, 165, 170, 220, 350\}$.[28]

We consider individuals i in periods $t \in \{2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013\}$ where $age_{it} \in \{15, 16, 17, 19, 20, 21\}$. That is, we use a bandwidth of three age-years before the cut-off point, from 15 to 17, and three years after, from 19 to 21.[29] [30] We center age around 18 for a straightforward interpretation of the coefficients: $\tilde{age}_{it} = age_{it} - 18$. α_i denote individual fixed effects and α_t year fixed effects. We also estimate model (2) without α_i to assess the importance of unobserved individual characteristics. ϵ_{it} is the error term and standard errors are clustered at the individual level to correct for correlation (Lee and Lemieux, 2010).[31]

In the baseline specification, we include the size of cost-sharing linearly, as it only ranges between 150 and 350 euros. However, we also estimate model (3) which replaces $\gamma r_t R_{it}$ and $\delta d_t D_{it}$ with $\tau_t T_{it}$ and which does not impose a linear relationship:

$$y_{it} = \tau_t T_{it} + \beta \tilde{age}_{it} + \beta' T_{it} \tilde{age}_{it} + \alpha_t + \alpha_i + \epsilon_{it} \tag{3}$$

τ_t is captures the effect of cost-sharing kicking in at 18 for each year t. The advantage of this year-by-year estimation, is that it uncovers the yearly dynamics. For example, in 2008 not only the *type* of cost-sharing changed from a rebate to a deductible, also the *level* of cost-sharing changed from 255 euros to 150 euros. A disadvantage of year-by-year model (3) is however that the estimated coefficients τ_t are harder to interpret as they change over time. In this sense, the coefficients γ, δ in equation (2) are more intuitive.

Although not shown explicitly in equations (2) and (3), we allow for different age and year

[28] A more traditional difference-in-differences model is: $y_{it} = \theta T_{it} + \delta D_{it} + \beta \tilde{age}_{it} + \beta' T_{it} \tilde{age}_{it} + \alpha_t + \alpha_i + \epsilon_{it}$ where θ captures the effect of cost-sharing at age 18 and δ measures whether θ differs for years the deductible was in place. However, this cannot account for the size of cost-sharing, making it hard to compare the rebate and deductible properly.

[29] Other age bandwidths are estimated as well. Here, we explain our empirical strategy for 15 to 21 year olds. Our results hold across other age bandwidths. See section 7.

[30] We have also explored another approach, as described by Dalton (2014). Dalton focuses on individuals who are price sensitive at the margin, i.e., their healthcare expenditure is just below or just above the deductible. These people would benefit from reducing their health consumption. Therefore, a local effect can be found near the threshold of the deductible: a 'bump' in the distribution of healthcare costs just before the threshold and a drop just after. In our data, however, no such effect is present. See the figures in Appendix A.4.

[31] Some studies (e.g. Lee and Card (2008), Card et al. (2008), and Ferreira (2010)) suggest that standard errors must be clustered by age when conducting a regression discontinuity design with age as the running variable. If we do that, we find that the standard errors become much smaller compared with the standard errors clustered by individual. See Appendix A.5.

effects for men and women, as the trend in health expenditure over age is different for (young) men and women.[32]

5. Results

The results of model (2) are reported in Table 5. The estimated coefficient δ is larger (in absolute value) than γ in both the ordinary least squares specification and the fixed effects specification: the deductible reduces healthcare expenditure significantly more than the rebate per euro of cost-sharing. For the fixed effects estimation, one euro of the rebate leads on average to a reduction of healthcare expenditures of 27 eurocents. For one euro of the deductible, this reduction is 45 eurocents: 18 eurocents larger, slightly more than 1.5 the reduction of the rebate. The difference between these coefficients is statistically significant at a 1 percent significance level. Similar results are found for ordinary least squares estimation.

We also compare effects across sex and income categories by estimating equation (2) separately for men and women, and individuals living in areas with different average household income quintiles. Table 6 shows the estimated coefficients γ for the rebate and δ for the deductible for these groups. For both men and women, we see that δ is significantly higher than γ. Women respond significantly stronger to the rebate as well as the deductible than men. Comparing individuals living in zip code areas with different incomes, we see that people living in a low income area (quintile 1) have a big and significant difference between the effect of the rebate and the deductible. Although not in a monotone way, this difference shrinks as the average income in the area increases. For the high-income areas (quintile 5) the difference is no longer statistically significant. This suggests that people with high-income do not respond differently to a rebate and a deductible.

The estimated coefficients τ_t of the year-by-year model (3) are reported in Table 7. Although the size of the deductible in year 2008-2011 is lower than the rebate, the estimated effects τ_t for 2008-2011 are not statistically different from 2006 and 2007.[33] In 2012 the size of deductible is still below the rebate, with 220 and 255 euros respectively, but they are comparable in size. The effect of the deductible in 2012 is, however, significantly larger than the effect of the rebate

[32] To illustrate, the full specification of (2) becomes $y_{it} = \gamma r_t R_{it} + \delta d_t D_{it} + \beta \tilde{age}_{it} + \zeta \tilde{age}_{it} * male + \beta' T_{it} \tilde{age}_{it} + \zeta' T_{it} \tilde{age}_{it} * male + \alpha_t + \omega_t * male + \alpha_i + \epsilon_{it}$ where $male$ denotes a binary variable for male. As equation (2) and (3) are easier to read, we refer to those equations.

[33] The lower panel in Table 7 lists all differences between the coefficients of the rebate and deductible as reported in upper panel with fixed effects. We see that the coefficients do not differ much for the rebate and deductible up to 2011. An F-test shows that up to 2011 the estimated coefficients did not differ significantly from each other, using a 1 percent significance level.

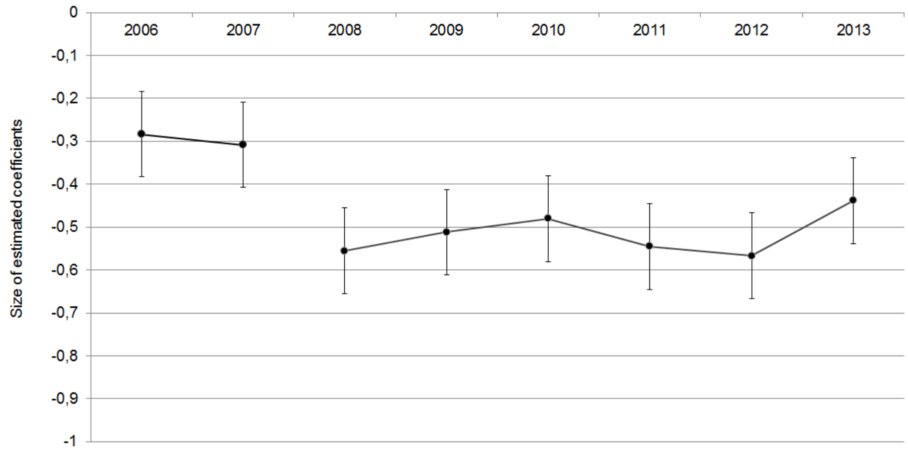


Figure 3: Estimated τ_t coefficients scaled by cost-sharing size and their 95% confidence intervals

in 2006 and 2007. Hence, the effect of the deductible on health care expenditure is bigger than for the rebate; in line with the comparison of γ and δ above. In 2013, the deductible of 350 euros exceeds the rebate and –as one would expect– the estimated treatment effect is bigger (in absolute value) than for 2006 and 2007.

Model (2) imposes a linear relationship in the size of cost-sharing. Figure 3 shows that this assumption is reasonable: if we scale the τ_t coefficients from model (3) by the size of cost-sharing we see a linear horizontal pattern between 2008 and 2013. The estimated coefficients are not significantly different from each other at a 5% significance level.[34]

To conclude: the deductible is more effective in reducing healthcare expenditures than the rebate. We observe this for both men and women. Persons living in low income areas do not respond strongly to a rebate but do respond to a deductible. The next section explores a number of reasons that may explain the differential response of individuals to a rebate and a deductible.

6. Mechanisms

We first present a standard model where a deductible and rebate lead to the same choices by the consumer. Then we present a number of deviations from the standard model which explain why a deductible reduces healthcare expenditure more than a rebate. Our results suggest that budget constraints play a role.

[34]The τ_t coefficients scaled by the size of cost-sharing were computed by estimating: $y_{it} = \tau_t d_t T_{it} + \beta a\tilde{g}e_{it} + \beta' T_{it} a\tilde{g}e_{it} + \alpha_t + \alpha_i + \epsilon_{it}$

6.1. Standard rational framework

With a standard utility function and no imperfections in consumer behavior or on the insurance market, consumer behavior should be the same under a deductible and a rebate. This can be seen as follows. Consider a consumer with initial wealth w who has bought insurance with a deductible D at a premium equal to σ. For ease of exposition, we assume that financial utility u (e.g. utility derived from consuming other goods) and health utility v are additively separable. Hence, overall utility is of the form $u + v$. We assume that the patient is offered only one treatment per period with utility v which is drawn from some distribution defined on $\mathbb{R}_+$. The patient decides whether to be treated or not.

Assume that the patient is offered a treatment with value v at a cost equal to $y \in [0, D]$.[35] She decides to undergo the treatment if:

$$u(w - \sigma - y) + v \geq u(w - \sigma). \tag{4}$$

Now consider the same consumer buying health insurance with a rebate D. That is, if her healthcare expenditures y are below D, she receives a bonus at the end of the period equal to $D - y$. For the insurance market to be able to finance this bonus, the premium σ needs to be increased with D, assuming that the rebate leads to the same healthcare expenditure as the deductible, as indeed it will in this model. Further, assume that all these payments are close enough together in time that no discounting is needed. Then the consumer accepts the treatment if:

$$u(w - (\sigma + D) + D - y) + v \geq u(w - (\sigma + D) + D). \tag{5}$$

Clearly, the trade offs are the same under the deductible and the rebate. Hence, a treatment is accepted under the rebate if and only if it is accepted under the deductible. According to this model, healthcare expenditures are the same under the rebate and the deductible.

6.2. Prospect theory

As a first explanation of the difference between healthcare expenditure under rebate and deductible, we discuss Kahneman and Tversky (1979), Johnson et al. (1993), and Thaler (1999). We present a simple model in this vein to show that treatments exist that are consumed if a person faces a rebate but not in case of a deductible. Accordingly, healthcare expenditure will be lower with a deductible than a rebate of the same magnitude D.

Figure 4 plots the value function of financial utility under prospect theory, $u(.)$. In a system with deductible D, if a patient decides to accept a treatment with value v and costs $y \in \langle 0, D \rangle$,

[35] For costs $y > D$, the expressions below are valid with $y = D$, both for the deductible and the rebate case.

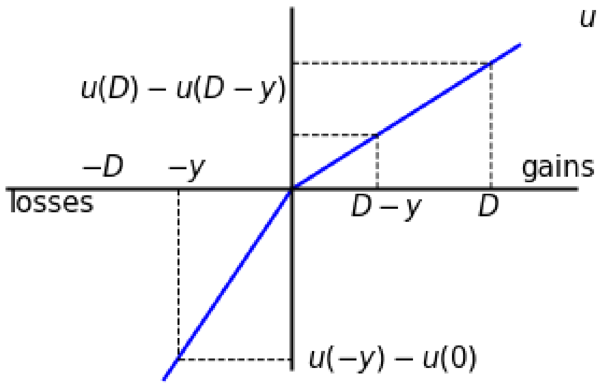


Figure 4: Value function $u(.)$ of an individual facing either deductible or rebate of D (based on Kahneman and Tversky (1979)).

then he or she will pay y. This can be considered as a financial loss compared to the status quo of not paying for treatment, which is depicted in the left half of the quadrant in Figure 4.[36] Costs y of the treatment lead to value $u(-y) < 0$. Therefore, a patient will only choose to be treated if $u(-y) + v > u(0)$ or equivalently, $v > u(0) - u(-y)$.

If the same patient decides to accept the treatment when a rebate is in place, this implies that she will not receive a rebate/bonus D at the end of the year, but $D - y$. In other words, the financial gain at the end of the year is reduced from D to $D - y$. Gains are depicted in the right half of the quadrant in the figure. Hence, by choosing the treatment, value from the financial gain is reduced by $u(D) - U(D - y)$. Consequently, the patient accepts treatment only if treatment utility $v > u(D) - u(D - y)$.

The idea of prospect theory is that value is increasing but less steep in gains than it is in losses (compared to the status quo), as in Figure 4. The figure shows that $u(0) - u(-y) > u(D) - u(D - y)$. Therefore, there will be treatments that a patient chooses if she faces a rebate but not under a deductible. These are treatments generating utility $v \in \langle u(D) - u(D - y), u(0) - u(-y) \rangle$. Losses (or expenditure under the deductible) have a bigger impact than gains (or expenditure under the rebate). Further, as the value function is steeper for losses than for gains, we find a similar effect for treatments with costs $y \geq D$. To be precise, the properties of Figure 4 that we need for this result are: (i) the reference/status quo point is a patient who has paid her premium

[36]To be precise, the status quo in this example is a person who has paid his or her insurance premium and who has not used any health care yet. An out-of-pocket expense due to the deductible is therefore a financial loss.

and who has not used healthcare yet and (ii) financial utility is steeper for losses than for gains (Kahneman and Tversky, 1979, pp. 279).

6.3. Discounting

If there is discounting, an intuitive effect is caused by the difference in timing between rebate and deductible. With a deductible, the out-of-pocket payment is made when the treatment is received. Hence, the comparison between expenditure and health benefit is the one in equation (4). With a rebate, the bonus is received at the end of this period (beginning of next period). Let r denote the discount rate used by insurers who need to reserve $D/(1+r)$ when receiving the premium to be able to pay a bonus D at the end of the period. We denote the discount rate used by the agent by r_a. Then, the comparison for the rebate becomes:

$$u(w-(\sigma+\frac{D}{1+r})+\frac{D-y}{1+r_a})+v \geq u(w-(\sigma+\frac{D}{1+r})+\frac{D}{1+r_a}). \tag{6}$$

First consider the case where $r_a = r$. Then the D-terms drop out in this comparison. The effect that we are left with is that the price of the out-of-pocket payment equals $1/(1+r) < 1$ with a rebate. As the price falls, people consume more healthcare. This is consistent with the results we find above.

An interpretation of $r_a > r$ is the finding by Brot-Goldberg et al. (2017) that people are myopic and do not respond to end-of-year prices in healthcare but rather to spot prices. With $r_a = +\infty$, people do not respond to end-of-year prices at all. In case of the rebate, people then face a spot price of zero, but with a deductible a spot price of 1. Aron-Dine et al. (2015) and Einav et al. (2015), however, show that people are partially myopic ($r_a > 0$ but finite). One reason for such myopia is that people do not know or are not aware that under a rebate, healthcare expenditure now can affect their income in the next period. With the deductible, the connection between treatment and payment is more clearly linked and people take this into account. Again, this is consistent with our findings above.

6.4. Liquidity constraints

With discounting, as in (6) with $r = r_a$, agents can move their money "freely" between periods. This is no longer true if agents face liquidity constraints. Again assume that with the deductible all expenditures are done in the same period (with the same liquidity constraint), while with a rebate the premium is paid in this period and the rebate is received in the next period. Liquidity constraints in this form need not create a difference between expenditure under the rebate and deductible. Under the rebate people pay an additional D for their insurance premium. If they are prudent enough to set the same amount D aside under a deductible, they can spend the same on healthcare under both systems.

However, if they are not this prudent and spend more on other (consumption) goods under the deductible in the first period, they can run into liquidity problems. When they fall ill, they do not have the resources to pay the out-of-pocket payment with the deductible in this period. In contrast, with the rebate the out-of-pocket payment has already been sunk in terms of a higher premium σ. The effect of a reduced bonus only comes in the next period. Hence, the treatment can be accepted in this period.

As such, a combination of liquidity constraints and a lack of prudence leads to the prediction that healthcare expenditure is higher under a rebate than under a deductible. Moreover, one expects this effect to be stronger for lower income households as liquidity constraints are more likely to be binding for them. Indeed, this is what we find in Table 6. For the low income quintiles, the difference between the effects of a rebate and a deductible is bigger than for high income quintiles.

Note that even if agents are prudent, liquidity constraints may still lead to higher healthcare expenditure under a rebate scheme than under a deductible if we consider more sub-periods. Marzilli Ericson and Sydnor (2018) introduce a model where health insurance premiums and out-of-pocket payments can be paid on a monthly basis. If a liquidity constrained agent faces high out-of-pocket payments, e.g. she exhausts her deductible entirely, at the beginning of the year, then she may not have been able to put aside the full amount D. In the Dutch context, this is less likely as health insurers tend to offer payment plans for people who cannot pay their bills in full at once. They can then distribute the out-of-pocket payment over multiple months, which smooths out the out-of-pocket payment shock over the year.

6.5. Drawing conclusions from our results

We cannot pinpoint exactly which of the mechanisms above contributes most to the difference between the rebate and deductible, but our data and results give some suggestions. We do an additional analysis in which we consider three healthcare categories and five income classes. We have chosen the three categories with the following (tentative) interpretation in mind. Hospital care is expensive and often seen as high value care. If there are binding budget constraints for low income people, one would expect to see this for hospital care. Physiotherapy tends to be cheap and people can judge for themselves whether it is working or not and to which extent it relieves problems that they face. Hence, financial incentives can play a role when a patient considers whether to go for a 7th or 8th session with her physiotherapist. Finally, pharmaceutical care in the Netherlands can only be bought when prescribed by a physician. It is harder for a patient to judge the value of taking a certain drug but the fact that it is prescribed by a physician may give the idea of high value care at an (often) relatively low price.

Since pharmaceutical care and physiotherapy are low cost, we do not expect budget constraints to play a role. Hence, the reaction to rebate and deductible should be similar for low and high income quintiles. For prospect theory and discounting there is a range of treatment values such that treatment is accepted under the rebate but not the deductible. As we view drugs prescribed by a physician to be high value care, we expect most treatment values to lie above the critical value for the deductible. Hence, the switch between rebate and deductible should not have much effect on the use of drugs. As physiotherapy sessions continue, the incentive to stop (early) will tend to be higher under a deductible than under a rebate; both under prospect theory and a model with discounting. If for hospital care budget constraints are important, we expect the difference between the rebate and deductible effects to be bigger for low income than high income people.

Table 8 shows the coefficients γ, δ for these different healthcare categories and income quintiles. There is basically no significant effect of the deductible or rebate on pharmaceutical expenditures for any income quintile. This is in line with our interpretation above that pharmaceutical care is good value for money. For physiotherapy the effects are significant and for each income quintile the effect is stronger for the deductible than for the rebate. The difference between the deductible and rebate effect is around 0.07 for each income category. This is in line with prospect theory or discounting. For hospital care, the difference between the deductible and the rebate effect is big and significant for the lowest income quintile but not significant for the highest quintile (and the others in between). This suggests that liquidity constraints play a role. Focusing on the fixed effect estimations, the difference in the effects is approximately 0.20 for quintile 1 and 0.04 (and insignificant) for quintile 5.

Although more analysis is needed here on more detailed data than we have access to, we find the following tentative results. For physiotherapy there is a difference between the rebate and deductible that is consistent with either prospect theory or discounting. For hospital care, there are indications that budget constraints cause low income people to consume less of it under a deductible than a rebate.

7. Robustness analyses

In this section, we test the robustness of our results by checking a number of our assumptions, performing different sample selections, rescaling variables to analyze possible price level effects and documenting fictional discontinuities. On the whole, we find that our conclusion –a deductible is more effective in reducing healthcare expenditure than a rebate of similar size– is robust.

7.1. Functional forms and bandwidths

In Section 5, we assume that expenditure is linear in age allowing for a different slope before (β) and after (β') the discontinuity. The fit of the estimated model to the raw data, as presented in Figure 5, shows that this linear specification is appropriate. To get the best specification, we formally test for five other functional forms: no age specification, linear, quadratic, as well as these forms including an interaction allowing for a different slope before and after the discontinuity.[37]

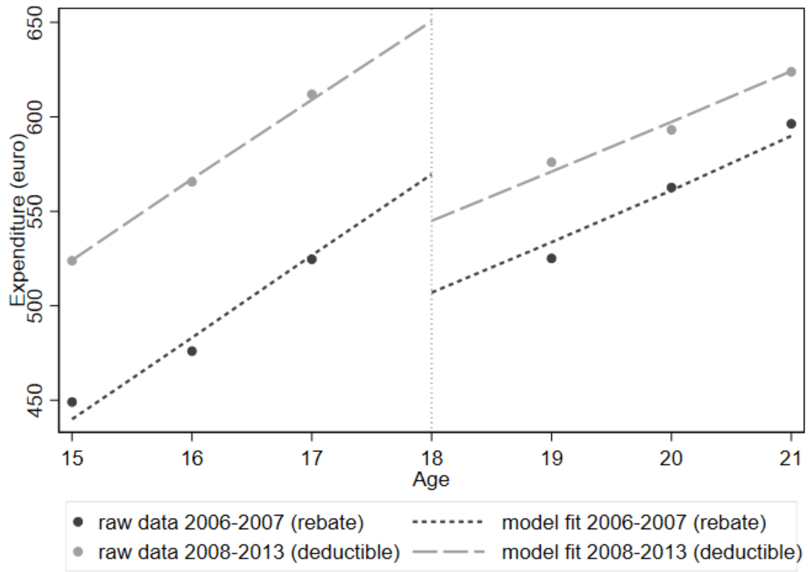


Figure 5: Model fit to raw data

To identify the best functional form, we follow Jacob et al. (2012) and Lee and Lemieux (2010) and estimate the simplest functional form –no age specification– up to the most flexible form.[38] Appendix A.6 and A.7 show the results for ordinary least squares and fixed effects estimations respectively of year-by-year model (3) for five different functional forms and a one-, two-, three-, and five-year age bandwidth. The results in bold indicate the best specification

[37] Table A.6 presents the results of the different functional forms. We also tested the cubic, quartic, and quintic forms but do not report these as they do not improve the specification.

[38] Jacob et al. (2012) and Lee and Lemieux (2010) argue that each functional form must be estimated twice: once 'normally', as described above (restricted model), and once including age dummies (unrestricted model). If the latter model significantly improves the former, then this means that the restricted model is too limited and a more flexible model is baseline. This process must be repeated until the unrestricted model is no longer better than the restricted model in the sense that an F-test, which tests whether the age dummies are jointly significant, is no longer significant (Jacob et al., 2012).

given a bandwidth. The linear specification with an interaction term is the best functional form for a two- and three-year age bandwidth, so we chose this functional form as our baseline specification. Given the narrow bandwidth, it may not be surprising that a linear specification performs best. Appendix A.6 and A.7 also show that a quadratic specification with interaction term is best for a five-year age bandwidth. Our findings are very similar for the five-year age bandwidth and overall, the coefficients are quite stable throughout different bandwidths and functional forms.

The results of model (2) are also stable when different age bandwidths are used. The difference between the effect of the rebate and the deductible is at least 13 cents and always significant at 1% significance level across all specifications in Table 9. Our conclusion that the deductible has a bigger effect on consumption than a rebate of a similar magnitude is robust with respect to our bandwidth choice.

7.2. Balancing tests

An important assumption for our empirical strategy is that discontinuities at 18, other than the rebate or deductible, may occur as long as they are constant over time (see Section 4). Below we show important potential causes of discontinuities at 18, revealing that they are indeed constant over time, and therefore do not invalidate our design.

The first potential factor is the share of persons moving at 18. Many students in the Netherlands graduate from secondary education ('voortgezet onderwijs') at 18 and continue their education at university. Within this group, a relatively large share moves out of their parental home. Moving out often coincides with changes in income and life style, which may affect healthcare expenditure. Our data show a small jump in the number of people who move at 18, compared with 17. However, this jump is constant over time and will therefore not affect our results. To prove this with our data, we exclude all people from our sample who at one point moved between 2006 and 2013 and reestimate our model. The results are reported in Appendix A.8. The estimated coefficients do not change much: for fixed effects estimation the effect of the rebate is -0.27 and for the deductible -0.44 when persons who move are excluded, compared to -0.27 and -0.45 for the baseline specification.

Statistics Netherlands offers population data on education levels of individuals by age and year.[39] Appendix A.9 reports the share of individuals at each level of education: secondary education, vocational education, university of applied sciences and university.[40] Again, there

[39]We can use and compare these data with our own data, because they are both based on the whole Dutch population, but are not allowed to merge the datasets.

[40]In Dutch secondary education is 'voorgezet onderwijs,'vocational education is 'middelbaar beroepsonderwijs,' university of applied sciences is 'hoger beroepsonderwijs,' and university is 'wetenschappelijk onderwijs.' These

are differences for persons below 18 and above 18 years old, but these are not very different between 2006-2007 and 2008-2013.

7.3. Sample selections

As described in Section 3 several groups of persons and healthcare categories are excluded from the baseline specification: persons who choose a voluntary deductible at least once between 2006 and 2013, persons who have any mental healthcare costs between 2006 and 2013, and dental costs.

To test the impact of excluding persons with any mental healthcare on our results, we reestimate our baseline regression including these individuals, but excluding their mental healthcare expenditures. Recall from Section 3 and Appendix A.1 that coverage of mental healthcare in the basic package has varied substantially over time. Hence, comparing healthcare expenditures including mental care expenditures over time may give untrustworthy results. The results are reported in Appendix A.8. The fixed effects coefficients are very robust: the effect of the rebate (γ) is -0.26 and the effect of the deductible (δ) is -0.48, compared to -0.27 and -0.45 of the baseline specification. The individual fixed effects pick up differences in net-rebate or net-deductible after mental care expenditures have been accounted for. The ordinary least squares estimates are affected by introducing users of mental care: we find a coefficient of -0.23 for the rebate and -0.32 for the deductible. The differences between γ and δ is for ordinary least squares estimation as well as fixed effects estimation highly significant at a 1% significance level.

To illustrate the problem of changes in coverage over time and motivate why we excluded dental costs from our dependent variable, let's consider these costs. In 2008, 2009 and 2010 the deductible for dental care did not kick in at 18 but at 21. If we estimate the year-by-year model (3) for healthcare expenditure including dental costs, this change in coverage is clearly visible. To understand the pattern of estimated coefficients, consider Figure 6. This simple illustration is drawn under the following assumptions. First, for the ages drawn, everyone has the same dental expenditure if they face the same cost sharing (ignoring possible interaction effects with other healthcare expenditure). Hence, below 18 we see a parallel shift upwards in expenditure if we include dental care: from the blue dots to the green squares. In the years 2008, 2009, 2010, the deductible for dental care kicked in at 21 (instead of 18). Hence, the difference between the blue dots and the red diamonds at ages 19 and 20 is equal to the difference for the below 18s. From 21 onwards, the deductible for dental care causes a fall in dental costs. In the years 2006, 2007, 2011, 2012, 2013, the deductible for dental care coincided with the normal deductible at 18. This is indicated by the purple crosses, which coincide with the red diamonds for ages 21 and

education levels do not overlap, e.g. university of applied sciences and university are two different levels.

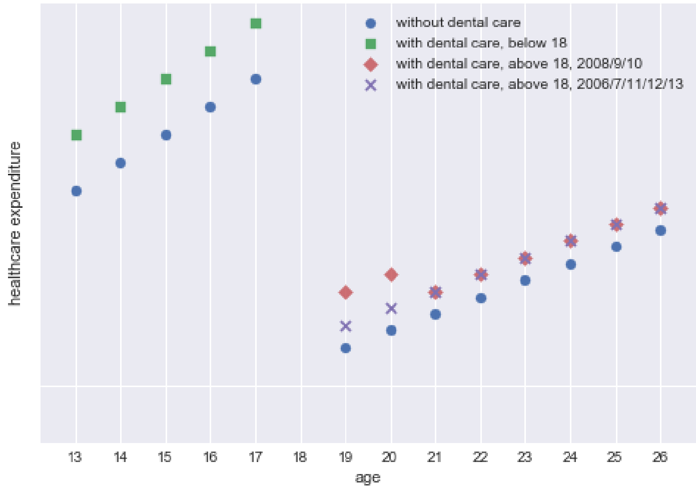


Figure 6: Illustration of healthcare expenditure with and without dental costs for different years

older. Hence comparing our results without dental care in Table 7 with the table in Appendix A.10 that includes dental care we see the following pattern. For the years 2008, 2009, and 2010, when the 'dental care deductible' kicked in at 21, we find comparable year effects in the fixed effect estimation between an estimation with and without dental costs. But for the other years, the differences are at least equal to 100 euros: the difference between the green squares and the purple crosses in Figure 6. Note that comparing the years 2006 and 2007 with 2012 (when cost-sharing was comparable in magnitude), the effect is bigger with a deductible than with a rebate also when including dental costs.

Persons who choose at least once a voluntary deductible are also omitted from the baseline model. Including them in the analysis does not change the results: for fixed effects estimation, we find a γ coefficient of -0.26 and a δ coefficient of -0.44. The difference between γ and δ is significant at a 1% significance level. The difference between γ and δ becomes larger for ordinary least squares estimation: γ is -0.16 and δ is -0.50.

7.4. Anticipatory behavior

The identification strategy in this paper exploits that persons below the age of 18 do not face the rebate or deductible and therefore can be used as a control group. However, persons at the age of 17 may already react to the rebate and deductible by consuming more healthcare consumption before they turn 18, when it is still free. Anticipatory behavior or timing of healthcare consumption in response to cost-sharing is established and can be substantial (see for example Einav et al. (2015) for Medicare Part D, and Cabral (2013) for dental care in the United States). And this anticipatory behavior could be different for a rebate than a deductible. We expect that anticipatory behavior will be at its highest in the year that persons turn 18. This is one of the reasons why in our baseline specification we remove from our data persons who turn 18 in a given year. As an additional robustness check, we also exclude persons who turn 17 in a given year. Appendix A.8 shows the results of estimations of equation (2) in which 17 and 18 year olds are excluded from the sample. δ is significantly higher than γ at a 1% significance level for both ordinary least squares and fixed effects estimation and thus, anticipatory effects at 17 do not explain the different effects between a rebate and deductible. For ordinary least squares we find γ is -0.11 and δ is -0.33 and for fixed effects estimation we find γ is -0.23 and δ is -0.40.

7.5. Price level effects

In our analysis, we estimate the effects of the rebate and deductible over the years 2006-2013. Treatment prices may vary over these years. To illustrate, prices fall with the introduction of generic drugs and prices tend to rise when an old treatment is replaced by newly developed drugs. In principle, time fixed effects will correct for price changes. To check if somehow price changes still bias the results over the years, we perform the following test. We scale each year's health expenditures with the ratio of average healthcare expenditure for 17 year olds in that year and the average healthcare expenditure of 17 year olds for all years (unfortunately we do not have treatment prices in our data and cannot perfectly adjust them). To illustrate, the average health expenditures of 17 year olds in 2006 are 0.8 times the average healthcare expenditures of 17 year olds between 2006 and 2013. Assuming that treatment quantities did not change (much) for 17 year olds over the years, prices were relatively low in 2006. The idea is that the development of expenditures for 17 year olds is not affected by the development of rebate and deductible and represents a "truer" price effect. We divide the healthcare expenditures for all age groups in 2006 by 0.8 and similarly for other years.

Appendix A.11 shows the results of the estimation with these rescaled variables. The differences between the coefficients of the rebate and the deductible remain.

7.6. Fictional discontinuities

A regression discontinuity design should only measure an effect on healthcare expenditure at 18 with the switch from no-treatment to treatment group. If our specified model (3) works properly it should therefore only pick up an effect at the actual discontinuity at 18, not at other ages. We ran our model numerous times assuming fake or placebo discontinuities, at other ages than 18.[41] For example, in Appendix A.12 we show the estimation results when we assumed a discontinuity at age 24. Of course, we know that there was no discontinuity at that age, and, consequently, our model should not pick up any effects. In contrast to our results in the paper, we find only small coefficients with positive as well as negative signs. Moreover, except for 2008, all coefficients are insignificant for the fixed effects estimation. In Appendix A.13, the τ_t coefficients are graphically shown for multiple fictional discontinuities from ages 10 to 50 and for all years 2006-2013.[42] The figure shows variation in the estimated coefficients for the placebo tests. The coefficients of the real discontinuity, at 18, are clearly distinguishable from the placebo discontinuities. These results suggest that our estimates in the paper are strongly related to the discontinuity of the deductible or rebate at age 18.

[41] To clarify, the analyses in this section are solely a test of the specification of our model. We do not conduct a real placebo test in the sense that we used a control group.

[42] We did not include placebo discontinuities in the bandwidth of our baseline specification, from 15 to 21, as they may pick up the effect at 18.

8. Concluding remarks

In this study, we compare the effect of the rebate (in 2006 and 2007) and the deductible (from 2008 to 2013) on healthcare spending of 18 year olds in the Netherlands. Our main result is that people respond in significantly different ways to a rebate than to a deductible: one euro of a rebate reduces healthcare expenditures by 18 cents less than one euro of a deductible. The results are also robust to multiple specifications of the model and not driven by anticipatory or price level effects. Our difference-in-differences approach relies on a discontinuity at the age of 18. Hence, our estimated effects are local and apply to 18 year olds. They may not be generalized to other ages or the whole population.

Three possible explanations for these results are discussed in this paper: prospect theory, discounting, and liquidity constraints. With our data and analyses we cannot determine which of these explanations contributes most to the differences we find. However, our comparisons of persons living in an area with the lowest and highest average household income quintile suggest that liquidity constraints can be important for hospital care. Persons with a high income (no liquidity problems expected) do not respond in significantly different ways to the rebate or deductible, whereas persons with a low income do. The latter do not respond strongly to the rebate but do respond strongly to the deductible.

This study, together with the work of Stockley (2016) and Newhouse (1993), is important for policy making in healthcare as it compares different cost-sharing designs. Small differences in the design of cost-sharing schemes lead to significantly different effects on healthcare expenditures. Unfortunately we cannot determine the optimal form of cost-sharing as we cannot measure the effects of the rebate and deductible on welfare, health status, or quantity of care, nor can we determine with any precision whether people reduce wasteful or valuable care. Our results suggest that if policymakers' priority is to reduce expenditure and to offer a low health insurance premium, then a deductible is more effective than a rebate. Nevertheless, policymakers may favor a rebate if they are concerned that a deductible discourages (low income) individuals from using necessary care.

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Tables

Table 2: List of healthcare expenditure categories

Type of costs	Apply to deductible or rebate	Included in y_{it}
GP registration		
GP visits		
Other costs of GP care		
Pharmaceutical care	X	X
Dental care	X	
Obstetrical care		
Hospital care	X	X
Physiotherapy	X	X
Paramedical care	X	X
Medical aids	X	X
Transportation for persons lying down	X	X
Transportation for seated persons	X	X
Maternity care		
Care that is delivered over the Dutch borders	X	X
Primary healthcare support		
Primary mental healthcare support		
Mental healthcare with (overnight) stay	X	
Mental healthcare without (overnight) stay:		
- at institutions	X	
- by self-employed providers	X	
Other mental healthcare costs	X	
Geriatric revalidation	X	X
Other costs	X	X

Notes: Cost categories marked with X in the second column apply to the rebate or deductible. The other cost categories are exempted from these cost-sharing schemes. y_{it} in the third column refers to the dependent variable in our baseline specification. See equation (3) in Section 4. The cost categories marked with an 'X' in the third column are included in y_{it} for the analyses in, for example, Table 7.

Table 3: Descriptive statistics of baseline sample

	15 to 17 years old		19 to 21 years old	
	rebate	deductible	rebate	deductible
Healthcare with cost-sharing (€)	481	557	533	589
	(3079)	(3719)	(3272)	(3294)
Of which:				
Hospital care (€)	322	373	399	436
	(2569)	(3211)	(2998)	(2866)
Physiotherapy (€)	24	40	5	8
	(115)	(156)	(86)	(110)
Pharmaceutical care (€)	88	89	90	97
	(1241)	(1289)	(703)	(1101)
Other care with cost-sharing (€)	46	55	38	47
	(480)	(679)	(378)	(506)
Age (years)	16	16	20	20
	(0.82)	(0.82)	(0.82)	(0.82)
Male (%)	0.52	0.51	0.51	0.52
	(0.50)	(0.50)	(0.50)	(0.50)
Diagnosis cost related group (%)	0.00	0.01	0.00	0.02
	(0.03)	(0.09)	(0.05)	(0.13)
Pharmaceutical cost related group (%)	0.03	0.02	0.03	0.03
	(0.16)	(0.15)	(0.17)	(0.16)
Standardized household income quintile	3.12	3.21	2.93	2.93
	(1.39)	(1.37)	(1.41)	(1.43)
Observations	756,237	2,578,967	812,569	2,406,300

Notes: Standard deviations are reported between parentheses. The mean values are calculated for 2006 and 2007 (rebate) and 2008 to 2013 (deductible). All the differences between characteristics are all significant at a 1% significance level. The only exception for the difference in pharmaceutical care between the rebate and the deductible is not significant for 15 to 17 year olds (i.e. the second vs the third column) and the difference between 15 to 17 year olds and 19 to 21 year olds in years the rebate was in place (i.e. the second vs the fourth column). The extremely small p-values are a result of the large sample size: even very small differences are highly significant. Healthcare expenditure with cost-sharing excludes users of mental care between 2008 and 2013, dental healthcare costs, and individuals with a voluntary deductible. Household income is the average standardized disposable household income. Quintile 1 is the lowest quintile and quintile 5 is the highest quintile. This is the sample of our baseline specification.

Table 4: Parallel trends assumption test

	15 - 21 year olds OLS	15 - 21 year olds FE	16 - 20 year olds OLS	16 - 20 year olds FE	17 - 19 year olds OLS
β_{2006} * treatment	**13.77***	**13.44**	**9.83**	**9.13**	**1.29**
	(8.21)	(8.90)	(10.44)	(13.49)	(18.30)
β_{2007} * treatment	-	-	-	-	-
β_{2008} * treatment	-14.96**	-13.35	-20.04*	-18.35	0.15
	(7.59)	(8.58)	(10.73)	(13.18)	(17.84)
β_{2009} * treatment	-28.50***	-16.63	-28.53**	-32.19*	-39.02**
	(8.77)	(10.39)	(12.50)	(17.86)	(19.24)
β_{2010} * treatment	-25.94**	-25.47**	-37.45***	-38.84*	-23.64
	(10.47)	(12.46)	(12.81)	(20.36)	(16.88)
β_{2011} * treatment	-28.63***	-47.81***	-32.86***	-43.56**	-22.03
	(11.02)	(13.33)	(12.54)	(21.32)	(17.58)
β_{2012} * treatment	-49.58***	-89.66***	-53.91***	-102.60***	-78.53***
	(12.64)	(17.11)	(14.75)	(28.43)	(22.67)
β_{2013} * treatment	-67.99***	-126.33***	-66.31***	-137.16***	-40.06**
	(11.96)	(17.09)	(13.37)	(30.65)	(18.97)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	No	Yes	No	Yes	No

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation. A one-year age bandwidth could not be estimated with individual fixed effects estimation. Other coefficients are available upon request. 2007 is reference category

Table 5: Results of scaled estimations

	OLS	FE
γ (rebate)	-0.17***	-0.27***
	(0.03)	(0.03)
δ (deductible)	-0.40***	-0.45***
	(0.03)	(0.03)
Age centered	Yes	Yes
Age centered * male	Yes	Yes
Age centered * treatment	Yes	Yes
Age centered * treatment * male	Yes	Yes
Year dummies	Yes	Yes
Individual fixed effects	No	Yes
Constant	Yes	Yes
Observations	6,678,669	6,678,669
R^2	0.000	0.691
P-value of test $\gamma=\delta$	0.000	0.000

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation (see equation (2)). The dependent variable y_{it} is healthcare expenditures with cost-sharing (excluding dental care). Other coefficients are available upon request.

Table 6: Estimated coefficients γ and δ for multiple groups

	Estimated γ (rebate)		Estimated δ (deductible)		P-value of test γ=δ		Mean expenditure	Observations
	OLS	FE	OLS	FE	OLS	FE		
Baseline	-0.17***	-0.27***	-0.40***	-0.45***	0.000	0.000	568	6,678,669
	(0.03)	(0.03)	(0.03)	(0.03)				
Men	-0.13***	-0.21***	-0.35***	-0.41***	0.000	0.001	527	3,417,362
	(0.05)	(0.05)	(0.04)	(0.05)				
Women	-0.22***	-0.33***	-0.46***	-0.51***	0.000	0.001	611	3,261,307
	(0.04)	(0.04)	(0.04)	(0.05)				
Household income:								
Quintile 1 (lowest)	-0.10	-0.15*	-0.57***	-0.43***	0.000	0.001	560	1,264,843
	(0.07)	(0.08)	(0.09)	(0.09)				
Quintile 2	-0.08	-0.26***	-0.37***	-0.39***	0.000	0.088	570	1,244,994
	(0.07)	(0.07)	(0.07)	(0.07)				
Quintile 3	-0.21***	-0.26***	-0.34***	-0.47***	0.027	0.005	572	1,350,469
	(0.06)	(0.06)	(0.07)	(0.07)				
Quintile 4	-0.22***	-0.25***	-0.35***	-0.41***	0.037	0.041	566	1,395,225
	(0.06)	(0.07)	(0.06)	(0.07)				
Quintile 5 (highest)	-0.26***	-0.38***	-0.34***	-0.49***	0.245	0.203	573	1,362,477
	(0.07)	(0.07)	(0.06)	(0.07)				

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation. The dependent variable y_{it} is the same as in Table 5. The Table shows the estimated coefficients of γ and δ. The estimated coefficients of the other variables are available upon request.

Table 7: Results of year-by-year estimation

	OLS	FE
τ_t (rebate)		
2006	-56.47***	-72.25***
	(8.85)	(13.28)
2007	-68.86***	-78.55***
	(9.09)	(11.19)
τ_t (deductible)		
2008	-83.25***	-83.36***
	(9.03)	(9.67)
2009	-97.41***	-79.36***
	(8.26)	(8.44)
2010	-95.20***	-79.23***
	(8.10)	(9.03)
2011	-99.35***	-92.60***
	(8.45)	(10.09)
2012	-119.47***	-124.74***
	(11.21)	(14.91)
2013	-136.71***	-153.29***
	(9.79)	(15.55)
Age centered	Yes	Yes
Age centered * male	Yes	Yes
Age centered * treatment	Yes	Yes
Age centered * treatment * male	Yes	Yes
Year dummies	Yes	Yes
Individual fixed effects	No	Yes
Constant	Yes	Yes
Observations	6,678,669	6,678,669
R^2	0.000	0.687

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation (see equation (3)). The dependent variable y_{it} is the same as in Table 5. Other coefficients are available upon request.

	τ_{2006}	τ_{2007}
Difference with:		
τ_{2006}	-	6.30
τ_{2007}	-6.30	-
τ_{2008}	-11.11	-4.81
τ_{2009}	-7.11	-0.81
τ_{2010}	-6.98	-0.68
τ_{2011}	-20.35	-14.05
τ_{2012}	-52.49**	-46.19**
τ_{2013}	-81.04***	-74.74***

Notes: The lower panel reports the differences between the τ coefficients presented in the upper panel. In the first two columns, we show the difference between τ_{2006} and the τ values of the other years. The last column shows the difference with τ_{2007}. The coefficients are estimated with individual fixed effects. τ_{2012} and τ_{2013} are significantly different, at a 1% significance level, from τ_{2008}- τ_{2011}.

Table 8: Estimated coefficients γ and δ for household income quintiles and healthcare categories

	Estimated γ (rebate)		Estimated δ (deductible)		P-value of test γ=δ		Mean expenditure	Observations
	OLS	FE	OLS	FE	OLS	FE		
Hospital care								
Quintile 1 (lowest)	-0.09	-0.10	-0.46***	-0.29***	0.000	0.014	409	1,264,843
	(0.06)	(0.07)	(0.08)	(0.09)				
Quintile 2	-0.02	-0.12*	-0.21***	-0.23***	0.001	0.147	406	1,244,994
	(0.06)	(0.07)	(0.07)	(0.07)				
Quintile 3	-0.16***	-0.15***	-0.25***	-0.30***	0.064	0.041	402	1,350,469
	(0.05)	(0.06)	(0.05)	(0.07)				
Quintile 4	-0.13**	-0.14**	-0.22***	-0.23***	0.106	0.179	395	1,395,225
	(0.05)	(0.07)	(0.05)	(0.06)				
Quintile 5 (highest)	-0.17***	-0.21***	-0.17***	-0.25***	0.954	0.666	398	1,362,477
	(0.06)	(0.07)	(0.05)	(0.06)				
Physiotherapy								
Quintile 1 (lowest)	-0.04***	-0.05***	-0.09***	-0.11***	0.000	0.000	14	1,264,843
	(0.00)	(0.00)	(0.00)	(0.00)				
Quintile 2	-0.06***	-0.08***	-0.12***	-0.14***	0.000	0.000	20	1,244,994
	(0.00)	(0.00)	(0.00)	(0.00)				
Quintile 3	-0.06***	-0.09***	-0.14***	-0.16***	0.000	0.000	24	1,350,469
	(0.00)	(0.00)	(0.00)	(0.00)				
Quintile 4	-0.07***	-0.09***	-0.14***	-0.16***	0.000	0.000	26	1,395,225
	(0.00)	(0.00)	(0.00)	(0.00)				
Quintile 5 (highest)	-0.07***	-0.10***	-0.15***	-0.17***	0.000	0.000	28	1,362,477
	(0.00)	(0.00)	(0.00)	(0.00)				
Pharmaceutical care								
Quintile 1 (lowest)	0.03	0.02	0.00	-0.01	0.485	0.374	92	1,264,843
	(0.02)	(0.02)	(0.03)	(0.02)				
Quintile 2	-0.01	-0.04**	-0.02	-0.01	0.883	0.167	94	1,244,994
	(0.02)	(0.02)	(0.02)	(0.02)				
Quintile 3	0.02	0.01	0.05*	0.01	0.164	0.981	94	1,350,469
	(0.02)	(0.02)	(0.03)	(0.02)				
Quintile 4	-0.01	-0.01	0.01	0.00	0.163	0.390	93	1,395,225
	(0.02)	(0.01)	(0.01)	(0.01)				
Quintile 5 (highest)	0.02	-0.03*	0.01	-0.03	0.803	0.951	96	1,362,477
	(0.02)	(0.02)	(0.02)	(0.02)				

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation, and FE individual fixed effects estimation. The Table shows the estimated coefficients of γ and δ.The estimated coefficients of the other variables are available upon request.

Table 9: Results of scaled estimations for multiple bandwidths

	15-21 year olds		16-20 year olds		13-23 year olds	
	OLS	FE	OLS	FE	OLS	FE
γ (rebate)	-0.17***	-0.27***	-0.14***	-0.25***	-0.25***	-0.28***
	(0.03)	(0.03)	(0.04)	(0.05)	(0.02)	(0.02)
δ (deductible)	-0.40***	-0.45***	-0.37***	-0.46***	-0.39***	-0.42***
	(0.03)	(0.03)	(0.04)	(0.05)	(0.02)	(0.02)
Age centered	Yes	Yes	Yes	Yes	Yes	Yes
Age centered * male	Yes	Yes	Yes	Yes	Yes	Yes
Age centered * treatment	Yes	Yes	Yes	Yes	Yes	Yes
Age centered * treatment * male	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	No	Yes	No	Yes	No	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,678,669	6,678,669	4,386,799	4,386,799	11,045,569	11,045,569
R^2	0.000	0.691	0.000	0.726	0.001	0.641

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation (see equation (2)). The dependent variable y_{it} is the same as in Table 5. The difference between γ and δ is significant at a 1% significance level across all specifications. Other coefficients are available upon request.

A. (Online) Appendix

A.1. Overview of policy changes between 2006 and 2013

Year	Policy change
2006	Introduction of managed competition 'Health Insurance Act' (Zvw)
2006	Agreement to curb pharmaceutical costs (extension of 'preferentiebeleid geneesmiddelen')
2006	**Introduction of rebate of 255 euros**
2007	Abdominoplasty (for severe cases) is included in basic package
2007	Psychotherapy (for severe cases) is included in basic package
2007	First IVF treatment (of maximum 3) is included in basic package
2008	**Introduction of mental healthcare in 'Health Insurance Act' (Zvw)**
2008	Contraceptives are included in the basic package
2008	**Limited dental care for 18 to 22 year olds included in basic package. The deductible does not apply to dental care.**
2008	Five hours of extra maternity care are included in basic package
2008	The first 8 sessions of psychological counseling are included in the basic package plus co-payment of 10 euros per session
2008	**Introduction deductible of 150 euros**
2009	Chairs to help a person stand up ('sta op stoelen'), strollers, and anti-allergen mattress covers removed from the basic benefit package
2009	Reimbursement for statins limited
2009	Sleeping pills and tranquilizers removed from the basic package
2009	Severe dyslexia diagnostics and treatment for 6 and 7 year olds included in basic package
2009	**Increase of deductible to 155 euros**
2010	Introduction of diagnosis treatment combinations (DBCs)
2010	Acetylcysteine removed from basic package
2010	Lowering of registration fee for general practitioner
2010	Severe dyslexia diagnostics and treatment for 9 year olds included in basic package
2010	More precise requirements about reimbursement of IVF treatments
2010	Maximal reimbursement of wigs increases from 294 euros to 374 euros
2010	MRA machine is reimbursed in specific cases
2010	Reimbursement of devices to ease breathing in specific cases included
2010	Anti-snoring device ('snurkbeugel') included in basic package for specific cases
2010	**Increase of deductible to 165 euros**
2011	Contraceptives for individuals aged over 21 years removed from the basic benefit package
2011	**Dental care for 18 to 21 year olds removed**

2011	Stricter indication for anti-depressants
2011	Physiotherapy limited: patient must pay for first 12 sessions (it used to be the first 8 sessions)
2011	Physical therapy for urine incontinence included in basic package
2011	Uncomplicated dental extraction by dental surgeon removed from basic package
2011	Quit smoking treatments included in basic package
2011	**Increase of deductible to 170 euros**
2012	**Additional deductible for specialist mental healthcare introduced**
2012	Gastricacid blockers removed from basic package
2012	Physiotherapy (first 20 sessions) removed from basic package
2012	Treatments to quit smoking removed from basic package
2012	Dietary advice removed from basic package
2012	Treatment of adjustment disorders (mental healthcare) removed
2012	Primary psychological care reduced from 8 to 5 sessions
2012	**Increase of deductible to 220 euros**
2013	Paracetamol-codeine combination medication removed
2013	Co-payment of 25 percent for hearing aids introduced to replace the fixed fee of 500 euros
2013	Co-payment of 7.50 euros per day for 'hotel' costs in hospital or other overnight stay
2013	Simple walking aids removed from basic package
2013	Repositioning helmet for babies removed from basic package
2013	Treatments to quit smoking included
2013	**Co-payments for specialist mental healthcare abolished**
2013	IVF treatment for women aged 43 years and over removed from basic package
2013	Geriatric rehabilitation care switched from Exceptional Medical Expenses Act (AWBZ) to Health Insurance Act (Zvw)
2013	**Increase of the deductible to 350 euros**

Notes: This list is an adaptation of Kroneman and Jong (2015). We have emphasized those policy changes important to our study.

A.2. Descriptive statistics of full sample after cleaning

	Mean	Minimum	Maximum
Total health care expenditure (euro)	1966	0	2253745
	(6414)		
Hospital care (euro)	1101	0	2234379
	(4838)		
Physiotherapy (euro)	28	0	34796
	(208)		
Pharmaceutical care (euro)	299	0	728415
	(1381)		
Mental health care (euro)	184	0	1217864
	(2863)		
Dental care (euro)	40	0	28002
	(221)		
Other care with cost-sharing (euro)	155	0	951926
	(917)		
Other care without cost-sharing (euro)	159	0	152028
	(281)		
Age (years)	41	0	115
	(23)		
Male (%)	0.49	0	1
	(0.50)		
Voluntary deductible (%)	0.04	0	1
	(0.21)		
Diagnosis cost-related group (%)	0.06	0	1
	(0.24)		
Pharmaceutical cost-related group (%)	0.22	0	1
	(0.41)		
Household income quintile	3.08	1	5
	(1.40)		
Number of observations	126,987,098		

Notes: Standard deviations are reported between parentheses. The category 'other care with cost-sharing' includes costs of paramedical care, medical aids, transportation costs of patients, care that is provided over the Dutch borders, geriatric revalidation, and other healthcare costs that do not apply to any of the cost categories listed in Table 2. The category 'other care without cost-sharing are maternity care, obstetrical care, primary mental health care support and GP care. The sum of hospital care, physiotherapy, pharmaceutical care and other care with cost-sharing is used as the dependent variable in the main specification. Household income is the average standardized disposable household income. Quintile 1 is the lowest quintile and quintile 5 is the highest quintile.

A.3. Data cleaning procedure

We clean our data set by excluding persons with a missing (pseudonymized) social security number, an invalid zip code, or a missing or invalid health insurance registration period.[43] We exclude observations with other administrative errors: individuals with negative healthcare expenditures and individuals with errors in their age pattern over time. In total, we remove 6,073,106 observations from our data which corresponds to 4 percent of the total number of observations.

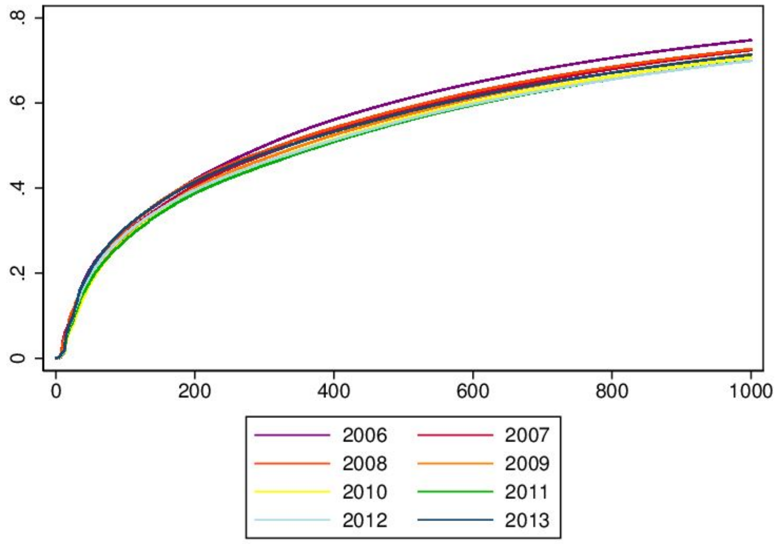
Appendix A.2 reports descriptive statistics of our data after cleaning. The data consist of 127 million observations over eight years, of which 49 percent is male and 4 percent of the population has opted for a voluntary deductible between 2006 and 2013. On average, 6 percent of the population is classified in the risk equalization as having a chronic disease and 22 percent a chronic user of medication.[44] The mean household income quintile is 3.08.[45] On average, a person in our data has 1966 euros of healthcare expenditure. The standard deviation is large, because the distribution of healthcare expenditure is highly skewed. The majority of persons in our data has no or very little healthcare expenditures, while a small number of individuals has very high expenditures. Expenditures also differ substantially per healthcare category: the average expenditures are highest for hospital care, with 1101 euros per person, and lowest for physiotherapy, with an average of 28 euros per person.

[43] The registration period is usually one year, because health insurance is compulsory and an individual can only switch in January of a given year. In some cases, an observation can have a shorter registration period if the enrollee emigrates or dies. We exclude persons with a registration period of more than one year.

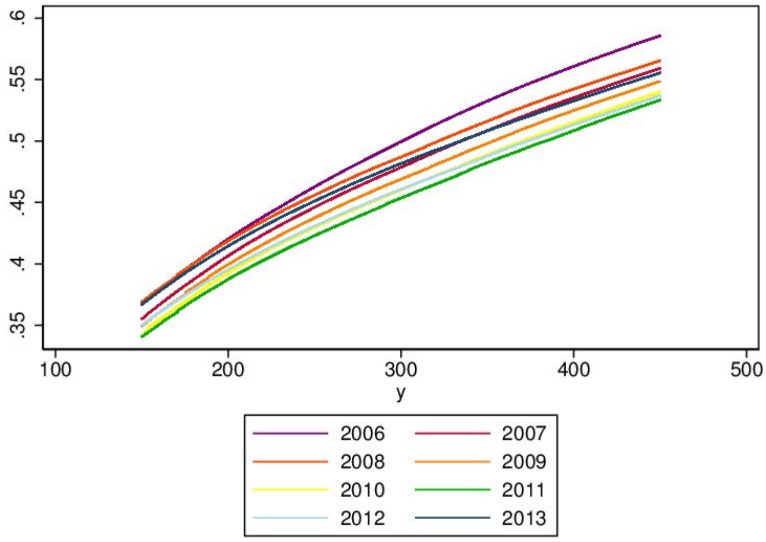
[44] The definition of diagnosis cost-related group has changed in the period of our data. The definition expanded, which increased the share of persons with a DCG. DCG is short for diagnosis cost group ('diagnosekostengroep') and indicates whether a person had high healthcare costs in the previous years. PCG is an abbreviation of pharmaceutical cost group ('farmaciekostengroep') and indicates whether a person is a chronic user of medication.

[45] That is, after cleaning the mean quintile is not exactly $(5 + 1)/2 = 3$.

A.4. Density functions expenditures



Between 0 and 1000 euros



Between 150 and 450 euros

Figure 7: Cumulative density distribution of healthcare expenditure with cost-sharing of 18-65 year olds

A.5. Standard errors for different clusters

	(1)	(2)	(3)	(4)
τ_t (rebate)				
2006	13.3	5.8	8.2	10.9
2007	11.2	5.3	6.4	9.5
τ_t (deductible)				
2008	9.7	7.3	6.4	8.7
2009	8.4	6.7	7.5	7.9
2010	9.0	5.3	7.0	8.2
2011	10.1	6.1	7.3	9.3
2012	14.9	9.6	10.0	12.2
2013	15.6	5.9	10.1	12.3

Notes: The analyses that were conducted for this Table are the same as Table 5, column (2), but vary in the way we clustered the standard errors. For all four columns, the coefficients of τ_t are the same as in column (2) in Table 7. All analyses include fixed effects and the dependent variable y_{it} is the same as in Table 5. (1) is estimated with standard errors clustered by individuals, (2) clustered by age, (3) clustered by age cohort (age x birth year) and (4) clustered by individual x age.

A.6. Results of year-by-year estimation for four age bandwidths and five functional forms (OLS)

	17-19 year olds	16-20 year olds	15-21 year olds	13-23 year olds	17-19 year olds	16-20 year olds	15-21 year olds	13-23 year olds
			2006				*2007*	
(1)	0.57	47.24***	83.24***	119.99***	-0.03	38.87***	71.22***	115.84***
	(13.28)	(8.62)	(6.90)	(5.36)	(12.60)	(8.64)	(7.38)	(5.54)
(2)	-	-59.03***	-57.13***	119.99***	-	-66.27***	-68.98***	115.84***
		(11.62)	(8.87)	(5.36)		(11.42)	(9.10)	(5.54)
(3)	-	**-58.55*****	**-56.47*****	-71.92***	-	**-66.31*****	**-68.86*****	-77.04***
		(11.60)	(8.85)	(6.68)		(11.42)	(9.09)	(6.57)
(4)	-	-58.57***	-56.53***	-70.74***	-	-66.06***	-68.56***	-76.55***
		(11.60)	(8.85)	(6.63)		(11.41)	(9.08)	(6.53)
(5)	-	-	-57.40***	**-70.92*****	-	-	-70.35***	**-76.43*****
			(16.11)	(6.63)			(15.83)	(6.52)
			2008				*2009*	
(1)	-0.33	18.30*	55.55***	105.02***	-39.18***	10.24	42.57***	108.96***
	(12.62)	(9.56)	(7.43)	(5.42)	(12.87)	(8.37)	(6.80)	(5.10)
(2)	-	-86.47***	-84.07***	105.02***	-	-94.82***	-97.86***	108.96***
		(11.90)	(9.04)	(5.42)		(11.01)	(8.26)	(5.10)
(3)	-	**-85.87*****	**-83.25*****	-88.17***	-	**-94.48*****	**-97.41*****	-85.76***
		(11.89)	(9.03)	(6.52)		(11.01)	(8.26)	(6.24)
(4)	-	-85.89***	-83.34***	-87.14***	-	-94.51***	-97.46***	-85.34***
		(11.89)	(9.03)	(6.48)		(11.01)	(8.26)	(6.23)
(5)	-	-	-84.23***	**-87.31*****	-	-	-98.41***	**-85.42*****
			(15.95)	(6.48)			(15.52)	(6.23)
			2010				*2011*	
(1)	-23.25**	2.06	45.90***	119.77***	-21.49*	6.83	43.26***	115.18***
	(11.23)	(7.94)	(6.57)	(5.12)	(12.27)	(8.30)	(6.58)	(5.46)
(2)	-	-103.77***	-95.52***	119.77***	-	-99.52***	-99.53***	115.18***
		(10.52)	(8.10)	(5.12)		(10.89)	(8.45)	(5.46)
(3)	-	**-103.37*****	**-95.20*****	-75.31***	-	**-99.21*****	**-99.35*****	-79.97***
		(10.51)	(8.10)	(6.32)		(10.88)	(8.45)	(6.39)
(4)	-	-103.40***	-95.26***	-75.07***	-	-99.24***	-99.40***	-79.75***
		(10.51)	(8.10)	(6.32)		(10.88)	(8.45)	(6.39)
(5)	-	-	-96.16***	**-75.09*****	-	-	-100.29***	**-79.73*****
			(15.40)	(6.32)			(15.46)	(6.39)
			2012				*2013*	
(1)	-77.81***	-14.54	22.24**	94.55***	-40.27***	-27.32***	3.53	59.83***
	(18.83)	(11.96)	(9.22)	(7.00)	(14.18)	(10.21)	(8.76)	(6.66)
(2)	-	-120.84***	-119.69***	94.55***	-	-132.81***	-136.88***	59.83***
		(15.10)	(11.21)	(7.00)		(12.35)	(9.80)	(6.66)
(3)	-	**-120.92*****	**-119.47*****	-99.88***	-	**-132.64*****	**-136.71*****	-133.72***
		(15.12)	(11.21)	(8.03)		(12.35)	(9.79)	(7.38)
(4)	-	-120.94***	-119.47***	-99.51***	-	-132.67***	-136.74***	-133.21***
		(15.12)	(11.21)	(8.03)		(12.36)	(9.79)	(7.39)
(5)	-	-	-120.56***	**-99.51*****	-	-	-137.74***	**-133.24*****
			(17.21)	(8.03)			(16.46)	(7.39)

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. The dependent variable y_{it} is the same as in Table 7. Ordinary least squares estimations are performed for four age bandwidths and five functional forms. Estimations in bold indicate the best specification. For a two and three-year age bandwidth, the F-test, testing for the best functional form, showed the linear model with an interaction to be the best model, with p-values of 0.248 and 0.080 respectively. For a five-year age bandwidth, the quadratic model with an interaction, with a p-value of 0.059. Model (1) does not include any age specification. Model (2) is a linear specification, (3) is linear with interactions, (4) and (5) are quadratic specifications without and with interactions, respectively. Cubic, quartic and quintic models were also estimated but they did not improve the specification. Specifications that include an interaction allow for a different slope before and after the discontinuity.

A.7. Results of year-by-year estimation for three age bandwidths and five functional forms (FE)

	16-20 year olds	15-21 year olds	13-23 year olds	16-20 year olds	15-21 year olds	13-23 year olds
		2006			*2007*	
(1)	-39.40**	-41.99***	-53.53***	-49.22***	-56.32***	-62.84***
	(18.49)	(11.22)	(7.22)	(15.95)	(10.03)	(6.84)
(2)	-39.40**	-41.98***	-53.51***	-49.20***	-56.30***	-62.82***
	(18.49)	(11.22)	(7.22)	(15.95)	(10.03)	(6.84)
(3)	**-70.62*** **	**-72.25*** **	-86.92***	**-68.23*** **	**-78.55*** **	-89.92***
	(20.73)	(13.28)	(9.78)	**(17.02)**	(11.19)	(8.24)
(4)	-70.62***	-69.76***	-71.67***	-68.23***	-76.60***	-77.37***
	(20.73)	(13.31)	(9.83)	(17.02)	(11.18)	(8.18)
(5)	-	-70.42***	**-72.83*** **	-	-77.49***	**-79.68*** **
		(20.09)	(12.61)		(18.24)	(10.90)
		2008			*2009*	
(1)	-67.74***	-70.16***	-68.74***	-81.86***	-73.85***	-77.61***
	(13.84)	(9.31)	(6.60)	(12.61)	(8.52)	(6.17)
(2)	-67.72***	-70.14***	-68.72***	-81.86***	-73.86***	-77.62***
	(13.84)	(9.31)	(6.60)	(12.84)	(8.52)	(6.17)
(3)	**-74.84*** **	**-83.36*** **	-86.44***	**-83.06*** **	**-79.36*** **	-84.43***
	(14.11)	(9.67)	(6.98)	**(12.84)**	(8.44)	(6.06)
(4)	-74.84***	-82.41***	-78.25***	-83.06***	-78.91***	-81.32***
	(14.11)	(9.67)	(6.95)	(12.84)	(8.43)	(6.02)
(5)	-	-82.28***	**-79.02*** **	-	-78.96***	**-80.19*** **
		(17.14)	(9.61)		(16.64)	(8.86)
		2010			*2011*	
(1)	-88.22***	-82.54***	-83.69***	-92.88***	-104.59***	-99.71***
	(13.63)	(8.89)	(6.10)	(14.29)	(9.36)	(6.23)
(2)	-88.24***	-82.57***	-83.71***	-92.89***	-104.59***	-99.72***
	(13.62)	(8.89)	(6.10)	(14.29)	(9.36)	(6.23)
(3)	**-89.08*** **	**-79.23*** **	-78.71***	**-87.23*** **	**-92.60*** **	-83.47***
	(13.60)	(9.03)	(6.33)	**(14.62)**	(10.09)	(7.27)
(4)	-89.08***	-79.53***	-81.08***	-87.23***	-93.48***	-91.04***
	(13.60)	(9.03)	(6.37)	(14.62)	(10.13)	(7.43)
(5)	-	-79.25***	**-77.70*** **	-	-93.28***	**-85.64*** **
		(16.87)	(9.35)		(18.03)	(10.76)
		2012			*2013*	
(1)	-151.72***	-146.39***	-130.25***	-186.49***	-183.12***	-164.98***
	(23.52)	(14.00)	(8.73)	(26.17)	(13.93)	(8.48)
(2)	-151.74***	-146.38***	-130.26***	-186.51***	-183.12***	-165.00***
	(23.52)	(14.00)	(8.73)	(26.17)	(13.93)	(8.48)
(3)	**-133.62*** **	**-124.74*** **	-104.12***	**-155.88*** **	**-153.29*** **	-132.09***
	(24.23)	(14.91)	(10.15)	**(27.77)**	(15.55)	(10.94)
(4)	-133.62***	-126.58***	-116.25***	-155.88***	-155.69***	-147.08***
	(24.23)	(15.07)	(10.50)	(27.77)	(15.76)	(11.33)
(5)	-	-125.58***	**-109.14*** **	-	-154.74***	**-140.58*** **
		(22.13)	(13.44)		(22.91)	(13.93)

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. The dependent variable y_{it} is the same as in Table 7. Fixed effects estimations are performed for three age bandwidths and five functional forms (a one year bandwidth could not be estimated, using fixed effects). Estimations in bold indicate the best specification. For a two and three-year age bandwidth, the F-test, testing for the best functional form, showed the linear model with an interaction to be the best model, with p-values of 0.692 and 0.824 respectively. For a five-year age bandwidth, the quadratic model with an interaction, with a p-value of 0.859. Model (1) does not include any age specification. Model (2) is a linear specification, (3) is linear with interactions, (4) and (5) are quadratic specifications without and with interactions, respectively. Cubic, quartic and quintic models were also estimated but they did not improve the specification. Specifications that include an interaction allow for a different slope before and after the discontinuity.

A.8. Estimated coefficients γ and δ for multiple specifications

	Estimated γ (rebate)		Estimated δ (deductible)		P-value of test γ=δ		Mean expenditure	Observations
	OLS	FE	OLS	FE	OLS	FE		
Baseline	-0.17***	-0.27***	-0.40***	-0.45***	0.000	0.000	568	6,678,669
	(0.03)	(0.03)	(0.03)	(0.03)				
Excluding movers	-0.16***	-0.27***	-0.37***	-0.44***	0.000	0.000	565	6,118,215
	(0.03)	(0.04)	(0.03)	(0.04)				
Including persons who have used	-0.23***	-0.26***	-0.32***	-0.48***	0.002	0.000	628	7,800,808
mental healthcare	(0.03)	(0.04)	(0.03)	(0.03)				
Including persons who choose	-0.16***	-0.26***	-0.50***	-0.44***	0.000	0.000	526	8,003,258
a voluntary deductible (at least once)	(0.03)	(0.03)	(0.03)	(0.03)				
Excluding 17 year olds	-0.11***	-0.23***	-0.33***	-0.40***	0.000	0.000	563	5,590,653
	(0.04)	(0.04)	(0.04)	(0.05)				

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation. The dependent variable y_{it} is the same as in Table 5. The Table shows the estimated coefficients of γ and δ. The estimated coefficients of the other variables are available upon request.

A.9. Share of individuals no longer living in parental home and per education level

Average share of individuals (%)	2006-2007	2008-2013
Below 18 years old:		
In secondary education	0.73	0.74
In vocational education	0.24	0.23
At a university of applied sciences	0.02	0.02
At a university	0.00	0.00
Above 18 years old:		
In secondary education	0.01	0.01
In vocational education	0.42	0.39
At a university of applied sciences	0.37	0.38
At a university	0.19	0.21

Note: These data were taken from StatLine, the open data source of Statistics Netherlands, on August 16, 2018. The shares are based on the entire Dutch population. We computed the average values for persons above and below 18 years old and the two time period ourselves. The data reflect the number of individuals on January 1st of each year.

A.10. Results year-by-year estimations including dental costs

	OLS	FE
τ_t (rebate)		
2006	-160.18***	-181.19***
	(8.86)	(13.31)
2007	-179.16***	-195.33***
	(9.10)	(11.22)
τ_t (deductible)		
2008	-92.31***	-96.30***
	(9.05)	(9.70)
2009	-103.75***	-85.32***
	(8.28)	(8.47)
2010	-86.63***	-67.28***
	(8.12)	(9.06)
2011	-234.36***	-225.82***
	(8.47)	(10.11)
2012	-258.64***	-264.73***
	(11.23)	(14.93)
2013	-273.41***	-292.95***
	(9.81)	(15.58)
Age centered	Yes	Yes
Age centered * male	Yes	Yes
Age centered * treatment	Yes	Yes
Age centered * treatment * male	Yes	Yes
Year dummies	Yes	Yes
Individual fixed effects	No	Yes
Constant	Yes	Yes
Observations	6,678,669	6,678,669
R^2	0.001	0.691

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation. The dependent variable y_{it} is healthcare expenditures with cost-sharing *including* dental expenditure. Other coefficients are available upon request.

A.11. Results scaled estimations with a correction for a general price effect

	OLS	FE
γ (rebate)	-0.13***	-0.26***
	(0.03)	(0.04)
δ (deductible)	-0.41***	-0.43***
	(0.03)	(0.03)
Age centered	Yes	Yes
Age centered * male	Yes	Yes
Age centered * treatment	Yes	Yes
Age centered * treatment * male	Yes	Yes
Year dummies	Yes	Yes
Individual fixed effects	No	Yes
Constant	Yes	Yes
Observations	6,678,669	6,678,669
R^2	0.000	0.695
P-value of test γ=δ	0.000	0.000

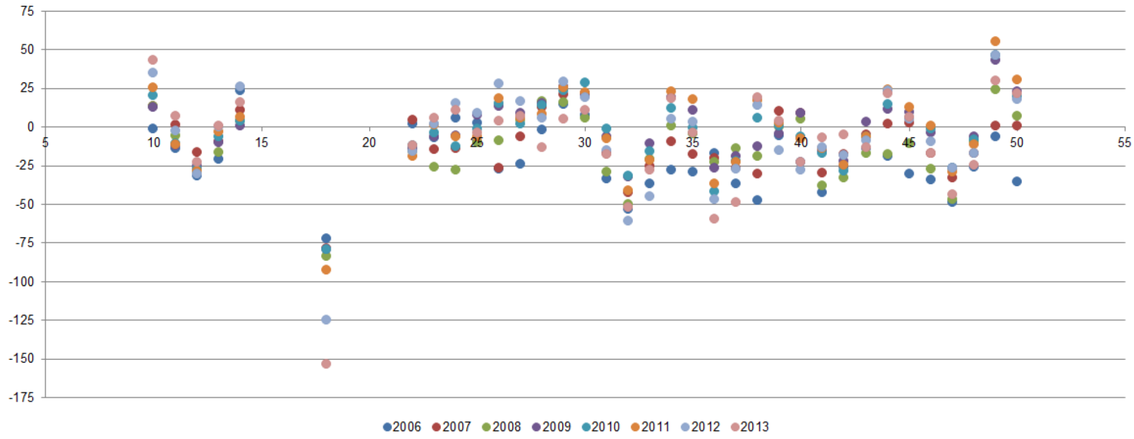
Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation. The dependent variable y_{it} is the same as in Table 5 but now corrected for prices. Other coefficients are available upon request.

A.12. Results of year-by-year estimation for a fictional discontinuity at 24

	OLS	FE
τ_t (rebate)		
2006	16.4*	5.9
	(8.7)	(14.5)
2007	7.6	-13.6
	(9.4)	(12.6)
τ_t (deductible)		
2008	-17.8**	-28.0***
	(8.4)	(10.2)
2009	1.8	-5.6
	(8.1)	(9.5)
2010	-8.7	-12.3
	(8.3)	(10.0)
2011	12.0	15.1
	(10.3)	(14.3)
2012	11.3	12.1
	(10.3)	(14.3)
2013	-0.7	10.6
	(10.0)	(16.2)
Age centered	Yes	Yes
Age centered * male	Yes	Yes
Age centered * treatment	Yes	Yes
Age centered * treatment * male	Yes	Yes
Year dummies	Yes	Yes
Individual fixed effects	No	Yes
Constant	Yes	Yes
Observations	6,549,271	6,549,271
R^2	0.003	0.659

Notes: Standard errors are reported between parentheses and clustered at the individual level. *, **, and *** indicate significance based on a two-sided test at the .10, .05, and .01 levels, respectively. OLS denotes ordinary least squares estimation and FE individual fixed effects estimation. The analyses are performed for individuals aged 21 to 27. τ_t is a fictional discontinuity placed at 24 years old. The dependent variable y_{it} is the same as in Table 7.

A.13. Estimated treatment effects τ_t for placebo discontinuities at ages 10 - 50



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